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Nicolas S. Uriarte

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BAMBOO PRODUCTION IN THE PHILIPPINES: FINANCIAL ANALYSIS AT THE SMALL FARMHOLDER LEVEL

By

Nicolas Salazar Uriarte

A DISSERTATION

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ABSTRACT

BAMBOO PRODUCTION IN THE PHILIPPINES: FINANCIAL ANALYSIS AT THE SMALL FARMHOLDER LEVEL

By

Nicolas Salazar Uriarte

One significant effort pursued by the Philippine government to remedy problems of rural poverty and underemployment is bamboo production. This study is a component of the Bamboo Research and Development Project and focuses on the financial viability and optimal development schedules for bamboo plantations in three regions of the country, namely: Region 6, Western Visayas; Region 7, Central Visayas; and Region 11, Northeastern Mindanao. Species evaluated were *B. blumeana, B. philippinensis, D. asper, D. merrillianus, and S. lumampao.*

Financial viability was estimated by calculating costs and revenue streams over the 25-year project duration for different management schemes (MS) in three regions of the country. The optimal development schedules, on the other hand, were determined using linear programming (LP). The two objective functions used were: (1) maximize NPV of cash flows and (2) maximize the amount of total employment. Family labor, land and available loan funds were constraints. Primary (survey) data and secondary data were used to develop the analyses.

Financial evaluations indicate that 5-ha bamboo plantations are financially profitable in 30 of 32 management schemes evaluated. The NPVs, however, vary depending on management scheme (i.e., species, spacing, harvest schedule, stock source, site) and region.

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Development schedules of bamboo plantations vary depending on the amount of family labor contribution (FLC), represented by household type (HT). Variations in FLC affect timing of plantation development and ultimately NPVs. Depending on HT, MS, and region, total hectares developed range from 3.62-5.00 ha with NPVs in pesos (P) ranging from P2,010-P286,832.

Considerable employment may be generated through bamboo production. For 5-ha plantations, the amount of labor-use ranges from 7,075-11,831 person-days over the 25-year period depending on MS and HT. This is equivalent to fully employing 1-2 members of a household. Potential income from labor wages is estimated to range from P530,625-P887,325.

Potentials of bamboo production to improve the financial status of poor farmers through increased employment are great. High demand for bamboo products and diminishing natural supplies provide an impetus for implementing this project. Analysis results indicate that expanding opportunities for poor farmers can provide needed income and employment in rural Philippines.

To my mother,

Mrs. Corazon S. Uriarte

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CHAPTER 1

BACKGROUND AND JUSTIFICATION

1.1. Introduction

Rural poverty is widespread in the Philippines. Several efforts are underway to address this problem; one such effort is the Bamboo Research and Development Project (hereafter referred to as the Bamboo Project). The main objective of this project is to assist the Philippine Government in creating new sources of employment and thereby raising the income levels in appropriate rural areas of the country. It is funded by the Food and Agriculture Organization of the United Nations (FAO) and aggressively pursued by the government of the Philippines. Specifically, the project intends to broaden the raw material base, generate jobs, increase income, and rehabilitate vast denuded areas created by the rampant timber exploitation of the past three decades.

Pursuit of this undertaking is driven by a combination of factors having some collateral implications for the other rural-oriented, poverty-alleviating and developmental-type programs pursued by the Philippine government. Some of these programs are: the Comprehensive Agrarian Reform Program (CARP), the Community Employment and Development Program (CEDP), and the Integrated Social Forestry Program (ISF).

The Bamboo Project's focus was the outgrowth of several considerations. First and foremost, the choice of bamboo species is borne out from the realization that a wide gap between quantity demanded and quantity supplied has been experienced and will continue to exist in the years to come. Bamboo, though endemic to the country, has dwindled considerably because of over-exploitation. Conversion of lands to other uses is another contributory factor to its depletion. As built-up areas expanded to accommodate the swelling population, total elimination of these species in some areas has occurred. Though certain areas still contain considerable stands, transportation of bamboo products to markets is difficult.

Another compelling reason for encouraging this type of activity is the recognition that there exists a considerable surplus of labor in the rural sector. The National Economic and Development Authority (NEDA) estimated that while the rural unemployment rate was only 7.4%, the underemployment figure was a staggering 40.4% (NEDA, 1989). NEDA added that labor productivity in the agricultural sector has declined considerably from previous years although this sector continues to absorb the bulk of the labor force.

Promotion of bamboo plantations in the countryside is one possibility that has great potential for creating employment and increasing income. It has the potential for profound economic and social implications. The impact is expected to extend beyond household basic needs or community satisfaction. It is hoped that it will affect other more pressing problems (e.g., social unrest). Relative to the CARP, this project would serve as an additional option for farmers in improving their well-being.

One goal of Bamboo Project is to provide poor farmers access to government lands for plantation development. Conversion of marginal lands into productive areas is vital in sustaining the livelihood of the poor people. Moreover, this has a strategic advantage in some respects because it will mostly involve upland and landless farmers, the social group most vulnerable to the anti-government campaign.

The Commodity - Bamboo

Bamboos have many uses. Historically, bamboos form the single most important forest product used by rural communities in Asia and the Pacific (Sharma, 1985). They are so closely intertwined with the lives of the people that it is beyond comprehension (as one Chinese author said) for one to live in ancient times without bamboo for a single day. The close relationship between this commodity and the people is succinctly phrased by the famous poet of the Sung Dynasty (1312 A.D.), Su Dongpo, when he said:

> "*there are bamboo tiles for shelter, bamboo hats for shading, bamboo paper for writing, bamboo rafts for carrying, bamboo skin for clothing, bamboo shoes for wearing, bamboo shoots for eating, and bamboo fuels for fire*" (Wo and Ma, 1985).

Its significance is so great, especially in South and Southeast Asia, that it is difficult to speculate what would have happened to the people in this part of the world without bamboo. Lessard (1980) hypothesized that if all countries in Asia where bamboo is abundant are taken into account, then at least one-third of the human race is making use of this perennial plant.

The Philippines is one of the countries endowed with this valuable resource. Bamboo plays a distinct role in the lives of Filipinos. In the rural areas, 26% of the housing units are constructed from bamboo materials (Philippine Yearbook, 1975). As one of the most versatile natural materials, bamboo makes possible the development of various products. The ease with which this material can be worked, its strength, its durability, and availability makes it eminently suitable for domestic and commercial consumption (Tamolang *et al.*, 1980). In addition, bamboo is native to the country and has extraordinary growth[1] compared to tree species promoted in domestic reforestation projects.

In recent years, utilization of bamboo has evolved tremendously from the very traditional uses as house construction materials and agricultural implements to furniture and handicrafts. It has become one of the primary materials for banana propping since cutting permits for saplings were cancelled. The fishery industry is also getting a large share of the bamboo material due to expanding fishpen operations in some regions of the country. Prospects in other sectors are even higher as technology for its utilization is being developed.

The continued growth of bamboo-using industries in the country has tremendously accelerated the exploitation of the natural stands. Extensive harvesting is rampant. In some areas, indiscriminate cutting is very noticeable. Pressure is so great on the demand side that it is contributing heavily to the depletion of the resource. As indicated by the Forest Management Bureau (FMB) formerly the Bureau of Forest Development (BFD), only about 15,574 hectares of natural bamboo stands were left in

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[1]*The Guiness Book of World Records (1989) noted that some species of the 45 genera of bamboo have attained growth rates up to 36 inches per day. Observation in Hawaii indicated that a certain species of bamboo can reach 100 feet in height in less than 3 months.*

1980 from the 200,000 hectares surveyed in 1963 (BFD Statistics,1980; PCARRD Recommends, 1984). As estimated by Tesoro (1983), these stands may contain a total of 1.77 million culms (woody stems arising from the rhizomes with a cylindrical form and comprising a series of nodes and internodes). This inventory is, however, insignificant compared to the annual projected demand of about 31.27 million culms (Tesoro, 1983).

The wide gap between quantity demanded and quantity available has resulted in more harvesting of immature culms. Coupled with the absence of clear government regulations on management and harvesting, the remaining source will be continually threatened. The future seems bleak for this commodity given the persistent pressure from end-users. Reliance on remaining stands to support raw-material requirements is no longer possible.

Increased consumption of this resource has greater repercussions for the local people. Recently, prices rose to high levels inhibiting local users from competing with industrial users. This complaint was raised by some farmers during the conduct of the ground verification survey of bamboo stands in selected provinces of the Philippines (Uriarte,1985). Bamboo owners prefer to sell their produce to industrial users rather than to their co-farmers because prices offered by the former are higher. Besides, industrial users tend to buy in larger quantities so that even lower quality culms can still command good prices.

The imminent shortage of this valuable resource has been recognized by different sectors of the industry (PCARRD, 1984; DENR, 1988). As a result, the exploitation of bamboo poles has greatly diminished, and there is concensus that dwindling stock must be replenished. Moreover, what has been a readily available material for rural people seems too scarce for them to acquire, and there is a clamor for establishing bamboo plantations.

But addressing simply the concern for expanding the raw-material base may not be a sufficient solution considering that the need for an equitable distribution of income is even more pressing. Therefore, it is crucial to evaluate how investments in this particular activity can affect the plight of the primary beneficiaries--the small farmers.

Prospective Participants - Small Farmers

The added concern for farmers is as critical as the concern for the commodity. Creation of bamboo plantations may help the government reach the most neglected segment of Filipino society.

Poverty in the country is deepening. The incidence of the population living below the poverty threshold[2] is very alarming. In absolute measure, IBON Databank Philippines (1983), a private research organization, estimated that about 71% of the population or approximately 6.6 million households are living below the poverty line. Although other estimates are less definitive, all groups concerned with the incidence of poverty in the Philippines are in complete agreement that the upward trend of families falling below the poverty threshold is continuing. Coupled with the steady contraction

[2]Jurado (1979) *defines the poverty threshold in the Philippine context as the cut-off point below which income cannot buy for the family its recommended nutrient requirements, cannot permit two changes in garment for each family member, cannot cover the minimal cost of medical care...and cannot afford to pay roughly imputed rent and fuel costs for families who meet the food standard.*

of the economy, it can be surmised that the trend will continue or will even worsen in the years to come (Miranda, 1988). In relative terms using the Gini coefficient[3], the National Census and Statistics Office (NCSO) indicated that the poorest 60% of the households, which received only 25% of the total income in 1971, suffered a further decline of their share to 22.5% in 1979. This is not a recent phenomenon as Miranda (1988) indicated because the social struggle waged by the peasants was deeply rooted in this inequality. President Aquino in her sincere initiative to offer negotiations for peace and reconciliation with the insurgents has fully recognized that "*the roots of the insurgency are in the economic conditions of the people and the social structures that oppress them*".[4]

The government has a strong anti-poverty agenda. Critics, however, are very vocal that most programs have short-term implications and merely focus on the reduction of poverty without any reference whatsoever to income distribution and distributive justice (IBON, 1987). Therefore, by focusing mainly on rural employment like the CEDP without the accompanying structural reforms, the government may encounter difficulty in solving the conflict in the countryside that has bred the poverty (Miranda,1988).

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[3]*The degree of inequality is measured using the GINI coefficient: Introduced in 1912 by C. Gini, an Italian statistician. Gini ratio ranges from 0.0 (absolute equality) to 1.0 (absolute inequality).*

[4]*On Dec. 10, 1986, the Government of the Republic of the Philippines and the National Democratic Front (NDF), the political arm of the Communist Party of the Philippines (CPP) entered into a preliminary ceasefire agreement in preparation for a negotiated peaceful settlement of the present armed conflict between the government forces and the New Peoples' Army (NPA), the military arm of the CPP. The agreement expired on Feb. 8, 1987 without achieving its objectives.*

Family labor utilization on farms is very low. Hayami (1978), in his study of one agricultural village in the Philippines, found that the labor utilization rate was less than 70% of full capacity even at peak season. The opportunity to find jobs outside farming is limited, and labor is underutilized especially between planting and harvesting (Ledesma, 1982). Diversifying the activity of the farmer may, therefore, lessen the labor surplus and increase productivity.

Target Areas - Public Lands

The Philippine forest resources situation indicated that of the country's 30.0 million hectares total land area, about 15.0 million are forest lands, 14.1 million are Alienable and Disposable (A&D)[5] and the remaining 0.9 million hectares are still unclassified (DENR, 1987). Considering that the bulk of the land is under public domain, promotion of bamboo production may be easier than other projects (e.g., pulpwood plantations, and fuelwood productions) because of the wide adaptability of the species (Bumarlong, 1985).

Considerable areas are available for bamboo plantation development in different regions of the country. Attention should be given, however, to tenural and traditional rights mitigating against ownership. In light of this, policies evolving for democratization of public lands use by projects such as pulpwood plantations,

[5] *Alienable and Disposable refers to all lands which are classified for other purposes aside from forestry. These lands can be converted to agriculture, residential, commercial, or any other purpose outside forestry. These lands are under the control of the FMB-DENR, but as soon as these lands are further classified to specific uses, the jurisdiction is transferred to LMB-DENR.*

fuelwood production and the recent Integrated Social Forestry Program may need to be adopted (DENR, 1987). For this project, the basic provisions of a leasehold contract should spell out the details on such delicate aspects dealing with: (1) security of tenure, (2) continued occupancy of present clearings, (3) size of holdings, (4) development of forest lands by individuals, and (5) such other provisions that may be developed in the course of this inquiry. This is also in line with Section 3, Schedule 1 of the Comprehensive Agrarian Reform Program (CARP)[6] which states:

> "*All lands of the public domain and other lands owned by the government or by government-owned or controlled corporations, associations, institutions or entities leased or held by multinational corporations or foreign individuals shall be acquired and distributed immediately upon the effectivity of R.A. 6657 (CARP), with the implementation to be completed within 3 years*" (Administrative Order No. 11, Series of 1988, DAR).

These core programs of the government are very vital in the pursuance of Bamboo Project.

1.2. Context of Study

Background information about the Philippines is important for understanding how this project could fit with other programs the government is pursuing. By briefly looking into some aspects of the country and its people, insights can be gained regarding the relevance and timeliness of this study. Especially in project design, historical perspectives are needed. Lessons from the past are of great value as this project implementation is pursued. The remainder of this section presents a brief

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[6]CARP *is the biggest government program instituted under the new leadership of President Aquino. The underlying principle behind it is the promotion of equity coupled with the democratization of access to land and the benefits derived from it.*

sketch of the Filipino people, the government, the economy, the rural community structure, and recent reforms.

The People

The population was approximately 58 million in 1988 (NEDA, 1989). Density was estimated at 492 per square mile with 95% of the area and population found on the 11 largest islands. The Population Reference Bureau (PRB) estimated a growth rate of 2.8% and ranked the country as the 17th most populous country in the world. Average family size is six. Distribution is approximately 70% rural and 30% urban.

The Government and the Economy

A legitimate democratic government is now in place after Filipinos ratified the New Constitution in a plebiscite held on February 2, 1987. Prior to that, however, the old regime was toppled peacefully in the famous "February Revolution". The challenge facing the nation is to overcome economic inequities and social injustices remaining after the change in government.

The Gross National Product (GNP) was valued at US$39.04 billion in 1988. The growth rate was estimated to range between 5.8-6.0% in 1988, but in previous years performance was very low. The positive growth in recent years was primarily driven by the renewed confidence of the business sector in the new government. The inflation rate was 8% in 1988, much higher than in previous year's 0.34%. In terms of jobs, about 35% (or equivalent to 2.6 million Filipinos) were jobless in 1988. Another 5 million were underemployed out of a total workforce of 21.7 million. Real earnings in terms of wages received indicated a drop of 6% from 1987 to 1988.

The government is heavily depressed economically. Current external debt is aprroximately US$28.6 billion with a domestic debt of about US$13.3 billion. To service outstanding debt for 1989 alone, an amount of US$3.3 billion is required.

Overall, the standard of living declined slightly in 1988 with the poor two-thirds of the population dependent on agriculture suffering the most (World Bank, 1987). A September, 1988 survey by Ateneo de Manila University indicated that about 66% of the families are living below the poverty threshold (Miranda, 1988).

Family/Community Structure in a Rural Setting

In rural Philippines, the family is the basic social unit or institution "which public policy cherishes and protects" (Ortigas and Regalado,1978; Maceda,1967). It is the center of activities for maintaining society. In terms of economic affairs, the family is the major unit of both consumption and production. It is the family that decides which goods are to be purchased and how they are to be used. The head of the family, usually the husband, directs and allocates labor in agricultural occupations which accumulates capital and which, on occasion, will loan capital to its members. Above all, it is a prime responsibility of the family to provide nurture and protection for the young, support for the unemployed and less fortunate members, and care and companionship for the aged and sick.

These family-oriented values have a profound influence on individuals and their behavior towards society. If individuals become insecure socially and economically, it causes some social problems (Maceda, 1967; Andres and Andres, 1987). Family members think that they have no one to fall back upon except the family. As a consequence, the family has become the highest norm of morality--everything is good that serves the family welfare; everything else is an instrument for achieving the family's goal of socio-economic security (McMillan and Rivera, 1952; Andres and Andres, 1987). In addition, families have a high degree of unity and some traditions bind them closely to their place of birth. Migration to another place often is difficult.

Several sociologists consider some traits of the Filipino family as barriers to progress or as divisive factors in the community and even to the nation as a whole (Maceda, 1967; McMillan and Rivera, 1952; Ortigas and Regalado, 1978; Andres and Andres, 1987). By their nature, families militate against working together for the broader common welfare.

Social/Political Structure Synthesis

The Filipino concept of society is segmentary (Weintraub, 1973). Rather than viewing society as a collective group striving to achieve common goals, Filipinos perceived it as a system of relationships between people of different heirarchical levels, bound in a network of mutual obligations. The explanation forwarded by Weintraub (1973) is two-fold: (1) the traditional value of reciprocity (utang-na-loob) and (2) the belief that an individual alone is powerless, with security depending on the help and protection of a powerful person. Reciprocity and dependency have thus been key factors in the Filipinos immediate reality. Filipinos view relations among people and social organizations in general in terms of mutual obligations between the weaker and the stronger, obligations which are best expressed in terms of the use of power.

Politics in the Philippines is deeply rooted in the social relationships of a population composed of a small, land-owning national elite on the one hand, and a large, impoverished, peasant working class, on the other. This is exemplified by ownership of private lands which indicates that 10% of population owns 90% of the land (Freisen, 1988). These social relationships that have traditionally influenced political behavior can be traced to the periods of colonial rule. Families favored by colonial governing powers established regional strongholds based on landholdings and eventually assumed economic and political prominence. The current political setting in the Philippines, therefore, can be best understood in the light of historical events that have shed political thought during the country's transformation from a colony to a republic. The evolution of the Filipino social infrastructure is amply described by Infante (1980) in the following quote:

> *"For the vast majority (Filipinos)...their lives continued to be governed by the economic guidance of a landlord who maintained a mutually satisfactory patron-client relationship with his tenants. The latter relationships, together with the closeness of family ties and associated values and behavior patterns was basic to the social, economic, and political life of Filipinos. The landlord although customarily taking about half of the harvest, provided his tenants with various forms of security-cash loans, rations to tide the family over the preharvest shortage, assistance in family crisis, financing the education of a promising child, or assuming the important social role of godparent. In exchange, the tenant offered a variety of personal services as well as political and economic loyalty."*

Structural Reforms

The highest priority of the government is economic recovery. The overall strategy, as spelled out in the Medium-Term Development Plan (NEDA, 1988), emphasizes three key economic principles, namely: (1) greater attention to poverty alleviation and social justice, (2) acceleration of growth and increased economic efficiency, and (3) reduced government involvement in the economy and an emphasis on private initiative. Heavy emphasis will be placed on programs to reduce poverty, to raise employment particularly in rural areas, and to accelerate agricultural production and exports (World Bank, 1989).

Three vital programs that have some direct impact on the rural people and are being aggressively pursued by the government are: (1) the Comprehensive Agrarian Reform Program (CARP), (2) the Community Employment and Development Programme (CEDP), and (3) the Integrated Social Forestry Program (ISF).

CARP is the centerpiece program of the present administration. This program has great appeal to the government because it is believed to form a solid base for industrial development. Its focus is to increase consumption and investment of the peasant workers and to stimulate higher demand for industrial products. It is intended to increase productivity by expanding production of raw materials for industrial consumption. More importantly, it has wide-ranging implications because (1) it may undercut the level of support among rural communities for the New Peoples' Army guerillas, (2) it encourages agricultural diversification, and (3) it helps stimulate domestic demand by raising rural incomes, thereby breaking the cycle of chronic underconsumption which characterize the country's economy.

CEDP was launched as a direct government response to rural poverty. The rationale behind the program is to create jobs through the establishment of rural-based projects. The employment of excess labor may ultimately increase the purchasing power of the rural population.

This program is envisioned to provide employment opportunities via labor-intensive development and infrastructure projects such as construction of feeder roads, school buildings, communal irrigation systems, reforestation, seed production, and distribution of planting materials.

ISF aims to mobilize forest resources for economic and social progress of the nation through the involvement of upland farmers (kaingineros) and other occupants of forest lands who shall be made effective agents of the state in food production and in rehabilitation of forest lands. The government, on the other hand, shall provide security of tenure and assist the farmers in improving and sustaining the productivity of the land. Creation of agroforestry farms is one of the vital components of this program.

1.3. Objectives of the Study

The goals of this study are tied to the overall objective of the Bamboo Project spelled out in the first section of this chapter. Establishment of pilot scale bamboo plantations in the different regions of the country is an attempt to bring the project closer to the people and at the same time to accelerate generation of technology on bamboo production.

There are two main objectives in this study. The first objective is to determine the financial viability of bamboo plantations in different regions with different bamboo species and family labor availability. To achieve this objective, income streams must be calculated using different species and management schemes. In addition, labor requirements over time and credit extension and repayment schemes must be assessed.

The analysis is carried out using the financial analysis procedures commonly applied in forestry projects. The net present value (NPV) is used as a measure of the net incremental farm income for farmers who may engage in bamboo plantations.

The second major objective is to determine the optimal development schedules for bamboo plantations based on a 5-hectare module. Two goals (i.e., objective functions) are considered: (1) maximizing the net present value of cash flows and (2) maximizing the amount of employment. Models are developed based on the amount of surplus labor each household type can provide for an appropriate species for a given region.

The family labor supplied in peso equivalents serves as equity for financial assistance; a loan equal to three times this equity can be secured. The Bamboo Project's intention is to tap idle labor without disrupting the usual livelihood activities of the farmers. This project is perceived as increasing labor productivity. Financial implications are determined by how bamboo plantation development proceeds. Individual household capability plays a major role in determining how the income streams are affected by the limitations of the family labor contribution. The outcome may serve as a guide in formulating assistance packages that would best suit the successful implementation of the Bamboo Project.

1.4. Scope of the Study

Bamboo production, as viewed from this study, is a part time activity. The study's framework is only to consider the surplus labor of each household type. The analysis does not consider the whole farm plan but focuses only on the optimal use of excess family labor.

Only five species of bamboo are covered in this study. Selection was primarily based on the demand for the species, availability of yield data, and inclusion of the species in the pilot plantation projects undertaken by the Ecosystem Research and Development Bureau (ERDB). Although other species are also commercially utilized, data inavailability, especially on yield, prohibits inclusion at this time.

Three regions in the country are included in the analysis, namely: Region 6 (Western Visayas), Region 7 (Central Visayas), and Region 11 (Northeastern Mindanao) (see Figure 1). These regions have shown great promise in the market for bamboo materials because of the presence of bamboo-using industries. The pilot plantations in these areas have also performed well during the initial evaluation in 1989 (ERDB, 1989). Besides, some bamboo owners in these regions are also willing to share their experiences and records which at this time are not yet available from the Bamboo Project.

This study utilizes a combination of survey and secondary data. Survey data include household profiles, farm gate prices, and production costs. Secondary data, on the other hand, include yield estimates and harvesting and hauling costs.

Since a considerable number of poor farmers are seeking employment opportunities and access to land, leasehold agreements are believed to provide sufficient tenural security for farmers. The 25-year lease period applied to the pulpwood plantation project, the fuelwood production program, and the ISF are also used here for purposes of determining the cash flows generated. Analyses are based on a 5-hectare module, which was deemed to be reasonable enough to gauge the income

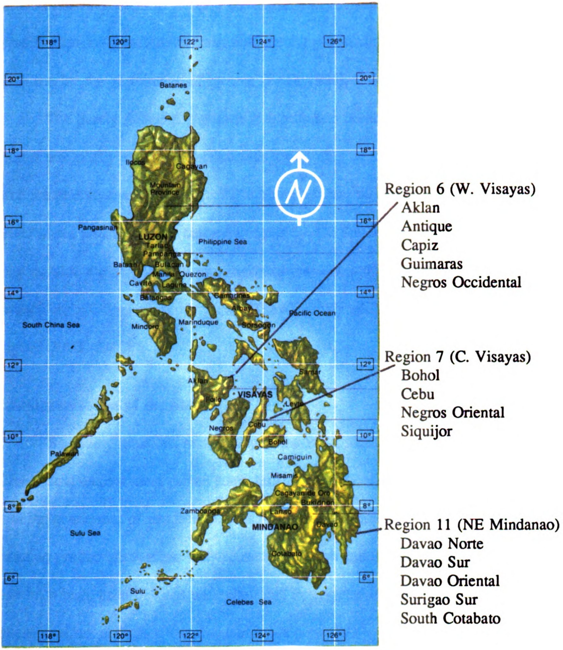

Figure 1. Map of the Philippines Showing Regions Included in the Study.

effect for potential bamboo farmers.

Financial analysis is the primary consideration of this study. The financial measures are sufficient to indicate the capacity of the farmers to repay loans. Clear identification of beneficiaries links commercial profitability of the project with concerns for the distribution of income (FAO, 1980).

The purely financial approach is appropriate because all of the production factors are locally secured. The domestic availability of the different resources used to produce the raw-material reflects the economic value except in cases where government policies distort the price of money. On the output side, the market price may provide a reasonable approximation of the economic value since the project outputs are not final consumer goods. They are only additions to the total intermediate supply (FAO, 1980).

1.5. Organization of the Study

Bamboo plantations particularly in the Philippines, are relatively new. While silvicultural studies have gained some breakthroughs in the past, not one study delves into the economics of production. Past reliance on natural stands undermines pursuit of bamboo production studies. Only recently, research and development efforts on bamboos have been pursued with vigor and determination. This study is part of an ongoing effort to further examine bamboo's potential.

The preceding review of the current situation in the Philippines has been included to show how the Bamboo Project could fit into the other government programs dealing with rural employment and income expansion. The need for some structural reforms are also noted because of the clamor for income redistribution and distributive justice.

Chapter 2 deals principally with the distribution and characteristics of different bamboo species. Traits of bamboos are discussed to distinguish their relative advantages over tree species generally planted in reforestation projects. In addition, production factors are identified. Factor identification is valuable for assessing how farmers' resources can be complemented by government programs. Selected studies of analytical techniques for financial evaluations and activity schedulings are also reviewed.

Data requirements and sources, methods for gathering data, model formulation and the sequence of study analyses are expounded in Chapter 3. The focus on farmholders was given special attention in the financial analysis and activity scheduling because of the limited resources farmers can invest in bamboo plantation.

Chapter 4 presents the results from this study's survey, financial analyses, and optimal scheduling for plantation development. Results are discussed relative to species, household type and region. Optimal schedules were developed on the basis of maximum net present values and maximum amount of labor generated.

In the final chapter, significant findings are summarized with implications for other bamboo species, for other regions of the country and for other participants of the Bamboo Project. Shortcomings encountered in the course of the investigation are described and recommendations for further research are identified.

CHAPTER 2

REVIEW OF LITERATURE

This chapter is divided into three main sections. The first section deals with distribution, characteristics and uses of bamboos. Factors of production are treated in the next section. Analytical methods emphasizing applications of benefit-cost analysis and techniques for scheduling management activities over time are discussed in the last section. Linear programming (LP) is the principal analytic scheduling tool discussed with a focus on applications concerning small farmers. The appropriateness of the LP technique and its modifications and extensions are also presented.

2.1. Distribution of Bamboos

The *Bambuseae* family is a section of the great natural order *Gramineae*, the grasses (Gamble, 1986). These large tree-like members of the grass family, which are characteristic of tropical regions, are very useful in localities where they are found. Their distribution has even extended to subtropical and temperate zones. Some are found in forests and some on well-drained slopes.

Bamboos are usually gregarious, that is, they dominate the area once established. Bamboo forests are confined within 15-25 degrees of both sides of the equator. Locations include southern China, Burma, Thailand, Laos, Vietnam, India, Bangladesh and all of Southeast Asia. Colonies of bamboo are found in Columbia, Peru, Chile, Paraguay, Bolivia, Madagascar, Mozambique and Rhodesia (Tamolang *et al.*, 1980).

Bamboos generally grow well in places that have temperature between 8.8-36 degrees Centigrade (Tamolang *et al.*, 1980) and under a light to moderate canopy of deciduous species (Sharma, 1980). The distribution of bamboo in the Asia-Pacific region is presented in Table 1.

2.2. Description of Bamboo Species

Bamboos are perennial giant grasses. The rhizome of bamboo are of two kinds, namely, those with caespitose culms and those with distant culms. Those with caespitose culms have rhizomes which are short, knotty, thick, solid growths forming an entangled network below the surface of the soil from which buds are thrown out into culms. These are characteristic of the clump-forming erect bamboo species. Those with distant culms have rhizome which push underground and at intervals send out rootlets into the soil from which the culms arise singly. Monopodial species are of this type.

When the young culm emerges and the bud first begins to develop, a conical growth protrudes from the ground, covered with imbricating sheaths often bright in color and furnished with blades. Gradually, the cone lengthens, the sheath separates, the nodes appear, and a full culm is produced. Then usually, one by one, the sheaths drop off. The buds at the nodes put out branches, and these produce leaves. Depending on locality and climate, the timing of this process varies.

Table 1. Important genera of bamboos in the Asia-Pacific Region.

Country	No. of Species	Genera
India	136	*Bambusa, Dendrocalamus*
Bangladesh	33	*Bambusa, Dendrocalamus, Melocalamus, Melocanna, Neohouzeoua, Oxytenanthera*
Burma	90	*Sinobambusa, Chimonobambusa, Arundinaria, Phyllostachys, Gigantochloa, Dinochloa, Oxytenanthera, Dendrocalamus, Dendrochloa, Pseudostachyum, Schizostachyum, Neohouzeoua, Cephalostachyum, Melocanna, Teinostachyum*
Philippines	55	*Bambusa, Schizostachyum, Dendrocalamus, Gigantochloa*
Indonesia	31	*Arundinaria, Dendrocalamus, Bambusa, Gigantochloa, Nastus, Melocanna, Phyllostachys, Schizostachyum, Thyrsostachys*
Thailand	50	*Thyrsostachys, Bambusa, Dendrocalamus*
China	300	*Bambusa, Dendrocalamus, Lingnania, Sinocalamus, Schizos, Dinochloa, Pseudostachyum*
Japan	670	*Phyllostachys, Sasa, Pseudosasa*
Korea	13	*Phyllostachys, Pleioblastus, Sasa, Pseudosasa*
Malaysia-Sabah	12	*Gigantochloa, Schizostachyum*
Papua New Guinea	26	*Schizostachyum, Bambusa*
Bhutan	2	*Dendrocalamus, Bambusa*
New Caledonia	4	*Greslania*
Sri Lanka	14	*Dendrocalamus, Bambusa, Ochlandra*

Sources: Sharma, 1985 and Tamolang *et al.*, 1980.

Woody stems or culms arise from the rhizome. These culms are cylindrical with a series of nodes and internodes. Culm wall thickness, culm diameter and culm height vary. Distribution and site requirements of bamboo species used in the study are presented in Table 2.

2.3. Physical and Mechanical Properties of Bamboos

Bamboo compares well and favorably with other construction materials like steel, concrete and timber in strength and stiffness per unit area of material, ease and safety of use (Jansen, 1985).

Espiloy (1985) reported that the physico-mechanical properties of bamboo (e.g., relative density, shrinkage, moisture content, static bending and compression parallel to the grain) are correlated with anatomical characteristics such as fibrovascular bundles, frequency and dimensions of fibers, and vessels. These properties are necessary in assessing potential uses of bamboos as building materials for housing, furniture-making and for general construction work and in converting them to a variety of finished products. These properties not only serve as a basis for promoting acceptance of bamboos but also for improving their market potential.

Strength properties either increase or decrease along the length of the culm from the butt to the top (Espiloy *et al.*, 1982; Uriarte *et al.*, 1990). Mensurational attributes of bamboos used in the study are shown in Appendix A. Physical and mechanical properties of four erect bamboo species are presented in Appendix B. No data are available for *B. philippinensis*.

Table 2. Site requirements and distribution of five erect bamboo species in the Philippines.

Species	Site Requirements and distribution
B. blumeana	Moist soil, found throughout settled areas in the Philippines at low and medium altitude. Luxuriantly growing along river banks and creeks. Abundant in Rizal, Camarines provinces, Cavite, Batangas, Laguna, Pangasinan, La Union, Abra, Ilocos provinces, Davao Sur and North Cotabato.
B. philippinensis	Moist soil, growing luxuriantly in areas with rainfall evenly distributed throughout the year. Commercially cultivated in Davao provinces.
D. asper	Moist soil occuring profusely in areas with well distributed rainfall throughout the year. Grown in Bukidnon, Agusan Sur and Mt. Makiling in Laguna.
D. merrillianus	In relatively drier sites at low and medium elevation. widely distributed in the Philippines (Rizal, NE Luzon, Pangasinan, La Union, Ilocos Provinces and Tarlac).
S. lumampao	Relatively moist soil. Usually in forest hills. Naturally growing in Zambales, Bataan, Quezon, Laguna and Rizal.

Source: Lantican *et al.*, 1985.

2.4. Propagation Methods

Erect bamboo species can be propagated using either vegetative (asexual) or reproductive (sexual) methods. Vegetative methods for propagation includes combination of culm cuttings, layering, marcotting, and branch cuttings.

In using rhizomes, they are dug and severed from the mother plant and immediately planted in the field to avoid drying. They can also be grown in the nursery and allowed to develop for six months to a year before outplanting. Offsets from 1-2 year old culms give better results as the rhizomes are young and vigorous and possess active culm buds. The success of this method depends on the vitality of the culm bud in the rhizome and the time of the year when the offset is planted (Banik, 1985). In Japan, cultivation of bamboo by rhizome cuttings has been perfected (Uchimura, 1980). Generally, the use of rhizomes is limited to non-clump forming species (Uchimura, 1980).

The disadvantage of this method lies in the high cost of labor for excavation and transportation of the bulky planting stock. Also, only a limited supply of the planting material is available per clump; thus, this method is not practical for large plantations.

The second approach to vegetative reproduction is culm cutting. Cuttings of at least one node and two half internodes taken from the middle and the basal portion of one to two-year old culms are used. In 1980, two-node culm cuttings were directly planted in a grassland area (Lapis *et al.*, 1980). Results showed that the field survival rates of *B. blumeana* and *D. merrillianus* six months after planting were 25% and

35%, respectively. Survival rate of *D. asper* after 3 months was 32%. *S. lumampao* failed to grow. Suzuki and Ordinario (1977) also found that S. *lumampao* cannot be easily propagated by culm cuttings.

Experiments showed that rooting can be greatly enhanced by treating planting stocks with growth hormones like napthalene acetic acid (NAA) or indole butyric acid (IBA). The cuttings can be directly planted in the field or raised in the nursery for 6-12 months. Using *B. blumeana* and different levels of NAA and IBA, Bumarlong (1977) showed that 600 ppm NAA gave the highest total dry weight and mean total length of roots, and 200 ppm gave the highest mean number of roots. Suzuki and Ordinario (1977) obtained a 45% survival of *B. blumeana* treated with IBA and 32% for untreated; 60% for treated *D. merrillianus* and 53% for untreated ones.

A third approach is layering. This can be done by partly bending down two-year old culms and laying them in the ground so that they can produce roots. When the shoots appear, the culm is cut at the internode and the layers are planted separately. Cabanday (1957) obtained a survival rate of 28% for *B. blumeana* by ground layering 1-year old culms pruned of branches.

Marcotting is another method of vegetative reproduction. Two-year old culms are tapped down from the mother culms. These are supported with strong props. Ordinary garden soil and leaf with molds are placed around the node then wrapped with coconut husk fibers and tied with fine wire at both ends of the marcotted portion. Cabanday (1957) reported a 70% survival rate for 123 marcots of *B. blumeana*.

The final means of vegetative reproduction uses branch cutting. Branches from 1 to 2-year old culms with three nodal lengths are collected during the early rainy season. They can be treated with 100 ppm of NAA then propagated in a sand bed. Then they can be potted directly or can be potted after 20 days when it has already rooted.

Hasan (1977) found that using branch cuttings instead of offset overcame the difficulty of scarcity, bulk and weight of planting materials, but that success in propagation was very limited. His results showed that branch cuttings take 6-30 months to develop into good planting material.

Palijon (1983) obtained a rooting percentage of 83-90% using branch cuttings of *B. blumeana*. The same study showed that hormone treatment (100 IAA) enhanced root and sprout development.

The reproductive (sexual) method of propagation uses seeds gathered from the mother plant. These are readily germinated. In 1980, Lapis *et al*. conducted trial plantings of seeds of *S. lumampao* and found that this species can be successfully propagated by seeds. However, application of NPK (nitrogen, phosporus, potassium) fertilizer (50 kg/0.1 ha and 100 kg/0.1 ha) exhibited better growth than that of the control seedlings.

The principal disadvantage of this method is the infrequent to rare flowering of most bamboo species and the production of infertile seeds by most species when they bloom. Moreover, most species generally die soon or a year after flowering, or vegetative growth of some species that do not die slackens during the flowering. Furthermore, the genetic quality of the seeds is less certain than that of asexual reproduction (Uchimura, 1980). Thus, bamboo propagation by seeds is not dependable.

Establishment of bamboo plantations is very critical not only on its dependence on vegetative propagation but also on whether to use direct planting or grow the planting stocks in the nursery. Results from direct planting using culm cuttings were unsatisfactory with survival rate ranging from 32-60% even with applications of growth hormones (Suzuki and Ordinario, 1977; Lapis *et al.*, 1980). For plantation using nursery-grown stocks, survival rate ranges from 80-93% (Palijon, 1983; ERDB, 1989). With this high survival rate, only one replanting is required to attain the desired stocking.

2.5. Management and Care Practices

Management of bamboos is based on the physiologic development of the culms. New culms are produced from the rhizome generally along the periphery of the clump. Although the culms attain their maximum size in one season, these are not ready for utilization because they lack strength. Further, for proper development of new culms and their support, a certain number of culms one or more years old have to be left. Thus, although bamboos behave like an annual crop, it is not possible to harvest all the culms annually (Varmah and Banadur, 1980).

Several Japanese scientists found that fertilization increases growth, although the amount of increase varies more or less according to the composition of the fertilizer and season of application. They also observed that the stand structure and increment are improved remarkably if the culms that have reached an appropriate age are cut and a suitable number of good quality bamboos are left standing (Suzuki and Narita, 1975; Ueda *et al.*, 1957 and 1961; Aoki, 1957).

Fertilizing bamboo plantations is not a widespread practice in the Philippines

(Lantican *et al.*, 1985). However, weeding or brushing around the plants is carried out whenever necessary and watering is done when signs of wilting show up after planting.

In the Philippines, there are no specific rules that regulate felling of bamboos. In 1976, Virtucio recommended systematic and selective cutting of matured culms to ensure continuous production of young shoots. The impressive growth and regenerative characteristics of bamboo and high potential for industrial uses are important factors in its successful management. Robillos (1984) reported that the (1) removal of spiny branches in and around the lower portions of *B. blumeana* and (2) decongestion of the clumps by removing high stumps from previous harvesting and cutting of deformed and overmature culms resulted in higher culm production. Treated clumps produced an average of 8 culms while untreated clumps produced only 5 culms per growing season.

Bamboo forests in India, Bangladesh and Burma are generally managed according to a "culm-selection method". The dead, dying, and oldest culms are thinned out, care being taken so that one or two mature culms are retained adjacent to the new culms to give stability (Sharma, 1980).

Bamboo areas should also be protected from fire and grazing animals. About 3-4 weedings around the plant, hoeing around the plants, earthing up, and mulching should be done during the first 2 years.

2.6. Harvesting and Transport

In 1986, Robillos reported that clump-forming bamboo culms should be cut at about 15 to 30 cm above the ground, just above the node, in order not to leave a receptacle in which rainwater can collect. Cutting the culm too high results in unnecessary waste leading to clump congestion and difficulty in harvesting.

Fellers can cut *S. lumampao* and *D. merrillianus* close to the ground. Spiny bamboo like *B. blumeana* is usually cut about 2 or 3 m above the ground, thus leaving the best portion of the culm. The dense growth of spiny branches hinders the cutting of spiny bamboo closer to the ground (de la Cruz, 1989).

The harvesting and transport of bamboo is generally carried out by manual means and requires skill, considerable patience and energy. Cutting is generally done with a small axe, machete (bolo) or bill hook. Minor transport of bamboo is sometimes mechanized, however, water buffaloes (carabaos) are often used to transport bamboo from the clump site to the roadside. Manual skidding of bamboo is also common but is normally used for short distances up to 300 meters.

The subsequent major transportation of bamboo is done with small trucks, agricultural tractors and one or two axle trailers, or with water buffaloes pulling small wagons. River rafting is used for long distance transport of bamboo (Lundel and Liljibland, 1979).

2.7. Uses of Bamboos

Bamboos are suitable for a variety of purposes because of the strength of the culms, their straightness, lightness combined with hardness, range in sizes, hollowness, long fiber length and easy working qualities. These qualities prove to be useful for many products in rural, urban and industrial sectors of many countries (Table 3). Specific uses for this study's five different bamboo species in the Philippines are

Table 3. Consumption (%) of bamboos in the Asia-Pacific Region by end-use.

Country	End-Uses (percent)[a]					
	H	OCP	RU	P	PM	OU
Bangladesh	50	10	20	5	10	5
Burma	33	32	32	5	-	1
India	16	16	30	7	17	14
Japan	24	17	18	7	4	41
Philippines	80	-	15	2	-	3
Thailand	33	20	6	-	8	33

[a]H = Housing
OCP = Other construction purposes
RU = Rural uses
P = Packaging
PM = Pulp manufacture
OU = Other uses

Source: Sharma, 1985.

presented in Table 4.

2.8. Factors Of Production

In general, there are three essential but limiting factors of bamboo production, namely: land, labor and capital. Capital as used in this study refers to the funds, tools and other materials required in the development of plantations, managing the bamboo stands, harvesting and transporting culms to roadside.

Land is a fixed resource whose area can be expanded only based on the extent of open lands suitable and available for bamboo production. Site characterization has not been conducted to delineate areas for this particular purpose, but based on the recent land classification using the SPOT imagery, considerable hectarages may be suitable for bamboo plantations (Appendix C).

Topographically, the Philippines is mountainous having 58% of total land area over 18% in slope (DENR, 1987). Review of the land classification made in 1986-87, in line with the mandate of the CARP, indicated that some areas considered as Alienable and Disposable (A&D) are actually under the forest category because the slope is 18% and higher.[7] This has resulted in a slight increase of Forest Land to 54% from the total land area including areas which are yet to be classified (World Bank, 1989). In principle, these lands are public domain.

Land forms the basis for livelihood for a large percentage of Filipinos. For many tribal Filipinos across the archipelago, land is not only a means of livelihood but

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[7] *The main distinctions between A&D and Forest Land are legal and bureaucratic and not biogeographic. Forest Land may be either steeply sloped or forested. The term uplands as used in this study refers to the more steeply-sloped areas (above 18%).*

Table 4. Breakdown of uses by species in the Philippines.

Uses	Species[a]				
	Bb	Bp	Da	Dm	Sl
Walling	x		x		
Thatching and roofing	x				
Construction	x		x		
Basket making	x		x		x
Cooking utensils	x				
Mats	x				x
Water buckets/vessels	x		x		
Fuel	x	x	x	x	x
Furniture	x		x	x	x
Agricultural implements	x		x	x	
Rafts/floats	x		x		
Tool handles	x		x	x	
Fence	x	x	x	x	x
Shoots for food	x	x	x	x	
Cart sheds/roofs	x		x	x	
Stakes	x	x	x	x	x
Fishing implements	x		x		x
Bridges	x		x		
Barbeque skewers	x		x	x	
Trellises	x	x	x	x	x
Handicrafts	x	x	x	x	x
Afforestation/soil	x	x	x	x	x
Banana props		x			

[a]Bb = *B. blumeana* Bp = *B. philippinensis*
Da = *D. asper* Dm = *D. merrillianus* Sl = *S. lumampao*
Sources: Sharma, 1985 and Tamolang *et al.*, 1980.

is also a spiritual source and a means of maintaining connectedness with their ancestors. Land ownership, however, is greatly skewed (Friesen, 1988). This inequity of land ownership and the resulting poverty of the rural Philippines form the basis for agrarian unrest and discontent.

Rural programs are to be combined with structural reforms in the agrarian sector to increase farmers' welfare. Avushay and Srinivasan (1984) found that government assistance policies without land reform will leave the welfare of each potential tenant unaltered though affecting the level of output, the extent of tenancy, and the welfare of the landlord. The increase in surplus of tenants credits as a result of government subsidization will fully accrue to the landlord as a consequence.

"Land is the lifeblood of the Filipino people" (Friesen, 1988). During the height of the insurgency problem in the South, the Kilusang Magbubukid ng Pilipinas (KMP), a farmers' organization warns :

> *"Fearful forces still haunt*
> *Our hopes, half won and half aborted*
> *Listen, there will be no peace*
> *Till we reclaim our land."*

Land has psychological and cultural significance. It is a source of pride and a sense of personal security.

Rural labor is abundant. Of the 21.6 million Filipinos in the labor force, ten million are employed in agriculture and other related activities. Of these, five million are landless workers, 2 million are tenants, 1.5 million own land they are tilling, while another 1.5 million farm public lands without the benefit of a title (PCSO, 1985).

Employment of the unorganized rural household sector is difficult if not impossible to quantify and qualify (Laarman *et al.*, 1980). This is due to the many factors that have some bearing on the activities of farmers. In most cases, farmers work on their own and do not concern themselves with the time involved in the various activities they are undertaking. As defined by Byerlee and Eicher (1972), rural labor demand and supply can be determined at the micro and macro-levels. At the micro-level, labor demand depends upon such factors as seasonality, effective demand for the output of the sector, the production techniques employed, and the availability of other factors such as capital and land. On the supply side, labor is determined by such factors as health and nutrition, family participation in the labor force, and mobility of labor between small and large farms, farm and non-farm jobs and different regions. The macro-level focuses principally on the high rate of population growth.

Several authors (Mazundar, 1989; Findley, 1987; Ledesma, 1982; Laarman *et al.*, 1980; Einsiendel, 1968; Maceda, 1967) indicated that social mores of rural families ensure that all family members get a share of what the family produces and that they enjoy an income (or consumption level) approximating the average production of the farm. Obviously, there is no open unemployment because aside from household labor, other relatives and hired workers are also sharing the workload.

In most cases, each family member does only a small share of the work so that if one or two members of the family are absent, it is easier for the remaining members of the family to compensate for the shortage by increasing their own share of the total work requirements (Mazundar, 1989). In short, some family members are disguisedly underemployed. Although they contribute little or nothing to production, they still account for additional consumption. Therefore, it is possible to use the surplus labor in productive activities outside the farm. Farm output will not be decreased by the absence of these surplus workers: the possibility of "siphoning-off" these workers could be used to encourage activities away from the farm. Utilizing this labor source will increase the total output of the economy, while maintaining the consumption level either through fiscal measures or market mechanisms as Mazundar suggested. As observed by Findley (1987) in a rural Northern Philippines setting, the sexual division of labor calls for women and children to continue and intensify their work in the agricultural sector, while men seek wage labor nearby or in distant locations as migrant workers.

A case study by Laarman *et al.* (1980) of upland workers in the Philippines indicated that income and employment for most of these people were derived from the collection of so-called minor forest products.[8] Others were engaged on a part-time basis to salvage timber for sale as pulpwood and fuelwood or for their own consumption. Unfortunately, no measure was possible as to how much each person was earning and how much time was spent on the myriad of activities each one was undertaking. As Laarman *et al.* (1980) concluded, the determinant of the rural labor absorption in the years ahead will be the effort committed to reforestation and silviculture as the purely extractive logging phase comes to an abrupt end. What is even more alarming is the increase of upland population. A World Bank study (1989)

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[8]*Minor forest products connotes a miscellany of leaves, stems, barks, roots, saps, resins, flowers, nuts, seeds, etc. In 1980, about 85,000 persons were engaged in their processing and manufacture (as distinguished from collection).*

indicated a tremendous increase from about 5,868,000 in 1948 to 17,835,000 in 1988. Population density grew from 39 person per square kilometer in 1948 to 119 in 1988. This has added more pressure on the ever-deteriorating forest.

There is no question that potential labor in the rural sector is abundant. In many developing countries, however, the adoption of more labor-intensive methods is constrained by credit and by wage and price policies that distort the real scarcities of capital and labor. The imposition of a minimum wage and other extra social benefits pushes the market rate of hired labor above its social opportunity cost. Society's cost of employing labor may be less than the low money wage because the value of an alternative production program would be low (Laarman *et al.*, 1980).

In terms of rural income, Knight (1971) provided another view. He hypothesized that the supply price of labor varies depending on whether the individual or the household is the decision-making unit. If the marginal productivity of labor is less than the average productivity, the household as a decision-making unit is willing to subsidize a migrant relative. On the other hand, for an individual who cannot rent or sell his land because of the communal landholding system, the average product of labor is the relevant income. This shows that the agrarian system can also determine the level of the rural income. The rural Philippines typifies this condition due to close family ties, molded in the Filipino culture.

Family Labor Participation

The amount of time devoted to work varies across males and females and among children. In one survey in Laguna, Philippines, the findings unequivocably indicated that adult women worked longer hours than adult men. The difference is even more prevalent for nonfarm males as a result of the high unemployment rate.

The difference, however, cannot be interpreted to imply inequality in work effort, since they might be compensated for by differences in the intensity of work (Folbre, 1983). One hypothesis indicated that women might work more hours than men simply because the particular type of work they do is less demanding or less onerous. The mother has the control of her own work pace, and her activity in the household is not subject to direct supervision.

Examples of time allocation for adults and for children are summarized in Tables 5 and 6. In Table 6, marketed work refers to labor that is either an activity performed on their own farm or hours used to seek employment from others' farms. Household work, on the other hand, refers to the performance of household chores and is not valued at a market price for the purposes of this study. These activities include: cooking, taking care of the children, cleaning the house, doing the laundry, pitching water and other activities routinely performed by any member of the household.

For activities where labor performed by females is a perfect substitute for jobs performed by males, distinction between the sexes may no longer be an important issue. A household's labor availability for most farming activities, therefore, can be directly inferred from the number and ages of family members.

There are several forms by which labor is exchanged or purchased in the rural Philippines. One common form is the so-called *Bayanihan* in which labor is exchanged without payments, (i.e., in kind). This is very popular in rice planting where the job is preferably done in one short period of time. This type of arrangement is called

Table 5. Allocation of adult work time in Laguna households in hours per week.

Activity	Father's Time (1)	Mother's Time (2)	Ratio 1/2
All households:			
Market work	49.41	16.90	2.92
Home production	3.44	51.56	.07
Total	52.85	68.46	.72
Farm households:			
Market work	52.10	16.30	3.20
Home production	3.20	50.30	.06
Total	55.30	66.70	.83
Nonfarm households:			
Market work	45.50	17.70	2.57
Home production	3.80	53.30	.07
Total	49.30	71.00	.69

Source: Evenson *et al.*, 1979.

Table 6. Children's time contributions to the household (average annual hours/child).

Age Group (Yrs)	Marketed Work (Hrs)		Household Work (Hrs)		Total Work (Hrs)		Ratio (Male/ Female)
	Male	Female	Male	Female	Male	Female	
3-5	0	0	92	137	92	137	0.67
6-8	218	116	200	274	418	390	1.07
9-11	302	434	306	473	608	907	0.67
12-14	885	464	351	790	123	125	0.98
15-17	1148	976	454	633	160	171	0.94
18 & up	1523	1320	170	925	169	224	0.75

Source: Cabanero, 1977.

Contractual Reciprocity, in which a voluntary agreement between two or more people is reached to render a service toward one another in a specified way for a specified time in the future. It is a form of mutual assistance (Hollnsteiner, 1979). It assumes that the reciprocal acts are equivalent, their amount and form having been explicitly agreed upon beforehand.

In harvesting, another form is termed *Hunusan* (participation by harvest). It is practiced where any villager can participate in harvesting and threshing, and the group of harvesters is entitled to receive one-sixth of the output. From *Hunusan,* a new system has evolved called *Gama*. This system is a form of contractual arrangement wherein those who want to participate in harvesting agree to weed a field in exchange for the right to be employed as harvesters and receive one-sixth of the produce. On rice farms, this system is very common.

Employment of hired labor is not commonly practiced by small farmers. It is the small farmers who avail their services to big landowners. According to one study (Hayami, 1978), landless workers derived 80% of their income from hired employment. Hayami added, that on the average, each working family member worked about 160 days a year on income-generating activities.

Capital Requirements

Capital comes in various forms. The most critical is the availability of funds. One study in Nigeria on small farms indicated that access to loans was the major determinant to attaining optimal income of farmers (Iniodu, 1981). The availability of borrowed capital allows farmers to adopt improved technology, purchase equipment, and procure additional material inputs. Moreover, it has raised the efficiency of labor.

The fuelwood production project in the Philippines has earmarked funds for procurement of quality seeds, purchase of fertilizers and other purchased input because farmers cannot provide these items from their own resources. As Hyman (1983) indicated, utilization of family labor to the development of fuelwood plantations would have been minimal if capital were not available.

Another important component of capital is technical assistance. For projects involving small farmers, commitment by the government to provide technical help is as important as providing the farmers with funds through loans. For example, the failure of the fuelwood project in the Ilocos provinces was primarily attributed to delinquent forestry extension workers (Hyman, 1983).

2.9. Analytical Methods

The preceding sections focused on the need and availability of physical and economic data (and information) on bamboo production. This section presents background literature on how these data relate to financial feasibility and plantation development. Selected applications of benefit-cost analysis (BCA) and management activity scheduling techniques are reviewed. Literature covered focuses on short rotation crops which would use time frames comparable to those needed for bamboo management.

Financial Analysis

Generally called "investment planning" or "project appraisal", BCA is widely used to evaluate the economic efficiency of government actions, projects or programs.

It is applied in almost all disciplinary fields.

There are two distinct aspects of project analysis: financial and economic. Financial analysis takes the viewpoint of individual participants while economic analysis takes the view of the society as a whole (Gittinger, 1982). In economic analysis, taxes and subsidies are treated as transfer payments, whereas, in financial analysis taxes are treated as costs and subsidies as returns. Market prices are normally used in financial analysis while adjusted prices (i.e., shadow prices) reflecting social or economic values are required in economic evaluation. Finally, interest paid on capital is never separated and deducted from gross returns in economic analysis, while in the financial calculations, interest paid on borrowed capital is treated as a cost and deducted to derive net revenue.

A number of studies using BCA have been done in forestry (see for example, Talbert *et al.*, 1985; Crowell, 1984; Appleton, 1980; Ledig and Porterfield, 1982; Rose and DeBell, 1978; Bowersox and Ward, 1976). On short rotation crops, Ferguson *et al.* (1981) determined the financial viability of hybrid poplar plantations. They found that the single most important factor affecting performance measures is product sale value which has two components: yield and market price. A change in either or both could substantially change the economic attractiveness of an investment in hybrid poplar plantations. A study on *Paulownia* plantations by Hardie *et al.* (1984) indicated that well-managed plantations could be profitable provided prices are maintained at current levels. Expansion of supply beyond the current consumption for the species could drive *Paulownia* prices to levels that could make plantations uneconomic. In evaluating a tree improvement program for western larch, Fins and Moore (1984) found that results were most sensitive to changes in discount rate, site quality and cone production rate. Even minor changes in factors greatly affected the analysis outcome.

In the Philippines, two projects of vital interest are pulpwood plantations and fuelwood production. *Ex post* financial analyses indicated that pulpwood plantations yielded positive NPVs whereas fuelwood production had negative NPVs (Hyman, 1983). A number of factors influenced these outcomes. The post-project evaluation of pulpwood plantations made indicated a modest success. The project succeeded in recruiting a large number of participants due to (1) expectations of satisfactory economic returns, (2) provision of technical extension services, and (3) guarantee of a market for the product. It has, however, been afflicted with several problems: (1) abandonment of the sustained-yield agroforestry approach, (2) unanticipated harvesting difficulties, (3) imposition of government price controls on newsprint that set a cap on pulpwood value, and (4) selection of species that are prone to typhoon damage.

The fuelwood production project, on the other hand, was a total failure. Primary causes as enumerated by Hyman (1984) were: (1) unchanging local cultural attitudes, (2) limited borrowing, (3) inadequate extension services, and (4) dispersed fuelwood markets. Insufficient returns drove farmers to engage in planting fruit trees and in upland rice farming. Additional causes unraveled during Hyman's census of participants revealed that (1) a large portion of domestic demand for fuelwood is collected for free on lands belonging to the government, (2) some sites leased to farmers are not suitable for fuelwood plantation development, (3) technical assistance from the government was not sustained, and (4) species selection was erroneous.

Experiences gained from pulpwood production and fuelwood plantations provide insights regarding factors that are most relevant in determining the outcome of the project. These factors are largely not financial in nature. Economic and financial studies, on the other hand, indicate that analysis results are often sensitive to changing prices and costs. Hence, sensitivity analyses or numerous management scenarios are often needed.

Scheduling Techniques

Operations research (OR) techniques are commonly applied to seek the best (optimal) course of action or decisions given limited resources. They provide decision makers with information on which to base decisions. OR techniques systematize, in certain conditions, the process of selecting the most desirable courses of action, thereby leading to more effective decisions about resources under control. They provide a way to arrive at decisions rather than simply using intuitive judgements as in economics.

The second objective of this study deals with maximization. Several OR techniques involve optimization. Among them are linear programming, dynamic programming, recursive programming, goal programming, and integer programming. Most of these techniques have been applied to agroforestry (AF) problems similar to bamboo production. Betters' (1988) work focused on the importance of land-use planning processes in specifying optimal AF systems. His approach enables the analyst to harmonize traditional methods (i.e., BCA) of economic analysis with a linear programming framework. The BCA approach takes care of determining the decision variables while optimization methods are used to consider additional constraints and requirements of problems common to small farms.

Linear programming is the most widely applied optimization technique; it has been applied to several fields with impressive success. It has proved successful solving problems in industry, agriculture, economics, transportation and health. Moreover, LP provides important foundations for the development of solution methods of its extensions (e.g., dynamic, recursive, stochastic and quadratic methods). These extensions allow analysis of optimization problems incorporating market demand, time and probability distributions. It has considerable flexibility. Variants of LP include parametric or sensitivity models. They are used to test effects of price weights, technical coefficients and resource constraints on the determination of optimal plans.

Application of LP techniques to real world problems concerning small farmholders has been proven successful. Spencer (1973) was able to determine the efficient use of farmers' resources in the production of rice in Sierra Leone. His one-period LP model found that there was no correlation between farm size and output per acre, but there is negative correlation between farm size and total labor use per acre.

In Nigeria, optimal cropping patterns yielding the highest net farm income were analyzed by use of LP (Iniodu, 1981). Crop specialization was found to be most profitable, and with the availability of borrowed funds farmers were able to increase their profit by 30%. Borrowed funds not only allowed farmers to adopt improved technology, but also enabled them to raise the efficiency of family labor use. Credit, however, was only economically beneficial within a given range of interest rates.

Extending the ordinary LP to account for the time element was successfully applied by Ogungbile (1980) in evaluating the improved sole-crop production technology in Nigeria. Use of multi-period linear programming models was in recognition that production is seldom instantaneous. His findings indicated that farm size is valuable in determining profitability, because farms that are too small, though operated most efficiently, will result in low income. Farm power sources are also important in determining discounted net income. Comparisons indicated that an oxen-technology model has the highest net present value followed by a hand-labor system, and the lowest NPV was derived from use of herbicides.

Another economic evaluation using LP to maximize net return of small farmholders from agroforestry was made by Verinumbe *et al.* (1984). Given the resource constraints of the farmer and the type of land to be developed for AF, the maximum net profit that may be earned from a combination of crops was determined. Furthermore, they demonstrated the advantage of LP over a simple farm budgeting approach.

The work of Mendoza *et al.* (1986) is more comprehensive in the sense that it can accommodate the various features of agroforestry. Their conceptual framework of multiple objective programming (MOP) allows simultaneous evaluation of several objectives which is not possible in ordinary LP. The availability of several approaches to generate MOP solutions, depending on the type of problem, makes MOP more flexible.

2.10. Summary

Review of bamboo as a plantation crop revealed several interesting results. The potential for commercial-scale bamboo cultivation is great due to the following:

(1). Bamboo has a shorter rotation cycle and grows a large number (i.e., 5-20) of shoots simultaneously in one growing season. It is attractive in terms of crop yield and earlier harvest compared to hardwood and softwood tree species. This makes bamboo more suitable for those with limited capital who are interested in relatively early returns on investments (MacCormac, 1985),

(2). Bamboo has a rapid natural early growth which can be enhanced with the application of fertilizers. Traditional techniques of growing are relatively effective and traditional sector demand is increasing. Expanding the raw-material base would increase supply, and increased development of the processing sector is highly probable (Garcia, 1986),

(3). Bamboo is well-suited to polycyclic harvesting, having a capacity to regenerate through its rhizomes. It can be grown on a wide range of sites, has an interlocking root system and has leaf deposition which can inhibit soil erosion (Austin *et al.*, 1983), and

(4). Bamboo has potential in pure plantations or in integrated farming systems (e.g., agroforestry). Factors of production are locally available and abundant except for capital.

Limitations on farmers' resources are fully recognized as affecting choice and adoption of specific technologies. Traditional methods of economic analysis are not sufficient to integrate these limitations (Betters, 1988). Use of OR techniques in combination with valuation techniques to determine economic performance are best suited to address problems of this type. For this study, there are constraints on labor, land and budgets. In particular, the capability of LP to maximize income, determine optimal cropping patterns, and increase yield and labor use is important. If assumptions regarding LP are met, it may be sufficient to satisfy the analytical requirements of allocating farmers' resources in combination with borrowed funds to optimize returns. Integer programming and modifications advocated by Mendoza *et al.* (1986) are inappropriate for the type of single-objective problem at hand. Dynamic programming, nonlinear programming, and mixed integer programming may provide alternative techniques for addressing this problem.

The appropriateness of each technique and problems associated with their applications are discussed in Chapter 3.

CHAPTER 3

RESEARCH METHODS

3.1. Introduction

This study's objectives of examining financial feasibility and calculating optimal development schedules require several methods of inquiry. Since no studies are available on management costs and returns for bamboo, primary data collection is required. Standard financial analysis (or cash flow) methods are used to examine financial feasibility. For maximizing NPV of cash flows or amount of employment, an analytical method that has the capability and flexibility of considering limited resources simultaneously is required. Optimizing combinations of limited resources to produce the desired goals (i.e., increasing income and/or employment) of the farmers is the primary concern of this investigation. This chapter presents an overview of optimization models--it provides the general framework for the analyses. Then a specific model is formulated, data inputs are described and the analytic approach is presented.

3.2. Optimization Modeling

Linear programming (LP) is one of several techniques that is capable of finding an optimal solution from a number of alternative choices. Traditional methods of economic analysis (e.g., BCA) do not have the ability to handle limitations commonly encountered by farmers. Though they provide a good conceptual framework, they are limited in flexibility and in performing analyses on operational systems (Mendoza *et al.*, 1986). Moreover, BCA does not explicitly consider the additional constraints or requirements to the problem (Betters, 1988). However, the valuation techniques that provide measures of economic performance in terms of NPV, B/C ratios and IRR are valuable in generating the decision variables used in linear programming analysis.

Linear programming is a mathematical procedure for maximizing (or minimizing) a linear objective function subject to a number of linear constraints. It has three main components: (1) an objective function, (2) activities or processes, and (3) linear resource/personal constraints.

The general model is:

$$\text{Maximize } Z = \sum_{j=1}^{m} c_j x_j \tag{1}$$

$$\text{Subject to : } \sum_{i=1}^{n} \sum_{j=1}^{m} a_{ij} x_j \leq b_i \tag{2}$$

$$x_j \geq 0 \tag{3}$$

where:

Z = objective function,

x_j = level of the jth activity,

b_i = amount of the ith resource,

c_j = net revenue of the jth activity,

a_{ij} = amount of ith resources required to produce a unit of jth activity,

m = number of activities, and

n = number of different resources.

A linear programming model is subject to restrictive assumptions of additivity of resources and of activities, divisibility and finiteness of activities and resources and non-negativity of activities (Dykstra, 1984). In addition, LP is deterministic. It is based on the single value expectation assumption which indicates that the parameters of the model are known for certain. These assumptions define the limitations of LP and also indicate conditions in which it is useful. Other programming model modifications are available to handle relaxation of most of these assumptions whenever it is required for a specific problem.

One modification of LP is the multi-period linear programming approach (MPLP). This is an extension of the LP model that incorporates a time element into the formulation. The technique of MPLP permits the programming of activities and restrictions for a finite number of years. Outputs of any one year may become inputs for the following year. Thus, activities in each year or period represent the best or optimal plan in terms of the specified time horizon (Ogungbile, 1980).

A MPLP model with financial discounting is formulated as:

$$Maximize\ Z = \sum_{j=1}^{n}\sum_{t=1}^{k} \frac{c_{jt}x_{jt}}{(1+r)^{t}} \tag{4}$$

$$Subject\ to: \sum_{j=1}^{n}\sum_{i=1}^{m}\sum_{t=1}^{k} a_{ijt}x_{jt} \leq b_{it} \tag{5}$$

$$x_{jt} \geq 0 \tag{6}$$

where:

t= 1, 2,...k periods;

i= 1, 2,...m activities;

j= 1, 2,...n resources; and

r= discount rate in decimal form.

The variables of the MPLP model have the same interpretations as those of the basic LP described earlier.

Another approach is dynamic programming. This technique is an offshot of optimal control theory. Application to production models, however, is severely limited because of the enormous computations required (Minden, 1968). In fact, it is not possible to write down a standard mathematical formulation that applies to all dynamic programming problems (Dykstra, 1984). It requires a certain amount of ingenuity to recognize that a problem is solvable by dynamic programming procedures.

Recursive programming is another technique closely associated with dynamic programming. It is defined as a sequential optimizing rule with a functional relationship between any given period and preceding periods. The main difference between MPLP and recursive programming is that the former gives optimal solution for the entire planning period (under very restrictive assumptions) while the latter method provides a sequence of optimal solutions, one for each time period. While the sequential solutions satisfy the maximization for each time period, they do not necessarily satisfy the conditions for the entire planning horizon (Mendoza *et al.*, 1986).

Another technique is integer programming. It is an alternative approach developed to handle problem situations where all or some of the variables are restricted to integer values. In this study, all activities can have non-integer solution values so integer and mixed integer programming are inappropriate.

Nonlinear programming is an appropriate approach if function or at least one of the constraints is nonlinear. In this method, no general algorithm is available mainly because of the irregular behavior of the nonlinear functions (Taha, 1987). The application of the Kuhn-Tucker algorithm is very limited for solving these types of problems. Nonlinear programming includes separable, quadratic, geometric, and stochastic formulations. Since the objective function and constraints are treated as linear in this study for these small-scale plantations, nonlinear programming is not needed. However, if larger scale operations were used or other problem modifications occurred, a nonlinear programming formulation may be required.

A non-optimization approach that provides insight into a variety of relationships is simulation modeling. This approach is suitable when the decision process is so complex that it cannot be handled by a single analytical procedure.

Simulation can be used to generate the necessary sequences of data on the system's behavior which can then be analyzed by other techniques. The main disadvantage of simulation model technique is that it does not guarantee an optimum solution as compared with solutions generated by other techniques (Taha, 1987).

Thus, LP is used in this study because it has the flexibility to optimize returns by combining scarce resources such as labor, capital and land from the perspective of small farmers (Iniodu, 1981; Niang, 1980; and Ogungbile, 1980). It can be extended to the multi-period case where time element is incorporated. Verinumbe *et al.* (1984) have even noted that LP is superior to BCA because LP accounts for the resource bases of farmers. Furthermore, very efficient methods of solutions have been developed for LP problems in real world situations (Taha, 1987).

3.3. Model Formulation

Linear programming provides a satisfactory approach for addressing this study's second objective. The detailed formulation is:

$$\textit{Maximize } Z = c_1x_1 + c_2x_2 + c_3x_3 + c_4x_4 + c_5x_5 \tag{7}$$

$$\textit{Subject to}: a_{11}x_1 \leq b_1 \tag{8}$$

$$a_{21}x_1 + a_{22}x_2 \leq b_2 \tag{9}$$

$$a_{31}x_1 + a_{32}x_2 + a_{33}x_3 \leq b_3 \tag{10}$$

$$a_{41}x_1+a_{42}x_2+a_{43}x_3+a_{44}x_4 \leq b_4 \tag{11}$$

$$a_{51}x_1+a_{52}x_2+a_{53}x_3+a_{54}x_4+a_{55}x_5 \leq b_5 \tag{12}$$

$$a_{61}x_1+a_{62}x_2+a_{63}x_3+a_{64}x_4+a_{65}x_5 \leq b_6 \tag{13}$$

$$a_{71}x_1+a_{72}x_2+a_{73}x_3+a_{74}x_4+a_{75}x_5 \leq R_7 \tag{14}$$

$$\vdots$$

$$a_{251}x_1+a_{252}x_2+a_{253}x_3+a_{254}x_4+a_{255}x_5 \leq R_{25} \tag{15}$$

$$x_1+x_2+x_3+x_4+x_5 \leq 5 \tag{16}$$

where:

Z = total NPV.

c_t = NPV (1989 pesos) per hectare; subscript t refers to the year a plantation was established (1, 2, ..., 5).

x_t = hectares developed; subscript refers to the year a plantation was established.

a_{yt} = level of capital (1989 pesos) required to plant in year t and maintain hectares developed; subscript y refers to year during the analysis period (1, 2, ..., 25).

b_y = level of capital (1989 pesos) available; subscript refers to year in which investment/borrowing was made. This amount is equal to 4 times the amount of family labor contribution (FLC) by year. Note that borrowing is annual based on the amount of FLC.

R_y = refers to gross revenue and subscript refers to year the harvest will occur.

Equation (16) limits each farmer to five hectares. The objective function (Z) is formulated to be either in pesos, when maximizing NPV of cash flows or in person-days when maximizing labor use.

The separate treatment of NPVs for plantations developed in the different years indicated in the right hand side (RHS) of the objective function accounts for the effect of plantation scheduling. Delaying establishment lowers NPVs because years with positive cash flows are shortened and values are discounted. Cash flows beyond 25 years are ignored because that is the proposed lease duration and this is a government land (i.e., farmers cannot sell land).

The switch of the RHS in the constraints from b_y to R_y when the first harvest is realized is a mechanism to evaluate the performance of bamboo plantations. The self-sustainability of the project is gauged based on how values of RHS can meet the annual cost requirements of plantations developed from previous years using family labor in combination with borrowed capital. The switch from b_y to R_y as a RHS is variable and indicates borrowing has ceased and then a 10-year loan repayment schedule has begun. Thus, the revenues and FLC must be able to maintain the plantations and repay loans. Depending on the rotation of the bamboo species being analyzed (ranging from 3-7 years), the RHS will shift from b_y to R_y at different years.

What's Best!, a LINDO-based linear programming (LP) software package (Savage, 1990), was used to generate solutions. Models were developed in a spreadsheet environment and solved on a microcomputer.

Data used in the LP models include: periodic costs of production by management scheme (species, spacing, source of planting material, site characteristic, cutting age and cutting cycle) and by region; yield data; harvesting and hauling costs; farm gate prices for bamboo; family labor; amount of loan; amount of land; discount and interest rates; and labor cost. While some data were directly entered into the model, other data were pre-computed using the traditional analytical methods of determining economic measures of NPV, B/C ratio and IRR before they were entered as decision variables. Some data were based on assumptions as further explained below.

3.4. Data Collection

This study makes use of survey and secondary data. Procedures of how these data were collected and collated to harmonize data from various sources are outlined below.

Costs of Production

Production cost information were gathered from three pilot projects coordinated by ERDB and directly administered by the Regional offices of the DENR. Production input data forms (Appendix Table D1) were distributed to respective project supervisors in Regions 6, 7, and 11. Completed forms in the regional offices were further verified with the ERDB records to make sure that actual activities/expenses performed/spent in the field tallied with the quarterly financial statement prepared by the Project Staff. Since pilot projects are relatively new (about 3 years), cost on maintenance operations before first harvests occur were taken from the records of ERDB. Harvesting and hauling costs were taken from the study of de la Cruz (1989).

Yield Data

Standard bamboo yield tables are not available at this time, and harvests from pilot plantations are not yet allowable. Therefore, yield data were gathered from the records of ERDB. Annual harvests for 9 consecutive years (1978-1986) were collated and entered into a prepared format (Appendix Table D2) to suit the data requirements of this study. Data on periodic harvests for *B. philippinensis* were taken from the records of Mr. M. Caasi. Harvested culms were segregated by quality classes to reflect the actual returns differentiated by farm gate prices. Since yield data represent nine harvests only, projections were made to cover the entire analysis period by simple linear regression technique. This approach is deemed appropriate because no other data (i.e., edaphic or climatic factors) are available to use in the estimation of future yields.

Farm Gate Prices

A survey was conducted to determine the current buying prices of bamboo culms in all three regions. Survey questionnaires (Appendix Table D3) were prepared and ten respondents were randomly sampled in every region. Buying prices for each species in each region were tallied and the averages were computed.

Household Profile Survey

A survey instrument in the form of prepared questionnaires (Appendix Table D4) was used to gather profiles of households included in this study. Thirty households were randomly sampled from a population of 102 in Region 6, 90 in Region 7 and 137 in Region 11 for face-to-face interviews. A preliminary list of households was obtained from the Barangay[9] Office prior to the selection of respondents. Selection of samples was confined to areas adjacent to the location of pilot project.

A combination of objective (Appendix Table D4, Questions 1-9) and subjective (Questions 10-13) methods was used to estimate the amount of excess labor. The objective method is based on the production approach from the normal activities undertaken by the farmers while the subjective method is based on the willingness of the farmers to commit their extra time to bamboo production without unnecessarily disrupting their regular farm job. This latter approach was added during the conduct of the field survey to remedy a problem of non-response for some questions by selected households during the survey's validation phase. Inclusions of direct questions were suggested by the Project Staff as well as by Barangay council members.

3.5. Data Analysis

The analysis is split into two parts. The first part deals strictly with the financial viability of bamboo production based on the different management schemes in three regions of the country. The second part explores the possibility of how small farmers' involvement in the development of bamboo plantations affects plantation development scheduling. The evaluation is based on the family labor contribution (FLC) of small farmers. Two objective functions are used: maximizing net present

[9]*Barangay is the smallest administrative unit of the government. The governing council is headed by a Barangay Captain with eight members elected at large.*

value and maximizing labor use. The former is of specific interest to farm families while the latter may have broader social implications.

Financial Analysis

Three discounted measures were used to evaluate the feasibility of investments in bamboo production. These measures based on financial criteria are: net present value (NPV), benefit-cost ratio (B/C), and internal rate of return (IRR).

Net present value is defined as the discounted value of expected future returns minus the discounted value of future costs, using the appropriate discount rate. Gittinger (1984) described this measure as the most straightforward calculation (i.e., discounted cash flow stream) of project worth. It is interpreted as the present worth of the income stream accruing to the individual or entity. In practice, it is easier to compute NPV by discounting the incremental net benefit stream or incremental cash flow.

The formal selection criterion for the NPV of a project worth is to accept all independent projects with a zero or greater NPV when discounted at the opportunity cost of capital (Gittinger,1984; Mishan, 1982). No ranking of acceptable, alternative independent projects is possible with the NPV criterion because it is an absolute, not a relative measure. This means that small projects cannot be compared to big projects by just looking at the NPVs. The functional form is presented in Equation 17.

$$NPV = \sum_{t=1}^{n} \frac{B_t - C_t}{(1+i)^t} \tag{17}$$

where:

B_t = benefit (pesos) in each year,

C_t = cost (pesos) in each year,

t = 1, 2, ..., n years, and

i = discount rate in decimal.

Internal rate of return is the discount rate that makes the NPV of the net benefit stream or cash flow equal to zero. It is the maximum interest rate that a project could pay for the resources used if the project is to recover its investment and operating costs and still break even. In other words, it is the average annual percentage rate of return earned on all invested capital over the project's life. It is one of the very useful measures of project feasibility.

The formal selection criterion for the IRR of project worth is to accept all independent projects having an IRR equal to or greater than the opportunity cost of capital. It should be noted, however, that IRR of a series of values such as cash flow can exist only when at least one value is negative. If all the values are positive, no discount rate can make the present worth of the benefit stream equal to zero.

Projects cannot be ranked with confidence on the basis of the IRR, though it varies from project to project. Only a rough approximation can be made based on the cut-off rate of the opportunity cost of capital. In other words, it cannot be known with certainty that one project contributes relatively more than the other if both projects have an IRR greater than the cut-off rate.

The NPV formula including IRR is shown in Equation 18.

$$NPV = \sum_{t=1}^{n} \frac{B_t - C_t}{(1+IRR)^t} = 0 \tag{18}$$

Benefit-cost ratio is obtained when the present worth of the benefit stream is divided by the present worth of the cost stream. This measure is highly dependent on the discount rate. The higher the discount rate, the smaller the resultant B/C. It is useful in measuring how much costs could rise without making the project economically unattractive.

The formal selection criteria for the B/C ratio measure of project worth is to accept all independent projects with a B/C ratio of 1 or greater when the costs and benefits streams are discounted at the opportunity cost of capital. Caution, however, must be observed in the case of a mutually exclusive projects (Gittinger, 1984). The B/C ratio formula is presented in Equation 19.

$$B/C = \frac{\sum_{t=1}^{n} \frac{B_t}{(1+i)^t}}{\sum_{t=1}^{n} \frac{C_t}{(1+i)^t}} \tag{19}$$

3.6. Repayment of Loan

The scheme for servicing borrowed funds adapted in this study assumes equal installments with interest capitalized. This means that a farmer is not required to pay any amount, even the interest, during the grace period. The interest due is, in effect added to the principal of the loan (Gittinger, 1982). Remittances for loan are made in a series of equal installments beginning in the first harvest year.

The grace period is the time interval between plantation establishment and the time of first harvest. It varies between 3-7 years depending on the type of species. Repayment of the principal plus the capitalized interest is assumed to be in 10 equal annual installments commencing at the end of the grace period. For species where harvest is possible at year 4, the loan servicing is complete by year 13, but for species whose first harvest may not take place till year 8, the repayment extends to year 17.

The formula for an equal annual payment is presented in Equation 20.

$$A = P\frac{i(1+i)^n}{(1+i)^n-1} \tag{20}$$

where:

A = equal annual payment,

P = present total amount at the end of the grace period,

n = repayment period, and

i = interest rate.

Values generated in Equation 20 are undiscounted and are entered in the analysis as additional cost. In the LP problem, the payments are treated in constraints as annual costs and in the NPV objective function, as present values.

3.7. Summary

Linear programming as an analytical technique has the flexibility and capability deemed appropriate for the type of problem at hand. Linear programming (LP) procedures can be readily modified to accommodate specific requirements of the problem. Close linkage of LP methods with traditional economic approaches to evaluating financial profitability of investments is an additional advantage. These two approaches are complementary for the type of analysis required in this study. Furthermore, availability of LP software programs which can be readily modified to suit the goals of the users makes this technique appealing.

CHAPTER 4

RESULTS AND DISCUSSION

4.1. Introduction

This chapter consists of three sections. The first section focuses on the survey/data results. It describes the type of data obtained from secondary sources and those that were gathered from the survey. Also included are additional assumptions used in the analyses. The second section deals with the financial analysis. Individual management schemes (MS) were evaluated to determine the effects of the different factors on the viability of bamboo management. This is followed by a section on bamboo plantation development scheduling. Family labor contribution (FLC) based on household type together with other limiting factors (e.g., land and borrowing) were evaluated. Linear programming (LP) models were used to test the effects of these factors on net present values (NPV) and total amount of employment. Optimal solutions were generated based on individual species by household type in each region.

4.2. Survey/Data Results

The choice of whether farmers grow their own planting stock or buy planting stock from nurseries is one decision that has wide ranging implications. Field survey results indicate variation in cost of materials. Nursery grown stocks are more expensive than buying culms because of the cost of propagating the material as indicated in the survey (Table 7). Cost differences were also observed for harvesting and hauling (Table 8). These values are used as inputs in calculating NPVs for the different schemes and regions.

Yield Data

Basic yield data for *B. Blumeana* is presented in Appendix Tables E1 and E2; for *B. philippinensis* in Appendix Tables E3 to E6; for *D. asper* in Appendix Tables E7 and E8; for *D. merrillianus* in Appendix Tables E9 and E10; and for *S. lumampao* in Appendix Table E11. Projected yields are likewise presented in Appendix F.

For *B. blumeana*, per hectare yield ranges from 1,026-1,407 culms at 7x7 m spacing and 489-670 culms at 10x10 m spacing. For *B. philippinensis*, when planted on flat terrain, per hectare yield ranges from 5,858-6,167 culms while on hilly terrain, the yield is from 5,428-6,093 culms. For *D. asper*, the yield is from 975-1,216 culms at 7x7 m spacing and from 465-665 culms when planted at 10x10 m. The yield for *D. merrillianus* ranges from 904-1,166 culms at 7x7 m spacing and from 430-555 at 10x10 m. For *S. lumampao*, the projected yield per hectare ranges from 3,240-4,460 culms.

Farm Gate Prices

Buying prices vary within and between species and between regions. Culm quality is one important factor in the determination of price. Straight culms are highly desirable in construction while longer culms are preferred in the fishing industry. For banana props, smaller sizes and shorter poles are required. Weaving and production of fancy items need thin-walled species. Average farm gate prices for each species in each region are presented in Table 9.

Table 7. Average cost of planting material by species in 1989 pesos (P).

Species	Type of Planting Material[a]	Price (Pesos)
B. blumeana	culm	P40/culm
	nursery grown	P25/stock
B. philippinensis	culm	P5/culm
	nursery grown	P10/stock
D. asper	culm	P30/culm
	nursery grown	P20/stock
D. merrillianus	culm	P25/culm
	nursery grown	P20/stock
S. lumampao	culm	P5/culm
	nursery grown	P10/stock

[a]*Nursery grown refers to stocks purchased by the farmers from independent producers for outplanting. Culms refers to young bamboo poles which are suited for growing as planting stock and to be raised by the farmers.*

Source: Survey data.

Table 8. Average harvesting and hauling costs per culm by species in 1989 pesos (P).

Species	Harvesting	Hauling	Total Cost (Pesos)
B. blumeana	P2.00/culm	P1.00/culm	P3.00/culm
B. philippinensis	P0.25/culm	P0.25/culm	P0.50/culm
D. asper	P1.50/culm	P1.00/culm	P2.50/culm
D. merrillianus	P1.00/culm	P1.00/culm	P2.00/culm
S. lumampao	P0.25/culm	P0.25/culm	P0.50/culm

Source: de la Cruz (1989).

Table 9. Average buying prices per culm by quality type and by species in 3 regions in 1989 pesos (P).

Species	Quality[a]	Region		
		6	7	11
B. blumeana	high	P20.00	P25.00	P20.00
	ave.	P18.00	P20.00	P18.00
	low	P15.00	P15.00	P15.00
B. philippinensis	normal	-	-	P2.50
	over-s	-	-	P4.00
D. asper	high	-	P20.00	P18.00
	low	-	P15.00	P15.00
D. merrillianus	high	P17.00	P17.00	-
	low	P15.00	P15.00	-
S. lumampao	-	P3.00	P3.00	P3.00

*[a]For **B. blumeana**, high quality culms are those that are straight, 10 meters or longer; average quality are those that are below 10 meters but not shorter than 8 meters and relatively straight; low quality are those of smaller and shorter culms and usually crooked.*

*For **B. philippinensis**, normal sizes are those that attained at least 16 feet in length with a base diameter of 2.5 inches and bigger; culms whose length exceeds 32 feet are classified as oversized. Those culms that are crooked and less than 16 feet and base diameter of less than 2.5 inches are rejected.*

*For **D. asper**, high quality are those that attained 15 meters or longer in length and relatively straight; those that are crooked, smaller, and shorter are classified as low quality.*

*For **D. merrillianus**, high quality are those culms that are relatively straight, at least 8 meters in length, and a base diameter of not less than 4 inches. Those that are crooked, smaller, and shorter than 8 meters are considered low quality.*

*For **S. lumampao**, no strict classification is adapted. Selling/buying is based on number of culms harvested without particular concern on length and diameter, although extremely smaller and immature culms are discarded.*

Source: Survey data.

Surplus Household Labor

Household as used in this study refers to a single dwelling unit composed of not only the immediate members of the family (i.e., parents and children) but also other members of the clan living with the family. Household type (HT) refers to its composition (number of persons).

Six household types per region were identified on the basis of thirty samples interviewed in each region. Amount of family labor contribution (FLC) varies. Labor availability varies with the number of working members of the family. Another variation of FLC is seasonal fluctuation. When dry and wet months are distinct (Climatic Type 1), characteristic of Regions 6 and 7, fluctuation is apparent because conflict arises from other farm activities. But when rainfall is evenly distributed (Climatic Type 4), other farm activities can be adjusted as is the case in Region 11.

Total marketed labor for each household type based on percent contribution of all adult family members is presented in Table 10. An adult is a person 15 years old and older regardless of gender. Young children are those below 15 years old, but not younger than 10 years old. Small children are those below 10 years old. Other refers to those that are not members of the immediate family.

The amount of labor each household can commit to bamboo production is computed based on labor availability of the husband, wife and adult children only. This assumption is based on the premise as noted by Findley (1987) that in the rural Philippines, division of labor calls for women and young children to intensify their work in the field, while men and adult children seek wage labor nearby. The survey results confirm this finding. In most cases, husbands seek employment for wages to

Table 10. Household type (HT), household composition, percent labor contribution of adult family members and total marketed labor in 3 regions.

Household Type (HT)	Family Composition	Contribution of Family Member to Marketed Labor(%)	Total Labor in Person-days
HT1	Husband	100	264
	Wife	25	66
	1 Adult	50	132
	1 Young	0	0
	2 Small	0	0
Total			462
HT2	Husband	100	264
	Wife	50	132
	2 Adult	25	132
	2 Young	0	0
Total			528
HT3	Husband	100	264
	Wife	25	66
	1 Young	0	0
	2 Small	0	0
Total			330
HT4	Husband	100	264
	Wife	50	132
	1 Young	0	0
	1 Small	0	0
Total			396

Table 10 (continued)

Household Type (HT)	Family Composition	Contribution of Family member to Marketed Labor (%)	Total Labor in Person-days
HT5	Husband	100	264
	Wife	25	66
	1 Adult	100	264
	1 Young	0	0
	3 Small	0	0
Total			594
HT6	Husband	100	264
	Wife	50	132
	2 Adult	100	528
	1 Young	0	0
Total			924

Source: Survey data.

meet the cash needs of the family.

The amount of FLC provides the basis of classifying households into 6 types. Typing is based on the number of respondents for a particular group. Those with most respondents are classified as household type 1, the second highest number of respondents as household type 2 and further down to household type 6. Thus, household type numbers reflect the relative abundance of family labor for a given household.

Family labor availability is affected by seasonal differences roughly reflected by quarters as presented in Table 11. In Region 6, FLC ranges from 10-40% of total marketed labor depending on quarter; in Region 7, FLC ranges from 10-50%; and in Region 11, FLC is stable at throughout the year at 30%. The amount of excess labor varies by household type and region. For example, there are only 76 person-days of labor available in household type 3 in Region 6. Household type 6 has much more available labor; this provides more equity if needed for plantation development.

In the analysis, total annual labor was considered instead of quarterly labor availability because of the prevalence of labor exchange between farmers. Required labor requirements can easily be secured from other farmers in case where family labor availability is not sufficient. The assumption of taking the total labor to serve as equity will allow farmers more flexibility in scheduling their on-farm activities.

4.3. Other Assumptions

Assumptions are necessary in virtually all economic analyses. The following assumptions were made for this study:

Table 11. Amount of labor each household type (HT) can commit to bamboo production by quarter (% of person-days in column 4 of Table 10) for 3 regions.

Region	Qtr[a]	%	Household Types					
			1	2	3	4	5	6
6	1	25	29	33	20	24	37	57
	2	40	46	52	32	39	59	92
	3	10	11	13	8	9	14	23
	4	20	22	26	16	20	28	46
Total			108	118	76	92	138	218
7	1	30	34	39	24	29	44	69
	2	50	57	66	41	49	74	115
	3	10	11	13	8	9	14	23
	4	20	22	26	16	20	28	46
Total			124	144	89	107	160	253
11	1	30	34	39	24	29	44	69
	2	30	34	39	24	29	44	69
	3	30	34	39	24	29	44	69
	4	30	34	39	24	29	44	69
Total			136	156	96	116	176	276

[a]Qtr = quarter
1 = January-March
2 = April-June
3 = July-September
4 = October-December

Source: Survey data.

1. Discount Rate = 10%. This is the real interest rate. This was computed from the average lending rate of the Central Bank of the Philippines minus the average inflation rate from 1983-1990. The interest rates for the past eight years are shown in Appendix F. While the discount rate is fairly stable the lending rate fluctuates from year to year as a result of inflation. For purposes of this analysis, the 9.86% is conservatively rounded to 10%. The real lending rate calculated from the Central Bank data was also 10% and used as a basis for repayment of loan.
2. Tax Rate = 5% of gross sales of the product.
3. Land Rent = P100/hectare/year.
4. Time Frame = 25 years based on a Leasehold Contract (Lease) of 25 years renewable for another 25 years based on the some established criteria.
5. Area Limit = 5 hectares per family.
6. Family labor contribution by household type as shown in Table 11 is assumed to be constant throughout the plantation development phase, which is limited to the first five years from the time when a Lease is awarded. It is further assumed that no major change in FLC is expected to occur for the 5-year period.
7. Borrowed Funds = up to 3 times the amount of FLC in peso equivalents. The loan is annually provided from the time of approval of the Lease until first harvest is realized.
8. Labor Wage = P75 per person-day based on the minimum wage for agricultural worker in 1989.

Assumptions 2-5 are based on existing policy applied from other projects (i.e., fuelwoood plantations and agroforestry).

4.4. Financial Analyses

This part of the analysis provides estimates of returns assuming farmers have all the resources needed to develop and manage the plantations without borrowing funds. Other assumptions regarding these analyses are mentioned in the preceding section in Chapter 3. Thus, the only concern here is to determine if investment in bamboo production pays. Factors considered in bamboo management are species, spacings, site, harvest age and schedule. Seasonal variation was not included because of data limitations.

The net present value (NPV), the benefit-cost ratio (B/C), and the internal rate of return (IRR) of the different management schemes included in the analysis are presented for each species. Each scheme is evaluated to determine its financial performance so that individual farmers can have a wide array of choices in the event they finally decide to engage in bamboo production. Regional variations are also considered because of the differences in the market prices of the product (Table 9). Other factors of production, however, are assumed to be the same across regions because primary sources of the data are government-administered projects. Labor wages, cost of materials and other miscellaneous expenses relative to the development of pilot plantations are equal according to the records of the Project Staff, Bamboo Research and Development Project.

Bambusa blumeana

This species is widely used in all three regions covered in this study. The values of NPV between regions are different (Table 12). The most important factor influencing the variation is the difference in bamboo market price. All management schemes passed the NPV criterion in all regions. However, the NPV difference is large across regions. Comparing the NPV of the same scheme between regions, Region 7 Scheme 1 (i.e., 7x7 m spacing with a "grow" stock source and first cut in year 7) has a value of P56,823, whereas, only P37,340 is realized in Regions 6 and 11. This wide variability is solely attributed to the difference in the market price. Regional variation in prices or costs for a given scheme could lead to profit in one area and possibly losses in another.

Evaluation of the different management schemes indicated that spacing, establishment of farmer's own nursery (raising their own planting stock) and harvest schedule are all critical factors in bamboo management. At 7x7 m spacing with farmers producing their own planting stock, and assuming all other factors constant, the highest attainable NPV is P56,823 as compared to only P22,555 at 10x10 m spacing. Reduction in income attributed to spacing is large so that in project design this factor should be carefully considered. Long-term studies on spacings are needed. However, when bamboo stands are properly managed and an adequate number of young and healthy culms are retained, productivity is enhanced (Uchimura, 1980). Concerns that closer spacings may result in early overcrowding and subsequent reduction in culm yields may not pose a problem. Bamboo stands can be manipulated to allow continuous regeneration at high levels.

Table 12. Results of the financial analysis for ***Bambusa blumeana*** on flat terrain with annual harvests at 10% discount rate in 1989 pesos (P).

Region	Spacing (m)	Stock Source[a] Grow	Stock Source[a] Buy	First Cut	PNV (P)	B/C	IRR (%)
7	7x7	x		Year 7	56823	1.83	21.9
6 & 11	7x7	x		Year 7	37340	1.57	18.7
7	7x7		x	Year 7	57827	1.85	22.4
6 & 11	7x7		x	Year 7	38344	1.56	19.1
7	7x7	x		Year 8	45033	1.67	18.9
6 & 11	7x7	x		Year 8	27658	1.41	16.1
7	7x7		x	Year 8	46036	1.69	19.3
6 & 11	7x7		x	Year 8	28662	1.43	16.5
7	10x10	x		Year 7	22555	1.60	18.1
6 & 11	10x10	x		Year 7	13280	1.35	15.2
7	10x10		x	Year 7	22908	1.62	18.3
6 & 11	10x10		x	Year 7	13633	1.37	15.4
7	10x10	x		Year 8	17007	1.47	15.8
6 & 11	10x10	x		Year 8	8736	1.24	13.3
7	10x10		x	Year 8	17358	1.48	16.0
6 & 11	10x10		x	Year 8	9087	1.25	13.5

[a]Buy- farmers purchase planting stock from a nursery.
Grow- farmers grow their own planting stock.

Whether farmers will establish their own nurseries or buy planting stock ready for outplanting is another choice which has important implications on profitability. Raising bamboo planting stock is technically difficult because of its dependence on vegetative propagation. Techniques for mass propagation through other means are yet to be developed. Buying planting materials ready for outplanting may, therefore, be preferred to raising planting stock. The highest NPV for a scheme which includes raising planting material (i.e., MS1), all other factors constant, is slightly lower at P56,823 whereas the comparable scheme which directly buys nursery stock (i.e., MS2) is P57,827.

Harvest schedule and first harvest age are two other factors of importance in the management of bamboo plantations. For this species, the harvest schedule is annual once it commences in year 7 or 8. If the harvest schedule begins in year 7, culms 3 years old and older are harvested. If the schedule begins in year 8, culms 4 years old and older are harvested. While the properties of a 3-year old bamboo culm are not much different to a 4-year old in terms of physical and mechanical characteristics, the timing of the first harvest is very critical.

The highest attainable NPV if harvest schedule commences in year 7 is P57,827. By postponing the harvest schedule by one year (i.e., from 7 to 8) and using an older minimum culm age (i.e., 4 instead of 3), the NPV is reduced by 20% or down by P11,791. This has wider implications to the overall performance of the plantations. If at year 7, the clumps have not yet fully developed to allow harvesting, postponing the first harvest by another year would decrease the expected NPV by as much as 20%. It seems apparent, therefore, that maintenance operations and protection measures are very critical in optimizing returns from engaging in bamboo plantation. The time factor is so vital that care and management of the stands should not be taken for granted.

Bambusa philippinensis

The bulk of production from this species is marketed to the banana plantation owners in Region 11. No other region is engaged in plantation development of this species at present. In Region 11 several private individuals are involved in planting the species. Management schemes employed by a private grower in the region form the basis of the financial analysis of this species.[10]

Evaluation of the eight (8) management schemes indicate a very high NPV for all schemes. Like *B. bambusa*, all schemes passed the financial-analysis criterion for acceptability. Variations, however, are apparent due to sites, harvest schedule, and source of planting stock. Spacing is not considered a variable because only 4x5 m spacing is used throughout the plantation from which data were gathered.

Plantations on a relatively flat terrain (i.e., 18% slope or less) yield more than those on hillsides, *ceteris paribus*. This is reflected in a high NPV of P44,623 per hectare on flat sites compared to only P31,829 on steeper terrain. The difference is very significant . However, considering that not everyone could acquire the most productive sites, developing plantations on hilly terrain is still a worthwhile undertaking from an NPV perspective. Working conditions are also totally different

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[10]*Mr. M. Caasi provided data on plantation establishment and yield. Labor on person-days were converted into pesos (P) and yield in terms of number of culms were converted into pesos based on the current buying prices of the banana growers.*

between sites (pers. comm., M. Caasi). More favorable conditions are obtained in relatively flat terrain. Due to difficult working conditions in hilly areas, development costs are much higher. This has significant effects on the reduction of NPV along with differences in yield (Appendix Tables E3 and E5).

Harvest schedules are critical. One practice is annual while the other is periodic. Annual harvests are for culms 1-year old and older commencing in year 4 and leaving behind shoots and younger culms. The highest NPV for annual harvests is P44,623 (Table 13a). For periodic harvesting, the practice is to conduct the first harvest in year 4 with subsequent harvests every three years thereafter. This means that second harvest is performed in year 7, third harvest in year 10 and so on. The highest NPV for this practice is P38,150 (Table 13b); much lower than the comparable annual harvest as shown in Table 13a.

The unequal occurrence of benefits between the two methods affects NPVs because of the discounting process. In periodic harvesting, there are years that no benefits are possible, though in some years the benefits are much higher than those for stands managed under annual harvests. It is alleged that as clumps grow and mature, emerging shoots begin to grow bigger. Hence, culms size may increase beyond the specifications of the banana growers. Research on this aspect has just started and information is limited in predicting the performance of the bamboo stands subject to these different regimes.

The effects of site on NPV are significant. On relatively flat sites, the highest attainable NPV is P44,623 while in hilly terrain, NPV drops to P31,829, *ceteris paribus*. This is explained by the difference not only in yield but also by the

Table 13a. Result of the financial analysis for *B. philippinensis* at 4x5 m spacing with annual harvests at 10% discount rate in 1989 pesos (P) in Region 11.

Site		Stock Source[a]		NPV (P)	B/C	IRR(%)
Flat	Hilly	Grow	Buy			
x		x		43014	1.48	28.0
x			x	44623	1.51	29.8
	x	x		31470	1.35	22.5
	x		x	31829	1.36	22.8

[a]See footnotes in Table 12.

Table 13b. Result of the financial analysis for *B. philippinensis* at 4x5 m spacing with periodic harvests at 10% discount rate in 1989 pesos (P) in Region 11.

Site		Stock Source[a]		NPV(P)	B/C	IRR(%)
Flat	Hilly	Grow	Buy			
x		x		36692	1.42	24.0
x			x	38150	1.45	25.4
	x	x		21770	1.24	18.0
	x		x	22213	1.25	18.3

[a]See footnotes in Table 12.

production cost. Stock source is also important in the establishment of bamboo plantations. Buying bamboo stock is more desirable than having farmers grow their own stock. The difference in NPV is P1,609. Although success in raising planting stocks for *B. philippinensis* is much higher than for other species (pers. comm., Caasi), techniques have not yet been simplified for mass adoption.

Dendrocalamus asper

Geographic distribution of this species is very limited. Although the culm possesses a remarkable quality suitable for various uses, its productive capacity is not comparable to the other endemic species. The market price is also much lower than *B. blumeana* because preference for this species has not yet developed.

Though all six management schemes passed the NPV criterion in both Regions 7 and 11, the NPVs are relatively lower than those of *B. blumeana* (Table 14). Price differentials between regions have profound effects to NPV as well. While in Region 7 the highest NPV is P29,615, only P23,299 is possible in Region 11. *Ceteris paribus,* one possibility of improving the financial feasibility of this species in Region 11 is in the improvement of market prices. On the other hand, assuming price stagnates, NPV may be remedied by inducing higher productivity. Marginal increases in yield may lead to increased sales.

Spacing is also very critical. While all management schemes have positive NPVs, the difference in values is very significant. The highest attainable NPV at 7x7 m spacing in Region 7 is P29,615, whereas increasing the spacing to 10x10 m drops the NPV to only P6,132. This is due to the direct correlation of spacing and yield.

Table 14. Result of the financial analysis for *D. asper* on relatively flat terrain with annual harvests at 10% discount rate, in 1989 pesos (P).

Region	Spacing (m)	Stock Source[a]		First Cut	PNV (P)	B/C	IRR (%)
		Grow	Buy				
7	7x7	x		Year 7	26066	1.38	16.5
11	7x7	x		Year 7	19749	1.29	15.2
7	7x7		x	Year 7	29615	1.46	17.5
11	7x7		x	Year 7	23299	1.36	16.1
7	7x7	x		Year 8	20018	1.31	14.7
11	7x7	x		Year 8	14380	1.22	13.5
7	7x7		x	Year 8	20991	1.33	15.0
11	7x7		x	Year 8	15353	1.24	13.8
7	10x10	x		Year 7	5143	1.13	12.2
11	10x10	x		Year 7	2108	1.05	10.9
7	10x10		x	Year 7	6132	1.16	12.7
11	10x10		x	Year 7	3097	1.08	11.4

[a]See footnotes in Table 12.

The earlier the first harvest is realized the higher the NPV. When harvest commences at year 7 with cutting of culms 3-years old and older, the highest NPV possible is P29,615 in Region 7. Delaying the first harvest by a year and cutting culms 4-year old and older, drops the NPV to P20,991. The 29% loss in NPV is large considering the financial status of the farmers.

The difference in NPV attributed to source of planting stock is not as high as those from other factors. Buying planting stocks has an NPV of P29,615 compared to only P26,066 to those that grow their own. Whenever nurseries are available in the locality, farmers should be advised to buy planting stock. The difference of P3,549 is a considerable amount to poor farmers.

Dendrocalamus merrillianus

Data available and basic assumptions used in the analysis indicated that only four of the six management schemes pass the NPV criterion. The lower yield of this species relative to the others and the lower price it commands in the market are the two principal causes for these results. Increases in price may be difficult to achieve because of inherent characteristics of the species--it is shorter and often crooked with shorter internode intervals and an almost solid base. However, productivity could be enhanced through application of fertilizers and proper maintenance of the clumps. Increases in yield, however, should be evaluated to determine the marginal gain from the additional inputs. Generally, this species has not yet found its way into industrial markets, hence, the lower price. According to this study's survey results, this species is marketed only to other users in the locality or to other farmers.

Average buying price is the same in two regions where this species is being cultivated. Only management schemes with 7x7 m spacing pass the NPV criterion (Table 15). All others failed to pass the test. In comparison to other species, the highest attainable NPV for this species is P12,667; this is considerably below those of the three other species discussed above.

Improvement in NPVs is attainable in cases where discount rate is lower than 10% (Table 15). This means that if a slightly lower real discount rate was used, the other schemes would have passed the NPV criterion.

Schizostachyum lumampao

Like *B. blumeana*, this species is highly demanded in all 3 regions covered by the study. Since the market price on the average is the same in all 3 regions, only one set of management schemes was analyzed. Results can be directly applied to any of the three regions of the country.

All four management schemes gained positive NPVs (Table 16). Values of the NPVs, however, vary widely depending on harvest schedule, cutting age of the culm and source of planting stock.

When first harvest is in the fifth year and culms 1-year old and older are harvested, the highest attainable NPV is P7,677. This scheme assumes that subsequent harvests are conducted annually. On the other hand, if the first harvest is delayed by a year, and the demand is for culms 2-years old and older, the NPV drops to P1,402. The loss of 81% in NPV is very significant. This indicates that if material preference is 2-year old, the farmers will incur a huge reduction in profit if they intend to

Table 15. Result of the financial analysis for *D. merrillianus* on relatively flat terrain with annual harvests at 10% discount rate in 1989 pesos (P) in Regions 6 and 7.

Spacing	Stock Source[a]		First Cut	PNV (P)	B	IRR (%)
(m)	Grow	Buy				
7x7	x		Year 7	11381	1.18	13.3
7x7		x	Year 7	12667	1.20	13.8
7x7	x		Year 8	3100	1.05	10.9
7x7		x	Year 8	6143	1.10	11.8
10x10	x		Year 7	(1522)	0.95	9.2
10x10		x	Year 7	(1320)	0.96	9.3

[a]See footnotes in Table 12.

Table 16. Result of the financial analysis for *S. lumampao* at 4x5 m spacing on relatively hilly terrain with annual harvests at 10% discount rate in 1989 pesos (P) in Regions 6, 7, and 11.

Stock Source[a]		First Cut	NPV (P)	B/C	IRR (%)
Grow	Buy				
x		Year 5	6802	1.12	12.8
	x	Year 5	7677	1.14	13.3
x		Year 6	523	1.01	10.2
	x	Year 6	1402	1.03	10.5

[a]See footnotes in Table 12.

continue supplying the market. Improved marketing may be needed. A good understanding of the characteristics of this species relative to its physical, mechanical and chemical properties is important. This may help in marketing the species.

As with other species, buying stock ready for outplanting is an advantage. The NPV is higher by P875 if farmers choose to buy stocks from legitimate producers rather than to grow their own stocks. However, in areas where no nurseries are producing bamboo stock, farmers have to grow them.

4.5. Sensitivity Analysis

Gittinger (1982) defines sensitivity analysis as an analytical technique used to systematically test potential earning capacity of a project if actual events differ from the initial estimation made in the pre-planning evaluation. It evaluates the change that results from changing some key variables, though the result may or may not warrant change in the decision. If carefully applied, sensitivity analysis can overcome some of the weaknesses of using a deterministic approach (Duvigneau and Prasad, 1984) because it provides flexibility of the utilization of the results. Its main objective is to modify assumptions on key variables (e.g., costs, yields, prices, etc.) thereby testing project viability as affected by different scenarios. It allows objective judgement on the riskiness of the project under alternative assumptions. From the analyst's point of view, a fairly accurate assessment of the strengths and weaknesses of an investment can be determined. It is also valuable in projecting impacts of changing factors over time.

Forestry investments are subject to some uncertain events as enumerated by

Price (1989), namely: (1) drought, floods and attacks by insects; (2) new technological advances; (3) human factors, such as illegal felling and arson; (4) changing markets for products and inputs; and (5) political factors.

Bamboo production is not an exception. As such, probable outcomes from variations of some assumptions previously made are evaluated. Selected scenarios are based on changing costs and prices by 10%. Results are based on the effects on NPV of the different schemes. The sensitivity analyses focus only on those schemes that had the highest NPVs for each species and region.

Different Scenarios

Results of sensitivity analyses of management schemes that gained the highest NPV for each species in every region are presented in Table 17. Percentage changes in NPV are presented for comparison to the percentage changes in costs and prices. Complete results for all schemes are available from the author.

Results show that in Region 7, all schemes for *B. blumeana* posted positive NPVs. For the scheme with the highest NPV, the value went down from P57,827 to P50,996; thus, a 10% increase in cost (Scenario 1 or S1) led to a loss of 12% in NPV. For *D. asper*, two schemes failed to pass the NPV criterion; that is, the NPVs turned negative. The scheme yielding the highest NPV declined by 22%, down from P29,615 to P23,111. Of the six schemes evaluated for *D. merrillianus*, only three schemes passed the NPV test. The NPVs of other schemes turned negative. Reduction in NPV for the scheme with the highest NPV was 49%, down from P12,667 to P6,485. For *S. lumampao*, only two of the four schemes had positive NPVs regardless of region. The

Table 17. Results of sensitivity analyses for management schemes that gained highest positive NPVs for each species in 3 regions at 10% discount rate in 1989 pesos (P).

Region	Species	Original NPV (P)	Percent NPV Loss by Scenario[a]		
			S1	S2	S3
7	*B. blumeana*	57827	12%	22%	34%
	D. asper	29615	22%	32%	54%
	D. merrillianus	12667	49%	59%	*
	S. lumampao	7677	40%	53%	*
6	*B. blumeana*	38344	18%	28%	46%
	D. merrillianus	12667	49%	59%	*
	S. lumampao	7677	40%	53%	*
11	*B. philippinensis*	44623	20%	30%	50%
	B. blumeana	38344	18%	28%	46%
	D. asper	23299	28%	38%	66%
	S. lumampao	7677	40%	53%	*

[a]S1= Scenario 1. Production cost increased by 10%.
S2= Scenario 2. Price reduced by 10%.
S3= Scenario 3. Combination of Scenarios 1 & 2.
* = NPV turns negative.

NPV loss, however, was high at 40%, a drop from P7,677 to only P4,589.

While all schemes for *B. blumeana* had positive NPVs in Region 6, the loss was greater in comparison to Region 7. The NPV dropped from P38,344 to P31,514 or a net loss of about 18%. For *D. merrillianus* and *S. lumampao*, the results are the same as in Region 7.

Results for *B. blumeana* in Region 11 are the same as in Region 6. For *D. asper* only three of the six schemes posted positive NPVs. The loss was much greater than in Region 7 at 28%, down from P23,299 to P16,795. All 8 schemes for *B. philippinensis* still retained positive NPVs. The loss, however, was 20%, down from P44,623 to P35,806. Like *B. blumeana*, the farmers still retained considerable income. Results for *S. lumampao* are the same in Regions 6 and 7.

Price decline is seen to happen in some areas where non-industrial users are prevalent. How farmers decision will be influenced in the event that market prices are reduced by 10% (Scenario 2 or S2) was also evaluated.

The effect on NPVs from reduction in price is greater than the effects of increased production costs. In Region 7, the loss for *B. blumeana* was 22%, down from P57,827 to P45,214. For *D. asper* the loss was 32%, down from P29,615 to P20,150. Reduction for *D. merrillianus* was 59%, down from P12,667 to P5,218 with four of six schemes turning negative NPVs. The loss to *S. lumampao* was 53%, down from P7,677 to only P3,595. However, two schemes failed to gain positive NPVs.

In Region 6 the loss of NPV for *B. blumeana* is higher at 28%, down from P38,344 to P27,679. For *D. merrillianus* and *S.lumampao*, the results are the same as in Region 7.

The results obtained in Region 6 for *B. blumeana* are the same as in Region 11. For *D. asper* the loss was 38%, down from P23,299 to P14,465. The loss to *B. philippinensis* was 30%. NPV drops from P44,623 to P31,343. For *S. lumampao* the results are the same as in Regions 6 and 7.

The combined effects of Scenarios 1 and 2 are additive (Scenario 3 or S3). Bamboo species whose combined loss to increase in cost and decrease in price is less than 100%, still attained positive NPVs (Table 17). This is true for *B. blumeana,* in all 3 regions; for *B. philippinensis* in Region 11; and for *D. asper* in Regions 7 and 11. The other two species (i.e., *D. merrillianus* and *S. lumampao*), however, failed to pass the NPV test.

4.6. Regional Summary of Cash Flows

Management schemes that gave the highest NPV for each species in every region were chosen and graphed to discern how particular species perform relative to the others based on annual discounted cash flow of net benefits. Other schemes, of course, would yield different cash flows.

Region 7 - Central Visayas

Of the four species planted in Region 7, *S. lumampao* exhibited the earliest positive cash flow commencing in year 5 while the other 3 species did not gain positive cash flows till year 7. The timing of positive cash flows is governed by the assumption on first harvest in combination with the harvest age of the culms. The relationships of cash flows for four species is depicted in Figure 2. The earlier harvest

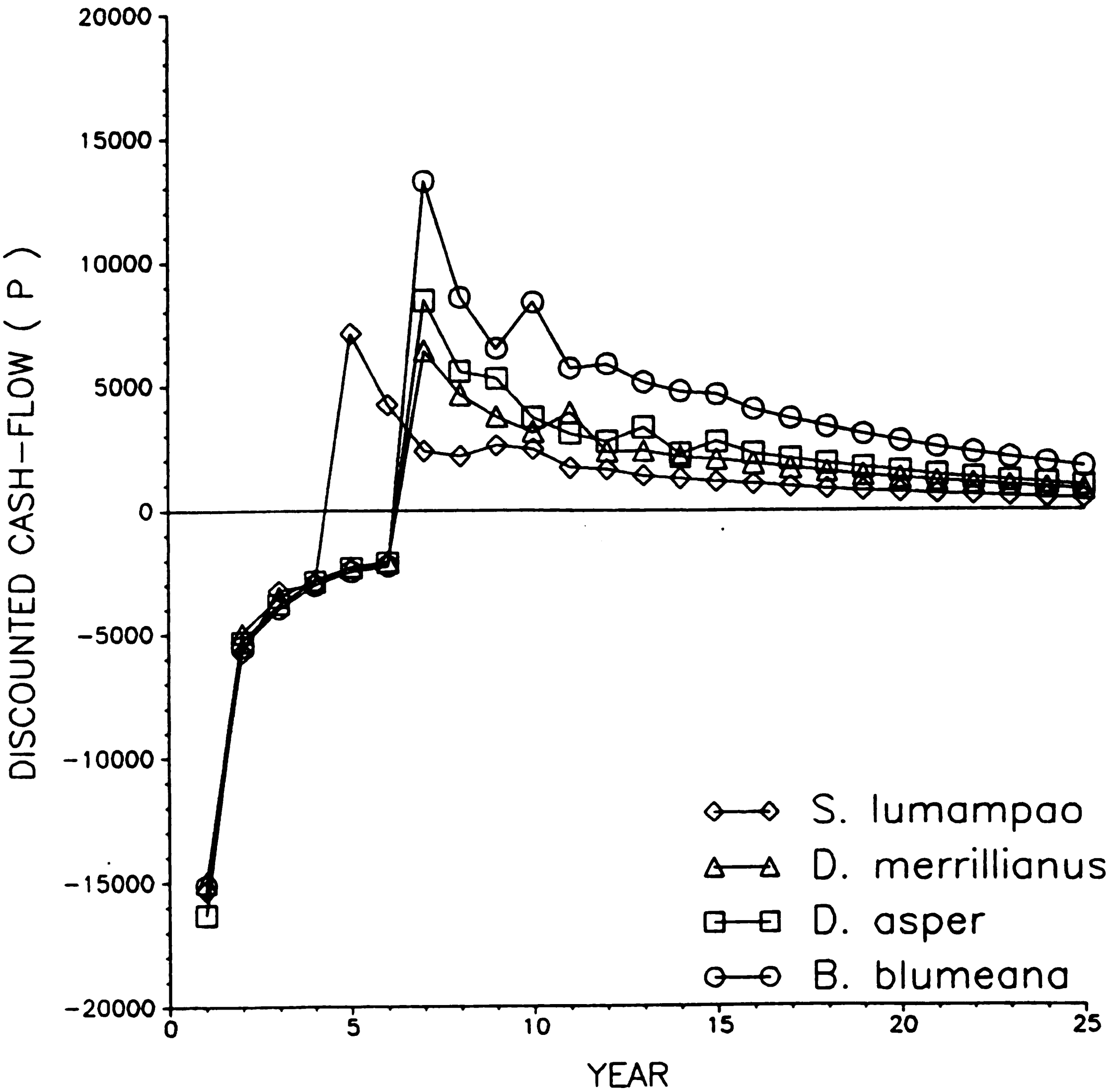

Figure 2. Discounted Cash Flow of Net Benefits of 4 Bamboo Species in Region 7.

for *S. lumampao* is an advantage over the other species from the vantage of the small farmers who are in dire need for cash at the earliest time possible.

B. blumeana posted the highest positive discounted net cash flow. Though positive cash flow may not occur until year 7, the benefits derived thereafter are consistently higher throughout the analysis period. High demand for this species as reflected in its higher market price contributes to this result.

D. asper had higher discounted cash flows than *D. merrillianus* and *S. lumampao*, but consistently lower than *B. blumeana*. *D. merrillianus*, on the other hand, was superior to *S. lumampao* but not comparable to the other two species.

Region 6 - Western Visayas

Comparison of the three species planted in Region 6 is shown in Figure 3. The behavior of the discounted cash flows of net benefits is similar to Region 7, though actual values for *B. blumeana* and *D. merrillianus* are slightly lower. The difference is solely attributed to lower buying prices in Region 6. Despite the lower prices, the NPVs for *B. blumeana* and *D. merrillianus* are still higher than that of *S. lumampao*. Species preference, therefore, still favors *B. blumeana*.

Region 11 - Northeastern Mindanao

Of the four species evaluated in Region 11, *B. blumeana* and *B. philippinensis* have the highest NPVs (Figure 4). The advantage of *B. philippinensis* over *B. blumeana* is its earlier harvest which commences in year 4. For subsistence farmers, it is important to gain earlier returns because of the need to raise cash. This is further

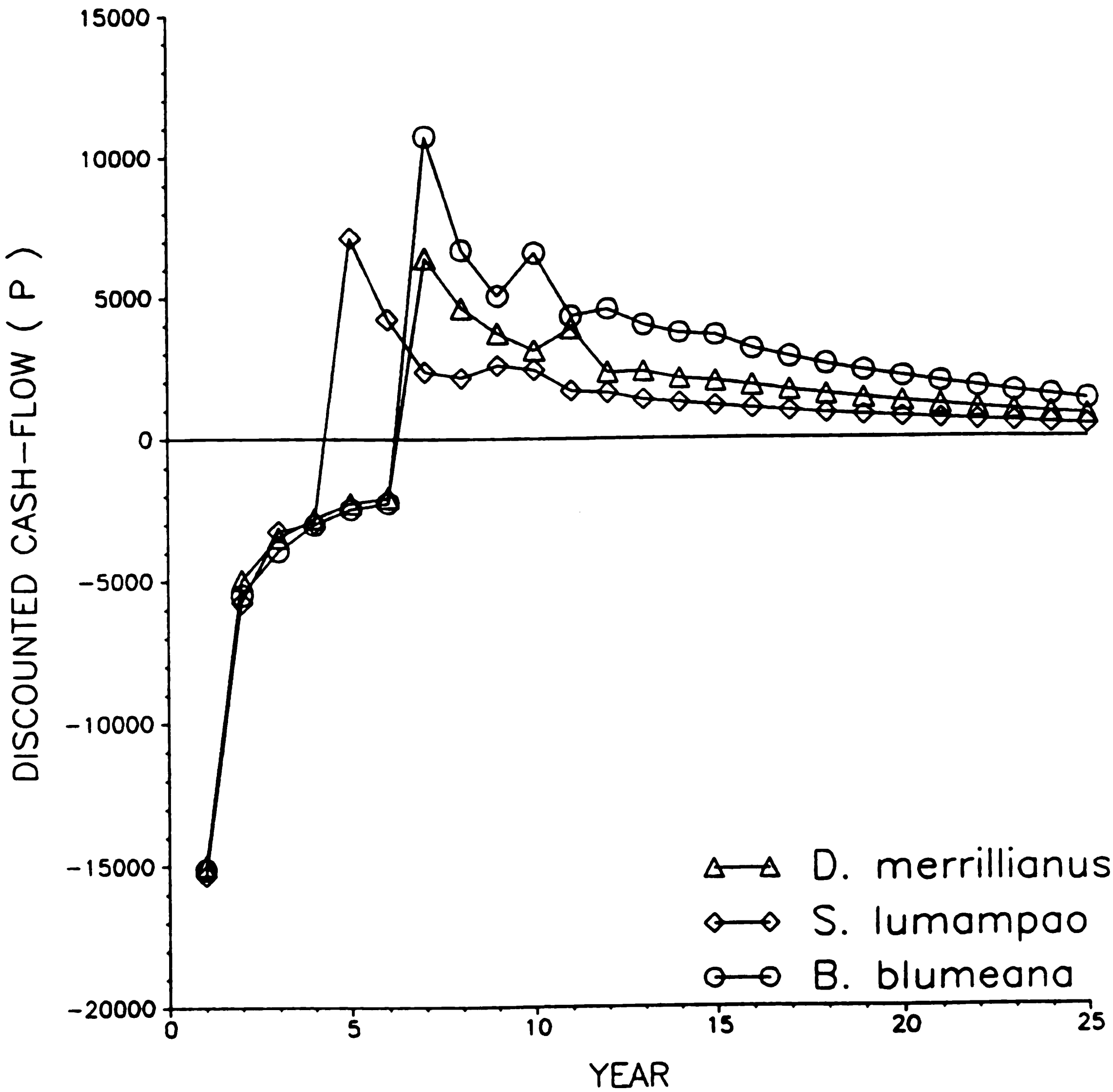

Figure 3. Discounted Cash Flow of Net Benefits of 3 Bamboo Species in Region 6.

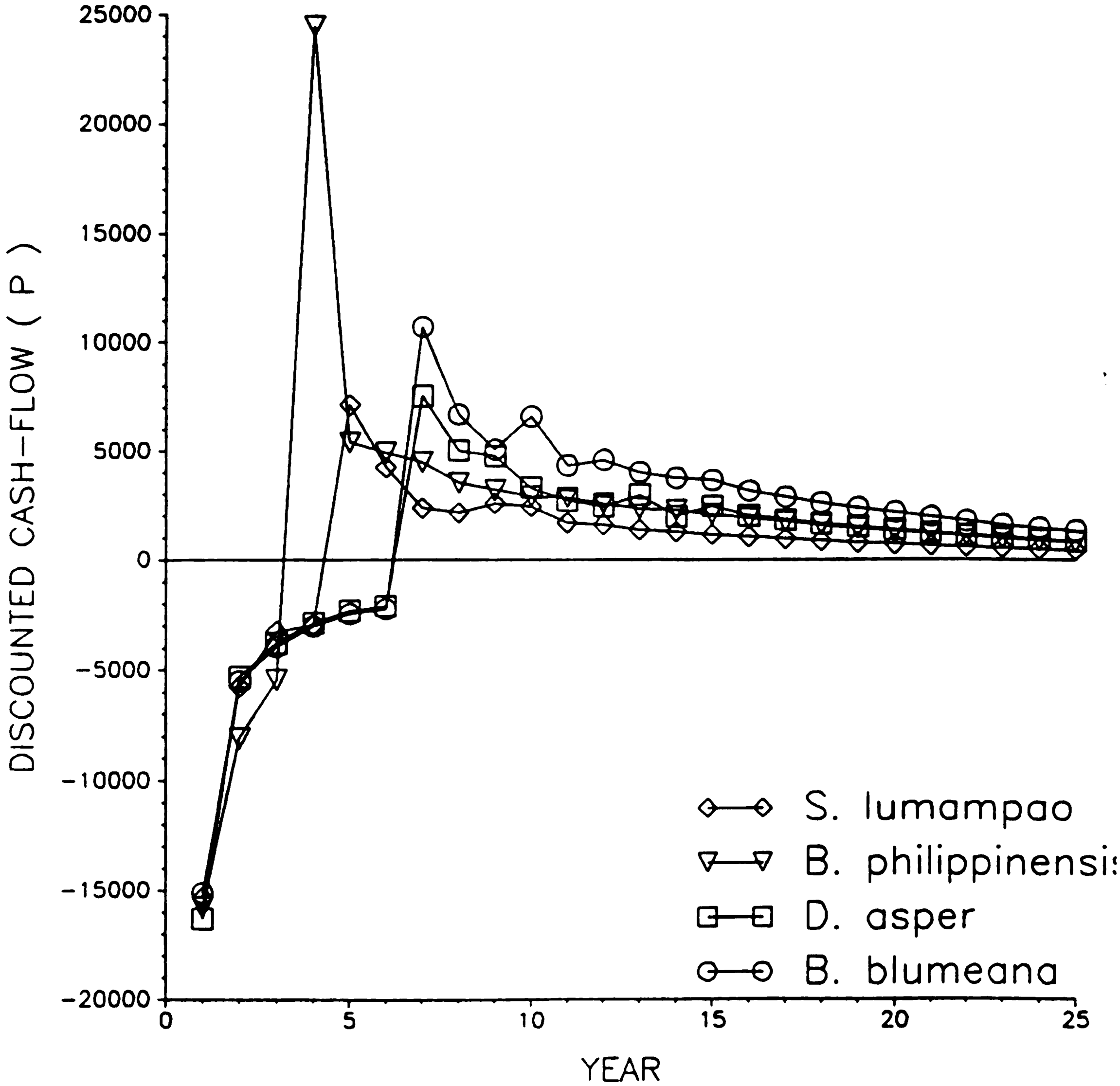

Figure 4. Discounted Cash Flow of Net Benefits of 4 Bamboo Species in Region 11.

exemplified by a very high initial harvest of *B. philippinensis*.

D. asper is closely behind the other two species. With the favorable weather in Region 11, this species may be grown with the other two provided market prices improve. Net present values for *S. lumampao* are consistently lower than those of other species but always positive. This indicates that planting of this species is still profitable provided all assumptions in the analysis are met.

4.7. Plantation Development Scheduling for Each Management Scheme

Individual LP models were generated by matching individual household types (HT) with the different management schemes (MS) for appropriate bamboo species in three regions of the country. This analysis provides insight regarding the development schedule that is most efficient for individual species given individual management constraints. Management schemes are described in Chapter 3 and in Appendix H. NPVs of the different management schemes as affected by year when planting starts by region are presented in Appendix I. Complete results indicating the NPV, the number of hectares developed by year and the total labor used (TLU) in Region 7 are presented in Appendix J. Results for Region 11 are shown in Appendix K, and results for Region 6 are presented in Appendix L.

The FLC was found to be binding and clearly influences timing of plantation development. As amount of labor contribution increases, borrowing can also increase (loan amount is up to 3 times the family labor in peso equivalents) allowing farmers to be in a better position for developing more area in the first few years of the project. The capacity of the farmers to develop larger areas in the earlier years substantially contributes to higher NPVs.

The models developed satisfactorily met the constraints imposed on the problem. Solutions indicate that in the earlier years, all available resources except land are used up to allow development of more plantations. As imposed on the model, plantation development is sequential whereby resources are allocated in such a way that in the succeeding years provision for maintenance of those previously established plantations are jointly determined with the extent of additional hectares to be established in the same year. The provision of constraints throughout the entire duration of the Leasehold Contract further ensures that as soon as harvests start, the project is assured to be self-supporting. This is vital considering that borrowed funds must be repaid in a specified period of time.

A vivid illustration on how *B. blumeana* plantation development proceeds, given the limitations imposed on FLC, is presented below. Three household types (HT) in Region 7 were chosen to represent the range of family labor available: the least (HT3), the average (HT1) and the most (HT6). Management Scheme 1 (MS1) was matched with these three HTs, and LP models were generated. MS1 assumes an initial harvest at year 7 so that borrowing is allowable up to year 6.

For HT3 which can only provide 88 person-days or a peso equivalent of P6,675 per annum, the family is allowed to borrow to as much as P20,025 per year (3 x P6,675). As such, HT3 accumulate an annual capital of P26,700. To maximize NPV, the model indicated that the farmer has to fully utilize his labor, as well as, the borrowing for the full 5 years as shown in Table 18. In the sixth year, however, the borrowing drops to only P12,616 as most activities are confined to maintenance and

Table 18. *B. blumeana* plantations developed, funds borrowed and total NPV by household type (HT) in Region 7 at 10% discount rate in 1989 pesos.

HT	Year	Funds Borrowed (Pesos)	Area Developed (ha)	NPV (Pesos)
3	1	20,025	1.50	
	2	20,025	0.94	
	3	20,025	0.71	
	4	20,025	0.59	
	5	20,025	0.50	
	6	12,616	-	
Total		112,741	4.24	211,803
1	1	27,900	2.10	
	2	27,900	1.31	
	3	27,900	0.98	
	4	24,231	0.61	
	5	14,075	-	
	6	12,819	-	
Total		134,915	5.00	259,037
6	1	56,925	4.56	
	2	22,314	0.44	
	3	8,313	-	
	4	3,770	-	
	5	1,250	-	
	6	925	-	
Total		93,497	5.00	280,387

protection services only. Under "Area Developed", the schedule indicated that fewer hectares are developed each year. Since part of the constraint is to confine development in the first 5 years, this HT was not able to develop the total 5 hectares. A surplus of 0.76 ha remained unplanted. To develop the 4.24 ha, HT3 needs a total loan of P112,741. The total NPV is calculated at P211,803.

For HT1 which can provide a total of 124 person-days or a peso equivalent of P9,300 per annum, the family can accumulate a total of P37,200 annual capital including the allowable borrowings. With this amount, the farmer is better off developing more area than with HT3. The LP model indicated that the NPV increases to P259,037. The borrowings followed the same pattern as in HT3 but the decline occurs earlier. For this HT, the borrowing decreased beginning in year 4 and continued to decline until the first harvest occurs. The five hectares were fully developed. Total borrowing was P134,915.

Household type 6 (HT6) which can contribute the most number of person-days at 253, or a peso equivalent of P18,975, could raise up family's annual capital to P75,900. With this amount, HT6 can develop 4.56 ha in the first year and the balance of 0.44 ha in the second year. In terms of loan, HT6 made full use of it in the first year only. Beginning in year 2, borrowing abruptly drops and continues to decline until year 6. To develop the 5-ha lot, HT6 borrows a total of P93,497. Household's capability to develop more area in the earlier years allows a higher NPV of P280,387.

The direct correlation of the family labor contribution to the NPV is further explained by the dependency of the borrowings on the family labor resource. The provision that borrowing should not be more than three times the family labor contribution in peso equivalent compounded the limitation on family's capability to develop more area. For instance, where family labor is more limited, the 5 hectare limit is not fully developed. Where family labor is relatively abundant, the family is constrained only by the timing of when planting starts. The timing is very important because of its implications to NPV. As plantation establishment is delayed, the NPV declines. As more areas are developed in earlier years, higher NPVs are expected.

Three of the species follow similar harvest schedules as *B. blumeana*. Having a rotation of five years and longer, *B. philippinensis* exhibited a different development schedule for farmers with less labor. The possibility of an earlier harvest occurring in the 4th year after planting allows small farmers to develop additional areas even though borrowing has already ceased. Since the LP model is formulated with constraints on the entire planning period, the proceeds for the earlier harvests can be saved and used for planting additional areas in years 4 and 5. As it turned out, development in year 4 is even higher than in year 1 or from previous years because farmers are in a better position from earlier returns. Without the possibility of deriving benefits in year 4, more areas will remain undeveloped for farmers with less labor.

4.8. Cash Flows of Discounted Net Benefits

Farmers that could provide the required inputs without borrowing funds have a different cash flow schedule than those that provide a family labor as equity for borrowing (Table 19). In the former case, the cash flow considers all actual costs occurring in the same year. Discounting takes effect as soon as the money is spent. In the case of the latter, the repayment of borrowed funds are not directly reflected in the

Table 19. Gross returns, development cost and cash flow schedule for two types of farmers (with & without borrowing) in 1989 pesos (P).

Year	Gross Returns	No Borrowing		With Borrowing	
		Cost	Cashflow	Cost	Cashflow
1	0	37200	-37200	9300	-9300
2	0	37200	-37200	9300	-9300
3	0	37200	-37200	9300	-9300
4	0	33531	-33531	9300	-9300
5	0	23375	-23375	9300	-9300
6	0	21119	-21119	9300	-9300
7	76771	34298	42473	66439	10332
8	102033	35916	66117	68057	33976
9	115300	35996	79304	68137	47163
10	138456	38913	99543	71054	67402
11	128672	39689	88983	71830	56842
12	129809	39005	90804	71146	58663
13	128525	37804	90721	69945	58580
14	125167	35783	89384	67924	57243
15	128064	34884	93180	67025	61039
16	127644	34735	92909	66876	60768
17	128152	34940	93212	34940	93212
18	128244	35139	93105	35139	93105
19	127680	35125	92555	35125	92555
20	127680	35125	92555	35125	92555
21	127680	35125	92555	35125	92555
22	127680	35125	92555	35125	92555
23	127680	35125	92555	35125	92555
24	127680	35125	92555	35125	92555
25	127680	35125	92555	35125	92555

year borrowed funds are spent but rather they are brought forward (compounded) including the interest to some later years when harvest is realized. This means that farmers have to shoulder the cost of borrowing (time value of money), which is assumed to be a 10% rate in real terms (see Appendix G). What appear as costs in the earlier years are family labor contribution only. The borrowed funds only enter as costs when repayment commences. The assumption for repayment to be made in 10 equal annual installments, however, allows farmers to have some considerable latitude in repayment. This indicates that it takes a longer time for farmers without funds to enjoy higher cash flows than for those who can provide their own capital (Table 19). The cash flow schedules are different for farmers who do not borrow and those who do. As borrowed funds are paid in full, cash flows for both types of farmers are equal. The remaining analyses are based on the use of borrowed funds; this is consistent with economic reality in the rural Philippines.

4.9. Optimal Development Schedule by Species--Maximizing NPV

As previously described (see Appendix H), there are several ways to manage a particular bamboo species in a plantation. Management schemes (MS) vary according to source of planting stock, spacing, harvest schedule and harvest age. To choose the optimal development schedule and scheme from among the schemes for a particular species, LP models were created by allowing choice among alternative MS for a given species by region and household type. The same types of constraints were entered and tested for all 6 household types in each region. The following discussion is organized by species and region for maximizing NPV (Table 20).

Table 20. Ranges of NPVs based on optimal development schedule for each species by region at 10% discount rate in 1989 pesos.[a]

Region	Species	Management Scheme[b]	Ranges of NPV (Pesos)
7	*B. blumeana*	MS2	222,936-286,832
	D. asper	MS18	105,879-145,216
	D. merrillianus	MS24	47,007-65,592
	S. lumampao	MS30	38,371-49,035
11	*B. blumeana*	MS2	151,987-191,611
	B. philippinensis	MS10	187,550-222,050
	D. asper	MS18	89,117-115,378
	S. lumampao	MS30	41,085-49,569
6	*B. blumeana*	MS2	120,323-186,693
	D. merrillianus	MS24	40,141-61,402
	S. lumampao	MS30	23,042-37,150

[a]*Maximizing NPV*

[b]*These are optimal schemes for each species in each region for all household types. The management schemes are fully described in Appendix H. Net present value, area planted by year and total labor used are presented in Appendices J, K and L.*

The optimal schedule and scheme for *B. blumeana* is MS2 in all 3 regions for all 6 household types (see Appendices J, K and L). The NPV ranges from P120,323-P286,832 depending on household type and region. The use of NPV as the only measure to determine the optimal scheme indicated that MS2 is preferable over the other seven schemes currently employed by farmers. The amount of labor contribution did not in any way affect the choice. To optimally manage *B. blumeana*, a farmer has to (1) purchase planting stock from legitimate producers to minimize costs and mortality, (2) use 7x7 m spacing, (3) start harvesting at year 7 with subsequent annual harvests, and (4) begin with a cutting age of 3 years old and older. In case harvesting is delayed by a year or 4-year old culms are demanded, this scheme is still a better choice over the others assuming that corresponding adjustments are also made in the other schemes. If no producers for planting stock (i.e., nurseries) are available locally, farmers have the next best alternative scheme as an option. Management Scheme 1 (MS1), which assumes that farmers have to produce their own planting materials comes out to be the next best choice in comparison to the other schemes. The NPV, however, is slightly lower (between 4% to 6% lower than MS2) depending on household type and region. Since the optimal model was selected from individual models previously generated, the comparison can be directly inferred from Appendices J, K, and L.

For *B. phillipinensis*, which is planted only in Region 11, the optimal solution for all household types is MS10. This scheme produces the highest NPV from among the 8 schemes for this species. The NPV ranges from P187,570-P222,051 depending on household type. As prescribed in this scheme, the farmer has to (1) purchase planting material from legitimate producers, (2) use a 4x5 m spacing, (3) start harvesting in year 4 with subsequent annual harvests, and (4) begin with a cutting age of 1 year old and older. Even if the first harvest is delayed, this scheme is still far better than the other schemes, provided corresponding adjustment is applied to the other schemes. The next best alternative scheme for this species is MS9. This is appropriate in case planting stock ready for outplanting is not available in the area. This scheme assumes that the farmer has to produce the planting stock. Switching to the next best scheme reduces NPV by about 4-5% depending on household type. Since two distinct sites (relatively flat and hilly terrain) were analyzed for this particular species, site specific schemes must be determined so that NPV implications can be evaluated. On relatively hilly sites, the optimal scheme is MS14. Though NPVs are relatively high, they are approximately 30% lower than those calculated for flat sites using MS10. Complete results are presented in Appendix K.

D. asper is planted in Regions 7 and 11. Considering the six schemes of this species, the optimal solution for all household types is MS18 except for HT3 (HT which has the least labor). HT3, which could not afford to develop the full 5 hectares using MS18, uses slack area to develop a less intensive scheme. In Region 7, for example, the balance of 0.69 ha using an individual model approach was developed in combination with MS22 when all schemes for *D. asper* were combined. The full development of 5 ha, 4.31 ha for MS 18 and 0.69 ha for MS22, subsequently increases the NPV from P105,879 to P110,096 or an increase of P4,217. Total labor also increases from 6132 to 6697 person-days. In Region 11, the development of an additional 0.35 ha increases the NPV from P89,117 to P90,197. The strategy is to develop 4.65 ha using MS18 and 0.35 ha using MS22.

Of the six schemes evaluated for *D. merrillianus* in Regions 7 and 6, only 4 schemes yielded positive NPVs. The other 2 schemes, therefore, were excluded. The optimal scheme is MS24 regardless of household type. MS24 is superior from the NPV perspective, values range from P40,141-P62,592 depending on household type and region. This scheme prescribes that farmer has to (1) buy planting stock from legitimate growers, (2) use 7x7 m spacing, and (3) set cutting age at 3 years old and older with annual harvesting commencing at year 7. In case bamboo nurseries are not available in the locality, the next best option is MS23. This scheme requires that the farmer has to grow the planting stock. All other treatments are the same as in MS24. If the switch from MS24 to MS23 is inevitable, the NPV is reduced by as much as 11-15% depending on the household type. Of course, the household type that suffers the largest percentage decline is the one that can provide the least labor. However, despite the reduction, NPV is still high. Complete results are shown in Appendices J and L.

For *S. lumampao*, the optimal scheme is MS30 for all household types in all 3 regions. From the NPV standpoint, this scheme stands out over the other 3 schemes used in the analysis. Provided there is a demand for culms 1 year old and older, MS30 is the best option. In this scheme, it is prescribed that a farmer has to: (1) buy nursery-grown stock ready for outplanting, (2) use a 4x5 m spacing, (3) conduct the first harvest at year 5 with subsequent annual harvests, and (4) set the cutting age at 1 year old and older. In areas where bamboo nurseries are not yet available, farmers have to grow their planting stock. The next best option in this case is MS29. The switch to

MS29 would reduce the NPV by 9-13% depending on household type and region. The NPV, however, still remains relatively high. From the farmers' standpoint, either scheme is still a worthwhile undertaking. Complete results are shown in Appendices J, K, and L.

4.10. Optimal Development Schedule by Species--Maximizing Amount of Employment

As mentioned previously, promotion of bamboo plantations are not driven solely by an objective of increasing income. Implications for generating employment are also important. Since managing bamboo plantations is labor-intensive, an evaluation of how much labor is required relative to the number of hectares developed is important. The policy implications are wide-ranging because the results would serve as the basis for selecting the optimal scheme that would yield maximum employment. This may, of course, be different from results obtained by maximizing NPV.

The LP problem was reformulated by combining total labor requirements over the 25-year planning horizon as the objective function, but retaining all the constraints used in maximizing NPV. The analyses were run in similar fashion by allowing choice among all available schemes for particular species by region. Calculations were made for each household type since they are determinants of the family labor contribution. The subsequent discussions, therefore, focus on how decisions for selecting the optimal schemes are to be carried out for each species in each region by each household type to satisfy the objective of creating more employment (Table 21).

Table 21. Range of labor use (person-days) based on optimal development schedule for each species by region.[a]

Region	Species	Management Scheme[b]	Labor-Use (Person-days)
7	*B. blumeana*	MS1	6,446-7,968
	D. asper	MS17	6,160-7,785
	D. merrillianus	MS23	5,552-6,537
	S. lumampao	MS29	6,086-7,054
11	*B. blumeana*	MS1	6,953-7,993
	B. philippinensis	MS9	11,940-12,797
	D. asper	MS17	7,045-7,808
	S. lumampao	MS29	6,674-7,075
6	*B. blumeana*	MS1	5,505-7,930
	D. merrillianus	MS23	4,741-6,508
	S. lumampao	MS29	4,777-7,021

[a]*Maximizing amount of employment.*

[b]*These are optimal schemes for household types whose FLC is more than 100 mandays (i.e., HT1, HT2, HT5, and HT6). HT3 and HT4 have optimal shemes similar to Maximizing NPV or a combination of 2 schemes. Management schemes are fully described in Appendix H.*
Net present value, area planted by year and total labor used are presented in appendices J, K, and L.

Region 7 - Central Visayas

To maximize on-farm labor, the optimal scheme to develop *B. blumeana* plantations for all household types except one in Region 7 is MS1. Depending on household type, the difference in labor required is about 153-171 person-days over the 25-year period relative to the next labor-intensive scheme (i.e., MS2, which has the highest NPV). Results from this analysis indicate that choice for either the maximizing employment or NPV can be narrowed down to two from the eight schemes evaluated for *B. blumeana*. Since five out of six household types are capable of developing the 5-ha plot, the increased labor requirement stems from production of their own planting stock as required in MS1. This is the difference between MS1 and MS2.

The only household type whose solution differs from the others is HT3. This HT, which has the least labor, has MS2 as the optimal strategy. The major reason for this choice is that more hectares could be developed using MS2. About 4.37 ha can be developed from MS2 and only 4.24 ha by using MS1. The labor difference is only 46 person-days. The amount of labor incurred in nursery operation is more than compensated by the labor required for developing and maintaining the additional 0.13 ha plantation. The slack area remains undeveloped (Appendix J).

For *D. asper*, solutions for all household types except HT3 included MS17 only. This scheme requires an additional 226-245 person-days over the 25-year period relative to the next labor-intensive scheme, MS18. MS17 requires farmers to grow their planting stock, while MS18 does not. The development strategy is the same as the result obtained when maximizing NPV (Appendix J).

HT3 yielded an interesting result. To allocate the 6,831 person-days, MS17 is selected and scheduled in the same manner as in maximizing NPV; 6160 person-days were utilized. The balance of 671 person-days were used to develop the remaining 0.82 ha in year 1 with MS22. This generates an additional NPV of P5003. By maximizing labor therefore, in the combined approach, the NPV increases from P94,748 to P99,751. Though the total NPV is still lower by P6128 from MS18, the amount of labor increase was 699 person-days. This indicates that by combining the different schemes, the amount of labor use can still increase.

Solutions for *D. merrillianus* include MS23 only for all household types except HT3. The difference in person-days ranges from 170-192 over the 25-year planning period relative to the next most labor-intensive scheme, MS24. Since these five household types were able to develop the total 5 ha, the difference can be fully attributed to the person-days required in nursery operations.

For HT3, the optimal scheme for maximizing labor use is MS24. Though this scheme does not require nursery operation to be handled by farmers, the extent of areas planted determines the increase in labor use. Though the increase relative to MS23 is only 51 person-days, MS24 is also the scheme with highest NPV. Using either approach (maximizing NPV or labor), therefore, yields the same result. The strategy for plantation development is presented in Appendix J.

For *S. lumampao*, the solutions for all household types except HT3 included MS29 only. This scheme requires farmers to produce their own planting stock. The difference ranges from 178-192 person-days depending on household type over the 25-year period relative to the next most labor-using scheme is solely attributed to the activities incurred in raising the planting materials. The development strategy is presented in Appendix J.

For HT3, the optimal scheme is MS30. This scheme does not require that production of planting material be undertaken by the farmer. It allows farmers to develop more hectares than the next most labor-using scheme. This scheme also has the highest NPV. Maximizing either labor or NPV for this household type and species therefore, yields the same result (Appendix J).

Region 11 - Northeastern Mindanao

Optimal solutions for managing *B. blumeana* for all household types except HT3 included MS1 only. MS1, as defined in Appendix G, requires farmers to grow their planting stocks. The difference in labor use ranging from 147-165 person-days depending on household type over the 25-year period relative to the next most labor-intensive scheme is solely attributed to the additional labor required for nursery operations. (Appendix J).

Similar to Region 7, the optimal scheme for HT3 is MS2. This scheme has the highest NPV also. The objective of maximizing either labor or NPV for HT3 gives the same result. The difference of only 50 person-days from MS1 indicated that despite the nursery activities included in MS1, the additional area of 0.15 ha developed with MS2 more than compensated the labor needed for growing the planting stock. Total hectares developed using MS1 is only 4.57 ha while with MS2, the area increases to 4.72 ha (Appendix K). The labor required to develop, maintain and harvest the additional 0.15 ha is far more than the labor needed to grow the planting stock.

B. philippinensis is viewed differently from the other species because there are two distinct sites included in the analysis. Though this species is planted in Region 11 only, the clear distinction between the 2 sites is worth examining. To fully appreciate the result, the schemes are further broken down into two sites: relatively flat terrain, using MS9-MS12 and hilly areas, using MS13-MS16.

Using all the schemes available for relatively flat terrain for all six household types, MS9 turned out to be the best scheme to maximize labor. HT1 can generate 11,387 person-days; HT2, 11,507; HT3, 11,147; HT4, 11,267; HT5, 11,615; and HT6, 11,831 person-days. The labor difference relative to MS10 ranges from 62-87 person-days over the 25-year period depending on household type. The difference is solely attributed to labor required in nursery operations. The next most labor-intensive scheme is MS10 which has the highest NPV also. This means that whenever growing of planting materials is not really possible switching to MS10 still creates considerable jobs.

For hilly terrain, the optimal scheme for all household types included MS14 only. This scheme does not require farmers to produce their own planting stock. However, it allows farmers to develop more areas of plantations. The ability to plant more hectares in the earlier years requires labor more than that needed in the nursery operations. The amount of labor (person-days) generated by household type are as follows: HT1, 12,299; HT2, 12,432; HT3, 11,866; HT4, 12,166; HT5, 12,553 and HT6, 12,797. Results are presented in Appendix K.

If all the management schemes for *B. philippinensis* are combined, optimal scheme for all household types except HT3 included MS14 only. The development strategy is exactly the same as above. The HT3, however, being not capable of developing 5 ha, combined MS10 and MS14 and came up with a different strategy. The new schedule increases the person-days to 11,940 and all the 5 ha were developed. In MS14, 1.48 ha was developed in year 1; 1.68 in year 2; 0.56 in year 3; 1.61 in year 4 and 0.48 in year 5. The total person-days was 11,532 and the total NPV was P125,441. In MS10, 0.02 ha was planted in year 1; 0.05 in year 2; 0.01 in year 3; none in year 4 and 0.11 in year 5. Total person-days was 408 and the NPV generated was P6,378. The combination of MS10 and MS14 increases the NPV to P131,819 from P128,900 with individual LP approach.

For *D. asper,* optimal solution for all household types except HT3, include MS17 only. The main difference is on the amount of labor required to grow the planting materials. This scheme can generate labor (person-days) of 7,550 for HT1; 7,626 for HT2; 7,435 for HT4; 7,681 for HT5; and 7,808 for HT6. The next best option MS18 which has the highest NPV also. The difference is about 223-243 person-days over the 25-year period depending on household type (Appendices K).

For HT3, optimal scheme is MS17 in combination with MS22. The strategy for MS17 is exactly the same as the individual LP run. Total labor generated was 6,645 person-days. NPV was P79,771. The slack of 0.49 ha in MS17 was developed in year 1 with MS22. Total labor generated was 400 person-days. Combined labor increases to 7,045 and the NPV increases to P81,279.

The scheme that provides the most labor for *S. lumampao* is MS29 for all household types except HT3. This scheme requires farmers to grow their planting materials. Person-days needed to grow the seedlings is the major factor for the increase in labor use. To develop MS29, the total labor (person-days) required are : 6,880 for HT1; 6,929 for HT2; 6,797 for HT4; 6,978 for HT5; and 7,075 for HT6. Labor requirement for MS29 is greater by about 180-191 person-days over the 25-year period relative to the next most labor-using scheme, MS20 (Appendix K).

To maximize labor use, the solution for HT3 included MS29 and MS31. The strategy is to develop 1.46 ha in year 1, 1.07 in year 2, 0.93 in year 3, 0.79 in year 4, and 0.30 in year 5 with MS29. Total labor use was 6,108 person-days. With MS31, 0.15 ha was planted in year 1; none in year 2; 0.02 in year 3; 0.01 in year 4; and 0.27 in year 5. Total labor generated was 6,674 person-days. As previously described, both MS29 and MS31 require farmers to grow their own planting stocks (Appendix K).

Region 6 - Western Visayas

Solutions for household types capable of developing 5 hectares of *B. blumeana* included MS1 only. These are HT1, HT2, HT5 and HT6. This scheme requires farmers to grow their planting stock. Total employment (person-days) generated are: 7,570 for HT1; 7,683 for HT2; 7,756 for HT5 and 7,930 for HT6. Total labor use is higher by about 153-169 person-days over the 25-year period relative to the next most labor-intensive scheme depending on HTs (Appendix L).

Solutions for household types 3 and 4 whose labor contribution is not sufficient to develop the 5 ha included MS2 only. The opportunity of farmers to develop more area of bamboo plantation with MS2 allows use of more labor. The labor requirement for the additional area is more than that required in putting up the nursery. This scheme (MS2) has the highest NPV also. Either maximizing NPV or employment, the results are the same. To develop MS2, HT3 can generate 5,505 person-days. This is 40 person-days more than MS1. HT4, on the other hand, can generate 6664 person-days.

To manage *D. merrillianus* solutions for household types that have labor capable of developing the 5 ha plot included MS23 only. These are HT1, HT2, HT5, and HT6. Total labor generated for each HT are 6,294, 6,328, 6,383 and 6,508 person-days respectively. This scheme generates 169-195 person-days over the 25-year period relative to the next most labor-intensive scheme depending on HT. MS23 requires farmers to produce their own planting stock (Appendix L).

Optimal scheme for HT3 and HT4 is MS24. This scheme has the highest NPV also. This scheme allows the farmers to develop more hectares of bamboo plantation over MS23. Total labor (person-days) generated are 4,741 for HT3 and 5,739 for HT4. The results indicate that labor required to plant and manage the additional 0.16 ha for HT3 and 0.20 ha for HT4 is more than that needed to grow the planting stock. Labor difference is relatively small if viewed over the 25-year period. Additional employment of only 44 person-days for HT3 and 53 person-days for HT4 may be insignificant.

Solutions for HT2, HT5 and HT6 to manage *S. lumampao* included MS29 only. The other HTs (i.e., HT1, HT3 and HT4) require combination of 2-3 schemes to maximize employment.

The strategy for HT2, HT5 and HT6 is to develop the 5 ha plot and labor generated were: 6,813, 6,874 and 7,021 person-days, respectively. MS29 as described, requires farmers to produce their own planting stock. The additional labor needed for nursery activities made the difference.

For HT1 to maximize labor, a combination of MS29 and MS32 is required. To develop MS29, a total of 6,444 person-days is generated. The strategy is to develop 1.75 ha in year 1; 1.00 ha in year 2; 0.94 in year 3; 0.74 in year 4; and 0.36 in year 5. The balance of 0.21 ha was developed using MS32. About 277 person-days were generated to develop 0.21 ha. Planting schedule is 0.06 ha in year 1; 0.11 in year 2; and 0.40 in year 5. The combined labor generated was 6,720 person-days.

For HT3, strtegy is a combination of MS30, MS31 and MS32. Total person-days generated was 5,489. The schedule with MS30 is to plant 0.37 ha in year 1; 0.45 in year 2; and 0.52 in year 3. No planting is done in years 4 and 5. Labor used was 1,763 person-days. With MS31, 0.16 ha is planted in year 1; 0.27 in year 2; no planting was made in years 3 and 4; and 0.10 in year 5. Total labor used was 721 person-days. With MS32, planting is 0.81 ha in year 1; 0.06 ha in year 2; 0.16 in year 3; 0.56 in year 4 and 0.57 in year 5. Total labor generated was 3,005 person-days. The result was totally different from the previous run where NPV was maximized.

Optimal scheme for HT4 is the same with HT3. Combinations MS29, MS31 and MS32 are required to maximize employment. Labor generated was 1,808 person-days in MS29, 2,422 in MS29, and 2,282 person-days for MS32. Grand total is 6,511 person-days. For MS29, planting schedule is 0.40 ha in year 1; 0.17 ha in year 2; 0.68 in year 3; 0.20 in year 4 and no planting in year 5. For MS31, planting schedule is 0.50 ha in year 1; 0.86 ha in year 2; no planting in year 3; 0.39 in year 4; and 0.04 in year 5. For MS32, Planting is 0.68 ha in year 1; no planting in year 2; 0.12 in year 3; 0.03 in year 4; and 1.02 ha in year 5. Total labor generated has risen by 728 person-days using the combined approach.

CHAPTER 5

SUMMARY AND IMPLICATIONS

Two main objectives are addressed in this study. The first is to determine the financial viability of bamboo plantations in different regions with different bamboo species and family labor availability. The second objective is to determine the optimal development schedules for bamboo plantations based on a 5-hectare module. Two objective functions (goals) are considered: (1) maximizing the net present value of cash flows, and (2) maximizing the amount of employment.

Major findings from this study are reviewed and discussed in this chapter along with their implications to other bamboo species, to other regions of the country and to other participants of the project. Finally, limitations of this research are addressed and opportunities for further research are identified.

5.1. Summary of Findings

Bamboo plantations, in general, are a viable undertaking from a financial perspective. Of the 32 schemes evaluated involving 5 species, only 2 schemes (MS27 and MS28) failed to meet the financial analysis criteria. That is, the NPVs were negative, the B/C ratios were less than unity and the IRR values were below the real discount rate used (i.e. 10%) in the analyses as shown in Table 15. The outcomes of the other 30 schemes, however, were very impressive.

Management schemes vary with species, spacing, cutting age, cutting schedule, site characteristics and the requirement for farmers to produce their own planting materials or buy planting stocks ready for outplanting from established nurseries in the region. Appendix H describes these schemes in detail. Natural characteristics of the species as described in Appendices A and B are determinants of their final use.

The first phase of the financial analysis, which assumes development of 1 hectare bamboo plantations across regions without regard to family labor availability, demonstrates the attractiveness of the project. Planting *B. blumeana* in Region 7 can generate NPVs ranging from P17,007-P56,823 depending on the management scheme for the 25-year planning horizon. In Regions 6 and 11, realizable NPVs are from P8,736-P37,340. For *B. philippinensis* which is planted only in Region 11, NPVs range from P21,770-P44,623 depending on the scheme. *D. asper* can generate NPVs ranging from P5,143-P29,615 in Region 7, while in Region 11, the NPVs range from P2,108-P23,299. For *D. merrillianus*, the positive NPVs range from P3,100-P12,667. NPVs for *S. lumampao* which are applicable to 3 regions ranges from P523-P7,677 depending on management scheme.

The main difference of NPVs between regions for a particular species was primarily attributed to the farm gate prices presented in Table 7. Buying prices vary considerably across regions. Species that meet the requirements of the industries (e.g., construction, furniture, cottage, fishing, and banana plantations) command higher prices than those that are traded between local people only. Culm quality is another factor that differentiates prices. Quality classifications are based on the size of the culm (i.e., length and diameter), straightness, and culm wall thickness. Even within species, price differences are common because of these variations.

Spacing is another component that has a great influence on the financial outcome of the plantation. Spacings have direct correlation with yield. Closer spacings allow more clumps per hectare and subsequently more culms are produced. For *B. blumeana*, the loss in NPV of increasing spacing from 7x7 m to 10x10 m ranges from 60-64% depending on regions; for *D. asper*, the loss in NPV ranges from 80-89%; and for *D. merrillianus*, NPVs turn negative if spacings are increased from 7x7 m to 10x10 m in both Regions 6 and 7.

Harvest schedule (i.e., age of culm, first harvest, annual and periodic) is another factor that has an influence on the overall performance of the plantation. Postponing the first harvest by a year for *B. blumeana* creates losses in NPV ranging from 20-25% depending on region; for *D. asper*, NPV loss ranges from 23-27%; for *D. merrillianus*, NPV loss is 50%; and for *S. lumampao*, the loss in NPV is 81% if the demand is for 2 year old culms rather than for 1 year old culms.

Though only *B. philippinensis* was subjected to 2 cutting schedules, annual and periodic, results indicate that annual harvesting is superior to the periodic schedule. Annual harvesting yields NPV higher by 14.5%. Annual harvest schedules also allow farmers to earn sufficient cash flows regularly whereas cash flows from periodic harvesting fluctuates from year to year. Careful plantation development and management could overcome the problem of fluctuations, but farm yields would be lower.

Recognition of site variability is as important as the other factors that were included in distinguishing management schemes. The effect of site differences not only affect the cost of development, but the yield as well. As shown in Table 13a, relatively flat site yields NPVs aproximately 29% higher than those on hilly terrain.

The choice by farmers to grow their planting materials or to buy planting stock ready for outplanting is included as an option. In some regions of the country, commercial growing of planting stock is not yet available. From all species evaluated, buying planting stocks ready for outplanting is preferable to farmers putting their own nursery if maximizing NPV is the objective function. Although the difference in NPVs is small ranging from 2-11% depending on the species, the timing of coming up with sufficient number of planting stock for a given year may pose problems for some farmers.

Bamboo plantations, like other biological undertakings, are subject to some uncertain events beyond the control of farmers. As such, sensitivity analyses were conducted to test the financial performance of the project in the event that selected factors change (Table 17).

The effect on increasing production costs by 10% to NPV is large. In Region 7, loss in NPV ranges from 12-49% depending on the species. For Region 6, the loss in NPV ranges from 18-40%; and in Region 11, the loss in NPV ranges from 18-49%. From an NPV perspective, the project is still profitable even after income taxes of 5% from gross sales are deducted.

Loss to NPV from 10% reduction of farm gate prices is considerably higher than losses from the cost sensitivity analysis. In Region 7, loss in NPV ranges from 22-59% depending on species; in Region 6, NPV loss ranges from 28-59%; and in

Region 11, NPV loss ranges from 28-53%. The project is still profitable, though income loss is greater than in Scenario 1 where production cost is increased by 10%. Thus, the project performance was found to be more sensitive to depression of farm gate prices for bamboo products than increase in production cost.

The combined effects of increasing cost and reducing price by 10% are profound. Of the five species evaluated, only 3 species yield positive NPVs. For those species that yield positive NPVs, the losses range from 34-66% depending on region.

Optimizing development schedules for bamboo plantations based on a 5-ha module indicated that family labor contributions (FLC) over time were the most binding constraints; this is true especially in the early years of development. No test was done to evaluate the capability of household types with higher FLCs if area is not limited. Without question, some household types could develop additional area if the constraint on land were relaxed. For household types where FLC is less than 100 person-days (i.e., HT3 in 3 regions and HT4 in Region 6), development of the whole 5-ha is not possible regardless of species. But for HTs where FLC is over 100 person-days, development of 5-ha is attainable; plantation development schedules, however, vary.

Maximizing NPV of cash flows indicated that the higher the FLC, the higher is the NPV. As more family labor is available, corresponding borrowing also increases. The higher capital accumulated allows more hectares to be developed in the earlier years. As more hectares are developed in the earlier years, higher NPVs result. This is due to the discounting effect and fewer years with positive cash flows for those hectares established in later years.

For maximizing NPV, the optimal solution for *B. blumeana* for all household types in all 3 regions is MS2. NPV ranges from P120,323-P286,832 depending on HT and region. For *B. philippinensis*, the optimal scheme is MS10 for all HTs. The NPVs range from P187,570-P222,051 depending on HT. The scheme that yielded optimal schedule for *D. asper* is MS18. With this scheme, NPV ranges from P89,117-P145,216 depending on HT and region. For *D. merrillianus*, the optimal scheme is MS24. With this scheme, NPV ranges from P40,141-P62,592 depending on HT and region. Solution for *S. lumampao* is MS30 for all HTs and regions. With this scheme, NPV ranges from P23,042-P49,569 depending on HT and region. The wide variability of NPVs between species can be attributed to the differences in yield and prices from region to region.

Maximizing the amount of employment yielded results different from maximizing NPV. For HTs which are capable of developing the whole 5 ha within the 5-year period, the solution is to adopt schemes requiring the farmers themselves to raise their own planting stocks. The additional person-days required in the nursery operations generally led to the increase in labor requirement. Another factor that influences the choice is spacing. As spacings get closer, more person-days are needed to prepare the site, plant the area, maintain the plantations and harvest the culms. The last factor that contributes to higher labor use is site quality. As terrain gets increasingly difficult to manage, more labor is required to perform similar activities than on flat terrain.

For farmers whose FLCs are more limited, the optimal solution is not dependent on schemes requiring the farmers to grow their own planting stocks, but on schemes that would allow them to develop more hectares of bamboo plantations. The solution was typically a combination of 2-3 schemes. By combining the different schemes, farmers were able to develop the whole 5-ha, and this contributed much to the increase in labor use. Though NPVs declined in most cases, the values are still positive. In some instances however, the optimal solution for maximizing NPV is the same as the optimal solution for maximizing amount of employment. Summary of results for species with highest NPV and highest amount of labor-use for the entire analysis period (25 years) are presented in Table 22.

5.2. Implications of Findings

Promotion of bamboo plantations in the countryside is both appealing from a political standpoint and financially attractive from a farmer's perspective. The study results indicate that despite the very limited input (i.e., family labor), households can invest in bamboo production, returns are very significant in terms of added income. The assumption of considering surplus labor as the sole basis of a family's contribution (and equity basis) assures the farmers that their normal livelihood activities are not jeopardized. Involvement in bamboo plantations would be a matter of putting their slack time to some productive use. A government program using this slack time as equity could be very beneficial to farmers who do not have real assets to serve as collateral.

The high return generated even for part-time bamboo farmers suggests wide adaptability of the results. This indicates that other participants interested in investing their resources in bamboo plantations may be feasible. However, land cost must be

Table 22. Summary of species having highest NPV, highest labor use, and highest labor availability by Region at 10% discount rate in 1989 pesos.

Species	Region	Highest Values		
		FLC[a] (Person-days)	NPV (Pesos)	Labor (Person-days)
B. blumeana	7	253	286,832	7,968
	6	218	186,693	7,930
	11	276	191,611	7,993
B. philippinensis	11	276	222,051	11,831
D. asper	7	253	145,216	7,785
	11	276	115,328	7,808
D. merrillianus	7	253	62,592	6,537
	6	218	61,402	6,508
S. lumampao	7	253	49,035	7,054
	6	218	37,150	7,021
	11	276	49,569	7,075

[a]FLC= highest annual family labor contribution. These are contributed by household type 6 in all regions.

added if it is not a government sponsored program. Those that can provide the capital without borrowing are in a better position because they will not be paying for the cost of money. Those with extensive landholdings have the opportunity to develop more plantations.

The structural component of allowing farmers access to public lands through Leasehold Contracts has wide-ranging implications. While active involvement of government and funding agencies is required in the initial years to complement the limited resources farmers can put up as equity, structural arrangements allow farmers to be self-reliant and to become small enterpreneurs. As time passes, public assistance programs can be shifted to other deserving clients as bamboo plantations become self-sustaining.

The financial analysis clearly demonstrated that as soon as first harvest is realized, the plantation can generate income more than sufficient to service the borrowed funds and cover the other costs as shown by high NPVs of cash flows. This is due, in part, to the government's ability to bear the risk of the initial investment by delaying loan repayment until harvests are realized. Inclusion, therefore, of other bamboo species from other regions is not difficult if similar conditions exist. Special attention should be given to demand-side/market forces because bamboo production is highly sensitive to changing prices.

The tremendous deficit of bamboo materials in recent years due to conversion of lands to other uses and mismanagement of natural stands in some areas can be augmented through bamboo plantations. Study results indicate that financial returns are more than sufficient to meet the production costs. The added income farmers can generate is a strong motivation for them to engage in bamboo growing. The results however, should not be viewed as a framework for total farm planning. Each farmer is unique that models developed may serve only as a qualified guidelines in making use of farmer's excess labor to bamboo management. Indications as to what species and timing of development farmers may adopt were demonstrated by the study's results.

The continuous cover bamboo stands can provide is an added advantage from an environmental perspective. It stabilizes soil and water flow. Besides, bamboos can also be developed in pure plantations or can be integrated into agroforestry farms.

Revenue from taxes cannot be underestimated. The gross sales tax of 5% levied on all products derived from bamboo plantations can generate a sizeable amount income to the government. This money could be channeled to support other public projects related to conservation and management of natural resources.

All respondents signified interest in bamboo plantations. This overwhelming response is an indication of the attractiveness of the project, but this should not be interpreted as a pre-condition for acceptability. Unless problems raised by the farmers on financing, land acquisition, technical assistance, continuity of the project and product marketing are resolved, this project will suffer the same predicament as the fuelwood production project (Hyman, 1983) or the dendrothermal plantations (Durst, 1989).

5.3. Limitations

Several limitations were encountered in the conduct of this investigation. These are related principally to limitations on data needed in the analysis.

Time and data constraints are notable. For example, standard yield tables for bamboo species are not available at present. Direct inference of yields gathered from other regions posed problems of estimation because of climatic variability and edaphic differences. In addition, plantations where yield data were gathered were established for purposes different from this study. Thus, yield data for various schemes were not empirically developed using systematic silvicultural strategies.

Reliance on nationally set minimum wage is another limitation. Variations between regions in terms of hiring/exchanging labor may not reflect the actual wages received by farmers. Other cost information are also limited because most of the data were gathered from government-administered pilot projects. However, the approach used provides a consistent framework for analysis.

Another limitation is the household type classification. The typing based on 30 samples surveyed per region may not be a valid representative of the region because sampling was confined to areas adjacent to the pilot projects for purposes of this study. Farmers non-response to some important questions pertaining to income, harvests and landholdings may have masked some important information valuable in characterizing the households. Typing of households, therefore, as used in this study should be refined as data on family profiles become available. However, the data provided a basis for examining the effect of labor availability on optimal management schemes.

The optimal schedules developed should not be treated as a farm planning guide because the analysis was limited to the optimal use of surplus labor only. The results may be different if bamboo plantations were integrated with the other farm activities of the farmers.

The "sweat equity" (allowing farmers to borrow capital 3 times the FLC without collateral in terms of real asset) assumption though used for short-term crops was never tried for long-term projects. This is where political will is put to test on how sincere the government is in helping the poorest of the poor.

The assumption on the discount rate (i.e., 10%) is also a limitation because this is the government rate. The riskiness of the project from private point of view may require higher discount rates and may not be attractive to small farmers. Finally, the deterministic nature of the models used may not account for the changes that may happen beyond the control of the farmers or the government.

5.4. Further Research

The pioneering nature of this investigation contributed to its focus. That is, empirical data were gathered from various regions regarding labor availability, prices, costs, and yields. The focus on the supply-side does not present a complete picture of the status of bamboo in the Philippines nor does it deal with site-specific analyses. A number of research gaps still exist regarding production and consumption of bamboo.

One aspect of major concern is production of planting stocks. Dependence on vegetative propagation is difficult for large-scale plantations because culm cuttings are bulky, destructive, and expensive to transport. Further studies on propagating planting stock through tissue-culture and other methods are important and are of immediate concern. Until mass propagation is possible through inexpensive means with high survival rates, open acceptance of bamboo management by farmers can not be assured.

Related to this is the need to determine the effect of fertilization on commercial-scale plantations. Information of this nature is valuable for evaluating the marginal gains of using additional inputs to enhance productivity.

Integration of bamboo production to total farming systems should be studied. Evaluation is important on how farmers allocate family labor to a combination of subsistence and income generating activities. Research concerning earlier returns on bamboo management should be explored because it affects decision on the choice of the species, timing of development and product diversification. Shoot production is one avenue that is worthwhile pursuing.

To refine the determination of returns, detailed buying prices of raw materials must be related to the specific end-products for which bamboos are used. It has been observed that differences in prices vary depending on the end-use for which the material is purchased. A complete picture of bamboo production and consumption status is valuable in determining the total economic impact of the species to the Philippine economy.

On the supply-side (production), silvicultural studies must be pursued to develop refined yield tables that would account not only spacings and harvest schedule but also edaphic and climatic factors. Site specific yield tables are valuable in predicting future harvests.

On the demand-side (consumption), the marketing structure should be studied. Marketing schemes for bamboos are not yet developed in a manner comparable to other forestry products. The role of middlemen should be studied because their presence may have masked the real potential returns from selling/buying bamboos.

APPENDICES

APPENDIX A

Ranges of Mensurational Attributes of Bamboo

Table A1. Ranges of mensurational attributes of bamboo species used in the study.

Attribute	Species[a]			
	Bb	Da	Dm	Sl
Culm Length (m)	11.2-20.0	13.6-29.2	6.1-13.0	6.5-11.0
No. of Nodes	32.0-53.0	33.0-68.0	20.0-58.0	11.0-25.0
Length of Internodes (cm)				
Butt	14.0-35.5	16.6-41.5	10.0-26.0	14.0-55.5
Middle	33.3-46.6	44.0-72.5	16.5-32.0	42.4-76.0
Top	27.0-37.6	24.3-58.0	27.5-35.5	43.2-72.8
Internode Diameter (cm)				
Butt	6.3-10.8	12.1-18.8	4.9-8.2	3.8-7.3
Middle	7.2-11.3	9.2-15.4	4.4-7.5	5.4-7.0
Top	4.3-7.6	4.4-8.7	2.2-5.1	2.7-4.7
Culm Wall Thickness (cm)				
Butt	1.38-3.80	1.79-3.63	1.8-4.50	0.50-1.6
Middle	0.60-3.17	0.85-1.44	1.3-2.50	0.30-0.9
Top	0.44-0.69	0.56-0.95	1.3-2.50	0.30-0.9

[a]Bb = *Bambusa blumeana*
Da = *Dendrocalamus asper*
Dm = *Dendrocalamus merrillianus*
Sl = *Schizostachyum lumampao*

Source: Uriarte *et al.*, 1990.

APPENDIX B

Physical and Mechanical Properties of Bamboo

Table B1. Physical and mechanical properties of bamboos used in the study.

Property	Species[a]			
	Bb	Da	Dm	Sl
Moisture Content (%)	82.21	121.03	98.44	123.88
Relative Density	0.65	0.55	0.59	0.53
Shrinkage (%)				
Thickness	12.45	12.85	11.29	15.44
Width	7.12	8.53	7.77	1.27
Maximum Crushing Strength (MPa)				
Nodal	492.15	411.07	402.18	382.58
Internodal	495.87	421.71	444.91	342.36
Static Bending				
Stress at proportional limit (MPa)	257.79	170.73	611.64	179.44
Modulus of rupture (MPa)	335.65	234.22	900.82	202.07
Modulus of elasticity (1000 MPa)	134.32	127.18	87.91	94.34

[a]See footnotes of species in Table A1.

Source: Uriarte *et al.*, 1990.

APPENDIX C

Classification of Land Area in the Philippines

Table C1. Classification of land area in the Philippines from SPOT survey.

Land Cover	Area ('000 ha)
Forest	7,226
Pine	81
Mossy/Unproductive	246
Dipterocarp	6,629
Closed	2,435
Open	4,194
Mangrove	149
Extensive Cultivation	11,958
Open in Forest	30
Grassland	1,813
Mixed	10,114
Intensive Cultivation	9,729
Plantation	5,336
Coconut	1,133
Other	91
Coconut and Cropland	3,748
Other and Cropland	365
Cropland	4,392
Fishponds	205
Fishponds from Mangrove	195
Other Fishponds	10
Other Lands/Lakes	542
Unclassified Area	546
TOTAL	30,205

Source: Solna, Sweden, 1988.

APPENDIX D

Survey Questionnaires and Input Data Forms

Table D1. Production input data form.

Species: ______________________
Spacing: _________
Region : _________
Type of Input: Labor (person-days) [ ] Cost (P) [ ]

Items	Year ___				
	Q1	Q2	Q3	Q4	Total
A. Procurement of					
planting materials					
1. Planting stock					
a. rhizome					
b. culms					
c. branch					
d. others					
2. Labor					
a. excavating					
b. cutting					
c. preparation					
B. Transport to nursery/					
plantation site					
1. Truck hire					
2. Man/animal hire					
3. Labor					
a. loading					
b. unloading					
c. distribution					

Table D1 (continued)

Items	Year ___				
	Q1	Q2	Q3	Q4	Total
C. Nursery operation					
1. Tools/materials					
a. shovel					
b. trowel					
c. bolo					
d. plastic bags					
e. net					
f. others					
2. Labor					
a. preparation					
b. potting					
c. setting up					
D. Care & Maintenance					
1. Fertilizer					
2. Labor					
a. watering					
b. cleaning					
c. fertilizer					
E. Transportation to					
plantation site					
1. Truck hire					
2. Man/animal hire					
3. Labor					
a. loading					
c. distribution					

Table D1 (continued)

Items	Year ____				
	Q1	Q2	Q3	Q4	Total
F. Plantation					
establishment					
1. Tools/materials					
a. bolo					
b. grass cutter					
c. shovel					
d. pickmattock					
e. hole digger					
2. Labor					
a. boundary survey					
b. brushing					
c. staking					
d. hole digging					
e. planting					
G. Maintenance					
1. Fertilizer					
2. Labor					
a. weeding					
b. fertilizer					
application					
c. replanting					
d. fireline					
construction					
e. others					

Table D1 (continued)

Items	Year ____				
	Q1	Q2	Q3	Q4	Total
H. Harvesting					
1. Tools					
a. chainsaw					
b. bolo					
c. bow saw					
2. Labor					
a. felling					
b. preparation					
I. Transportation					
1. Truck hire					
2. Man/animal hire					
3. Labor					
a. loading					
b. unloading					
c. piling					

Table D2. Yield (harvested) data form.

Species: ________________________
Spacing: __________
Region : __________

Clump	Yield (No. of culms)								
Number	Year ___			Year ____			Year ___		
	H	A	L	H	A	L	H	A	L

H = high quality
A = average quality
L = low quality

Table D3. Buying price questionnaire.

1. Name of Respondent/Title: ____________________
2. Name of Firm: ____________________
3. Address of Firm: ____________________

Q1. What type of firm are you engaged in? Choose from below:

[ ] Construction [ ] Cottage [ ] Furniture
[ ] Fishing [ ] Banana [ ] Food
[ ] Pulp and Paper [ ] Others

Q2. What type of products are you producing? What species?

	Product	Species
1.		
2.		
3.		
4.		
5.		

Q3. How much do you pay for the raw materials?

	Species	Price
1.		
2.		
3.		
4.		
5.		

Q4. What is your average consumption per month? Your projected demand?

	Species	Average/mo.	Projected
1.			
2.			
3.			
4.			
5.			

Q5. Where do you get your raw materials?

	Species	Source/Location/Distance
1.		
2.		
3.		
4.		
5.		

Table D4. Household profile questionnaire.

1. Name of Respondent: ______________________________
2. Address: ____
3. Age: _______
4. Status: [ ] Married [ ] Single [ ] Widow [ ] Widower

Q1. Do you have children? [ ] Yes [ ] No

Q2. How many? _____ What are their ages and gender?

	Age	Gender
1.	_______	______
2.	_______	______
3.	_______	______

Q3. Do you own the farm? [ ] Yes [ ] No Location: ______

Q4. Are you working as [ ] owner [ ] tenant or [ ] hired labor?

Q5. How many hectares are cultivated? ___________

Q6. What type of crops are growing?

Crops	Hectare	Yield (unit)
1. rice	______	________________
2. corn	______	________________
3. root crops	______	________________
4. Others	______	________________

Q7. How much time do you spend working/week? ___________

Q8. What percentage of your time is devoted to farming your land?

Your time	___________%
Your wife	___________%
Your children	___________%

Q9. What are your other sources of income? 1. _______ 2. ________

Q10. How much are you earning outside farming? _________

Q11. The government is planning to promote bamboo plantations. Are you interested to engage in bamboo farming? [ ] Yes [ ] No

Q12. How much time can you devote to bamboo plantation? ___

Q13. What problem do you forsee when you decide to go into bamboo plantation?
1. ___________ 2. ___________ 3. ____________

APPENDIX E

Per Hectare Yield Data

Table E1. Per hectare yield (number of culms) data for *B. blumeana* at 7x7 m spacing.

Harvest Year	High Quality	Average Quality	Low Quality	Total
1978	918	367	550	1,835
1979	732	305	183	1,220
1980	676	257	153	1,026
1981	844	352	211	1,407
1982	713	297	178	1,188
1983	737	307	184	1,228
1984	700	292	174	1,166
1985	704	294	176	1,174
1986	751	313	188	1,252

Source: ERDB, 1989.

Table E2. Per hectare yield (number of culms) data for *B. blumeana* at 10x10 m spacing.

Harvest Year	High Quality	Average Quality	Low Quality	Total
1978	487	175	262	874
1979	348	145	88	581
1980	293	122	74	489
1981	402	168	100	670
1982	340	142	84	566
1983	351	146	88	585
1984	333	139	83	555
1985	335	140	84	559
1986	358	149	89	596

Source: ERDB, 1989.

Table E3. Per hectare yield (number of culms) data for *B. philippinensis* at 4x4 m spacing in relatively flat terrain with annual harvesting.

Harvest Year	Normal Size	Oversize	Total
1978	14,625	4,875	19,000
1979	4,625	1,542	6,167
1980	4,625	1,542	6,167
1981	4.625	1,541	6,166
1982	4,397	1,459	5,856
1983	4,397	1,459	5,856
1984	4,398	1,460	5,858
1985	4,410	1,470	5,880
1986	4,410	1,470	5,880

Source: ERDB, 1989.

Table E4. Per hectare yield (number of culms) data for *B. philippinensis* in relatively flat terrain with periodic harvesting (every 3 years).

Harvest Year	Normal Size	Oversize	Total
1977	14,625	4,875	19,500
1980	13,875	4,625	18,500
1983	13,192	4,378	17,570
1986	13,230	4,410	17,640
1989	13,432	4,410	17,842

Source: Caasi, 1989.

Table E5. Per hectare yield (number of culms) data for *B. philippinensis* in hilly terrain with annual harvesting.

Harvest Year	Normal Size	Oversize	Total
1978	12,349	3,866	16,215
1979	4,134	1,295	5,429
1980	4,134	1,295	5,429
1981	4,133	1,295	5,428
1982	4,094	1,282	5,376
1983	4,095	1,282	5,377
1984	4,095	1,282	5,377
1985	4,637	1,456	6,093
1986	4,637	1,456	6,093

Source: ERDB, 1989.

Table E6.. Per hectare yield (number of culms) data for *B. philippinensis* in hilly terrain with periodic harvesting.

Harvest Year	Normal Size	Oversize	Total
1977	12,349	3,866	16,215
1980	12,401	3,834	16,235
1983	12,281	3,844	16,125
1986	12,852	4118	16,970
1989	12,845	4,032	16,877

Source; Caasi, 1989.

Table E7. Per hectare yield (number of culms) data for *D. asper* at 7x7 m spacing.

Harvest Year	High Quality	Low Quality	Total
1978	1,058	705	1,763
1979	711	474	1,185
1980	730	486	1,216
1981	644	429	1,073
1982	610	490	1,000
1983	585	390	975
1984	711	474	1,185
1985	590	392	982
1986	715	478	1,193

Source: ERDB, 1989.

Table E8. Per hectare yield (number of culms) data for *D. asper* at 10x10 m spacing.

Harvest Year	High Quality	Low Quality	Total
1978	504	336	840
1979	339	226	565
1980	347	232	579
1981	327	211	538
1982	297	188	485
1983	279	186	465
1984	338	226	664
1985	293	189	482
1986	341	227	568

Source: ERDB, 1989.

Table E9. Per hectare yield (number of culms) data for *D. merrillianus* at 7x7 m spacing.

Harvest Year	High Quality	Low Quality	Total
1978	746	746	1,492
1979	639	426	1,065
1980	560	372	932
1981	582	378	960
1982	700	466	1,166
1983	548	364	912
1984	556	370	926
1985	544	360	904
1986	572	368	940

Source: ERDB, 1989.

Table E10. Per hectare yield (number of culms) data for *D. merrillianus* at 10x10 m spacing.

Harvest Year	High Quality	Low Quality	Total
1978	354	354	708
1979	304	203	507
1980	266	178	444
1981	328	219	547
1982	333	222	555
1983	260	174	434
1984	265	176	441
1985	258	172	430
1986	258	172	430

Source: ERDB, 1989.

Table E11. Per hectare yield (number of culms) data for *S. lumampao* at 4x5 m spacing in hilly terrain.

Harvest Year	Yield
1978	5,945
1979	4,460
1980	3,240
1981	3,240
1982	3,870
1983	3,965
1984	3.340
1985	3,390
1986	3,275

Source: ERDB, 1989.

APPENDIX F

Projected Yield Data

Table F1. Projected per hectare yield for *B. blumeana* at 7x7 m spacing.

Harvest Year	High Quality	Average Quality	Low Quality	Total
16th	738	310	172	1,220
17th	709	329	186	1,224
18th	722	298	216	1,236
19th	690	323	192	1,205
20th	741	311	180	1,232
21st	725	302	181	1,208
22nd	725	302	181	1,208
23rd	725	302	181	1,208
24th	725	302	181	1,208
25th	725	302	181	1,208

Table F2. Projected per hectare yield for *B. blumeana* at 10x10 m spacing.

Harvest Year	High Quality	Average Quality	Low Quality	Total
16th	351	147	82	580
17th	340	149	83	572
18th	360	122	93	575
19th	354	138	76	568
20th	348	140	88	576
21st	345	144	86	575
22nd	345	144	86	575
23rd	345	144	86	575
24th	345	144	86	575
25th	345	144	86	575

Table F3. Projected per hectare yield for *B. philippinensis* at 4x5 m spacing with annual harvesting in relatively flat terrain.

Harvest Year	Normal Size	Oversize	Total
13th	4,622	1,346	6,018
14th	4,608	1,420	6,028
15th	4,592	1,400	5,992
16th	4,460	1,481	5,941
17th	4,472	1,468	5,940
18th	4,520	1,455	5,975
19th	4,485	1,468	5,953
20th	4,518	1,482	6,000
21st	4,477	1,470	5,947
22nd	4,477	1,470	5,947
23rd	4,477	1,470	5,947
24th	4,477	1,470	5,947
25th	4,477	1,470	5,947

Table F4. Projected per hectare yield for *B. philippinensis* in relatively flat terrain with periodic harvesting (every 3 years).

Harvest Year	Normal Size	Oversize	Total
6th	13,432	4,410	17,842
7th	13,432	4,410	17,842
8th	13,432	4,410	17,842

Table F5. Projected per hectare yield for *B. philippinensis* at 4x5 m spacing in hilly terrain with annual harvesting.

Harvest Year	Normal Size	Oversize	Total
13th	3,617	1,206	4,823
14th	3,282	1,094	4,376
15th	3,282	1,094	4,376
16th	3,282	1,094	4,376
17th	3,282	1,094	4,376
18th	3,282	1,094	4,376
19th	3,281	1,094	4,375
20th	3,282	1,094	4,376
21st	3,282	1,094	4,376
22nd	3,281	1,094	4,375
23rd	3,282	1,094	4,376
24th	3,282	1.094	4,376
25th	3,281	1.094	4,375

Table F6. Projected per hectare yield for *B. philippinensis* in hilly terrain with periodic harvesting.

Harvest Year	Normal Size	Oversize	Total
6th	9,845	3,282	13,127
7th	9,845	3,282	13,127
8th	9,845	3,282	13,127

Table F7. Projected per hectare yield for *D. asper* at 7x7 m spacing.

Harvest Year	High Quality	Low Quality	Total
16th	690	428	1,118
17th	672	421	1,093
18th	649	442	1,091
19th	700	429	1,129
20th	650	440	1,090
21st	652	435	1,087
22nd	652	435	1,087
23rd	652	435	1,087
24th	652	436	1,088
25th	652	435	1,087

Table F8. Projected per hectare yield for *D. asper* at 10x10 m spacing.

Harvest Year	High Quality	Low Quality	Total
16th	318	205	523
17th	320	210	530
18th	296	221	517
19th	332	198	530
20th	300	215	515
21st	311	207	518
22nd	311	207	518
23rd	311	207	518
24th	311	207	518
25th	311	207	518

Table F9. Projected per hectare yield for *D. merrillianus* at 7x7 m spacing.

Harvest Year	High Quality	Low Quality	Total
16th	582	366	948
17th	602	335	937
18th	596	380	976
19th	590	400	990
20th	584	394	978
21st	574	370	944
22nd	574	370	944
23rd	574	370	944
24th	574	370	944
25th	574	370	944

Table F10. Projected per hectare yield for *D. merrillianus* at 10x10 m spacing.

Harvest Year	High Quality	Low Quality	Total
16th	260	178	438
17th	272	156	428
18th	290	148	438
19th	268	184	452
20th	270	182	454
21st	265	175	440
22nd	265	175	440
23rd	265	175	440
24th	265	175	440
25th	265	175	440

Table F11. Projected per hectare yield for *S. lumampao* at 4x5 m spacing in hilly terrain.

Harvest Year	Yield
14th	2,865
15th	2,985
16th	3,135
17th	3,210
18th	3,060
19th	3,155
20th	3,095
21st	3,095
22nd	3,095
23rd	3,095
24th	3,095
25th	3,095

APPENDIX G

Interest Rates in the Philippines

Table G1. Interest rates in the Philippines from 1983-1990.

Year	Lending Rate (%)	Inflation Rate (%)	Discount Rate (%)
1983	19.24	11.19	8.05
1984	28.20	16.09	12.11
1985	28.61	17.11	11.50
1986	17.53	7.90	9.63
1987	13.34	4.26	9.08
1988	15.92	6.98	8.94
1989	19.27	9.63	9.64
1990	24.54	14.65	9.89
Total	166.65	87.81	78.84
Average	20.83	10.98	9.86

Source: IMF, 1991.

APPENDIX H

Description of Management Schemes

Table H1. Description of the different management schemes which form the basis of the financial analysis in the study.

Management Scheme	Scheme Code	Description
MS1	BbS7FWN3A	*B. blumeana,* planted at 7x7 m spacing in relatively flat terrain, farmers grow own planting stock, cutting age is 3 years old, harvesting starts at year 7 with subsequent annual harvests.
MS2	BbS7NN3A	Similar to scheme 1 except procurement of planting stock. This scheme, farmers has the option to buy planting stock ready for outplanting.
MS3	BbS7FWN4	Similar to scheme 1 except cutting age is 4 years old and harvest starts at year 8.
MS4	BbS7FNN4A	Similar to scheme 2 except cutting age is 4 years old and harvest starts at year 8.
MS5	BbSOFWN3A	Similar to scheme 1 except spacing is changed to 10x10 m.
MS6	BbSOFNN3A	Similar to scheme 2 except spacing is changed to 10x10 m.
MS7	BbSOFWN4A	Similar to scheme 3 except spacing is changed to 10x10 m.
MS8	BbSOFNN4A	Similar to scheme 4 except spacng is changed to 10x10 m.
MS9	BpS4FWN1A	*B. philippinensis* planted at 4x5 m in relatively flat terrain with farmers raising own plantting stock. Cutting is 1 year old, first harvest is at year 4 with subsequent annual harvests.

Table H1 (continued)

Management Scheme	Scheme Code	Description
MS10	BbS4FNN1A	Similar to scheme 9 except farmers has the option to but planting stock ready for outplanting.
MS11	BpS4FWN1P	Similar to scheme 9 except harvest is periodic. First harvest is at year 4, subsequent harvests every 3 years thereafter (year 7, year 10, ...).
MS12	BpS4FNN1P	Similar to scheme 10 except harvest is periodic. First harvest is at year 4 with subsequent harvests every 3 years thereafter.
MS13	BpS4HWN1A	Similar to scheme 9 except area is hilly (slope over 18%).
MS14	BpS4HNN1A	Similar to scheme 10 except area is hilly.
MS15	BpS4HWN1P	Similar to scheme 11 except area is hilly.
MS16	BpS4HNN1P	Similar to scheme 12 except area is hilly.
MS17	DaS7FWN3A	*D. asper*, planted at 7x7 m spacing in relatively flat terrain. The farmer has to raise own planting stock. Cutting age is 3 years old with subsequent annual harvests.
MS18	DaS7FNN3A	Similar to scheme 17 except the farmers has the option to buy planting stock ready for outplanting.
MS19	DaS7FWN4A	Similar to scheme 17 except cutting age is 4 years old and first harvest starts at year 8.
MS20	DaS7FNN4A	Similar to scheme 18 except cutting age is 4 years old and first harvest starts in year 8.
MS21	DaSOFWN3A	Similar to scheme 17 except spacing is 10x10 m.
MS22	DaSOFNN3A	Similar to scheme 18 except spacing is 10x10 m.

Table H1 (continued)

Management Scheme	Scheme Code	Description
MS23	DmS7FWN3A	*D. merrillianus* planted at 7x7 m spacing in relatively flat terrain with farmers raising own planting stock. Cutting age is 3 years old and first harvest starts at year 7 with subsequent annual harvest.
MS24	DmS7FNN3A	Similar to scheme 23 except farmers has the option to buy planting stocks ready for outplanting.
MS25	DmS7FWN4A	Similar to scheme 23 except cutting age is 4 years old and first harvest starts in year 8.
MS26	DmS7NN4A	Similar to scheme 24 except cutting age is 4 years old and first harvest starts in year 8.
MS27	DmS0WN3A	Similar to scheme 23 except spacing is changed to 10x10m.
MS28	DmS0NN3A	Similar to scheme 24 except spacing is changed to 10x10m.
MS29	SlS4HWN1A	*S. lumampao* planted at 4x5 m spacing in hilly terrain. The farmers grow own planting material, cutting age is 1 year old, first harvest starts in year 5 with subsequent annual harvest.
MS30	SlD4HNN1A	Similar to scheme 29 except farmers has the option to buy planting stocks ready for outplanting.
MS31	SlS4HWN2A	Similar to scheme 29 except cutting age is 2 years old and first harvest starts in year 6.
MS32	SlS4HNN2A	Similar to scheme 30 except cutting age is 2 years old and first harvest starts in year 6.

APPENDIX I

NPV of Management Schemes as Affected by Year of Planting

Table I1. Per hectare NPV of different management schemes in Region 7 as affected by year when planting starts at 10% discount rate in 1989 pesos.

Scheme No.[a]	Year Planting Starts				
	Year 1	Year 2	Year 3	Year 4	Year 5
MS1	56,283	51,657	46,961	42,692	38,811
MS2	57,827	52,570	47,791	43,446	39,497
MS3	45,033	39,386	34,252	29,585	25,342
MS4	46,036	40,298	35,081	30,339	26,028
MS5	22,555	19,757	17,213	14,900	12,797
MS6	22,908	20,078	17,504	15,165	13,038
MS7	17,007	14,713	12,627	10,731	9,008
MS8	17,358	15,032	12,917	10,995	9,248
MS17	27,471	23,984	20,815	17,934	15,314
MS18	29,615	25,892	22,507	19,430	16,633
MS19	20,018	17,167	14,575	12,219	10,078
MS20	20,991	18,052	15,380	12,951	10,743
MS21	5,143	4,222	3,384	2,622	1,930
MS22	6,132	5,121	4,201	3,365	2,606
MS23	11,381	9,630	8,037	6,590	5,274
MS24	12,667	10,798	9,100	7,556	6,152
MS25	3,008	2,017	1,117	299	(445)
MS26	6,143	4,868	3,708	2,654	1,696
MS27	(1522)	(1680)	(1824)	(1954)	(2073)
MS28	(1320)	(1497)	(1657)	(1803)	(1935)
MS29	9,063	7,837	6,722	5,709	4,788
MS30	9,938	8,633	7,446	6,367	5,386
MS31	3,704	2,693	2,046	1,458	924
MS32	4,284	3,492	2,773	2,119	1,524

[a]See Appendix H for description of management schemes.
MS9-16 = not included in Region 7.

Table I2. Per hectare NPV of different management schemes in Region 11 as affected by year when planting starts at 10% discount rate in 1989 pesos.

Scheme No.	Year Planting Starts				
	Year 1	Year 2	Year 3	Year 4	Year 5
MS1	37,340	32,730	28,538	24,728	21,264
MS2	38,344	33,642	29,368	25,482	21,949
MS3	27,658	23,927	20,536	17,453	14,650
MS4	28,662	24,840	21,366	18,207	15,336
MS5	13,280	11,485	9,854	8,370	7,022
MS6	13,633	11,806	10,145	8,635	7,263
MS7	8,736	7,354	6,098	4,956	3,918
MS8	9,087	7,673	6,388	5,220	4,157
MS9	43,014	38,365	34,140	30,296	26,805
MS10	44,623	39,828	35,469	31,507	27,904
MS11	36,692	30,581	28,123	25,889	20,760
MS12	38,150	31,907	29,329	26,985	21,756
MS13	31,470	27,977	24,801	21,914	19,290
MS14	31,829	28,304	25,098	22,184	19,535
MS15	21,770	17,249	16,064	14,987	11,083
MS16	22,213	17,562	16,431	15,320	11,386
MS17	21,621	18,771	16,179	13,823	11,682
MS18	23,299	20,254	17,486	14,969	12,682
MS19	14,380	12,145	10,114	8,268	6,589
MS20	15,353	13,031	10,919	8,999	7,254
MS21	2,108	1,512	971	478	30
MS22	3,097	2,412	1,788	1,221	706
MS29	9,063	7,837	6,722	5,709	4,788
MS30	9,938	8,633	7,446	6,367	5,386
MS31	3,404	2,693	2,046	1,458	924
MS32	4,284	3,492	2,773	2,119	1,524

Table I3. Per hectare NPV of different management schemes in Region 6 as affected by year when planting starts at 10% discount rate in 1989 pesos.

Scheme No.[a]	Year Planting Starts				
	Year 1	Year 2	Year 3	Year 4	Year 5
MS1	37,340	32,730	28,538	24,728	21,264
MS2	38,344	33,642	29,368	25,482	21,949
MS3	27,658	23,927	20,536	17,453	14,650
MS4	28,662	24,840	21,336	18,207	15,336
MS5	13,280	11,485	9,854	8,370	7,022
MS6	13,633	11,806	10,145	8,635	7,263
MS7	8,736	7,354	6,098	4,956	3,918
MS8	9,087	7,673	6,388	5,220	4,157
MS23	11,381	9,630	8,037	6,590	5,274
MS24	12,667	10,798	9,100	7,556	6,152
MS25	3,008	2,017	1,117	299	(445)
MS26	6,143	4,868	3,708	2,654	1,696
MS27	(1522)	(1680)	(1824)	(1954)	(2073)
MS28	(1320)	(1497)	(1657)	(1803)	(1935)
MS29	9,063	7,837	6,722	5,709	4,788
MS30	9,938	8,633	7,446	6,367	5,386
MS31	3,404	2,693	2,046	1,458	924
MS32	4,284	3,492	2,773	2,119	1,524

[a]See Appendix G for description of management schemes.
MS9-22 = not planted in Region 6.

APPENDIX J

Schedules of Plantation Development in Region 7

Table J1. Maximum net present value (NPV), hectares planted by year and total labor used (TLU) in person-days for different management schemes (MS) for household type 1 in Region 7 at 10% discount rate in 1989 pesos.

MS[a]	NPV (P)	Area Planted by Year (ha)					TLU
		1	2	3	4	5	
1	259,037	2.10	1.51	0.98	0.61	-	7,683
2	265,936	2.24	1.34	0.99	0.43	-	7,530
3	197,747	2.10	1.31	0.98	0.61	-	7,508
4	204,859	2.24	1.34	0.99	0.43	-	7.355
5	106,437	2.85	2.02	0.13	-	-	4,240
6	108,692	2.94	2.06	-	-	-	4,122
7	79,840	2.85	2.02	0.13	-	-	4,160
8	81,984	2.94	2.06	-	-	-	4,067
17	119,052	1.96	1.29	1.00	0.75	-	7,490
18	129,994	2.07	1.33	1.02	0.58	-	7,258
19	85,123	1.96	1.29	1.00	0.75	-	7,315
20	90,682	2.07	1.33	1.02	0.58	-	7,133
21	23,171	2.63	1.94	0.43	-	-	4,158
22	28,383	2.85	2.04	0.11	-	-	4,035
23	48,658	2.08	1.38	1.08	0.46	-	6,328
24	55,653	2.26	1.43	1.10	0.21	-	6,152
25	10,375	2.08	1.38	1.08	0.46	-	6,228
26	25,472	2.26	1.43	1.10	0.21	-	6,052
29	39,720	2.08	1.39	1.23	0.30	-	6,833
30	44,298	2.20	1.42	1.26	0.12	-	6,655
31	13,775	2.08	1.39	1.23	0.30	-	6,803
32	18,149	2.20	1.42	1.26	0.12	-	6,575

[a]MS9-16 = not included in Region 7.
MS27 & 28 = not included having negative NPVs.

Table J2. Maximum net present value (NPV), hectares planted by year and total labor used (TLU) in person-days for different management schemes (MS) for household type 2 in Region 7 at 10% discount rate in 1989 pesos.

MS[a]	NPV (P)	Area Planted by Year (ha)					TLU
		1	2	3	4	5	
1	265,964	2.44	1.52	1.04	-	-	7,780
2	272,457	2.60	1.56	0.85	-	-	7,619
3	205,320	2.44	1.52	1.04	-	-	7,605
4	211,977	2.60	1.56	0.85	-	-	7,444
5	108,047	3.31	1.69	-	-	-	4,259
6	110,042	3.41	1.59	-	-	-	4,138
7	81,159	3.31	1.69	-	-	-	4,179
8	83,094	3.41	1.59	-	-	-	4,083
17	123,792	2.27	1.50	1.16	0.06	-	7,589
18	134,885	2.41	1.54	1.05	-	-	7,353-
19	88,998	2.27	1.50	1.16	0.06	-	7,414
20	94,542	2.41	1.54	1.05	-	-	7,229
21	23,920	3.05	1.95	-	-	-	4,186
22	28,949	3.31	1.69	-	-	-	4,054
23	50,807	2.41	1.60	0.99	-	-	6,396
24	57,670	2.62	1.66	0.72	-	-	6,210
25	11,590	2.41	1.60	0.99	-	-	6,296
26	26,849	2.62	1.66	0.72	-	-	6,110
29	41,062	2.42	1.61	0.97	-	-	6,899
30	45,572	2.56	1.65	0.79	-	-	6,713
31	14,554	2.42	1.61	0.97	-	-	6,869
32	18,921	2.56	1.65	0.79	-	-	6,633

[a]MS9-16 = not included in Region 7.
MS27 & 28 = not included having negative NPVs.

Table J3. Maximum net present value (NPV), hectares planted by year and total labor used (TLU) in person-days for different management schemes (MS) for household type 3 in Region 7 at 10% discount rate in 1989 pesos.

MS[a]	NPV (P)	Area Planted by Year (ha)					TLU
		1	2	3	4	5	
1	211,803	1.50	0.94	0.71	0.59	0.50	6,400
2	222,936	1.60	0.96	0.71	0.59	0.50	6,446
3	159,085	1.50	0.94	0.71	0.59	0.50	6,251
4	168,643	1.60	0.96	0.71	0.59	0.50	6,293
5	99,799	2.05	1.45	1.12	0.38	-	4,155
6	102,050	2.11	1.48	1.13	0.28	-	4.039
7	74,399	2.05	1.45	1.12	0.38	-	4,075
8	76,526	2.11	1.48	1.13	0.28	-	3,984
17	94,748	1.40	0.93	0.72	0.60	0.53	6,160
18	105,879	1.49	0.95	0.73	0.61	0.53	6,132
19	67,244	1.40	0.93	0.72	0.60	0.63	6,014
20	67,288	1.49	0.95	0.73	0.61	0.53	6,025
21	20,920	1.89	1.39	1.08	0.64	-	4,069
22	25,984	2.04	1.47	1.11	0.38	-	3,951
23	39,780	1.49	0.99	0.77	0.63	0.55	5,501
24	47,007	1.62	1.03	0.79	0.64	0.55	5,552
25	7,536	1.49	0.99	0.77	0.63	-	4,813
26	20,508	1.62	1.03	0.79	0.64	0.55	5,460
29	33,197	1.49	0.99	0.88	0.73	0.36	5,988
30	38,371	1.58	1.02	0.91	0.75	0.43	6,086
31	11,213	1.49	0.99	0.88	0.73	0.62	6,267
32	15,395	1.58	1.02	0.91	0.75	0.62	6,233

[a]MS9-16 = not included in Region 7.
MS27 & 28 = not included having negative NPVs.

Table J4. Maximum net present value (NPV), hectares planted by year and total labor used (TLU) in person-days for different management schemes (MS) for household type 4 in Region 7 at 10% discount rate in 1989 pesos.

MS[a]	NPV (P)	Area Planted by Year (ha)					TLU
		1	2	3	4	5	
1	250,820	1.81	1.13	0.85	0.70	0.51	7,562
2	257,880	1.93	1.16	0.86	0.71	0.35	7,415
3	188,765	1.81	1.13	0.85	0.70	0.51	7,387
4	196,065	1.93	1.16	0.86	0.71	0.35	7,240
5	103,644	2.46	1.75	0.79	-	-	4,205
6	105,789	2.53	1.78	0.69	-	-	4,086
7	77,550	2.46	1.75	0.79	-	-	4,125
8	79,599	2.53	1.78	0.69	-	-	4,031
17	113,445	1.69	1.12	0.86	0.73	0.60	7,367
18	124,226	1.79	1.15	0.88	0.73	0.45	7,141
19	80,538	1.69	1.12	0.86	0.73	0.60	7,192
20	86,128	1.79	1.15	0.88	0.73	0.45	7,016
21	22,314	2.27	1.68	1.05	-	-	4,125
22	27,372	2.46	1.76	0.78	-	-	4,000
23	46,075	1.79	1.19	0.93	0.76	0.33	6,243
24	53,063	1.95	1.24	0.95	0.77	0.10	6,073
25	9.060	1.79	1.19	0.93	0.76	-	5,786
26	23,704	1.95	1.24	0.95	0.77	0.10	5,973
29	38,129	1.80	1.20	1.06	0.88	0.06	6,753
30	42,590	1.90	1.23	1.09	0.78	-	6,574
31	12,852	1.80	1.20	1.06	0.88	0.06	6,723
32	17,113	1.90	1.23	1.09	0.78	-	6,494

[a]MS9-16 = not included in Region 7.
MS27 & 28 = not included having negative NPVs.

Table J5. Maximum net present value (NPV), hectares planted by year and total labor use (TLU) in person-days for different management schemes (MS) for household type 5 in Region 7 at 10% discount rate in 1989 pesos.

MS[a]	NPV (P)	Area Planted by Year (ha)					TLU
		1	2	3	4	5	
1	269,426	2.71	1.69	0.60	-	-	7,827
2	276,180	2.89	1.73	0.38	-	-	7,668
3	209,105	2.71	1.69	0.60	-	-	7,652
4	216,041	2.89	1.73	0.38	-	-	7,493
5	109,076	3.68	1.32	-	-	-	4,271
6	111,116	3.79	1.21	-	-	-	4,150
7	82,003	3.68	1.32	-	-	-	4,191
8	83,976	3,79	1.21	-	-	-	4,095
17	126,178	2.53	1.67	0.80	-	-	7,637
18	137,368	2.68	1.72	0.61	-	-	7,399
19	90,950	2.53	1.67	0.80	-	-	7,462
20	96,502	2.68	1.72	0.61	-	-	7,274
21	24,233	3.39	1.61	-	-	-	4,197
22	29,319	3.67	1.33	-	-	-	4,066
23	51,987	2.68	1.78	0.54	-	-	6,432
24	59,022	2.91	1.85	0.24	-	-	6,249
25	12,257	2.68	1.78	0.54	-	-	6,332
26	27,772	2.91	1.85	0.24	-	-	6,149
29	41,890	2.69	1.79	0.52	-	-	6,939
30	46,499	2.84	1.84	0.32	-	-	6,754
31	15,034	2.69	1.79	0.52	-	-	6,909
32	19,483	2.84	1.84	0.32	-	-	6,674

[a]MS9-16 = not included in Region 7.
MS27 & 28 = not included having negative NPVs.

Table J6. Maximum net present value (NPV), hectares planted by year and total labor used (TLU) in person-days for different management schemes (MS) for household type 6 in Region 7 at 10% discount rate in 1989 pesos.

MS[a]	NPV (P)	Area Planted By Year (ha)					TLU
		1	2	3	4	5	
1	280,387	4.28	0.72	-	-	-	7,968
2	286,832	4.56	0.44	-	-	-	7.082
3	221,087	4.28	0.72	-	-	-	7,793
4	227,668	4.56	0.44	-	-	-	7,627
5	112,777	5.00	-	-	-	-	4,315
6	114,541	5.00	-	-	-	-	4,190
7	85,036	5.00	-	-	-	-	4,235
8	86,791	5.00	-	-	-	-	4,135
17	133,844	3.99	1.01	-	-	-	7,785
18	145,216	4.23	0.77	-	-	-	7,540
19	97,218	3.99	1.01	-	-	-	7,610
20	102,698	4.23	0.77	-	-	-	7,415
21	25,715	5.00	-	-	-	-	4,250
22	30,660	5.00	-	-	-	-	4,110
23	55,574	4.24	0.76	-	-	-	6,537
24	62,592	4.60	0.40	-	-	-	6,345
25	14,285	4.24	0.76	-	-	-	6,437
26	30,209	4.60	0.40	-	-	-	6,245
29	44,390	4.25	0.75	-	-	-	7,054
30	49,035	4.50	0.50	-	-	-	6,862
31	16,486	4.25	0.75	-	-	-	7,024
32	21,020	4.50	0.50	-	-	-	6,782

[a]MS9-16 = not included in Region 7.
MS27 & 28 = not included having negative NPVs.

APPENDIX K

Schedules of Plantation Development in Region 11

Table K1. Maximum net present value (NPV), hectares planted by year and total labor used (TLU) in person-days for different management schemes (MS) for household type 1 in Region 11 at 10% discount rate in 1989 pesos.

MS	NPV (P)	Area Planted by Year (ha)					TLU
		1	2	3	4	5	
1	168,253	2.30	1.44	1.08	0.18	-	7,745
2	175,139	2.45	1.47	1.08	-	-	7,594
3	123,364	2.30	1.44	1.08	0.18	-	7,570
4	129,831	2.45	1.47	1.08	-	-	7,419
5	63,038	3.13	1.87	-	-	-	4,253
6	64,916	3.22	1.78	-	-	-	4.131
7	41,090	3.13	1.87	-	-	-	4,173
8	42,919	3.22	1.78	-	-	-	4,076
9	190,106	2.14	1.04	0.79	1.03	-	11,387
10	200,085	2.35	1.03	0.79	0.83	-	11,317
11	159,181	2.14	1.04	0.79	1.03	-	10,820
12	168,114	2.35	1.03	0.79	0.83	-	10,749
13	138,096	2.08	1.03	0.81	1.09	-	12,160
14	140,018	2.12	1.03	0.81	1.04	-	12,299
15	92,240	2.08	1.03	0.81	1.09	-	11,826
16	94,514	2.12	1.03	0.81	1.04	-	11,727
17	95,467	2.15	1.42	1.10	0.34	-	7,550
18	104,307	2.27	1.46	1.11	0.15	-	7,321
19	61,992	2.15	1.42	1.10	0.34	-	7,375
20	67,469	2.27	1.46	1.11	0.15	-	7,196
21	9,272	2.88	2.10	0.01	-	-	4,180
22	14,159	3.12	1.81	0.06	-	-	4,046
29	40,648	2.28	1.52	1.20	-	-	6,880
30	45,109	2.42	1.56	1.02	-	-	6,692
31	14,314	2.28	1.52	1.20	-	-	6,875
32	18,640	2.42	1.56	1.02	-	-	6,812

Table K2. Maximum net present value (NPV), hectares planted by year and total labor used (TLU) in person-days for different management schemes (MS) for household type 2 in Region 11 at 10% discount rate in 1989 pesos.

MS	NPV (P)	Area Planted by Year (ha)					TLU
		1	2	3	4	5	
1	172,818	2.64	1.65	0.71	-	-	7,815
2	179,300	2.81	1.69	0.50	-	-	7,655
3	127,056	2.64	1.65	0.71	-	-	7,640
4	133,214	2.81	1.69	0.50	-	-	7,480
5	63,863	3.59	1.41	-	-	-	4,268
6	65,782	3.70	1.30	-	-	-	4,147
7	41,725	3.59	1.41	-	-	-	4,188
8	43,589	3.70	1.30	-	-	-	4,092
9	195,785	2.45	1.20	0.91	0.45	-	11,507
10	206,342	2.70	1.18	0.91	0.21	-	11,445
11	163,554	2.45	1.20	0.91	0.45	-	10,915
12	172,996	2.70	1.18	0.91	0.21	-	10,852
13	142,188	2.39	1.18	0.93	0.51	-	12,287
14	144,297	2.43	1.18	0.93	0.46	-	12,432
15	94,785	2.39	1.18	0.93	0.51	-	11,932
16	97,149	2.43	1.18	0.93	0.46	-	11,835
17	98,516	2.46	1.63	0.91	-	-	7,626
18	107,230	2.61	1.67	0.72	-	-	7,388
19	64,382	2.46	1.63	0.91	-	-	7,451
20	69,699	2.61	1.67	0.72	-	-	7,263
21	9,528	3.31	1.69	-	-	-	4,192
22	14,520	3.58	1.42	-	-	-	4,065
29	41,683	2.62	1.74	0.64	-	-	6,929
30	46,267	2.77	1.79	0.44	-	-	6,744
31	14,914	2.62	1.74	0.64	-	-	6,924
32	19,342	2.77	1.79	0.44	-	-	6,664

Table K3. Maximum net present value (NPV), hectares planted by year and total labor used (TLU) in person-days for different management schemes (MS) for household type 3 in Region 11 at 10% discount rate in 1989 pesos.

MS	NPV (P)	Area Planted by Year (ha)					TLU
		1	2	3	4	5	
1	142,722	1.62	1.01	0.76	0.63	0.54	6,903
2	151,987	1.73	1.04	0.77	0.63	0.54	6,953
3	103,794	1.62	1.01	0.76	0.63	0.54	6,743
4	111,724	1.73	1.04	0.77	0.63	0.54	6,788
5	59,354	2.21	1.57	1.21	0.01	-	4,182
6	61,305	2.27	1.59	1.14	-	-	4,063
7	38,255	2.21	1.57	1.21	0.01	-	4,102
8	40,125	2.27	1.59	1.14	-	-	4,008
9	178,748	1.51	0.74	0.56	2.20	-	11,147
10	187,570	1.66	0.72	0.56	2.06	-	11,060
11	138,477	1.33	0.78	0.61	1.89	-	9,781
12	150,332	1.32	0.83	0.64	2.03	-	10,101
13	125,212	1.47	0.72	0.57	1.53	0.57	11,548
14	128,900	1.50	0.72	0.57	1.61	0.55	11,866
15	67,858	1.24	0.78	0.63	1.16	-	8,902
16	69,958	1.24	0.79	0.63	1.18	-	8,903
17	79,771	1.52	1.00	0.77	0.65	0.57	6,645
18	89,117	1.61	1.03	0.79	0.66	0.57	6,615
19	50,940	1.52	1.00	0.77	0.65	0.57	6,487
20	5,626	1.61	1.03	0.79	0.66	0.57	6,499
21	7,838	2.04	1.50	1.16	0.30	-	4,094
22	12,804	2.20	1.58	1.20	0.02	-	3,977
29	35,808	1.61	1.07	0.95	0.79	0.39	6,459
30	41,085	1.71	1.10	0.98	0.80	0.41	6,499
31	12,005	1.61	1.07	0.95	0.79	0.57	6,670
32	16,201	1.71	1.10	0.98	0.80	0.41	6,419

Table K4. Maximum net present value (NPV), hectares planted by year and total labor used (TLU) in person-days for different management schemes (MS) for household type 4 in Region 11 at 10% discount rate in 1989 pesos.

MS	NPV (P)	Area Planted by Year (ha)					TLU
		1	2	3	4	5	
1	161,245	1.96	1.23	0.92	0.76	0.13	7,633
2	168,161	2.09	1.25	0.93	0.72	-	7,486
3	117,693	1.96	1.23	0.92	0.76	0.13	7,458
4	124,159	2.09	1.25	0.93	0.72	-	7,311
5	61,492	2.67	1.89	0.44	-	-	4,223
6	63,509	2.75	1.93	0.32	-	-	4,105
7	39,900	2.67	1.89	0.44	-	-	4,143
8	41,830	2.75	1.93	0.32	-	-	4,050
9	184,427	1.82	0.89	0.67	1.61	-	11,267
10	193,827	2.01	0.88	0.67	1.44	-	11,188
11	154,808	1.82	0.89	0.67	1.61	-	10,726
12	163,233	2.01	0.88	0.67	1.44	-	10,646
13	133,825	1.77	0.88	0.69	1.66	-	12,033
14	135,739	1.81	0.87	0.69	1.63	-	12,166
15	81,995	1.50	0.94	0.76	1.40	-	10,757
16	84,533	1.50	0.95	0.77	1.43	-	10,758
17	91,093	1.83	1.21	0.94	0.79	0.23	7,435
18	99,814	1.94	1.24	0.95	0.80	0.07	7,212
19	58,564	1.63	1.21	0.94	0.79	0.23	7,260
20	64,042	1.94	1.24	0.95	0.80	0.70	7,087
21	8,636	2.46	1.82	0.72	-	-	4,142
22	13,620	2.66	1.91	0.43	-	-	4,019
29	38,999	1.95	1.30	1.15	0.60	-	6,797
30	43,494	2.06	1.33	1.18	0.43	-	6,617
31	13,357	1.95	1.30	1.15	0.60	-	6,792
32	17,661	2.06	1.33	1.18	0.43	-	6,537

Table K5. Maximum net present value (NPV), hectares planted by year and total labor used (TLU) in person-days for different management schemes (MS) for household type 5 in Region 11 at 1% discount rate in 1989 pesos.

MS	NPV (P)	Area Planted by Year (ha)					TLU
		1	2	3	4	5	
1	176,680	2.98	1.86	0.16	-	-	7,873
2	183,132	3.17	1.83	-	-	-	7,711
3	130,181	2.98	1.86	0.16	-	-	7,698
4	136,328	3.17	1.83	-	-	-	7,536
5	64,688	4.05	0.95	-	-	-	4,283
6	66,647	4.17	0.83	-	-	-	4,163
7	42,360	4.05	0.95	-	-	-	4,204
8	44,259	4.17	0.83	-	-	-	4,108
9	200,936	2.76	1.35	0.89	-	-	11,615
10	211,028	3.05	1.33	0.62	-	-	11,538
11	167,620	2.76	1.35	0.89	-	-	11,005
12	176,947	3.05	1.33	0.62	-	-	10,939
13	146,179	2.69	1.33	0.98	-	-	12,408
14	148,227	2.75	1.33	0.93	-	-	12,553
15	97,258	2.69	1.33	0.98	-	-	12,036
16	99,650	2.75	1.33	0.93	-	-	11,938
17	100,775	2.78	1.84	0.38	-	-	7,681
18	109,769	2.94	1.89	0.17	-	-	7,445
19	66,153	2.78	1.84	0.38	-	-	7,506
20	71,635	2.94	1.89	0.17	-	-	7,320
21	9,785	3.73	1.27	-	-	-	4,208
22	14,830	4.04	0.96	-	-	-	4,078
29	42,718	2.95	1.97	0.08	-	-	6,978
30	47,248	3.13	1.87	-	-	-	6,787
31	15,515	2.95	1.97	0.08	-	-	6,973
32	19,937	3.13	1.87	-	-	-	6.707

Table K6. Maximum net present value (NPV), hectares planted by year and total labor used (TLU) in person-days for different management schemes (MS) for household type 6 in Region 11 at 10% discount rate in 1989 pesos.

MS	NPV (P)	Area Planted by Year (ha)					TLU
		1	2	3	4	5	
1	185,167	4.67	0.33	-	-	-	7,993
2	191,611	4.98	0.02	-	-	-	7,828
3	137,048	4.67	0.33	-	-	-	7,818
4	143,219	4.98	0.02	-	-	-	7,653
5	66,401	5.00	-	-	-	-	4,315
6	68,165	5.00	-	-	-	-	4,190
7	43,679	5.00	-	-	-	-	4,235
8	45,433	5.00	-	-	-	-	4,135
9	211,979	4.34	0.66	-	-	-	11,831
10	222,051	4.78	0.22	-	-	-	11,745
11	175,363	3.90	0.55	0.55	-	-	11,216
12	182,445	3.90	0.55	0.55	-	-	11,091
13	154,631	4.22	0.78	-	-	-	12,646
14	156,699	4.31	0.69	-	-	-	12,797
15	101,400	3.54	0.76	0.70	-	-	12,201
16	103,530	3.54	0.76	0.70	-	-	12,091
17	106,271	4.36	0.64	-	-	-	7,808
18	115,328	4.62	0.38	-	-	-	7,565
19	70,460	4.36	0.64	-	-	-	7,633
20	75,875	4.62	0.38	-	-	-	7,440
21	10,542	5.00	-	-	-	-	4,250
22	15,487	5.00	-	-	-	-	4,110
29	44,863	4.63	0.37	-	-	-	7,075
30	49,569	4.91	0.09	-	-	-	6,885
31	16,760	4.63	0.37	-	-	-	7,070
32	21,344	4.91	0.09	-	-	-	6,805

APPENDIX L

Schedules of Plantation Development in Region 6

Table L1. Maximum net present value (NPV), hectares planted by year and total labor used (TLU) in person-days for different management schemes (MS) for household type 1 in Region 6 at 10% discount rate in 1989 pesos.

MS[a]	NPV (P)	Area Planted by Year (ha)					TLU
		1	2	3	4	5	
1	157,457	1.83	1.14	0.86	0.71	0.47	7,570
2	164,270	1.95	1.17	0.86	0.71	0.31	7,423
3	114,628	1.83	1.14	0.86	0.71	0.47	7,395
4	120,997	1.95	1.17	0.86	0.71	0.31	7,248
5	60,649	2.48	1.76	0.76	-	-	4,207
6	62,627	2.56	1.79	0.65	-	-	4,088
7	39,251	2.48	1.76	0.76	-	-	4,127
8	41,148	2.56	1.79	0.65	-	-	4,033
23	46,259	1.81	1.20	0.94	0.77	0.28	6,249
24	53,271	1.97	1.25	0.96	0.78	0.05	6,080
25	9,144	1.81	1.20	0.94	0.77	-	5,840
26	23,847	1.97	1.25	0.96	0.78	0.05	5,980
29	27,480	1.81	1.11	0.94	0.74	0.38	6,692
30	31,935	1.92	1.13	0.96	0.74	0.25	6,545
31	1,028	1.81	1.11	-	-	-	4,077
32	4,050	1.92	1.13	0.96	-	-	5,291

[a]MS9-22 = not included in Region 6.
MS27 & 28 = not included having negative NPVs.

Table L2. Maximum net present value (NPV), hectares planted by year and total labor used (TLU) in person-days for different management schemes (MS) for household type 2 in Region 6 at 10% discount rate in 1989 pesos.

MS[a]	NPV (P)	Area Planted by Year (ha)					TLU
		1	2	3	4	5	
1	164,317	2.10	1.31	0.98	0.61	-	7,683
2	170,971	2.24	1.34	0.99	0.43	-	7,530
3	120,178	2.10	1.31	0.98	0.61	-	7,508
4	126,443	2.24	1.34	0.99	0.43	-	7,355
5	62,335	2.85	2.02	0.13	-	-	4,240
6	64,390	2.94	2.06	-	-	-	4,122
7	40,549	2.85	2.02	0.13	-	-	4,160
8	42,512	2.94	2.06	-	-	-	4,067
23	48,657	2.08	1.38	1.08	0.46	-	6,328
24	55,653	2.26	1.43	1.10	0.21	-	6,152
25	10,375	2.08	1.38	1.08	0.46	-	6,228
26	25,472	2.26	1.43	1.10	0.21	-	6,052
29	29,023	2.08	1.27	1.08	0.57	-	6,813
30	33,448	2.20	1.29	1.10	0.41	-	6,632
31	1,181	2.08	1.27	-	-	-	4,681
32	4,650	2.20	1.29	1.10	-	-	6,074

[a]MS9-22 = not included in Region 6.
MS27 & 28 = not included having negative NPVs.

Table L3. Maximum net present value (NPV), hectares planted by year and total labor used (TLU) in person-days for different management schemes (MS) for household type 3 in Region 6 at 10% discount in 1989 pesos.

MS[a]	NPV (P)	Area Planted by Year (ha)					TLU
		1	2	3	4	5	
1	112,989	1.29	0.80	0.60	0.50	0.43	5,465
2	120,323	1.37	0.82	0.61	0.50	0.43	5,505
3	82,170	1.29	0.80	0.60	0.50	0.43	5,338
4	88,448	1.37	0.82	0.61	0.50	0.43	5,374
5	55,380	1.75	1.24	0.96	0.82	0.24	4,098
6	57,421	1.80	1.26	0.96	0.82	0.15	3,983
7	35,196	1.75	1.24	0.96	0.82	0.24	4,018
8	37,120	1.80	1.26	0.96	0.82	0.15	3,928
23	33,970	1.27	0.85	0.66	0.54	0.47	4,697
24	40,141	1.38	0.88	0.67	0.55	0.47	4,741
25	6,435	1.27	0.85	0.66	0.54	-	4,110
26	17,513	1.38	0.88	0.67	0.55	0.47	4,662
29	19,338	1.28	0.78	0.66	0.52	0.27	4,709
30	23,042	1.35	0.79	0.68	0.52	0.33	4,777
31	724	1.28	0.78	-	-	-	2,869
32	2,850	1.35	0.79	0.68	-	-	3,723

[a]MS9-22 = not included in Region 6.
MS27 & 28 = not included having negative NPVs.

Table L4. Maximum net present value (NPV), hectares planted by year and total labor used (TLU) in person-days for different management schemes (MS) for household type 4 in Region 6 at 10% discount rate in 1989 pesos.

MS[a]	NPV (P)	Area Planted by Year (ha)					TLU
		1	2	3	4	5	
1	136,776	1.56	0.97	0.73	0.61	0.52	6,616
2	145,655	1.66	1.00	0.74	0.61	0.52	6,664
3	99,469	1.56	0.97	0.73	0.61	0.52	6,462
4	107,069	1.66	1.00	0.74	0.61	0.52	6,505
5	58,625	2.11	1.50	1.16	1.23	-	4,167
6	60,674	2.18	1.53	1.17	0.12	-	4,050
7	37,693	2.11	1.50	1.16	0.23	-	4,087
8	39,637	2.18	1.53	1.17	0.12	-	3,995
23	41,121	1.54	1.02	0.80	0.65	0.57	5,686
24	48,592	1.67	1.06	0.82	0.66	0.57	5,739
25	7,790	1.54	1.02	0.80	0.65	-	4,975
26	21,200	1.67	1.06	0.82	0.66	0.57	5,644
29	23,409	1.54	0.94	0.80	0.63	0.32	5,071
30	27,893	1.64	0.96	0.82	0.63	0.39	5,783
31	876	1.54	0.94	-	-	-	3,473
32	3,450	1.64	0.96	0.82	-	-	4,507

[a]MS9-22 = not included in Region 6.
MS27 & 28 = not included having negative NPVs.

Table L5. Maximum net present value (NPV), hectares planted by year and total labor used (TLU) in person-days for different management schemes (MS) for household type 5 in Region 6 at 10% discount rate in 1989 pesos.

MS[a]	NPV (P)	Area Planted by Year (ha)					TLU
		1	2	3	4	5	
1	168,909	2.33	1.46	1.10	0.11	-	7,756
2	175,555	2.49	1.49	1.02	-	-	7,601
3	123,894	2.33	1.46	1.10	0.11	-	7,581
4	130,169	2.49	1.49	1.02	-	-	7,426
5	63,120	3.17	1.83	-	-	-	4,255
6	65,003	3.27	1.73	-	-	-	4,133
7	41,153	3.17	1.83	-	-	-	4,175
8	42,986	3.27	1.73	-	-	-	4,078
23	50,364	2.31	1.53	1.16	-	-	6,383
24	57,163	2.51	1.59	0.90	-	-	6,196
25	11,340	2.31	1.53	1.16	-	-	6,283
26	26,503	2.51	1.59	0.90	-	-	6,096
29	30,035	2.32	1.41	1.20	0.70	-	6,874
30	34,479	2.45	1.44	1.11	-	-	6,689
31	1,314	2.32	1.41	-	-	-	5,210
32	5,128	2.45	1.44	1.11	-	-	6,609

[a]MS9-22 = not included in Region 6.
MS27 & 28 = not included having negative NPVs.

Table L6. Maximum net present value (NPV), hectares planted by year and total labor used (TLU) in person-days for different management schemes (MS) for household type 6 in Region 6 at 10% discount rate in 1989 pesos.

MS[a]	NPV (P)	Area Planted by Year (ha)					TLU
		1	2	3	4	5	
1	180,644	3.69	1.31	-	-	-	7,930
2	186,693	3.93	1.07	-	-	-	7,761
3	133,389	3.69	1.31	-	-	-	7,755
4	139,222	3.93	1.07	-	-	-	7,586
5	66,402	5.00	-	-	-	-	4,315
6	68,165	5.00	-	-	-	-	4,190
7	43,679	5.00	-	-	-	-	4,235
8	45,433	5.00	-	-	-	-	4,135
23	54,547	3.65	1.35	-	-	-	6,508
24	61,402	3.97	1.03	-	-	-	6,313
25	13,704	3.65	1.35	-	-	-	6,408
26	29,396	3.97	1.03	-	-	-	6,213
29	32,641	3.66	1.34	-	-	-	7,021
30	37,150	3.88	1.12	-	-	-	6,828
31	2,010	3.66	1.34	-	-	-	7,016
32	6,414	3.88	1.12	-	-	-	6,748

[a]MS9-22 = not included in Region 6.
MS27 & 28 = not included having negative NPVs.

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