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By

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ABSTRACT

BENEFIT-COST ANALYSIS OF AGROFORESTRY PRACTICES TUMPANGSARI AND INMAS TUMPANGSARI IN CEPU FOREST DISTRICT, JAVA, INDONESIA

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The pressures of a predominantly agricultural population on forest lands in Java, Indonesia continue to be tremendous. Extensive deforestation has been the consequence of increasing agricultural activities resulting from expanding demographic and economic pressures. One solution implemented by the Forest Service under Perhutani (the state forestry corporation) is the use of agroforestry in forest plantations.

The purpose of this study was to conduct an analysis of whether the agroforestry projects (Tumpangsari and Inmas Tumpangsari) as implemented by Perhutani are economically beneficial to both Perhutani and the farmers. Benefit cost analysis was used to determine the economic feasibility of the projects. The criterion used to determine the feasibility was Net Present Value. The project is considered economically beneficial if the NPV of that project is positive and a project is not economically beneficial if the NPV is negative. In order to find the NPV of agroforestry models, the discounted costs and benefits of the projects are subtracted by the costs and benefits of without project.

BCA indicates that the Tumpangsari model with corn as

the crop planted by farmers, is not economically beneficial to the farmers because of low yields. However, with the use of fertilizers, the Inmas Tumpangsari model is economically beneficial to the farmers because of the increased yield. For Perhutani, both the Tumpangsari and Inmas Tumpangsari models are economically beneficial. This is due to the decrease of labor costs for planting and managing the forest plantations. Therefore, this research implies that any effort to increase agricultural yields is key if agroforestry projects are to be economically beneficial for the farmers.

DEDICATION

To my wife Martha Loise Magdalena, and our children

David, Sandra and Jonathan

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INTRODUCTION

Statement of the problem

The pressures of a predominantly agricultural population on forest lands in Java, Indonesia continue to be tremendous. Extensive deforestation has been the consequence of increasing agricultural activities resulting from expanding demographic and economic pressures. Attempts to meet demands for increased food production have resulted in the depletion of forest lands at alarming rates.

A finite land resource in Java coupled with an increase of the labor force in rural areas has resulted in an increased number of the landless farmers. This situation combined with the lack of employment opportunities in non-agricultural sectors, on an island comprising less than seven percent of Indonesia's total land area, but holding about 70 percent of the nations populace, has further exacerbated the pressure on forest lands (Hadi, 1982). Related factors include widescale cutting for construction timbers and secondly, the felling of trees to provide for the fuel wood needs of the rural poor (Dick, 1980).

Background of the study

The Indonesian government's formulation of goals and policies regarding a variety of pressing national concerns are set-forth in a series of five-year national development plans known as the REPELITA. Some concerns addressed specifically by the plans focus on the island of Java and include the interrelated issues of overpopulation, limited available agricultural land, and landless farmers.

National goals and purposes regarding these interrelated concerns are addressed and policies are implemented through programs of various national agencies. Major programs dealing with transmigration of excess population and family planning have been developed through individual agencies. Although not receiving major emphasis, the support for agroforestry practices has also been initiated.

Constitutionally, forestry development is based on article 33 of the Indonesian Constitution (Departemen Penerangan, 1960):

> ...Branches of production which are important for the State and which affect the life of most people shall be controlled by the State. Land and Water and the natural riches contained therein shall be controlled by the State and should be made of use for the people.

Based on this article, all forests in Indonesia are controlled by the government. The main objective of forestry

development as stated in the General Forestry Plan (Ministry of Forestry, 1986) is:

> ...maximum and sustained yield, directly or indirectly, for the sake of the people.

However, this objective has a potential contradictory goal. It is contradictory to expect a maximum yield from the forest, and on the other hand to fully consider the interest of the people.

There are several programs in existence by which the government is attempting to alleviate the pressure on forests lands in its effort to solve large national problems. Transmigration, family planning, and increased food production are the planks of the Indonesian government's population policy. The main objective of the family planning program is to reduce the population growth of the country by reducing the number of children in the family. This program can be categorized as a long-term program. Conversely, the transmigration program deals with migration of people from densely settled areas in Java to sparsely populated areas in the outer archipelago. This program is categorized as a short-term program. However, the transmigration program has not met expectations and may not. The main problem is that it is difficult to find suitable areas for transmigration programs, especially due to a general lack of soil fertility and accessibility (Hutabarat, 1985). In the forestry sector, the government has implemented programs using agroforestry

practices to lessen detrimental pressures on forest lands.

The geographic juxtaposition of forest lands and the burgeoning agricultural communities surrounding them continue to have acute effects upon the forest. Although forest lands are unevenly distributed throughout Java, there are approximately 6,100 villages with a population of 25 million surrounding the forest lands (Bratamihardja, 1988). Population density on Java is estimated to be 755 person per square kilometer and increasing yearly at a rate of about 2 percent. Available land for cultivation is both a scarce commodity and a very valuable one. Only marginal and forest lands remain uncultivated. Aggravating the situation further is the conversion of existing agricultural land to housing, industries, and highways (Hardjono, 1977).

The landless poor are almost exclusively dependent upon the forests as a source of free fuel wood and animal fodder. Additionally, they cut down trees or strip them of bark to obtain materials for the building of rudimentary shacks and furniture. Measures to protect forest lands from disturbances by surrounding populace are usually repressive in nature and have proven unsuccessful. Punitive measures towards peasants encroaching on forest lands often include monetary fines which ultimately worsen the peasants' economic condition without putting a halt to illegal activities (Atmosoedaryo and Banyard, 1978).

During the colonial era, forest management in Java was

focused on maximizing profit from the forest without considering the interests of the people. Now, there exists the realization that the benefits derived from the forests need to be used not only for general national development, but also for the benefit of local people. This is in accordance with the international movement in forest development, and was reinforced through holding the Forestry World Congress VIII in Jakarta with the theme "Forests for People". Indonesia, as the host country of the Congress has a responsibility to show its support and interest in developing its forests for the benefit of its local people. One program related to that goal centers upon agroforestry, a practice whereby local people are allowed to plant their own selected agricultural crops on forest lands while being required to plant trees in return.

Agroforestry as an alternative solution

The responsibility of managing forest lands in Java largely belongs to Perhutani, the state forestry corporation. The types and sizes of forest on Java under the responsibility of Perhutani are (Perum Perhutani, 1989):

(1) Productive forest : 1,934,218 hectares
(2) Non-Productive forest : 37,904 hectares
(3) Protective forest : 810,322 hectares

The problems of encroaching peasantry on forest lands and subsequent disturbances to the forest environment

constitute the main issues faced by Perhutani at this time. As the state forestry corporation of Indonesia, Perhutani, is incorporated administratively under the Ministry of Forestry. It is a self-supporting corporation independent of government loans and subsidies and whose existence dates from the Dutch colonial era, but has continued in its uninterrupted capacity of managing the lucrative teak forest plantations.

The protection of forest lands from destructive measures is very important. Forests are not only a source of timber, but they also preserve soil and protect downstream environments from erosion; level the supply of water for agriculture from irregular rainfall; and prevent water reservoirs and irrigation systems from sedimentation. They also provide a habitat for a diverse genetic pool, and influence local and regional climates substantially (Dasgupta, 1982).

Possible alternative solutions to the constant problems of encroachment on teak forest lands have been implemented by Perhutani. One of these solutions is to present people living around the forest opportunities to make some income from the forest. The economic opportunities include using the local populace as labor to plant the teak forests and to allow their utilization of the ground surrounding the trees for planting agricultural crops. Perhutani has three types of management models in teak forest plantation management.

They are:

1. Tumpangsari model: Peasants have opportunities to plant selected agricultural crops (as determined by Perhutani) in the teak forest plantations, while being employed to plant teak trees. This model utilizes agroforestry as a management practice.
2. Inmas Tumpangsari model: The primary difference between this model and the previously mentioned one is that Perhutani provides peasants with superior agricultural crop seed varieties; it also provides for use of fertilizers and pesticides to increase agricultural crop output.
3. Conventional model: Perhutani hires local farmers to plant teak trees without allowing them to plant any type of agricultural crops around the trees.

Purpose and Objectives

Agroforestry practices such as Tumpangsari have already been in existence on Java for over a century, and did focus on maximizing the interests of the colonial forest service. Even today, long after independence from the Dutch, it is still questionable whether or not the objectives employed in both Tumpangsari and Inmas Tumpangsari models have shifted

to include the interests of the local people.

Even though Perhutani is a government agency, it also functions as a corporation and seeks profit in order to continue and develop. Therefore any activity under its jurisdiction (e.g., plantation establishment) has to be profit-oriented. As a result, any program in Perhutani needs to be economically beneficial to the agency.

In determining whether agroforestry is an economically efficient tool for Perhutani and/or for the farmers, economic evaluations need to be carried out. One of the methods commonly used in economic evaluation is benefit-cost analysis. An inherent decision rule used in this analysis technique is that any project resulting in a positive net present value (the present net benefits of the project exceeds present net costs) is considered economically beneficial.

Study objectives.

The objectives of the study are:

1. To determine if the Tumpangsari program is an economically efficient tool for Perhutani to implement.
2. To conduct an analysis as to whether the inmas Tumpangsari program is an economically efficient tool for Perhutani.

3. To conduct an analysis as to whether the Tumpangsari program as implemented by Perhutani is economically beneficial to the farmers.
4. To conduct an analysis of whether Inmas Tumpangsari is economically beneficial to the farmers.

Research hypotheses.

The hypotheses to be tested in this study are:

1. Null hypothesis: Tumpangsari is economically beneficial to the farmers.

   Alternative hypothesis: Tumpangsari is not economically beneficial to the farmers.

2. Null hypothesis: Inmas Tumpangsari is economically beneficial to the farmers.

   Alternative hypothesis: Inmas Tumpangsari is not economically beneficial to the farmers.

3. Null hypothesis: Tumpangsari is an economically efficient tool for Perhutani.

   Alternative hypothesis: Tumpangsari is not an economically efficient tool for Perhutani.

4. Null hypothesis: Inmas Tumpangsari is an economically efficient tool for Perhutani

Alternative hypothesis: Inmas Tumpangsari is not an economically efficient tool for Perhutani.

Analysis model

Benefit-cost analysis is the economic evaluation framework used in this study. A hypothesis will be accepted or rejected based on the net present value. If net present value is positive, the project is considered economically beneficial. The net present value model used is:

NPV= PVB - PVC, where:

NPV= net present value

PVB= present value benefits

PVC= present value of costs

$$PVB = B_0 + \frac{B_1}{(1+r)} + \frac{B_2}{(1+r)^2} + \ldots + \frac{B_n}{(1+r)^n}$$

$$PVC = C_0 + \frac{C_1}{(1+r)} + \frac{C_2}{(1+r)^2} + \ldots + \frac{C_n}{(1+r)^n}$$

B_0 = benefits at year 0

B_1 = benefits at year 1

B_n = benefits at year n

C_0 = costs at year 0

C_1 = costs at year 1

C_n = costs at year n

r = discount rate. For Perhutani, it is based on the real interest rate used by the Bank of Indonesia to finance government projects (Bank of Indonesia, 1989). For farmers, it is based on the real interest rate when farmers save their own money in their banks.

Organization of the dissertation

The dissertation is divided into six chapters. Chapter I presents the problem statement, background of the study, discussion of agroforestry as an alternative solution, the objectives of the study and research hypotheses.

A literature review of agroforestry and benefit-cost analysis is presented in Chapter II, while characteristics of the study area are presented in Chapter III. Chapter IV presents the research method used in this study including the software used, valuation of benefits and costs and the discount rate. Results and discussion including benefits and costs of Non-Tumpangsari (without project model), Tumpangsari and Inmas Tumpangsari (with project models) are presented in Chapter V.

The conclusion and recommendations are presented in Chapter VI. Finally, references and appendices are placed at the end of this dissertation.

CHAPTER II

LITERATURE REVIEW

Agroforestry

Description

Agroforestry is an age-old land use practice that has once again become popular and is being benefitted by modern concepts and procedures (Wiersum, 1984). As a result boundaries of the concept of what constitutes agroforestry continue to evolve. Several definitions, however, are described in the literature and appear most relevant and applicable to Indonesia.

King and Chandler in King (1979) define agroforestry as:

> "A sustainable land management system which increases the overall yield of the land, combines the production of crops (including tree crops) and forest plants and/or animals simultaneously or sequentially, on the same unit of land, and applies management practices that are compatible with the cultural practices of the local population."

Another definition of agroforestry proposed by Atmosoedaryo and Wijayakusumah (1979) states that:

> "...the term agroforestry denotes all activities in land utilization where production of food goes hand-in-hand with the production of wood in the

widest sense. Thus food production from forest areas means not only the production of staple foods of the communities near it but also the production of fodder for cattle, tubers as supplements to staple food, bee forage for honey production and medicinal plants to maintain health. It also means the production of fish from ponds and rivers."

Based on the specific components involved, agroforestry can be categorized into several groups (King, 1979):

1. Agro-silvicultural systems: the specific use of land for the concurrent production of agricultural crops (including tree crops) and forest crops.
2. Silvo-pastoral systems: systems for managing land by which forests are managed for the production of wood and for raising domesticated animals.
3. Agro-silvo-pastoral systems: both agricultural and forest crops are concurrently produced along with the raising of domesticated animals. This system of land management is, in effect, a combination of agro-silviculture and the silvo-pastoral system.
4. Multipurpose forest tree production systems: forest tree species are regenerated and managed not only for wood production, but also for their leaves and/or fruit which is suitable for food and/or fodder.

For centuries and under varying site conditions many types of agroforestry have been applied by people around the world. Maydell (1979) states that almost all ethnic groups in the Sahel, North Africa, have applied agroforestry practices for more than a century. However, relevant techniques from the past, when adapted to current conditions, may need to be improved in order to meet present and future demands. Agroforestry also has been used by indigenous populations for centuries in Central and South America (Budowski, 1979).

Agroforestry in Indonesia

Manmade teak plantations in Java were started in 1796, during the Dutch colonial period. At that time, the procedures included the spreading of seeds on land, which had been specifically prepared. Selected seedlings from this initial site would later be used on the plantations. In 1830, the colonial government introduced "cultuurstelsel", whereby the government increased the land area reserved for commodity crops such as rubber (*Hevea brasiliensis*), coffee (*Coffee arabica*) and oil palm (*Elaeis guineensis*) through the use of force. Farmers had to "surrender" their agricultural lands in order that they be turned into cash-crop plantations. An outcome of this regulation was that farmers entered forests to plant their food-crops. This trend inspired the colonial forest service to use farmers as laborers on teak plantations. At this point, some teak plantation methods were created such

as "komplangan", "voorbow" and tumpangsari (UGM, 1990).

"Komplangan" is a plantation system whereby farmers were allowed to plant their own agricultural crops on forest lands, and at the same time they were required to plant teak on a different site. The distance between those two sites depended on the availability of land. Farmers usually obtained land with more fertile soil for their agricultural crops than they did for the teak. Critics of this system argued that because farmers had to work in two sites, their attention would be primarily focused on their own agricultural crops.

In the "Voorbow" system, the farmers were allowed to plant their own agricultural crops one year prior to planting teak on the same site. Criticism of this system was the same as that of the "komplangan" system.

Tumpangsari is an agro-silvicultural based system and the most popular for establishment of forest plantations in Java. It is actually the Indonesian name for the term 'taungya'. Taungya (taung=hill, ya=cultivated plot) is a Burmese word emanating from a practice started in Burma in the 19th century, as a modification of the undesirable practice of shifting cultivation. The system was introduced into Indonesia in 1875, by Buurman, a forest district administrator of Pemalang, Central Java (Kartasubrata, 1979). At present, the agroforestry program in Indonesia exists only on Java, and is run by Perhutani. The program is known as the "prosperity approach" with the objective being to improve

the standard of living of the community on the outskirts of the forest, in such a way that the community becomes aware that their development is closely related to the welfare of the forest itself (Atmosoedaryo and Banyard, 1978). All of approximately 3 million hectares of forest in Java and also the island of Madura are managed by Perhutani. Approximately one million hectares of the 3 million are covered in teak wood. The establishment of teak plantations was largely accomplished utilizing the Tumpangsari method.

In 1974, Perhutani introduced Inmas Tumpangsari or "mass intensification" of taungya. Inmas Tumpangsari was introduced to increase yields from the Tumpangsari system and improve the subsistence norm of the farmers. It includes:

1) Use of superior dry land rice varieties
2) Better soil tillage
3) Use of fertilizers
4) Control of pests and diseases
5) Correct adjustment of planting time to rainfall.

The rate of teak reforestation under Tumpangsari and Inmas Tumpangsari is approximately 40,000 hectares annually, which on the average, will provide employment for 160,000 farmers (Atmosoedaryo and Banyard, 1978; and Kartasubrata, 1979).

In general, the main objectives of the application of agroforestry practices are to (Srivastava, 1986):

(1) Limit or reduce the pressure on protected and productive forests from the surrounding human population in their constant search for fuel wood, timber, and animal fodder.

(2) Increase the productive level of forests and agricultural outputs per unit area and establish a time frame to meet future demands.

(3) Provide adequate employment and other opportunities for people living in surrounding forests in such a way that a better symbiotic relationship is created for both the forest and the populace dependent upon it.

(4) Maintain an ecological balance as a result of the presence of greater numbers of trees on farm and village lands.

In the application of Tumpangsari in Java, additional objectives are as follows (Becking in Hout, 1983):

(1) Decrease the establishment cost of a plantation.

(2) Create a situation whereby farmers obtain additional income from agriculture during the juvenile stages of tree stands.

(3) Gain better maintenance of young tree stands.

(4) Reclaim waste lands by means of agricultural crops before stand establishment.

(5) Meet the local shortage of good agricultural land.

Studies of Agroforestry in Indonesia

Even though agroforestry was introduced in Indonesia a century ago, very little research has been conducted on this practice. Most of the studies conducted have dealt with biological or silvicultural aspects, especially in regards to improving the physical output of Tumpangsari.

Satjapradja (1982) states that by practicing agroforestry, some benefits can be gained, such as the rehabilitation of degraded forest due to heavy exploitation, conservation of soil and water resources, fulfillment of the wood requirements and increases in the income of the people living near the forest. However, there is no explanation of how much income has actually increased by and the subsequent breakdown of costs to farmers. Based on the study of the Inmas Tumpangsari project in Cepu district, Sulthoni in Kartasubrata (1979) calculated that after subtraction of investment for seed, fertilizers and insecticides, the profit gained by farmers is about Rp. 9000 or U.S.$ 22.00 (based on foreign exchange of 1 U.S.$= Rp. 415.00 in 1979; however in 1989 the foreign exchange was that of 1 U.S.$= Rp. 1828.00) from 0.25 hectare of land during one harvesting period under Inmas Tumpangsari. However, there is no explanation of labor costs for various activities, such as site preparation, seed preparation, and planting.

Another study conducted by Wirjodarmodjo and Bratamihardja (1983) on a pine plantation (Pinus merkusii) in

Pekalongan District, found that by using Tumpangsari, Perhutani gained a net benefit of Rp. 205 and farmers gained a net benefit of Rp. 658,200 (using a 12 % discount rate).

Some of the studies dealt with the economic aspects of agroforestry. Palte (1981) describes some major socio-economic factors influencing the choices between agroforestry and other agricultural land use systems in peasant economies. Hout (1983) studied the effects of wider initial spacing of teak on income and income distribution in this system. He compared the effect of 3 x 1 m spacing and 6 x 1 m spacing on the output of traditional Tumpangsari. He concluded that 6 x 1 spacing gave more net farm income to the farmers compared to 3 x 1 m spacing. He focused the study on traditional Tumpangsari (without the use of fertilizers and pesticides). However, he did not mention the effect of site class to the yield, nor did he mention location of the project, but he used the island of Java as a unit of analysis.

Benefit-Cost Analysis

Foundation and history of BCA

Measurement of the net economic benefits from changes in resource allocation is referred to the term benefit-cost analysis (BCA). BCA was developed in the United States in response to a legal requirement imposed in 1936 (U.S. Flood Control Act of 1936) on water-resource projects of the federal government. For federal water projects in which public funds

are invested to provide a stream of public and private benefits, the United States has required formal economic evaluation for more than four decades. This evaluation is to take the form of benefit-cost analysis and is to be performed in accordance with a set of guidelines that have been refined over the years. As a precondition for project authorization, benefit-cost calculations must be performed and displayed and must demonstrate that the projected benefits from implementation of the proposed project exceed the projected costs. The use of BCA soon spread to other countries, especially to the United Kingdom, and to other sectors including highway transportation, urban planning, and environmental quality management. BCA was broadened in the 1960's to accommodate equity-income distribution issues and situations of unemployment and underemployment. In the 1970's, techniques were developed to deal with income distribution, unemployment, and foreign exchange issues in investment planning in developing countries (Just, Hueth and Schmitz, 1982).

Currently the World Bank provides guidelines for economic evaluation of agricultural projects in developing countries (Gittinger, 1982). These guidelines have become the standard text for those planning agricultural projects and teaching project analysis. This is the case in Indonesia as well.

Schmid (1989) pointed out that BCA is much like a consumer information system. This system neither tells

consumers what to do nor tells them what they should want. However, it does tell them which products will perform in selected ways and at what costs. This information helps consumers in making wise decisions. The importance of an information system for decision-making processes, and how an information system is influenced by data systems has been illustrated graphically by Chappelle (1971). These interactions are shown in Figure 1.

The importance of the information system is crucial if we consider that most resource-use, management, and conservation decision problems are perceived, and must be solved, in a complex context such as (Just et al., 1982):

1. The resources of immediate concern are components of highly complex systems. The earth's resource system is a vast, complex, dynamic, interactive system.
2. Most alternative courses of action have consequences that we perceive from our limited base of knowledge as both beneficial and adverse. What is seen as beneficial to one individual may be seen as adverse by another.
3. Any decision would influence numerous people, whose well-being will be affected differently and whose power to participate in decision-making will vary widely.

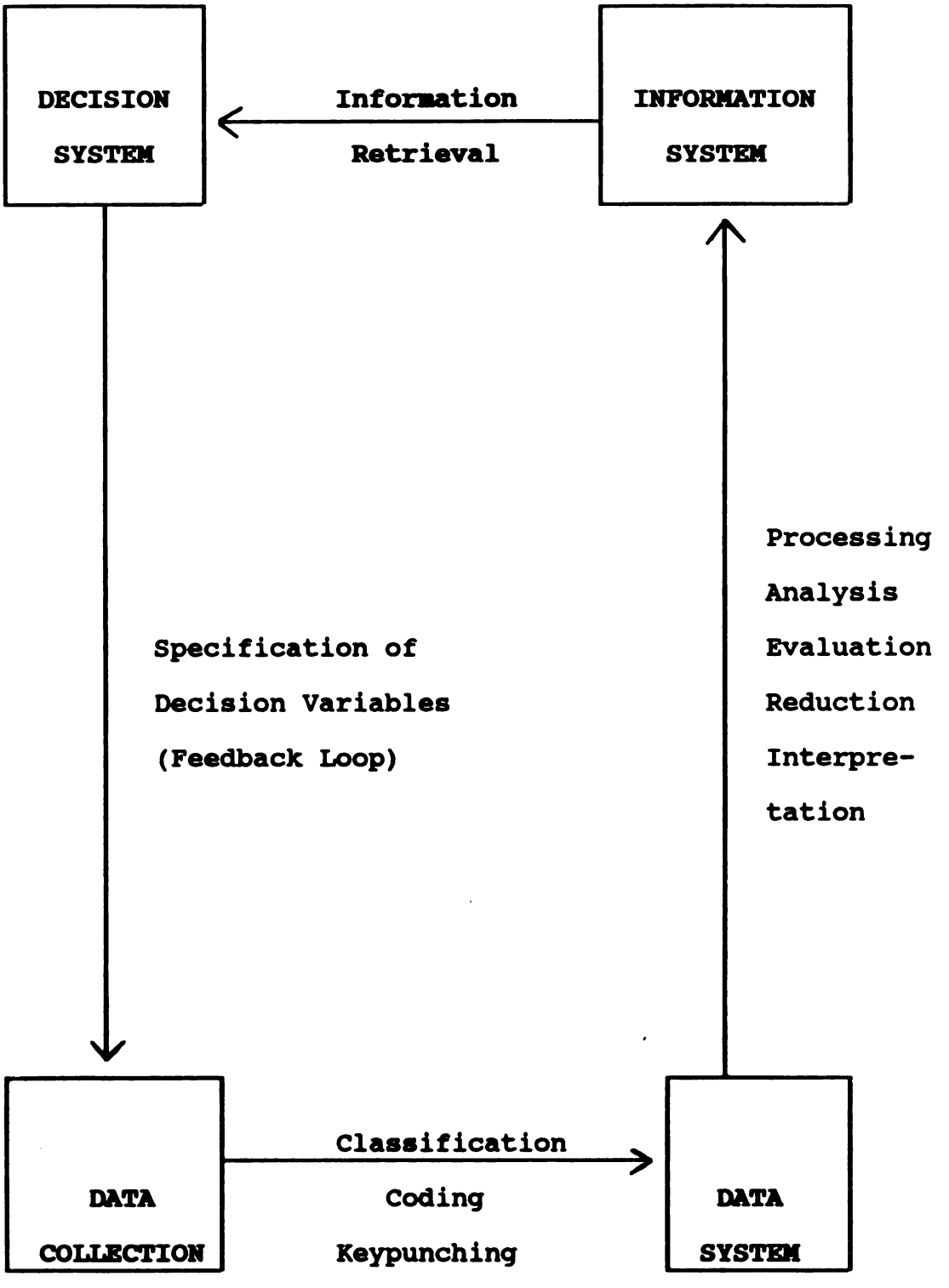


Figure 1. Interrelationships between Decision, Information and Data Systems (Source: Chappelle, 1971).

4. In any society, resource-related decisions are made within a complex institutional structure that assigns legal rights and liabilities and thus establishes the structure of incentives.

The BCA model is built on the welfare foundations of economics and seeks to quantify and present the net social benefit or cost from the society's view rather than that of the individual or the enterprise. In contrast, a financial appraisal of an investment gives a comprehensive picture of economic advantages and disadvantages to the individual or to the enterprise, however, it does not take into account effects of such a project on the community, which the BCA model does (Reddy, 1979).

In a wider sense, welfare economics is the branch of economics which is concerned with the formulation of criteria allowing those who make decisions to distinguish between activities, programs, or projects that would be to the benefit of a larger society and those decisions that would be to its detriment. BCA is applied welfare economics and entails application of the principles of welfare economics to specific and actual activities, programs or projects. An activity enhances a society's welfare if it results in a net increase in the value of the goods and services generated through the economy; the value of which is measured by the willingness of

the people to pay for those goods and services (Anderson, 1977).

The primary objective of benefit-cost analysis was and still is to help in determining both the size of government agency budgets or the number and type of projects that are to be undertaken. The determining criterion used to evaluate the merits of proposed projects was the ratio of benefits to costs or the magnitude of the net present value. The reflection of both benefit and cost values was the recommended basis for comparison of projects. Generally, the higher the ratio or the higher the net present value, the greater the possibility a proposed project had of being favorably received (McKean, 1958).

Characteristics of BCA

According to Libby (1985) and Howe (1971), BCA has some of following characteristics:

(1) With/without project: BCA is used to compare the situation with the project and without project, not before and after the project. This distinction is very important because many changes that might occur in the vicinity of the project should not be attributed to the existence of the project. For example, before the project, certain trends of change might well occur, such as a growth in agriculture yields. A soil fertilization project

may permit yields to increase even more. However, making attributions for increased crop yields as the sole result of project implementation would clearly be a mistake since part of that change towards increased productivity would have occurred without the project anyway. In this study, Inmas Tumpangsari will be compared with Tumpangsari and the Conventional teak plantation model.

(2) Discrete alternatives: BCA is not an optimizing technique, where maximizing profit is the main objective. BCA is concerned with a discrete and limited set of options for achieving some preferred output. In this study, there will not be any evaluation on the best crop combination, even though crop combinations have significant effects on the magnitude of benefits and costs.

(3) Present value: All benefits and costs of the project measured refer to the present value of future returns. Present value refers to the fact that a dollar or rupiah (Indonesian currency) expected in the future is worth less than a dollar or rupiah today.

Most investments produce a flow of returns over time. In order to compare investments with different flows, we need a discount rate to reduce these flows to present values. Those who are

interested in preserving resources for future use often try to implement their preferences by supporting a low interest rate for the evaluation of public resource projects.

(4) Measured in monetary terms: A common denominator is needed to facilitate comparison, therefore shadow valuation is used to value services that are not bought and sold in a market. For example, even though the farmers would not sell the crops yielded from the project, they will be valued based on market price as potentially benefiting the farmers. A shadow value adjustment is used as an attempt to make prices or costs reflect more closely the true social cost or value of an output or input than does the market price. Some areas where shadow adjustments must be considered include (Abouchar, 1985):

a) Labor and wages: Prices of labor should reflect the opportunity costs of its use, that is, the sacrifice involved by putting it to the particular use in question rather than using it in its best alternative elsewhere in the economy.

b) Fiscal distortions, especially sales taxes and tariffs: Sales taxes is an attempt to redistribute income indirectly by taxing the

purchase, rather than the consumer directly. They are not ordinarily construed to represent a resource cost. Therefore, they should be omitted from the calculation of both benefits and costs. This is also true for tariffs.

c) Capital charges and discount rates

(5) Measurement of project inputs: Some bases for measuring shadow values associated with certain outputs of public investment:

a. Willingness to pay: how much would people pay to enjoy the service being examined.

b. Cost avoided

c. Market analogy

d. Alternative cost

Assessment measures and their use

There are three common measures used in benefit-cost analysis:

- The Benefit-Cost Ratio (B/C)
- The Internal Rate of Return (IRR)
- The Net Present Value (NPV).

1. Benefit-Cost Ratio

The BC ratio can be defined as

$$\frac{B}{C} = \frac{\sum_{t=0}^{n} b_t (1+r)^t}{\sum_{t=0}^{n} c_t (1+r)^t}$$

where b_t = the benefits accruing in year t,

c_t = the costs accruing in year t

n = the number of periods

r = discount rate

B/C ratio has often been used as a measure of economic feasibility for government projects in the water resources field. This measure is called a benefit-cost ratio as it shows the ratio between present benefits and present costs (Marty, 1977). A project is acceptable to the government if B/C ratio is equal or higher than one. However, the B/C ratio cannot be used to rank projects because it is a ratio of average benefits to average costs, however, optimizing is done at the margin (Just, et al. 1982).

2. Internal Rate of Return

The internal rate of return is the discount rate that makes net present value equal zero. It can be defined as

$$NPV = \sum_{t=0}^{n} \frac{b_t - c_t}{(1+r)^t} = 0$$

A project is acceptable if its internal rate of return exceeds some specified interest or discount rate. In terms of two mutually exclusive projects, this criterion indicates that the

project with the highest internal rate of return should be selected (Dobbs, Paananen and Rechard, 1971). However, the magnitude of IRR is not a valid criterion to be used to rank projects in a capital-constrained environment. For example, if project A has a slightly higher IRR but much higher initial capital requirements than does project B, it is not certain that A should have higher priority than should B in a capital-constrained environment (Just et al., 1982).

3. Net Present Value

Net Present Value has been the most frequently used of all economic measures of effectiveness (Marty, 1977). Net Present Value can be defined as:

$$NPV = \sum_{t=0}^{n} \frac{b_t - c_t}{(1+r)^t}$$

A project is acceptable to the government if NPV > 0. Similar to the B/C ratio, the magnitude of NPV cannot be used to rank projects, because NPV does not provide direct information about the capital requirements of the projects. If, for example, project A has a higher NPV but much higher initial capital requirements than does project B, it cannot be said that project A should have higher priority than project B in a capital-constrained decision environment (Just et al., 1982). In terms of two mutually exclusive projects, the

project having the higher net present value should be selected.

In this study, the NPV criterion will be used as a decision rule whether a project is economically feasible or not. According to Dobbs et al. (1971) NPV is the one among the three criteria that truly measures the "economic efficiency" of the projects. It means that if net benefits exceed net costs the project is considered economically efficient.

Why BCA ?

Economic criteria are rarely the sole determinants controlling public investment projects. Other factors such as national security or the particular personal or political interests of involved policy makers may play a part in project-related decisions. Yet economic analysis can be a very useful indicator of the potential effect a proposed project may have on prospective clients and can aid in preventing costly errors.

The practice of appraising projects by public agencies or private enterprises to determine the extent to which these projects fulfill a country's economic and social objectives and to the degree these objectives are met efficiently is undertaken through a process known as "project appraisal" (Adler, 1987). Appraisal involves the investigation of six different aspects of a project: economic, technical, institutional, financial, commercial and social.

The basic purpose of the economic appraisal of a project is to measure its economic costs and benefits from the point of view of the country as a whole to determine whether the net benefits are at least as great as those obtainable from other marginal investment opportunities.

Economic evaluation can be divided into two categories: optimization and non-optimization. Optimization compels the analyst to find the optimum solution (e.g., minimum cost or maximum NPV). On the other hand, the second type involves the analyst in determining which of the alternative solutions gives a better overall result, not necessarily the optimum one. An example of these methods is BCA. The optimization methods are based on the technique of mathematical programming. However, these methods are not very popular for the analysis of agroforestry systems because of the rather large amount of data required over a long period of time (Hoekstra, 1985).

The basic technique of economic appraisal is benefit-cost analysis. It consists of adding up all the benefits and costs of the project to society, discounting them to reflect the opportunity cost of the invested funds, and calculating the absolute amount of discounted net benefits expected from the project. Social costs and benefits are intended to represent not financial costs and benefits to any particular individual, but the true opportunity cost of inputs and outputs to an economy, in this case to the government

(Perhutani) and to the farmers (group of individuals). In this study, there will not be any evaluation on income distribution effected by the projects.

The most important consideration in individual project analysis is not which specific type of economic analysis is used, but that some attempts are made to bring rational, objective, and, to the extent possible, quantitative analysis into the decision-making process. Systematic attempts at objective project appraisal will not always prevent poor investments, but if given sufficient weight in the allocation process, they are likely to provide some defense against the largest and most costly investment mistakes. They can also help in choosing among various alternatives for the size, location, components, timing, or technology of a proposed project (The World Bank, 1988). In terms of the potential Pareto-better criterion, a project should be implemented if those who gain can compensate those who lose.

Advantages and disadvantages of BCA

Cohn (1972) discusses advantages and disadvantages of BCA as follows:

Advantages of BCA:

1. The BCA model and its component costs and benefits data does increase the quantity of information available to the decision maker. Even if the decision maker were not to employ the model consistently throughout, the availability of

relevant data would lessen the possibilities of decisions being made on the basis of convention or interest of specific groups.

2. Alternatives are required to undergo comparison in a benefit-cost model. The decision maker is motivated to search for pertinent alternatives in addition to those he or she might have brought from previous project experience.

3. A proper utilization of benefit-cost techniques would determine:
   - whether any program being considered has social/economic worth and
   - whether one program when contrasted to a set of alternatives is superior to any other. The technique can thus be used for the program of most promise (or set of programs).
4. Even if it is not possible to choose the best program through the benefit-cost technique, still those programs which are notably less satisfactory can be pointed out.

5. Although decision-making procedures are not necessarily easier, the employment of the benefit-cost analysis does make them better as

specifications and quantifications regarding relevant costs and benefits can be used to formulate policy on the basis of objective analysis.

Disadvantages of BCA:

1. "Value judgement" is an inescapable component of decision-making when using benefit-cost analysis. The method does not allow for the absolute "best" choice when selecting between sets of alternatives. The number of alternatives selected in benefit-cost analysis are limited, therefore, it is difficult to determine the "best" alternative from the entire set of alternatives.

2. The optimal mix of programs can only be determined to the degree that the analysis used in the benefit-cost framework can satisfy a set of relatively rigid requirements. As all requirements cannot be met during practical application of the framework, an optimal solution cannot be guaranteed.

3. The selection of a benefit-cost framework involves heavy emphasis in the determination of costs and benefits as well as the recruitment of personnel

competent to undertake work in this model.

Since Inmas Tumpangsari is an investment for improving the standard of living of people surrounding the forest (to improve their income), there has been a commensurate concern for evaluating this project in terms of its effectiveness and economic efficiency. Therefore, in order to improve the farmers' standard of living, agroforestry projects should give positive net present value to them.

CHAPTER III.

STUDY AREA

Location of study area

The study area is located in the northeast portion of Central Java Province, Indonesia. Administratively, this area is located in Kabupaten Blora. Kabupaten is a political unit of varying size equivalent to county in the U.S. Its geographical position is situated from 111° 16′ to 111° 34′ East longitude and from 06° 53′ South latitude to 07° 25′ South latitude (see Figure 2). The topography of Kabupaten Blora is primarily flat and soils are dominated by alluvials and grumusols. The climate of Kabupaten Blora follows that of western Indonesia and has alternating seasons of wet and dry monsoons. Thus, it is categorized as type C based on the Schmidt and Ferguson classification (Kantor Statistik Blora, 1989), where Q= 60 %.

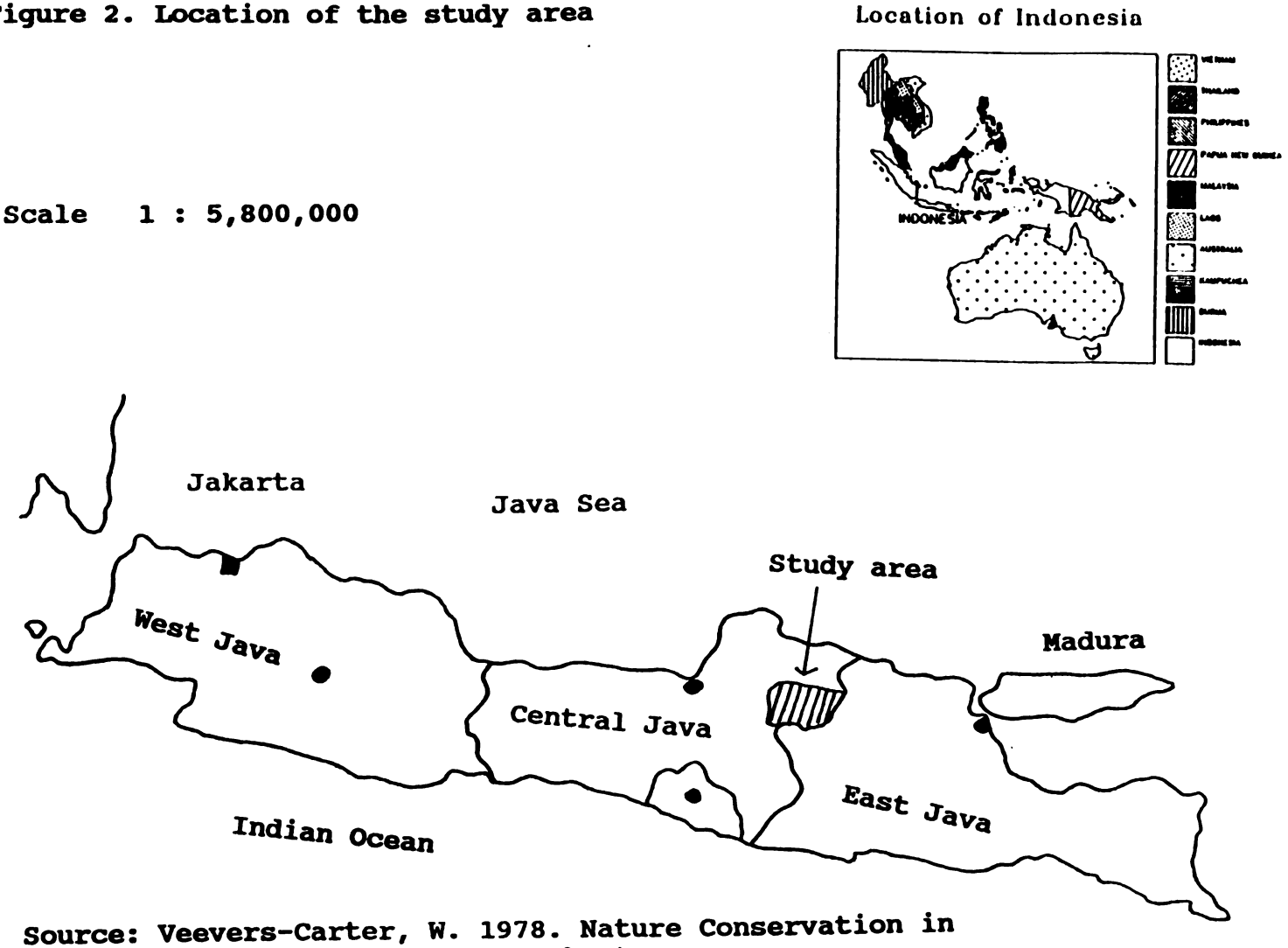
$$Q = \frac{\text{number of dry months}}{\text{number of wet months}} \times 100\ \%$$

dry month = if rainfall per month is less or equal to 60 mm.

wet month = if rainfall per month is higher or equal to 100 mm.

The dry period extends from July to October and the wet season runs from November until May. In general, the area has a wet tropical climate with mean high temperatures ranging from 26 to 28 °C, and average humidity mostly above 85 %.

Figure 2. Location of the study area



Source: Veevers-Carter, W. 1978. Nature Conservation in Indonesia. Intermasa, Jakarta.

Social-economic status

The population of Kabupaten Blora has not changed much since 1983, although there was a moderate increase and subsequent decrease from 1983 to 1985 (see Table 3.1). From 1983 to 1984 the population increased from 711,571 to 816,896. However, from 1984 to 1985 the population decreased from 816,896. This initial increase and following decrease was primarily the result of a transmigration program based in the kabupaten, a site from which peasants were processed for resettlement onto sparsely populated islands outside of Java. Secondly,the trend towards urbanization of big cities drew off people who left in search of more lucrative employment opportunities.

Table 3.1. Population of Kabupaten Blora 1983-1987

Year	Population	Pop. density/sq. km.
1983	711,571	391
1984	816,896	449
1985	720,538	396
1986	736,281	404
1987	739,458	406

Note: Total area of Kabupaten Blora is 1,820 sq. km.
Source: Kantor Statistik Blora, 1989.

According to Hugo et al. (1987), over one third of rural Java's population is landless. Although there are large plantations counted in hundreds of hectares owned by single individuals or families, the landholding of the majority of landowners are minuscule totaling less than 0.5 hectare. Land reform would have no discernible impact on the access to land for most of the rural landless population and largely for this reason has never been promoted as a major policy option in Indonesia.

The agricultural sector still provides the largest employment for people in Java, even though that percentage is decreasing (see Table 3.2).

Table 3.2. The Demographic Distribution of Employed Persons in Java according to 1961, 1971 and 1980 censuses.

Sectors	Males			Females		
	1961	1971	1980	1961	1971	1980
	Percentage distribution					
Agriculture	71.2	62.5	52.6	64.3	58.0	46.6
Mining	.1	.2	.7	.2	<.05	.3
Manufacturing	6.4	7.4	9.2	9.0	13.1	14.7
Construction	2.7	3.1	5.3	.2	.1	.2
Trade	7.0	10.6	11.5	10.3	18.4	23.1
Transport	3.1	3.8	4.6	.3	.2	.1
Services	9.5	12.4	16.1	15.7	10.2	15.0
Total	100.0	100.0	100.0	100.0	100.0	100.0

Source: Hugo et al., 1987.

Income distribution and wealth in Indonesia, including Java have become increasingly unequal. Again Hugo et al. (1987) shows how this income distribution is skewed to more benefit smaller numbers of people. Percentage shares of household income, by percentile groups of households (1976) are:

-lowest 20 % : 6.6

-second quintile: 7.8

-third quintile : 12.6

-fourth quintile: 23.6

-highest 20 % : 49.4

-highest 10 % : 34.0

The average annual income of farmers is low, averaging $520 per capita (Asiaweek, 1990). This low income can be seen also from the proportional amount of income spent on food. In Java, based on the National Social-Economic Survey in 1976, 71 % of consumption spending goes to food consumption (Salim, 1986). Gross Domestic Product (GDP) growth of Indonesia is 6.2 percent (Asiaweek, 1990) and average population growth is 2 percent (Salim, 1986). This will give an average personal income growth of 4.2 percent. If this trend continuous steadily then GNP per capita will be doubled in 17 years.

Forest characteristics

Administratively the forest land is located in two adjacent kabupatens (political units equivalent to counties in the U.S.). Kabupaten Blora, Central Java Province contains 82 percent of the Perhutani Cepu's forests totaling 26,700 hectares and Kabupaten Bojonegoro, East Java Province holds the remaining 18 percent or 5,860 hectares.

Teak (Tectona grandis) or 'jati' in Indonesian is one of the characteristic species of the monsoon forest and is native to India, Burma, Thailand and believed to be native also in Java. In the more humid climate of West Java, the tree grows more rapidly than in Central Java. For this reason, the teak wood of West Java is of inferior quality when compared to the teak wood of Central and East Java (Jacobs, 1988). Besides Java, teak is also found on the nearby islands of Kangean, Muna and Lombok (Hamzah, 1975). Most natural teak forests have already been converted into man-made plantations.

The forest district of Cepu is one of the best sites for teak plantations in Central Java Province. The forest composition is dominated by teak trees and includes:

- 78.69 % high-production teak forest
- 12.60 % low-production teak forest
- 7.60 % unproductive teak forest
- .66 % not suitable for teak
- .10 % non-teak forest

- .35 % protective forest

According to Beekman in Kartasubrata (1979) the optimum yearly temperature for teak growth is between 22° to 27 °C, but extremes of 15° to 30 °C are tolerated. Teak flourishes best in areas with a rainfall of 1250 to 3750 mm annually. These requirements correspond to the average annual rainfall of the types C, D and E according to the rainfall types classification of Schmidt and Ferguson, or on the range of Q value between 33.3 % to 167 %. Teak grows on volcanic soil, sedimentary soils, and alluvial soils of various and mixed origin. However, factors such as soil density, permeability and degree of aeration may have an effect on optimal growth regardless of soil type origin. Teak grows best on soils that are permeable and well aerated as opposed to soils that are denser and more compact.

CHAPTER IV

RESEARCH METHOD

Software used in the study

In this study, software entitled Bencos(a Lotus 1-2-3 template) was used to run the benefit-cost analysis. The template used was adapted from Bencost, a Fortran program written for the CDC Cyber 750 by R.F. Ranger, R.D. Stevens, R.A. Saper, and T.I. Ho. Bencos was down loaded for use on an IBM PC microcomputer, and can be run on any IBM-compatible system using Lotus 1-2-3, or any other spreadsheet program capable of reading .WK1 format files (Crawford and Schmid, 1990). The original Bencos could only simulate a maximum 25 year project period. The author modified the software so that projects ranging up to a 60 year period could be evaluated. The concepts, structure, and calculations of Bencos are generally consistent with those recommended by Gittinger (1982). The Bencos diagram is presented as Figure 3.

The Bencos template is divided into four main sections: (1) Parameters section, (2) Data section, (3) Output section, and (4) Summary. In the Parameters section, two parameters must be entered: the interest rate to be used for discounting and the user's definition of capital or scarce resource costs. In the Data section, information reflecting benefits and costs are entered. Incremental benefits and costs should

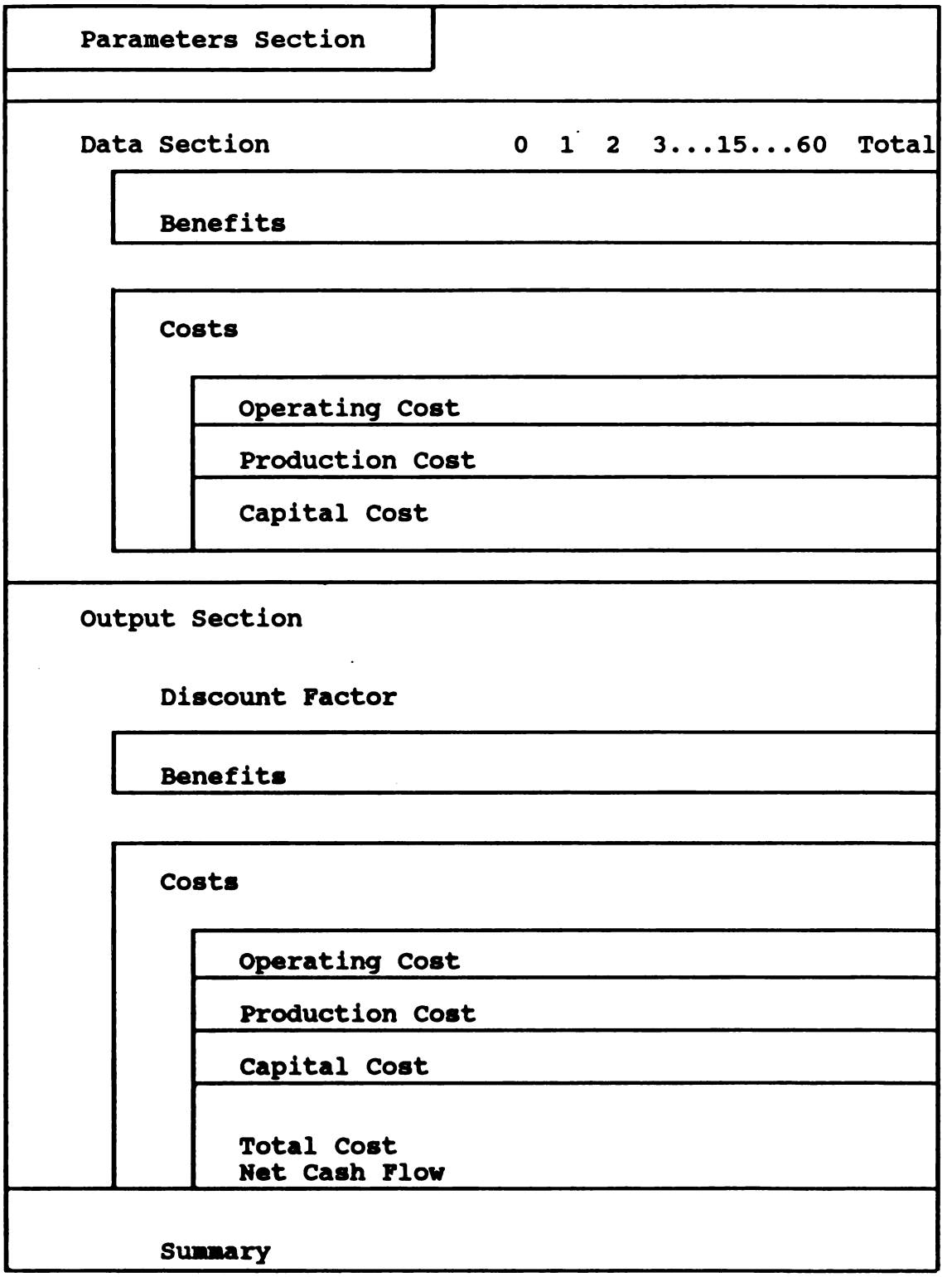


Figure 3. Diagram of the Bencos spreadsheet

be used; i.e., the differences between a situation with-project and one without-project. For example, the benefits entered in the data section should be the benefits of the project after having been subtracted by the benefits incurred in without project. Prices may be entered directly for each year, or they may be projected automatically on the basis of year 0 or year 1 figures and an annual price compounding factor. The Output section provides the discount factor for each year, based on the user-specified interest rate. Subsequent rows show the benefits and costs entered earlier by the user, the effect of the scale factor, and the final values obtained as the product of price times quantity. The present value of the benefit and cost streams is also shown, and the Summary section provides the present value of total benefits and costs.

Valuation

Benefits and costs of Tumpangsari and Inmas Tumpangsari are compared with a model not incorporating Tumpangsari or Inmas Tumpangsari, which is the case when Perhutani only hires laborers to establish the plantation. The benefits with project referred to the benefits of Tumpangsari or Inmas Tumpangsari. The benefits without project referred to the benefits when Perhutani only hires laborers to establish the plantation. The benefits and costs of agroforestry can be distinguished as perceived by both Perhutani and the farmers.

Benefits and costs of Tumpangsari as perceived by Perhutani

a. Land.

Opportunity cost of the forest land is considered zero, because with or without the establishment of Tumpangsari the value of the land remains the same. Land is owned by the government and by law cannot be rented or sold, therefore, there is no incremental benefit for the land due to the existence of Tumpangsari.

b. Labor.

There are differences between labor outlays on the part of farmers in Tumpangsari and hired laborers. Hired laborers receive wages, but Tumpangsari farmers do not. Tumpangsari farmers spend more time maintaining forest trees than do farmers on the conventional plantation.

On the conventional plantation, receiving a labor wage is considered as a benefit to the farmers. However, in Tumpangsari, the time devoted to caring for trees becomes a cost to the farmers, but not a labor cost to Perhutani.

c. Forest products.

Trees established by Tumpangsari are more protected than those under the conventional method[1], therefore, it is expected that the volume and quality of the harvest in the

[1]In tumpangsari and inmas tumpangsari, farmers have a vested interest in protecting their crops from disturbances from animals and humans. This will also indirectly protect forest trees from the same disturbances.

Tumpangsari model are higher than would be the case in the conventional establishment. However, there is not yet a study to prove or disprove this expectation, therefore, it is assumed that there is no incremental net benefit for Tumpangsari on forest products.

d. Maintenance cost

It is also expected that maintenance costs of the conventional method are higher than those in Tumpangsari. In the conventional method, Perhutani has to assign employees to watch over the forest to protect it from destruction by animals, fires and/or people. In Tumpangsari, because farmers work for agricultural crops in the same area as tree establishment, disturbances from animals, fires, or people are much less than those occurring in the conventional establishment.

e. Capital

Relatively, there are no discernible differences between capital requirements needed for Tumpangsari and the conventional method.

<u>Benefits and costs of Inmas Tumpangsari as perceived by Perhutani</u>

a. Land.

Opportunity cost of the forest land is considered zero, because with or without the use of Inmas Tumpangsari the value of the land remains the same. Land is owned by the

government and by law cannot be rented or sold, therefore, there is no incremental benefit of the land due to the existence of Inmas Tumpangsari.

b. Labor.

There are differences between labor outlays in Inmas Tumpangsari and hired laborers. Hired laborers receive wages, but farmers in Inmas Tumpangsari do not. Farmers laboring under Inmas Tumpangsari spend more time maintaining forest trees than do farmers in the conventional plantation.

In the conventional plantation, an actual labor wage is considered as a benefit to the farmers, however, in Inmas Tumpangsari, the time spent on labor becomes a cost for the farmers, but not to Perhutani.

c. Forest products.

Trees established by Inmas Tumpangsari are more protected from encroachment by both animals and humans than are those under the conventional method. In addition to a greater degree of protection, the use of fertilizers in Inmas Tumpangsari is expected to increase the volume and quality of the teak wood harvest in comparison to what could be expected under conventional establishment. Based on a study by Perhutani (KPLI, 1974), the growth of young trees (up to 2 years in age) in Inmas Tumpangsari was faster than that of without Inmas Tumpangsari.

d. Maintenance cost

It is also expected that the maintenance costs of the conventional method are higher than those of Inmas Tumpangsari. In the conventional method, Perhutani has to assign employees to guard the forest from possible disturbances by animals, fires or people. In Inmas Tumpangsari, farmers plant agricultural crops in the same area as the teak trees and subsequently guard their crops against these possible disturbances; thus damages could be expected to be considerably less than would occur under conventional practice.

e. Capital

Even though Perhutani provides fertilizers and high variety agricultural crop seeds, the farmers are still required to make payments in the form of agricultural produce following their harvest.

Benefits and costs of Tumpangsari as perceived by Farmers

a. Land.

An average annual rent for land without irrigation in Cepu is 200,000 rupiahs or equal to US $ 111. However, as forest land is usually less fertile and is usually located farther from the villages than already established agricultural land, its opportunity cost should be less than 200,000 rupiahs. In this study, the opportunity cost of land was estimated as the costs farmers spent on preparing land

for establishment of trees. This is based on the assumption that the willingness of farmers to work for land preparation is equal to the willingness of farmers to pay for land rent.

b. Agricultural products.

Agricultural crops provide the main benefits to the farmers. Therefore, the net benefits of Tumpangsari were determined by multiplying the projected crop yields times the unit price.

c. Labor.

There are differences between labor costs in Tumpangsari and those for hired laborers. Hired laborers receive wages, but Tumpangsari farmers do not. Farmers laboring under Tumpangsari spend more time maintaining forest trees than do farmers in the conventional plantation. Therefore, the time spent for labor becomes a cost for the farmers instead of a benefit.

d. Capital

Capital invested by farmers includes equipment used in agricultural work such as hand plows, machetes, and hoes. The actual amount invested on each farm is relatively small.

Benefits and costs of Inmas Tumpangsari as perceived by Farmers

a. Land.

The opportunity cost of the land is the same as in Tumpangsari. In this study, opportunity cost of land will be

estimated as the time farmers spent preparing land for tree establishment times the average labor cost.

b. Agricultural products.

Agricultural crops are the main benefits for the farmers. Therefore, the net benefit of Inmas Tumpangsari compared to without it represents crop yield times the unit price. As in this project fertilizers, high yield varieties of agricultural crop seeds, and pesticides are used; it is anticipated that the yields will be higher than those in Tumpangsari.

c. Labor.

There are differences between labor outlays in Inmas Tumpangsari and hired laborers. Hired laborers receive wages, but Inmas Tumpangsari farmers do not. Farmers laboring in Inmas Tumpangsari spend more time maintaining forest trees than do farmers working on the conventional plantation. As in Tumpangsari, labor remains a cost to the farmers instead of a benefit.

d. Capital

Capital invested by farmers includes equipment used for agricultural work such as hand plows, machetes, and sickles. Fertilizers and high yield varieties of corn seeds are also included.

Choosing discount rate

A dollar in benefits at the present time is worth more than a dollar in benefits several years from now. Therefore, in order to evaluate a particular program and to compare alternatives, a discount factor must be used to reduce the value of future benefits and costs to their present values.

In this study, the discount rate used for Perhutani represents the interest rate and self-financing regulations required by the Bank of Indonesia's refinancing facility. The Bank of Indonesia charges an interest rate of 12 percent for plantation credit (Bank of Indonesia, 1989). The inflation rate was calculated to be 6.55 % making the real discount rate 5.45 %. Interest rates on some investment credits of Bank of Indonesia are presented on Table 4.1.

However, the time preference of farmers would be differed from that of Perhutani. Farmers would like to receive their benefits in a much shorter time period than would Perhutani, therefore the discount rate for farmers would be higher than that for Perhutani. In this study, the discount rate for farmers is estimated by the interest rate of Indonesian banks when farmers deposit their money in savings accounts. According to the Bank of Indonesia (1989), the discount rate for savings accounts is 18 %, thus the real discount rate is 11.45 percent.

Table 4.1. Interest rates for investment credits from the Bank of Indonesia

Item	Interest rate (% per year)
Small investment credits	12
Plantation credits:	
- Nucleus Smallholder Estate	12
- Rejuvenation, Rehabilitation, and Expansion of Export Plants	12
- Private National Plantation	12
New Rice fields	12
Investment credits through Rp. 75 million	15
Credits to cooperatives	12
Credits to villages	12

Source: Bank of Indonesia, 1989.

Data

Data used in this study come from both primary and secondary sources. Primary data were gathered through interviews with Perhutani officials in Cepu and farmers by the author in the study area during February 1990. Pertinent data regarding agricultural yield were obtained from interviews with 20 farmers in the study area. The small numbers of farmers interviewed in this study were due to the

limitations of funds and the time period the author had. Secondary data reflecting prices were taken from Perhutani publications, and some data were obtained directly from Perhutani officials in February 1990. Further secondary data were obtained from other government publications.

The study area is located in the Forest District Cepu, Central Java. Detailed characteristics of the study area are presented in Chapter 3. The area unit of analysis is the hectare. Data are aggregated from several sites throughout the Cepu Forest Subdistricts. Data used in this study represent mean values as calculated by the Forest District. For example, yield data of timber and agricultural crops should be different with different site classes of forest land. However, because it is aggregate data, differences between the site classes cannot be discriminated.

Corn was selected as the agricultural crop for this study because the majority of farmers in the study area currently grow corn as their primary agricultural crop (630 hectares out of 777[2]).

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[2]Data from the Office of Biro Pembinaan Hutan, Perum Perhutani Unit I Jawa Tengah.

CHAPTER V

RESULTS AND DISCUSSION

The Net Present Value (NPV) of Tumpangsari and Inmas Tumpangsari are presented in this chapter. To determine the NPV it was first necessary to establish the discounted values of benefits and costs of these projects. To evaluate the economic feasibility of Tumpangsari and Inmas Tumpangsari, the benefits and costs of these projects had to be compared with benefits and costs incurred without project (Non-Tumpangsari model). The results of the benefit and cost analysis of (1) Non-Tumpangsari model, (2) Tumpangsari model and (3) Inmas Tumpangsari model are presented in this chapter.

To determine the NPV of the Tumpangsari model, the discounted costs and benefits of this project were subtracted from the costs and benefits of not having the project (the case when Perhutani only hires laborers to establish plantations). The same process was used for the Inmas Tumpangsari model. The costs and benefits of Tumpangsari and Inmas Tumpangsari are valued differently by both Perhutani and farmers. For example, the opportunity cost of land for plantations is considered zero by Perhutani, because it cannot rent the forest land to other parties. However, the farmers' opportunity cost for land is not zero, because they must work in the teak plantation in return for being granted

the use of forest lands for their own crops. Therefore, the opportunity cost of forest land to the farmers is estimated by the wages received by farmers working in teak plantations without access to land for their own crops.

Non-Tumpangsari Model.

In this model, the results were divided into two categories:

1. Benefits and costs of the Non-Tumpangsari model as perceived by Perhutani; and
2. Benefits and costs of the Non-Tumpangsari model as perceived by farmers.

Costs of Non-Tumpangsari as perceived by Perhutani.

The costs of establishing and maintaining a teak plantation without the use of Tumpangsari are divided into four categories: (1) land, (2) labor, (3) production, and (4) administrative costs.

(1) Land: The opportunity cost of forest land is considered to be zero, because there is no opportunity for Perhutani to gain benefits from the land, except through the establishment of teak plantations.

(2) Labor: Labor costs incurred by Perhutani for a teak plantation are shown in Table 5.1.

Table 5.1. Labor costs paid by Perhutani in the Non-Tumpangsari model.

Year 1			
Activities	Unit.	cost/unit (Rp.)	total cost (Rp.)
-Land clearing	1 ha.	5,000	5,000
-Plantation sign	1	7,500	7,500
-border signs (demarcating plantation boundaries)	4	250	1,000
-preparation of ground for fence trees	4 hm.	500	2,000
-wooden markers for fence trees	2,400	3.50	8,400
-soil loosening	50 hm.	600	30,000
-wooden markers for teak	3,300	3.50	11,550
-making holes for teak	3,300	12	39,600
-establishment of foot paths	1 hm.	500	500
-planting of fence trees	4 hm	440	1,760
-planting teak	1 ha	3,850	3,850
Labor costs for 1 ha			111,160
Year 2			
The average success rate of tree establishment is 50 percent[1]; therefore, in year 2 some replanting is needed. The activities for replanting are the same as those in year 1. Likewise, the costs would be 50 % of the total costs of year 1 which are (.5 x Rp. 111,160)= Rp. 55,580. Another activity is weeding around the teak trees: 3300 x Rp. 3 = Rp. 9,900. Total labor costs in year 2 would be Rp. 65,480.			
Year 3			
In the third year enrichment planting is still needed. The expected rate of enrichment planting is 10 percent, therefore, the cost would be 10 % of the total cost of year 1, .1 x Rp. 111,160 = Rp. 11,116.			

Note: ha = hectare; hm = hectometer (100 meter)
Source: KPH Cepu (1989)

[1]Based on interviews with officials in Perhutani Cepu, February 1990

(3) Production: Production costs of timber and fuel wood harvesting are Rp. 500 per cubic meter. Production costs per hectare for a 60 year period are shown in Table 5.2.

(4) Administration: In the Non-Tumpangsari model, Perhutani hires security foremen to guard the plantation. Each security foreman is responsible for an area of 10 to 20 hectares (15 hectares average) with an average wage of Rp. 60,000 per month; therefore, the cost per hectare per year is 12 x Rp. 60,000 divided by 15 hectares = Rp. 48,000.

Table 5.2. Production cost per hectare of timber and fuel wood harvesting in the Non-Tumpangsari model.

Year	Timber		Fuel wood	
	harvest Rp.	thinning Rp.	harvest Rp.	thinning Rp.
10	0	0	0	37,500
15	0	4,000	0	37,500
20	0	4,000	0	7,500
25	0	2,500	0	5,000
30	0	2,000	0	3,500
35	0	2,000	0	3,500
40	0	4,000	0	1,250
45	0	3,500	0	1,250
50	0	3,000	0	1,250
55	0	3,000	0	1,250
60	36,500		10,000	

Benefits of Non-Tumpangsari as perceived by Perhutani:

The benefits received by Perhutani are timber and fuel wood. The average yield of timber and fuel wood per hectare is shown in Table 5.3.

Table 5.3. Production per hectare of timber and fuel wood in Cepu Forest District.

Year	timber		fuel wood	
	harvest cu.m.	thinning cu.m.	harvest cu.m.	thinning cu.m.
10	0	0	0	75
15	0	8	0	75
20	0	8	0	15
25	0	5	0	10
30	0	4	0	7
35	0	4	0	7
40	0	8	0	2.5
45	0	7	0	2.5
50	0	6	0	2.5
55	0	6	0	2.5
60	73		20	

The price of teak per cubic meter is based on stumpage price which is calculated as follows:

- "teresan" (drying process by cutting cambium layer before tree is cut) 35
- cutting cost 330
- skidding cost (average distance 500 meters) 870
- mounting and dismounting costs 1,300
- tying and securing timber in piles 310
- transportation cost from forest to log yard (average distance 15 kilometers) 2,100

- transportation from log yard to industrial site (IPKJ)	480
total cost/ cubic meter	5,425

An average teak price at industry (IPKJ Cepu) is Rp. 290,360 per cubic meter. Thus, a stumpage price/cubic meter is equal to Rp. 284,935. The price of fuel wood per cubic meter in 1989 was estimated from the data below:

Table 5.4. Average price of fuel wood in Central Java

year	Rp./cubic meter
1983	3,627
1984	5,319
1985	5,697
1986	6,756
1987	7,084

Source: Perum Perhutani Unit I (1988)

Average price in 1989 as estimated by a linear function of (Y= m * x + b) is Rp. 9,037, where:

Y= average price in 1989

m= slope

x= historical data

b= intercept value

The benefits received by Perhutani from timber and fuel wood are shown in Table 5.5. The benefits are calculated by multiplying the production of timber and fuel wood in Table 5.3 (p. 60) with the price of timber and fuel wood.

Table 5.5. Benefits received by Perhutani in the Non-Tumpangsari model.

Year	Timber (1000xRp.)	Fuel wood (1000xRp.)	Total (1000xRp.)
10	-	678	678
15	2,279	678	2,957
20	2,279	135	2,414
25	1,425	90	1,515
30	1,140	63	1,203
35	1,140	63	1,203
40	2,279	23	2,302
45	1,994	23	2,017
50	1,710	23	1,733
55	1,710	23	1,733
60	20,800	181	20,981

Costs of Non-Tumpangsari as perceived by farmers:

In the Non-Tumpangsari model, farmers do not plant any agricultural crops on forest lands. They are only hired by Perhutani to plant teak trees. As there are no agricultural crops planted by the farmers, there are no opportunity costs for forest land, labor, seed, etc. borne by farmers. The cost outlay of farmers is only for the equipment used for

teak planting:

- plow : Rp. 3,500
- sickle : Rp. 1,500
- machete : Rp. 2,000

Total capital spent by farmers= Rp. 7,000 per year

Benefits of Non-Tumpangsari as perceived by farmers

The benefits for the farmers are equal to those of the labor costs paid by Perhutani (Table 5.1, p. 58), which are:

Year 1: Rp. 111,160

Year 2: Rp. 65,480

Year 3: Rp. 11,116

Tumpangsari Model

Costs of Tumpangsari as perceived by Perhutani

The costs of establishing and maintaining a teak plantation in the Tumpangsari model were divided into four categories: (1) land, (2) labor, (3) capital, and (4) production costs.

(1) Land: The opportunity cost of land is considered zero, as there is no opportunity for Perhutani to benefit from the land except through the establishment of a teak plantation.

(2) Labor: Labor costs incurred by Perhutani for teak plantation establishment and maintenance are zero. No labor costs are incurred as

plantation labor is provided by the farmers themselves in exchange for the right to grow their own agricultural crops on plantation land.

(3) Capital: Contract fee of Rp. 9,000 is paid to each farmer (.25 hectare) or 4 x Rp. 9,000 = Rp. 28,000 per hectare.

(4) Production : These costs are equal to production costs in the Non-Tumpangsari model (Table 5.2, p. 59).

Benefits of Tumpangsari as perceived by Perhutani

In this study, benefits of the Tumpangsari model for Perhutani are assumed to be equal to the benefits in the Non-Tumpangsari model. This assumption was necessary because no previous study had dealt with the positive effects of Tumpangsari for the production of timber and fuel wood. Even though, there should be a benefit, at least qualitatively, from Tumpangsari to Perhutani such as less disturbances from animals and humans to the forest. However, at this time, it is difficult to quantify them. Consequently, it was assumed that the benefits of Tumpangsari were equal to the benefits without the project (Table 5.5, p. 62).

Costs of Tumpangsari as perceived by farmers

The costs of Tumpangsari as perceived by farmers are divided into three categories: (1) land, (2) labor and (3) capital costs.

(1) Land: Farmers do not pay for the use of forest lands for planting their agricultural crops. However, they must work in the teak plantation in return for being granted the use of forest lands for their own crops. Therefore, the opportunity cost for the land was set as equal to the wages received by farmers working in teak plantations without access to land for their own crops. These costs designated as opportunity costs are presented in Table 5.6, p. 66.

(2) Labor : Labor costs borne by farmers in the Tumpangsari model equal all costs related to any activity involved in the production of agricultural crops (Table 5.7, p. 67).

(3) Capital: Costs incurred to the farmers as capital outlays reflect the equipment required. Three types of equipment are used by farmers:

- plow : Rp. 3,500
- sickle : Rp. 1,500
- machete : Rp. 2,000

Total capital expenditures each year are Rp. 7,000.

Table 5.6. The opportunity cost of land paid by farmers in the Tumpangsari model.

Year 1:

Activities	man day/ha.	Rp./man day[2]	Total cost
- land clearing	72	1,500	108,000
- soil loosening I	60	1,500	90,000
- soil loosening II	28	1,500	42,000
- marker sticks	4	1,500	6,000
- planting teak	4	1,500	6,000
- planting catch plants	4	1,500	6,000
- weeding	8	1,500	12,000
		total land cost	270,000

Year 2:

Activities	man day/ha.	Rp./man day	Total cost
- soil loosening I	60	1,500	90,000
- soil loosening II	40	1,500	60,000
- selection of best teak seedlings	4	1,500	6,000
- weeding	8	1,500	12,000
- thinning catch plants	8	1,500	12,000
		total cost	180,000

[2]Rp. 1,500 per day is based on "Tarip Upah" (KPH Cepu, 1989)

Table 5.7. Labor cost in Tumpangsari per year as perceived by the farmers

Activities	man day/ha.	Rp./man day	Total cost
- land clearing	20	1,500	30,000
- raising soil beds	16	1,500	24,000
- planting	16	1,500	24,000
- replanting	10	1,500	15,000
- harvesting	8	1,500	12,000
- shelling of corn kernels	10	1,500	15,000
- drying corn	4	1,500	6,000
Total cost per season			126,000
Total cost per year (two seasons)			252,000

Benefits of Tumpangsari as perceived by farmers

The farmers' benefits from Tumpangsari come mainly from agricultural crops. In addition to agricultural crops, benefits are received by farmers from contract fees paid by Perhutani of Rp. 28,000 per hectare.

Agricultural crops: Corn is the most common agricultural crop grown by farmers. Besides corn, Cassava is also grown in the same plot of land as the primary crop of teak and provides an additional benefit to the farmers.

a. Corn:

An average yield of corn per hectare and season in the study area is 340 kg. However, it must be understood that

the land area of one hectare is not solely used for corn. Corn, in addition to cassava and catch plants (planted for their soil-enriching nutrients) are planted in-between the teak trees. The average price of corn in the field is Rp. 210 per kilogram. Therefore, the total benefits gained from corn per season are 340 kg x Rp. 210 = Rp. 71,400. Farmers can plant corn twice a year, and increase their benefits two fold to Rp. 142,800.

Besides harvesting corn, the farmers also can sell the corn stalks for animal fodder. An average yield of stalks per hectare per season is 28 bunches or 56 bunches a year. The price per bunch is Rp. 1,000 or Rp. 56,000 per year.

b. Cassava:

An average yield per hectare of cassava per season is 600 kilograms. The average price of cassava per kg is Rp. 30, resulting in total benefits of 600 x Rp. 30 = Rp. 18,000 per season or Rp. 36,000 per year.

Inmas Tumpangsari Model

Costs of Inmas Tumpangsari as Perceived by Perhutani

As in to the Tumpangsari model, the costs of Inmas Tumpangsari were divided into four categories: (1) land, (2) labor, (3) capital and (4) production costs.

(1) Land: The opportunity cost of forest land is the same as in the Tumpangsari model, the opportunity cost for land in the Inmas Tumpangsari is also zero.

(2) Labor: Labor costs for Inmas Tumpangsari are also considered non-existent. There are no labor costs because these costs are borne by the farmers as compensation for having the right to grow their own agricultural crops on forest lands.

(3) Capital: The cost for capital paid by Perhutani to the farmers is Rp. 28,000 per hectare as a contract fee. Costs associated with fertilizers and high yield crop seed varieties used in Inmas Tumpangsari are paid by the farmers.

(4) Production: It is assumed that there is no positive effect of fertilizers on teak production[3], therefore, these costs are equal to production costs in the Non-Tumpangsari model (Table 5.2, p. 59).

Benefits of Inmas Tumpangsari as perceived by Perhutani

As assumed earlier, no positive effects of fertilizers are realized in teak production, therefore the benefits of Inmas Tumpangsari as perceived by Perhutani are equal to the

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[3]The research on the effects of agricultural crop fertilization on adjacent teak growth by Perhutani (KPLI, 1974) was conducted for only 2 years, therefore, at this time it is assumed there is no documented positive effects of fertilization on teak growth.

benefits of Tumpangsari or Non-Tumpangsari (Table 5.5, p.62)

Costs of Inmas Tumpangsari as perceived by farmers

Similar to the costs in the Tumpangsari model, the costs of the Inmas Tumpangsari model to the farmers were divided into three categories: (1) land, (2) labor and (3) capital costs.

(1) Land: The opportunity costs of the land equal the labor costs expended by the farmers on forest work. These costs are equal to those in the Tumpangsari model (Table 5.6, p. 66).

(2) Labor costs: Represent all costs related to any activity in the production of agricultural crops (Table 5.8).

(3) Capital: The capital costs to the farmers are used for fertilizers, high yield variety crop seeds, and equipment. These costs are presented in Table 5.9.

Table 5.8. Labor cost in Inmas Tumpangsari per year as perceived by the farmers.

Activities	man day/ha.	Rp./man day	Total cost
- land clearing	20	1,500	30,000
- raising soil beds	16	1,500	24,000
- planting	16	1,500	24,000
- fertilization I	10	1,500	15,000
- fertilization II	10	1,500	15,000
- replanting	10	1,500	15,000
- harvesting	8	1,500	12,000
- shelling of corn kernels	10	1,500	15,000
- drying corn	4	1,500	6,000
Total cost per season			156,000
Total cost per year			312,000

Table 5.9. Capital invested by farmers in Inmas Tumpangsari.

a. Fertilizers:

Type of fertilizer	amount/ha kg.	price/kg Rp.	total cost Rp.
KCl	100	350	35,000
TSP	100	225	22,500
Urea	250	200	50,000
Total cost for fertilizers per ha.			107,500

b. High yield varieties of corn seeds:

18 kg x Rp. 1,450 =	26,100
Total cost of fertilizers and seeds	
- per season (twice a year)	133,600
- per year = 2 x 133,600	267,200

c. Equipment replaced each year:

- plow	Rp. 3,500	
- sickle	Rp. 1,500	
- machete	Rp. 2,000	
Total cost		7,000
Total capital cost per year		274,200

Benefits of Inmas Tumpangsari as perceived by farmers

Similar to the Tumpangsari model, the benefits which Inmas Tumpangsari provides the farmers comes mainly from agricultural crops. Additionally, the farmers receive a contract fee from Perhutani of Rp. 28,000 per hectare.

Corn is the agricultural crop of choice by the farmers. Besides corn, cassava is also planted in the same plot to further increase the economic benefits.

a. Corn:

An average yield of corn per hectare per season in the Inmas Tumpangsari model is 2,800 kg[4]. The average farm gate price of corn is Rp. 210 per kilogram, resulting in total benefits of 2,800 x Rp. 210 = Rp. 588,000 per season and Rp. 1,176,000 per year from corn. As before the farmers can gain benefits from the corn stalks - 28 bunches per season and 56 bunches per year. The average farmgate price of corn stalks is Rp. 1,000 per bunch resulting in total revenue of Rp. 56,000 per year.

b. Cassava:

The average yield of cassava under Inmas Tumpangsari is equal to the yield of cassava in the Tumpangsari model. This is based on the assumption that cassava is not fertilized as it is planted only in the plot boundary and treated as a supplemental crop. An average yield per hectare of cassava is 600 kilograms per season. The average farmgate price of cassava per kg is Rp. 30, resulting in total benefits of Rp. 18,000 per season and Rp. 36,000 per year.

Net Present Value of Agroforestry

After benefits and costs of the Non-Tumpangsari, Tumpangsari and Inmas Tumpangsari models were determined, the next step was to calculate the Net Present Values of

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[4]Based on interviews with Perhutani Cepu officials. In agricultural land (all land planted with corn) the average yield is 5,000 kg (BIP Ungaran, 1989).

Tumpangsari and Inmas Tumpangsari to establish the economic benefits to Perhutani and the farmers. The first step was to compare the benefits and costs of Tumpangsari and Inmas Tumpangsari with the benefits and costs of the Non-Tumpangsari model. This was done by subtracting the benefits of Tumpangsari and Inmas Tumpangsari from the benefits of Non-Tumpangsari. The same calculations were used to establish the costs of the projects. The calculations of benefits and costs of each model (Tumpangsari and Inmas Tumpangsari) for the farmers and Perhutani are presented in the financial budget tables (Appendix 2 through 5). An example is provided in Appendix 2 illustrating the financial budget of Tumpangsari as perceived by Perhutani.

The next step was to discount the net benefits of each project to determine the NPV of each. This step was accomplished using the Bencos software program. Appendix 1 is an example of how the NPV of Tumpangsari for Perhutani was calculated. The discount rate used to determine the NPV for Perhutani is 5.4% and the discount rate used for farmers is 11.4%.

NPV of Tumpangsari to Perhutani

The first step before calculating the NPV is to subtract the benefits and costs of Tumpangsari to Perhutani from the benefits and costs determined using the Non-Tumpangsari model (Appendix 2). The NPV of Tumpangsari to Perhutani is the

result of discounting this net benefit (Appendix 1). The NPV of Tumpangsari for Perhutani is Rp. 146,650. This means that the Tumpangsari model provides net benefits of Rp. 146,650 more to Perhutani than does the Non-Tumpangsari model.

NPV of Tumpangsari to farmers

The procedure used to establish the NPV of Tumpangsari to the farmers is the same as for determining the NPV of Tumpangsari to Perhutani. The financial budget of Tumpangsari to the farmers is shown in Appendix 3. Based on a calculation used in Appendix 1, the NPV of Tumpangsari for farmers is a minus Rp. 557,720. This indicates that the Tumpangsari model when compared to the Non-Tumpangsari model provides a loss of Rp. 557,720 for the farmers. Thus, the Tumpangsari model used here is not economically beneficial for the farmers.

NPV of Inmas Tumpangsari to Perhutani

The procedure used to calculate the NPV of Inmas Tumpangsari for Perhutani is the same as the procedure used to establish the NPV of Tumpangsari. The financial budget of Inmas Tumpangsari as perceived by Perhutani is provided in Appendix 4. Based on a calculation equal to that in Appendix 1, the NPV of Inmas Tumpangsari for Perhutani is Rp. 146,650. This means that Inmas Tumpangsari provides benefits to Perhutani of Rp. 146,650 more than the benefits that were

provided from the Non-Tumpangsari model. Thus, the Inmas Tumpangsari model is economically beneficial for Perhutani.

NPV of Inmas Tumpangsari to farmers.

The procedure to establish the NPV is equal to the procedure used to establish the NPV of Tumpangsari for the farmers. The financial budget of Inmas Tumpangsari for the farmers is presented in Appendix 5. The NPV of Inmas Tumpangsari for the farmers is Rp. 899,490. This means that Inmas Tumpangsari provides Rp. 899,490 more benefits to the farmers than they receive from Non-Tumpangsari. Thus, the Inmas Tumpangsari model is economically beneficial to the farmers.

The summary of the NPV of Tumpangsari, Inmas Tumpangsari as perceived by Perhutani and the farmers is presented in Table 5.10.

Table 5.10. NPV of Tumpangsari and Inmas Tumpangsari as perceived by Perhutani and farmers

Types of agroforestry	Perceived by	NPV (Rp.)	Economic feasibility	Data shown in appendix
Tumpangsari	Perhutani	146,650	beneficial	A.2
	Farmers	-557,720	not ben.	A.3
Inmas Tumpangsari	Perhutani	146,650	beneficial	A.4
	Farmers	899,490	beneficial	A.5

Discussion of the results

According to the Ministry of Forestry (1986), 11 million family farmers in Java own 0.5 hectare of land or less, and 6 million of them own less than 0.25 hectare. With the average population growth rate 2 percent a year and the majority still dependent upon agricultural work, the need for farmland is increasing. The result is a continued increasing pressure on the forest lands.

The introduction of agroforestry has fostered a hope on the part of the government that the pressure exerted by the landless farmers on existing land resources can be partially alleviated. There exists a popular belief that all agroforestry models would result in economic benefits for landless farmers (Prahasto, 1987; Kartasubrata, 1987). This study's results indicate that this belief is not true.

The role of agroforestry to Perhutani

Through the use of benefit cost analysis, it appears that both Tumpangsari and Inmas Tumpangsari are beneficial to Perhutani. By using Tumpangsari or Inmas Tumpangsari, Perhutani can undertake more successful plantation projects because farmers would supervise the plantation for the first three years. During this time seedlings should become established without serious loss in numbers. This will substantially decrease uncertainty from the use of Tumpangsari and Inmas Tumpangsari practices as compared to

non-use of agroforestry practices. With generally increasing labor wages, Perhutani will benefit more from the Tumpangsari and Inmas Tumpangsari models because it would not have to pay the actual labor costs for planting and maintaining the trees.

In the Tumpangsari model, Perhutani gains a benefit of Rp. 146,650 more than it would in the Non-Tumpangsari model. Even without considering the positive effects of fertilizers in Inmas Tumpangsari, Perhutani likewise would receive a benefit of Rp. 146,650 more than with the Non-Tumpangsari model.

These data indicate that agroforestry projects (Tumpangsari and Inmas Tumpangsari) are economically beneficial to Perhutani. It appears that there is very little risk to Perhutani to engage in these agroforestry projects.

The role of agroforestry to the farmers.

> "The poorest rural inhabitants of the world are guided first by their need for food, not by visions of what could be hoped for in the future." (Gregersen and McGaughey, 1987).

This statement is very relevant when applied to agroforestry projects in Indonesia. Participation in agroforestry practices (Tumpangsari and Inmas Tumpangsari) by the farmers can place them in extremely precarious

economic situations regarding the level of wages and their expected crop yields. Clearly, in the Non-Tumpangsari model, the farmers are certain to receive some income. However, in agroforestry projects, the farmers' income is dependent upon the success rate of their agricultural work. Their income will be higher if their agricultural output is high, ceteris paribus, and vice versa. The uncertainty is very high, because their rate of success is dependent on so many unpredictable factors like weather, soil erosion and animal disturbances.

In the Tumpangsari model, the NPV to the farmers is negative (minus Rp. 557,720). Therefore, the Tumpangsari model is not economically beneficial to the farmers. The farmers continue to participate in the Tumpangsari project because Perhutani has already tied them to a contract stating that for the duration of 3 years the farmers are contractually obligated to work on the teak plantations. Furthermore, they may not understand the value of their own labor and consider the opportunity cost of labor to be zero. Even though they are aware of alternative job opportunities outside of Tumpangsari such as unskilled work in urban areas, they frequently do not have enough courage to leave or contacts with people in cities to attempt other types of employment.

In the Inmas Tumpangsari model, the NPV to the farmers is positive at Rp. 899,490. This indicates that Inmas

Tumpangsari is economically beneficial to the farmers. However, it has to be considered that this calculation is based on the outcome determined for one hectare sized plots of land. As each farmer actually has only 0.25 hectare, the actual income received by that farmer is much less than the above stated value.

Sensitivity Analysis

Sensitivity analysis refers to an analytical technique used to systematically test potential earning capacity of a project if actual events differ from the initial estimation made during the planning stage (Gittinger, 1982). This type of analysis is useful as it provides flexibility for the utilization of the results. It can be assumed that actual events will not materialize exactly as planned because of unexpected changes in factors used over time or the use of faulty or limited data in the initial projection. In forecasting any occurrence or events over time, an analyst will face two types of situations, those of risk and uncertainty. According to Anderson (1977), risk refers to situations where the probability of an outcome's occurrence is available, whereas uncertainty refers to situations where such information is not available. There are five sources of uncertainty in forestry according to Price (1989):

1. Drought, floods and attacks by insects,
2. New technological advances,

3. Human factors, such as illegal felling and arson,
4. Changing markets for timber and labor, and
5. The political factor.

Sensitivity analysis only deals with estimating the probable outcomes from fluctuations caused by uncertainty. The following scenarios show how changes in particular factors could influence the outcome of the project. The selected scenarios are based on some considerations:

1. In Tumpangsari and Inmas Tumpangsari, there are no wages paid by Perhutani to the farmers. However, based on a previous outcome (Table 5.10), it is not known what effects changes in wages would have on the NPV received by farmers and Perhutani. Increases in wages, however, can be expected as the current wages are considered low. Furthermore, crop yields would be expected to decrease in the future because of declining soil fertility. Therefore, in scenario 1, the effects of an increase in wages and a decrease in crop yields on the NPV received by Perhutani, and farmers was selected for investigation.
2. Fertilizers and high yield varieties of corn seeds are currently subsidized by the Government of Indonesia. The purpose of these subsidy programs is to boost the production of food crops for an increasing population. However, it cannot be

expected that the government would continue supporting this subsidy program indefinitely, because of the financial burden placed on government monetary resources. Therefore, in scenario 2, the effects of a price increase on fertilizers and crop seeds will be determined.

3. In order that the "prosperity approach" program be successful, Perhutani must increase the farmers' income from agroforestry projects. Perhutani could help farmers increase their income, thus reducing their costs, by taking over the expenses incurred in land clearing. The effects will be determined in scenario 3.

4. In this scenario, the effect of different discount rates on farmers' benefits will be determined.

Scenario 1:

The objective of this scenario is to determine how sensitive the impacts of wages and agricultural crop yields are to the NPV of Tumpangsari and Inmas Tumpangsari for Perhutani and farmers. Labor wages in Perhutani are lower than those received for outside agricultural work.[5] Furthermore, agricultural yield will decrease without additional inputs, such as fertilizers. Therefore, in this

[5]Labor wages outside of Perhutani are Rp. 1,500 per day plus meals equivalent to Rp. 500 - Rp. 1,000. However, this type of work is mostly seasonal.

scenario the effects of the increasing wages (10%) and decreasing crop yields (10%) are determined. The results are:

1. The effects of a 10% wage increase and a 10% decrease in corn production in Tumpangsari as perceived by Perhutani is presented in Appendix 6. The effects on NPV would be positive. The NPV would increase from Rp. 146,650 to Rp. 152,910.

2. The effects of the same factors on Tumpangsari as perceived by farmers are presented in Appendix 7. The NPV to the farmers would further decrease, from a minus Rp. 557,720 to a minus Rp. 652,710.

3. The effects of the same factors on Inmas Tumpangsari as perceived by Perhutani are presented in Appendix 8. The NPV of Perhutani would increase from Rp. 146,650 to Rp. 152,910.

4. The effects of the same factors on Inmas Tumpangsari as perceived by farmers are presented in Appendix 9. Even though the NPV is still positive, it would decrease from Rp. 899,490 to Rp. 640,190.

Scenario 2:

In this scenario, the impact of price increases of fertilizers and high yield varieties of corn seeds on the farmers are determined. Fertilizers and seeds are assumed to increase in price by 20 percent every year. The purpose is to indicate the direction and degree of effect this will have on farmers' benefits. The results are:

1. The effects on Inmas Tumpangsari as perceived by farmers are presented in Appendix 10. The NPV to the farmers would decrease from Rp. 899,490 to Rp. 814,920.

Scenario 3:

In this scenario, it is assumed that Perhutani would undertake land clearing in the Tumpangsari model. This will provide benefits to the farmers of Rp. 108,000 (Table 5.6 p. 66). This would decrease the loss to the farmers from a minus NPV of Rp. 557,720 (Appendix 3) to a minus Rp. 449,720. This would also decrease the NPV of Rp. 146,650 (Appendix 2) to Rp. 38,650 for Perhutani.

Scenario 4:

In this scenario, it is assumed that the discount rate used to determine the NPV of agroforestry to farmers is equal to the discount rate for Perhutani, which is 5.4%. The purpose of this scenario is to determine the effect of

different discount rates on the farmers' benefits. The result are:

1. The effects on Tumpangsari as perceived by farmers are presented in Appendix 11. This would increase the loss to the farmers from a minus NPV of Rp. 557,720 to a minus Rp. 603,970.

2. The effects on Inmas Tumpangsari as perceived by farmers are presented in Appendix 12. This would increase the benefits to the farmers from Rp. 899,490 to Rp. 1,002,850.

Summary of Simulation Analysis

The results of the Net Present Values of Tumpangsari and Inmas Tumpangsari based on some scenarios as perceived by Perhutani and the farmers are presented in Table 5.11.

Table 5.11. NPV of Tumpangsari and Inmas Tumpangsari based on some scenarios as perceived by Perhutani and farmers

Types of agroforestry	Perceived by	NPV (Rp.)	Economic feasibility	Data shown in appendix
Tumpangsari (10% increase in wages and agric. yield)	Perhutani	152,910	beneficial	A.6
	Farmers	-652,710	not ben.	A.7
Inmas T.sari (10% increase in wages and agric. yield)	Perhutani	152,910	beneficial	A.8
	Farmers	640,190	beneficial	A.9
Inmas T.sari (20% price increase in seeds and fertilizers)	Farmers	814,920	beneficial	A.10
Tumpangsari (land clearing by Perhutani)	Farmers	-495,970	not ben.	-
	Perhutani	38,650	beneficial	-
Tumpangsari (disc. rate at 5.4%)	Farmers	-603,970	not ben.	A.11
Inmas T.sari (disc. rate at 5.4%)	Farmers	1,002,850	beneficial	A.12

CHAPTER VI

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

As presented in Chapter I, the objectives of this study are:

1. To conduct an analysis of whether the Tumpangsari program as implemented by Perhutani is an economically efficient tool for Perhutani.
2. To conduct an analysis of whether the Inmas Tumpangsari program is an economically efficient tool for Perhutani.
3. To conduct an analysis of whether the Tumpangsari program as implemented by Perhutani is economically beneficial to the farmers.
4. To conduct an analysis of whether Inmas Tumpangsari is economically beneficial to the farmers.

Analysis of the hypotheses as defined above, regarding the outcomes of each agroforestry model for both farmers and Perhutani resulted in the following conclusions:

1. Agroforestry models as perceived by the farmers:
   a. The research null hypothesis: Tumpangsari is economically beneficial to the farmers is rejected. Thus, the alternative hypothesis: Tumpangsari is not economically beneficial to the farmers is accepted. The NPV of Tumpangsari to

the farmers is a minus Rp. 603,970 less than without the agroforestry project. This indicates that the Tumpangsari model made the farmers worse off when compared to without Agroforestry model.

b. The research null hypothesis: Inmas Tumpangsari is economically beneficial to the farmers is accepted. Alternative hypothesis: Inmas Tumpangsari is not economically beneficial to the farmers is rejected. The NPV of Inmas Tumpangsari to the farmers is Rp. 1,002,850 more than without the Agroforestry project. This indicates that Inmas Tumpangsari made the farmers better off when compared to a situation without Agroforestry project.

2. Agroforestry models as perceived by Perhutani:

a. The research null hypothesis: Tumpangsari is an economically efficient tool for Perhutani is accepted. The alternative hypothesis: Tumpangsari is not an economically efficient tool for Perhutani and is rejected. The NPV of Tumpangsari model to Perhutani is Rp. 146,650 higher than without Agroforestry project. This indicates that Tumpangsari would benefit Perhutani more than without Agroforestry project.

b. The research null hypothesis: Inmas Tumpangsari is an economically efficient tool for Perhutani is accepted. The alternative hypothesis: Inmas Tumpangsari is not an economically efficient tool for Perhutani is rejected. The NPV of Inmas Tumpangsari to Perhutani is Rp. 146,650 higher than without Agroforestry project. This indicates that Inmas Tumpangsari would benefit Perhutani more than not having the Agroforestry project.

Recommendations

The main objective of forest management under the Forestry Basic Law 1967, as well as the theme of the Forestry World Congress held in Jakarta in 1978, clearly states that forests are for people. Therefore, the role of the Forest Service in providing income to the local farmers from the forest is a very essential one.

A major shift is needed in the country's development objectives from one of maximizing economic growth and increasing GNP per capita, to one of improving income distribution, reducing poverty, and meeting the basic needs of the population. In terms of agroforestry projects, the emphasis should be on reducing the poverty of rural farmers and meeting their basic needs by increasing the opportunities to improve their productivity and income. Therefore,

Perhutani needs to reevaluate any agroforestry project that results in the farmers' plight becoming worse (e.g., the Tumpangsari model). Although use of the Inmas Tumpangsari management practice can result in economic gains to farmers, Perhutani should continue to make improvements to further increase farmers' gains.

Based on results of this study, some additional recommendations that might be considered are:

1. The NPV of the Tumpangsari and Inmas Tumpangsari models to the farmers is mostly dependent on the outcome of their agricultural yields. Therefore, Perhutani has to be more involved in providing inputs to increase agricultural outputs. In the Tumpangsari model, even if Perhutani could cover the cost for land clearing, the Tumpangsari project would still not be economically beneficial to the farmers (scenario 3). Furthermore, with the increase of labor wages and the decrease of agricultural yield (scenario 1), the NPV of Tumpangsari to the farmers would also decrease. Therefore, it is recommended that the Tumpangsari project with corn should be re-evaluated by Perhutani. More study on benefit-cost analysis of Tumpangsari with corn in different areas would beneficial in order for Perhutani to make more judicious decisions.

2. The effects of Inmas Tumpangsari on the farmers and Perhutani are positive. This indicates that Inmas Tumpangsari is economically beneficial to both parties. In scenario 2, with the assumption that the price of fertilizers and corn seeds would increase by 20 percent, the NPV of Inmas Tumpangsari to the farmers would still be positive. This indicates that Inmas Tumpangsari is a strong project and ought to be sustained. Improving agricultural yields is extremely important to the economic situation of the farmers. Therefore, more research to establish the most suitable crop combinations in the Inmas Tumpangsari model is needed to help the farmers increase crop yields and income.

3. Besides helping to facilitate farmers gaining opportunities to increase income from forest lands, Perhutani should not forget that agroforestry projects need to be sustained into the future. The Global Tomorrow Coalition (1986) has identified four elements they feel are necessary for achieving sustainability. They are: satisfaction of human needs, freedom from unwanted dependence, control of population growth, and maintenance of natural and life support systems. Two of these four components are very important and should be considered by Perhutani. They are:

a. Satisfaction of human needs: meeting the basic needs of the poor farmers has to be the central focus of agroforestry projects. Meeting basic needs cannot be fulfilled through only the utilization of agroforestry projects. Cooperation with other government agencies, such as the Ministries of Education and Public Health are required. Without increasing the low levels of education of the farmers' children, the dependency of farming families on forest lands increases.

b. Maintenance of natural and life support systems: It is very obvious that without preserving our natural and support systems, development will be seriously impeded. For example, if soil erosion continues to increase in our natural system, the productivity of this natural system will decrease.

Agroforestry projects are only one type of the many projects that deal with the rural poor. In order to optimize the success of agroforestry projects, it is important that they be integrated with other projects related to rural poor people, particularly the landless farmers. Overall, forest lands are too small in size to fulfill the land needs of all landless farmers in Java. Furthermore, the present plot allotment of 0.25 hectare per family as used in present agroforestry projects is too minuscule to provide a sufficient income for the farmer and his family. The possibility of expanding

agroforestry programs and moving Javanese farmers to other less-populated islands and in this way relieving some of the over-populated stress on Java is an alternative that bears some examination.

Finally, the author suggests more studies on the economic aspects of agroforestry for Perhutani to make more judicious decisions in determining the economic feasibility of agroforestry projects. They are:

(1) Continuous research on the effects of crop fertilization on teak growth.

(2) Research to find optimal tree spacing in agroforestry

(3) More research on benefit-cost analysis of different crop combinations, such as teak and rice in different site classes.

(4) Research on the effects of agroforestry on forest environment, such as the effects of agricultural crops on soil erosion, the effects of fertilization on water pollution, and the effects of agricultural crops on forest diseases and insects.

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APPENDICES

A.1. NPV calculation using Bencos (NPV of Tumpangsari for Perhutani)

BENCOS By Ting-Ing Ho and Eric W. Crawford (Michigan State Univ.). Modified 5/88 by Beaver & Crawford. Expanded from 25 to 60 year planning period by Silver Hutabarat 4/90
PARAMETERS SECTION!! To print worksheet, press <ALT> P for menu.!! 0.054 <<
(Enter a decimal value)
Definition of Capital or Scarce Resource Costs = >> 1 <<
(Enter 1 or 2 as described below)
(1): use rows 37 & 38; OR (2): use negative net cash flows from row 95

DATA SECTION

		Year0	Year1	Year2	Year3
Benefits					
Benefit 1:					
(constant scale factor = --)	units	--	83	65	11
(price compounding factor= 1)	price	--	1	--	--
Benefit 2:					
(constant scale factor = --)	units	--	--	--	--
(price compounding factor =--)	price	--	--	--	--

		Year0	Year1	Year2	Year3
Costs					
Operating Cost 1:					
(constant scale factor = --)	units	--	0	0	0
(price compounding factor =1)	price	--	1	--	--
Operating Cost 2:					
(constant scale factor = --)	units	--	--	--	--
(price compounding factor =--)	price	--	--	--	--
Production Cost 1:					
(constant scale factor = --)	units	--	0	0	0
(price compounding factor = 1)	price	--	1	--	--
Production Cost 2					
(constant scale factor = --)	units	--	--	--	--
(price compounding factor =--)	price	--	--	--	--

A.1. (cont'd)

DATA SECTION

Year4	Year5	Year6	Year7	Year8	Year9	Year10	Year11	Year12
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--

Year4	Year5	Year6	Year7	Year8	Year9	Year10	Year11	Year12
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--

A.1. (cont'd)

DATA SECTION

Year55	Year56	Year57	Year58	Year59	Year60	TOTAL	
--	--	--	--	--	--	159	(Units, Benefit 1)
--	--	--	--	--	--		
--	--	--	--	--	--	0	(Units, Benefit 2)
--	--	--	--	--	--		

Year55	Year56	Year57	Year58	Year59	Year60	TOTAL	
--	--	--	--	--	--	0	(Units, Op Cost 1)
--	--	--	--	--	--		
--	--	--	--	--	--	0	(Units, Op Cost 2)
--	--	--	--	--	--		
--	--	--	--	--	--	0	(Units, Prod Cost 1)
--	--	--	--	--	--		
--	--	--	--	--	--	0	(Units, Prod Cost 2)
--	--	--	--	--	--		
--	--	--	--	--	--	0	(Value, Capital Cost 1)
--	--	--	--	--	--	0	(Value, Capital Cost 2)

A.1. (cont'd)

		Year0	Year1	Year2	Year3
OUTPUT SECTION(I)					
Discount Factor	(at 5.4 %)	1	0.948767	0.900158	0.85404
Benefits					
Benefit 1:	(units)	--	83.00	65.00	11.00
	(price)	--	1.00	1.00	1.00
	(price*scale)	--	1.00	1.00	1.00
	(revenue)	0.00	83.00	65.00	11.00
Benefit 2:	(units)	--	--	--	--
	(price)	--	--	--	--
	(price*scale)	--	--	--	--
	(revenue)	0.00	0.00	0.00	0.00
Total Benefits		0.00	83.00	65.00	11.00
Present Value of Benefits		0.00	78.75	58.51	9.39

~~~~~~

		Year0	Year1	Year2	Year3
Costs					
Operating Cost 1:	(units)	--	0.00	0.00	0.00
	(price)	--	1.00	1.00	1.00
	(price*scale)	--	1.00	1.00	1.00
	(cost)	0.00	0.00	0.00	0.00
Operating Cost 2:	(units)	--	--	--	--
	(price)	--	--	--	--
	(price*scale)	--	--	--	--
	(cost)	0.00	0.00	0.00	0.00
Total Operating Cost		0.00	0.00	0.00	0.00
Present Value of Operating Cost		0.00	0.00	0.00	0.00
~~~~~~

A.1. (cont'd)

OUTPUT SECTION

Year4	Year5	Year6	Year7	Year8	Year9	Year10	Year11	Year12
0.810285	0.768771	0.729384	0.692015	0.656561	0.622923	0.591009	0.560729	0.532001
0.00	0.00	--	--	--	--	--	--	--
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

~~~~~~

Year4	Year5	Year6	Year7	Year8	Year9	Year10	Year11	Year 12
0.00	0.00	--	--	--	--	--	--	--
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
~~~~~~

A.1. (cont'd)

Year55	Year56	Year57	Year58	Year59	Year60	TOTAL	
0.055433	0.052593	0.049898	0.047342	0.044916	0.042615		
--	--	--	--	--	--	159.00	(Units, Benefit 1)
1.00	1.00	1.00	1.00	1.00	1.00		
1.00	1.00	1.00	1.00	1.00	1.00		
0.00	0.00	0.00	0.00	0.00	0.00	159.00	(Revenue, Benefit 1)
--	--	--	--	--	--	0.00	(Units, Benefit 2)
--	--	--	--	--	--		
--	--	--	--	--	--		
0.00	0.00	0.00	0.00	0.00	0.00	0.00	(Revenue, Benefit 2)
0.00	0.00	0.00	0.00	0.00	0.00	159.00	(Total Benefit)
0.00	0.00	0.00	0.00	0.00	0.00	146.65	(PV of Benefit)

Year55	Year56	Year57	Year58	Year59	Year60	TOTAL	
--	--	--	--	--	--	0.00	(Units, Op Cost 1)
1.00	1.00	1.00	1.00	1.00	1.00		
1.00	1.00	1.00	1.00	1.00	1.00		
0.00	0.00	0.00	0.00	0.00	0.00	0.00	(Cost, Op Cost 1)
--	--	--	--	--	--	0.00	(Units, Op Cost 2)
--	--	--	--	--	--		
--	--	--	--	--	--		
0.00	0.00	0.00	0.00	0.00	0.00	0.00	(Cost, Op Cost 2)
0.00	0.00	0.00	0.00	0.00	0.00	0.00	(Total Op Cost)
0.00	0.00	0.00	0.00	0.00	0.00	0.00	(PV of Op Cost)

A.1. (cont'd)

OUTPUT SECTION

		Year0	Year1	Year2	Year3
Production Cost 1:	(units)	--	0.00	0.00	0.00
	(price)	--	1.00	1.00	1.00
	(price*scale)	--	1.00	1.00	1.00
	(cost)	0.00	0.00	0.00	0.00
Production Cost 2:	(units)	--	--	--	--
	(price)	--	--	--	--
	(price*scale)	--	--	--	--
	(cost)	0.00	0.00	0.00	0.00
Total Production Cost		0.00	0.00	0.00	0.00
Present Value of Production Cost		0.00	0.00	0.00	0.00
Capital Cost 1		--	--	--	--
Capital Cost 2		--	--	--	--
Total Capital Cost		0.00	0.00	0.00	0.00
Present Value of Capital Cost		0.00	0.00	0.00	0.00
Total Cost		0.00	0.00	0.00	0.00
Present Value of Total Costs		0.00	0.00	0.00	0.00
Net Cash Flow		0.00	83.00	65.00	11.00
Present Value of Net Cash Flow		0.00	78.75	58.51	9.39

A.1. (cont'd)

SUMMARY

Year	Net Cash Flow (line 95)	Present Value at 5% Total Benefit (line 55)	Total Cost (line 94)	Net CashFlow (line 96)	Interest Rate	Net Present Value
0	0.00	0.00	0.00	0.00	0.05	147.51
1	83.00	78.75	0.00	78.75	0.10	137.44
2	65.00	58.51	0.00	58.51	0.15	128.56
3	11.00	9.39	0.00	9.39	0.20	120.67
4	0.00	0.00	0.00	0.00	0.25	113.63
5	0.00	0.00	0.00	0.00	0.30	107.31
6	0.00	0.00	0.00	0.00	0.35	101.62
7	0.00	0.00	0.00	0.00	0.40	96.46
8	0.00	0.00	0.00	0.00	0.45	91.77
9	0.00	0.00	0.00	0.00	0.50	87.48
10	0.00	0.00	0.00	0.00	0.55	83.56
11	0.00	0.00	0.00	0.00	0.60	79.95
12	0.00	0.00	0.00	0.00	0.65	76.63
13	0.00	0.00	0.00	0.00	0.70	73.55
14	0.00	0.00	0.00	0.00	0.75	70.71
15	0.00	0.00	0.00	0.00	0.80	68.06
16	0.00	0.00	0.00	0.00	0.85	65.59
17	0.00	0.00	0.00	0.00	0.90	63.29
18	0.00	0.00	0.00	0.00	0.95	61.14
19	0.00	0.00	0.00	0.00	1.00	59.13
20	0.00	0.00	0.00	0.00	1.05	57.23

A.1. (cont'd)

SUMMARY (CONTINUED)

Year	Net Cash Flow (line 95)	Present Value at 5% Total Benefit (line 55)	Total Cost (line 94)	Net CashFlow (line 96)	Interest Rate	Net Present Value
21	0.00	0.00	0.00	0.00	1.10	55.45
22	0.00	0.00	0.00	0.00	1.15	53.77
23	0.00	0.00	0.00	0.00	1.20	52.19
24	0.00	0.00	0.00	0.00	1.25	50.69
25	0.00	0.00	0.00	0.00	1.30	49.28
26	0.00	0.00	0.00	0.00	1.35	47.94
27	0.00	0.00	0.00	0.00	1.40	46.66
28	0.00	0.00	0.00	0.00	1.45	45.45
29	0.00	0.00	0.00	0.00	1.50	44.30
30	0.00	0.00	0.00	0.00		
31	0.00	0.00	0.00	0.00		
32	0.00	0.00	0.00	0.00		
33	0.00	0.00	0.00	0.00		
34	0.00	0.00	0.00	0.00		
35	0.00	0.00	0.00	0.00		
36	0.00	0.00	0.00	0.00		
37	0.00	0.00	0.00	0.00		
38	0.00	0.00	0.00	0.00		
39	0.00	0.00	0.00	0.00		
40	0.00	0.00	0.00	0.00		

A.1. (cont'd)

SUMMARY (CONTINUED)

Year	Net Cash Flow	Present Value at 5% Total Benefit	Total Cost	Net Cash Flow
41	0.00	0.00	0.00	0.00
42	0.00	0.00	0.00	0.00
43	0.00	0.00	0.00	0.00
44	0.00	0.00	0.00	0.00
45	0.00	0.00	0.00	0.00
46	0.00	0.00	0.00	0.00
47	0.00	0.00	0.00	0.00
48	0.00	0.00	0.00	0.00
49	0.00	0.00	0.00	0.00
50	0.00	0.00	0.00	0.00
51	0.00	0.00	0.00	0.00
52	0.00	0.00	0.00	0.00
53	0.00	0.00	0.00	0.00
54	0.00	0.00	0.00	0.00
55	0.00	0.00	0.00	0.00
56	0.00	0.00	0.00	0.00
57	0.00	0.00	0.00	0.00
58	0.00	0.00	0.00	0.00
59	0.00	0.00	0.00	0.00
60	0.00	0.00	0.00	0.00
TOTAL	159.00	146.65	0.00	146.65

A.2. Financial budget of Tumpangsari as perceived by Perhutani.

Item	Year1	year2	year3	year10	year15
BENEFITS--with project	(values in thousands of rupiahs)				
Timber revenue					2,279
Fuel wood revenue				678	678
Subtotal [1]				678	2,957
BENEFITS-- without project					
Timber revenue					2,279
Fuel wood revenue				678	678
Subtotal [2]				678	2,957
INCREMENTAL BENEFITS [1-2]				0	0
COSTS--with project					
Contract fee	28				
Timber harvesting					4
Fuel wood harvesting				37.5	37.5
Subtotal [3]	28			37.5	41.5
COSTS--without project					
Timber harvesting					4
Fuel wood harvesting				37.5	37.5
Plantation	111	65	11		
Subtotal [4]	111	65	11	37.5	41.5
INCREMENTAL COSTS [3-4]	-83	-65	-11	0	0
INCREMENTAL NET BENEFIT [INCR. BEN - INCR. COSTS]	83	65	11	0	0

NET PRESENT VALUE AT 5.4 % = Rp. 146,650.
(Calculation is equal to Appendix 1).

A.2. (cont'd)

year20	year25	year30	year35	year40	year45	year50	year55	year60
2,279	1,425	1,140	1,140	2,279	1,994	1,710	1,710	20,800
135	90	63	63	23	23	23	23	181
2,414	1,515	1,203	1,203	2,302	2,017	1,733	1,733	20,981
2,279	1,425	1,140	1,140	2,279	1,994	1,710	1,710	20,800
135	90	63	63	23	23	23	23	181
2,414	1,515	1,203	1,203	2,302	2,017	1,733	1,733	20,981
0	0	0	0	0	0	0	0	0
4	2.5	2	2	4	3.5	3	3	36.5
7.5	5	3.5	3.5	1.2	1.2	1.2	1.2	10
11.5	7.5	5.5	5.5	5.2	4.7	4.2	4.2	47.5
4	2.5	2	2	4	3.5	3	3	36.5
7.5	5	3.5	3.5	1.2	1.2	1.2	1.2	10
11.5	7.5	5.5	5.5	5.2	4.7	4.2	4.2	47.5
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0

A.3. Financial budget of Tumpangsari as perceived by Farmers

Item	Year1	year2	year3
BENEFITS--with project	(values in thousands rupiahs)		
Contract fee	28		
Corn revenue	143	143	71
Stalk revenue	56	56	28
Cassava	36	36	18
Subtotal [1]	263	235	117
BENEFITS-- without project			
Wages	111	65	11
Subtotal [2]	111	65	11
INCREMENTAL BENEFITS [1-2]	152	170	106
COSTS--with project			
Land	270	180	
Labor	252	252	126
Equipment	7	7	7
Subtotal [3]	529	439	133
COSTS--without project			
Equipment	7	7	7
Subtotal [4]	7	7	7
INCREMENTAL COSTS [3-4]	522	432	126
INCREMENTAL NET BENEFIT [INCR. BEN - INCR. COSTS]	-370	-262	-20

NET PRESENT VALUE AT 11.4 % = -Rp. 557,720.

(Calculation is equal to Appendix 1).

A.4. Financial budget of Inmas Tumpangsari as perceived by Perhutani.

Item	Year1	year2	year3	year10	year15
BENEFITS--with project	(values in thousands of rupiahs)				
Timber revenue					2,279
Fuel wood revenue				678	678
Subtotal [1]				678	2,957
BENEFITS-- without project					
Timber revenue					2,279
Fuel wood revenue				678	678
Subtotal [2]				678	2,957
INCREMENTAL BENEFITS [1-2]				0	0
COSTS--with project					
Contract fee	28				
Timber harvesting					4
Fuel wood harvesting				37.5	37.5
Subtotal [3]	28			37.5	41.5
COSTS--without project					
Timber harvesting					4
Fuel wood harvesting				37.5	37.5
Plantation	111	65	11		
Subtotal [4]	111	65	11	37.5	41.5
INCREMENTAL COSTS [3-4]	-83	-65	-11	0	0
INCREMENTAL NET BENEFIT [INCR. BEN - INCR. COSTS]	83	65	11	0	0

NET PRESENT VALUE AT 5.4 % = Rp. 146,650.
(Calculation is equal to Appendix 1).

A.4. (cont'd)

year20	year25	year30	year35	year40	year45	year50	year55	year60
2,279	1,425	1,140	1,140	2,279	1,994	1,710	1,710	20,800
135	90	63	63	23	23	23	23	181
2,414	1,515	1,203	1,203	2,302	2,017	1,733	1,733	20,981
2,279	1,425	1,140	1,140	2,279	1,994	1,710	1,710	20,800
135	90	63	63	23	23	23	23	181
2,414	1,515	1,203	1,203	2,302	2,017	1,733	1,733	20,981
0	0	0	0	0	0	0	0	0
4	2.5	2	2	4	3.5	3	3	36.5
7.5	5	3.5	3.5	1.2	1.2	1.2	1.2	10
11.5	7.5	5.5	5.5	5.2	4.7	4.2	4.2	47.5
4	2.5	2	2	4	3.5	3	3	36.5
7.5	5	3.5	3.5	1.2	1.2	1.2	1.2	10
11.5	7.5	5.5	5.5	5.2	4.7	4.2	4.2	47.5
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0

A.5. Financial budget of Inmas Tumpangsari as perceived by Farmers.

Item	Year1	year2	year3
BENEFITS--with project	(values in thousands rupiahs)		
Contract fee	28		
Corn revenue	1,176	1,176	588
Stalk revenue	56	56	28
Cassava	36	36	18
Subtotal [1]	1,296	1,268	634
BENEFITS-- without project			
Wages	111	65	11
Subtotal [2]	111	65	11
INCREMENTAL BENEFITS [1-2]	1,185	1,203	623
COSTS--with project			
Land	270	180	
Labor	312	312	156
Capital	274	274	141
Subtotal [3]	856	766	297
COSTS--without project			
Equipment	7	7	7
Subtotal [4]	7	7	7
INCREMENTAL COSTS [3-4]	849	759	290
INCREMENTAL NET BENEFIT [INCR. BEN - INCR. COSTS]	336	444	333

NET PRESENT VALUE AT 11.4 % = Rp. 899,490.

(Calculation is equal to Appendix 1).

A.6. Financial budget of Tumpangsari as perceived by Perhutani.
(wages increase by 10% and agric. yield decreases by 10%).

Item	Year1	year2	year3	year10	year15
BENEFITS--with project	(values in thousands of rupiahs)				
Timber revenue					2,279
Fuel wood revenue				678	678
Subtotal [1]				678	2,957
BENEFITS-- without project					
Timber revenue					2,279
Fuel wood revenue				678	678
Subtotal [2]				678	2,957
INCREMENTAL BENEFITS [1-2]				0	0
COSTS--with project					
Contract fee	28				
Timber harvesting					4
Fuel wood harvesting				37.5	37.5
Subtotal [3]	28			37.5	41.5
COSTS--without project					
Timber harvesting					4
Fuel wood harvesting				37.5	37.5
Plantation	111	71	12		
Subtotal [4]	111	71	12	37.5	41.5
INCREMENTAL COSTS [3-4]	-83	-71	-12	0	0
INCREMENTAL NET BENEFIT [INCR. BEN - INCR. COSTS]	83	71	12	0	0

NET PRESENT VALUE AT 5.4 % = Rp. 152,910.
(Calculation is equal to Appendix 1).

A.6. (cont'd)

year20	year25	year30	year35	year40	year45	year50	year55	year60
2,279	1,425	1,140	1,140	2,279	1,994	1,710	1,710	20,800
135	90	63	63	23	23	23	23	181
2,414	1,515	1,203	1,203	2,302	2,017	1,733	1,733	20,981
2,279	1,425	1,140	1,140	2,279	1,994	1,710	1,710	20,800
135	90	63	63	23	23	23	23	181
2,414	1,515	1,203	1,203	2,302	2,017	1,733	1,733	20,981
0	0	0	0	0	0	0	0	0
4	2.5	2	2	4	3.5	3	3	36.5
7.5	5	3.5	3.5	1.2	1.2	1.2	1.2	10
11.5	7.5	5.5	5.5	5.2	4.7	4.2	4.2	47.5
4	2.5	2	2	4	3.5	3	3	36.5
7.5	5	3.5	3.5	1.2	1.2	1.2	1.2	10
11.5	7.5	5.5	5.5	5.2	4.7	4.2	4.2	47.5
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0

A.7. Financial budget of Tumpangsari as perceived by Farmers (wages increase by 10 % and agric. crop yield decreases by 10 %)

Item	Year1	year2	year3
BENEFITS--with project	(values in thousands rupiahs)		
Contract fee	28		
Corn revenue	143	129	58
Stalk revenue	56	50	22
Cassava	36	32	14
Subtotal [1]	263	211	94
BENEFITS-- without project			
Wages	111	71	12
Subtotal [2]	111	71	12
INCREMENTAL BENEFITS [1-2]	152	140	82
COSTS--with project			
Land	270	198	
Labor	252	277	152
Equipment	7	7	7
Subtotal [3]	529	482	159
COSTS--without project			
Equipment	7	7	7
Subtotal [4]	7	7	7
INCREMENTAL COSTS [3-4]	522	475	152
INCREMENTAL NET BENEFIT [INCR. BEN - INCR. COSTS]	-370	-335	-70

NET PRESENT VALUE AT 11.4 % = -Rp. 652,710.

(Calculation is equal to appendix 1).

A.8. Financial budget of Inmas Tumpangsari as perceived by Perhutani.
(wages increase by 10% and agric. yield decreases by 10%)

Item	Year1	year2	year3	year10	year15
BENEFITS--with project	(values in thousands of rupiahs)				
Timber revenue					2,279
Fuel wood revenue				678	678
Subtotal [1]				678	2,957
BENEFITS-- without project					
Timber revenue					2,279
Fuel wood revenue				678	678
Subtotal [2]				678	2,957
INCREMENTAL BENEFITS [1-2]				0	0
COSTS--with project					
Contract fee	28				
Timber harvesting					4
Fuel wood harvesting				37.5	37.5
Subtotal [3]	28			37.5	41.5
COSTS--without project					
Timber harvesting					4
Fuel wood harvesting				37.5	37.5
Plantation	111	71	12		
Subtotal [4]	111	71	12	37.5	41.5
INCREMENTAL COSTS [3-4]	-83	-71	-12	0	0
INCREMENTAL NET BENEFIT [INCR. BEN - INCR. COSTS]	83	71	12	0	0

NET PRESENT VALUE AT 5.4 % = Rp. 152,910.
(Calculation is equal to Appendix 1).

A.8. (cont'd)

year20	year25	year30	year35	year40	year45	year50	year55	year60
2,279	1,425	1,140	1,140	2,279	1,994	1,710	1,710	20,800
135	90	63	63	23	23	23	23	181
2,414	1,515	1,203	1,203	2,302	2,017	1,733	1,733	20,981
2,279	1,425	1,140	1,140	2,279	1,994	1,710	1,710	20,800
135	90	63	63	23	23	23	23	181
2,414	1,515	1,203	1,203	2,302	2,017	1,733	1,733	20,981
0	0	0	0	0	0	0	0	0
4	2.5	2	2	4	3.5	3	3	36.5
7.5	5	3.5	3.5	1.2	1.2	1.2	1.2	10
11.5	7.5	5.5	5.5	5.2	4.7	4.2	4.2	47.5
4	2.5	2	2	4	3.5	3	3	36.5
7.5	5	3.5	3.5	1.2	1.2	1.2	1.2	10
11.5	7.5	5.5	5.5	5.2	4.7	4.2	4.2	47.5
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0

A.9. Financial budget of Inmas Tumpangsari as perceived by Farmers (wages increase by 10 % and agric. yield decrease by 10 %)

Item	Year1	year2	year3
BENEFITS--with project	(values in thousands rupiahs)		
Contract fee	28		
Corn revenue	1,176	1,058	476
Stalk revenue	56	50	22
Cassava	36	32	14
Subtotal [1]	1,296	1,140	512
BENEFITS-- without project			
Wages	111	71	12
Subtotal [2]	111	71	12
INCREMENTAL BENEFITS [1-2]	1,185	1,069	500
COSTS--with project			
Land	270	198	
Labor	312	343	188
Capital	274	274	141
Subtotal [3]	856	815	329
COSTS--without project			
Equipment	7	7	7
Subtotal [4]	7	7	7
INCREMENTAL COSTS [3-4]	849	808	322
INCREMENTAL NET BENEFIT [INCR. BEN - INCR. COSTS]	336	261	178

NET PRESENT VALUE AT 11.4 % = Rp. 640,190

(Calculation is equal to appendix 1).

A.10. Financial budget of Inmas Tumpangsari as perceived by Farmers (price of seeds and fertilizers increase by 20%).

Item	Year1	year2	year3
BENEFITS--with project	(values in thousands rupiahs)		
Contract fee	28		
Corn revenue	1,176	1,176	588
Stalk revenue	56	56	28
Cassava	36	36	18
Subtotal [1]	1,296	1,268	634
BENEFITS-- without project			
Wages	111	65	11
Subtotal [2]	111	65	11
INCREMENTAL BENEFITS [1-2]	1,185	1,203	623
COSTS--with project			
Land	270	180	
Labor	312	312	156
Capital	274	327	199
Subtotal [3]	856	819	355
COSTS--without project			
Equipment	7	7	7
Subtotal [4]	7	7	7
INCREMENTAL COSTS [3-4]	849	812	348
INCREMENTAL NET BENEFIT [INCR. BEN - INCR. COSTS]	336	391	275

NET PRESENT VALUE AT 11.4 % = Rp. 814,920.

(Calculation is equal to Appendix 1).

A.11. Financial budget of Tumpangsari as perceived by Farmers (discount rate at 5.4%)

Item	Year1	year2	year3
BENEFITS--with project	(values in thousands rupiahs)		
Contract fee	28		
Corn revenue	143	143	71
Stalk revenue	56	56	28
Cassava	36	36	18
Subtotal [1]	263	235	117
BENEFITS-- without project			
Wages	111	65	11
Subtotal [2]	111	65	11
INCREMENTAL BENEFITS [1-2]	152	170	106
COSTS--with project			
Land	270	180	
Labor	252	252	126
Equipment	7	7	7
Subtotal [3]	529	439	133
COSTS--without project			
Equipment	7	7	7
Subtotal [4]	7	7	7
INCREMENTAL COSTS [3-4]	522	432	126
INCREMENTAL NET BENEFIT [INCR. BEN - INCR. COSTS]	-370	-262	-20

NET PRESENT VALUE AT 5.4 % = -Rp. 603,970.

(Calculation is equal to Appendix 1).

A.12. Financial budget of Inmas Tumpangsari as perceived by Farmers (discount rate at 5.4%)

Item	Year1	year2	year3
BENEFITS--with project	(values in thousands rupiahs)		
Contract fee	28		
Corn revenue	1,176	1,176	588
Stalk revenue	56	56	28
Cassava	36	36	18
Subtotal [1]	1,296	1,268	634
BENEFITS-- without project			
Wages	111	65	11
Subtotal [2]	111	65	11
INCREMENTAL BENEFITS [1-2]	1,185	1,203	623
COSTS--with project			
Land	270	180	
Labor	312	312	156
Capital	274	274	141
Subtotal [3]	856	766	297
COSTS--without project			
Equipment	7	7	7
Subtotal [4]	7	7	7
INCREMENTAL COSTS [3-4]	849	759	290
INCREMENTAL NET BENEFIT [INCR. BEN - INCR. COSTS]	336	444	333

NET PRESENT VALUE AT 5.4 % = Rp. 1,002,490.

(Calculation is equal to Appendix 1).