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Sustaining Forest Management in the Amazon: An Application of the Simple Forestry Economics to the 'Strip Shelterbelt System' in the Palcazu Valley, Perú.

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LIST OF ACRONYMS AND ABBREVIATIONS
(Translation in Brackets)

APODESA	Apoyo para el Desarrollo de la Selva Alta (Support for the Development of the High Jungle, a government office)
MT	Metric Tons
m^3	Cubic metres
COFYAL	Cooperativa Forestal Yanesha, Limitada (Yanesha Forestry Cooperative, Ltd.)
ETC	Ecological Trading Company Ltd.
FAO	Food and Agriculture Organisation
FPCN	Fundación Peruana Para la Conservación de la Naturaleza (Peruvian Foundation for Conservation of Nature)
IDB	Inter American Development Bank
INADE	Instituto Nacional de Desarrollo (National Institute of Development)
INFOMAR	A Private Forestry Enterprise used to compare COFYAL' results with
IUCN	International Union for the Conservation of Nature
PDR	Programa de Desarrollo Rural (Rural Development Programme)
PEPP	Proyecto Especial Pichis-Palcazu (Pichis-Palcazu Special Project)
UNEP	United Nations Environmental Programme
TCA	Tratado de Cooperación Amazónica (Amazonian Cooperative Treaty, ACT)
TSC	Tropical Science Center (CCT)
UDF	Unidad de Desarrollo Forestal (Forestry Development Unit)
UNEP	United Nations Environmental Programme
USAID	United States Agency for International Development
WWF	World Wildlife Fund

ABSTRACT

In this dissertation the questions involved in applying the standard forestry economics to the sustainable use of an Amazonian rainforest are examined. A project, called the Strip Shelterbelt System, designed to maximise simultaneously the use of forest biomass and the socioeconomic welfare of local populations in the Peruvian High Jungle is evaluated. These features made of the project a unique experience and attracted the attention of the scientific community in an unusual manner.

We start off by summarising the main aspects of two theories of decision process related to the use of forestry resources, both of them rooted in the Cost Benefit Analysis approach. Then, we try to extend and complement the models in order to assess the ex-ante projection of the Strip Shelterbelt System, as planned by the designers in 1986. In addition, we conduct an ex-ante evaluation based on the actual data collected for the 1991 activities.

On the theoretical side, the exercise shows that the standard forestry economics can be extended so as to cope with the analysis and the design of possible solutions to the problem of sustainable management of Amazonian forests.

The practical implications of the evaluation of the ex-ante estimates make evident that the System's profitability could have been improved if some basic economic principles had been applied. The actual volume of production per hectare harvested is far less than what the designers expected, and this explains, partially, why the economic goals were not fulfilled.

The ex-post evaluation is based on the 1991 operations' data for levels of output, price, and costs. With that information, we obtain the financial results corresponding to tha year, and then project a flow of benefits and costs over a 40-year rotation cycle and the corresponding Cost Benfit Analysis. This is done for a single 40-year rotation and a multiple rotation scheme.

The results are quite encouraging indeed, and can be used to support the promotion of similar experiences of sustainable forestry management in the region. Our analysis is based on a conventional Cost Benefit Analysis, i.e., taking account only of private costs and benefits.

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PREFACE

The idea of this research was suggested by Dr Douglas Southagte (of The Ohio State University). The initial academic link gave origin, gradually, to a friendship of which I feel honoured. A personal intervention of Dr Southgate made possible the financial support by USAID for the field work. To him goes the first acknowledgement. The initial stage of the work was also encouraged and backed by Dr Antonio Brack-Egg (of The Amazon Cooperation Treaty), who showed enthusiasm when he knew of our interest in the Palcazu Valley, where he was born. Dr Alonso Zarzar, Prof Teodoro Bustamante and Dr Carlos Larrea (FLACSO-Ecuador), played an important role in the definition and monitoring of this investigation.

The conceptual approach was enriched by the lectures of Dr Joseph Swiersbinski, Prof David Pearce and Dr Malcolm Pemeberton at UCL. Prof Pearce and Dr Swierzbinski's contributions to the present output is immense and they will easily recognise their ideas throughout. They both acted as advisers and were always willing to provide the insight and incentive necessary to fulfil the duties of the dissertation.

The early influence of my undergraduate teachers at the Catholic University of Perú has still guided my work during the writing of this dissertation. I am grateful to Dr Javier Iguíñiz, Dr Máximo Vega-Centeno, Prof Néride Sotomarino and Prof Margarita Trillo. My interest for Amazonia was stimulated by Prof Martha Rodríguez, also of the Catholic University.

This dissertation would have never been possible without the cooperation of Javier Arce, Hugo Valdivia and Wilfredo Valencia, of the Peruvian Foundation for Conservation of Nature; Carlos Ayala of USAID mission in Lima; Fernando Razetto, President of the Peruvian Forestry Chamber; Isabel Canchaya, of the Agriculture Ministry; Mario Pariona and Alejandro José Farfán, former advisors of the Yanesha Forestry Cooperative (COFYAL); Dr Richard Smith and Dr Thomas Moore, anthropologists closely related to the Yaneshas; and the members of COFYAL, especially Manuel Lázaro (former manager of COFYAL), Jaime Chihuanco (who provided important pieces of information), Luis Conivo, and Diego Potesta; Wilfredo Quintana, colonist of the valley; and Reynaldo Schuller, a local forestry entrepreneur.

The late advances of the research were revised by Carlos Young and Loredana Torsello, colleagues at UCL, whose comments helped organise the presentation of the ideas.

My wife, Alicia, has never been so patient and helpful as during this period. She sacrificed many hours of her own activities to finish the typing of the dissertation. Her good temperament and her sweet smile were an endless source of inspiration. The gratitude to my parents could never be left behind at a moment so meaningful like this.

1. INTRODUCTORY CHAPTER

1.1 Relevance and Objectives of the Dissertation.-

It is commonly argued that Amazonian forests cannot be approached by standard forestry economics because of their singular features, which lead one to consider that once deforestation has taken place, the land will never return to its original state of productivity or will do so only after a very long time (Southgate, 1988). Accordingly, rotation, defined as the interval between harvests, is regarded as irrelevant.

In this disseration a particular experience of sustainable forest management in the Peruvian Amazon will be examined in the light of the standard forestry economics.

The Strip Shelterbelt System[1] was effectively implemented for a very short period of time by the Yanesha Forestry Cooperative, COFYAL. This enterprise was a part of the Palcazu Rural Development Programme, which, in turn, was just one component of a major development project known as the Pichis-Palcazu Special Project, based in the small Palcazu Valley, which extends to 140,00 hectares (ha)[2].

The Palcazu valley is located at the easternmost slopes of the Peruvian Andes, and its altitude ranges from 270 to 350 metres above sea level. This region corresponds to what is known as Terra Firme in the Amazonian literature, and is called *Selva Alta* by the Peruvians. (Cfr. Hartshorn, 1989; Simeone, 1990)

The theoretical appeal of the attempt lies on the fact that no attempt seems to have been made on the study of Amazonian forest management from the continuous harvest approach. This attitude is perfectly reasonable for the conventional practice of logging and exploiting resources in the region, characterised by a highly selective extraction of species and individuals. Under these conditions environmental constraints bite in a very short time. Nevertheless, given the specific features of the strip system, a sustainable management in concordance with the natural regeneration process of the forest seems feasible.

In addition, the empirical relevance of the dissertation rises from the fact that the design of the Strip Shelterbelt System lacked this formal economic treatment. Such analysis would have been crucial for monitoring and controlling important variables in order to enhance the project's profitability. Additionally, this analysis might prove useful to other similar projects currently being held in the Amazon.

From the strict forestry standpoint, the Palcazu system had the following interesting features:

i) It was based on logging narrow strips of the forests, generally no wider than twice

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[1] In Spanish it is known as the Sistema de Manejo Forestal en Fajas.

[2] The United States Agency for International Development (USAID), which offered technical and financial support, knew the Pichis-Palcazu Special Project as "Central Selva Resource Management Project".

the neighbour trees' canopy height, and removing all timber wider than 2 inches in diameter. This meant a significant departure from standard practices in the Amazon, by which conventional loggers use to cut down less than 10 mature trees per hectare. Toledo (1994) states that the widespread selective extraction of timber yields no more than 15 cubic metres (m^3) per hectare.

ii) Each strip is an elongated gap, bordered by primary forest which constitutes the source of seeds for natural regeneration. As a result of this so-called gap-phase dynamics principle, trees would regenerate on their own. (Hartshorn, 1989). In successive years, the new strips would be located at least 100 m from recently cut strips.

iii) Any particular strip would be logged once every forty years, giving an annual yield equivalent to one fortieth of all possible harvest within a forested tract. The system allowed for small interventions in between the begining and the end of the rotation cycle in order to enhance the regeneration of highly valued species.

Additionally, on-site processing of various timber goods, and involvement of the local indigenous community in all stages of the activity, from designing to marketing, made of the project a singular, unprecedented one in the region.

1.2. On the Use of the Peruvian Amazon Rainforest.-

Let's consider, by way of introduction, some of the main problems concerning the trade-off between sustainable[3] and non-sustainable use of the Amazonian rainforest in Perú. In this section we will highlight the fact that, when properly accounted for, the discounted total costs of non sustainable use (including private and social costs[4]) will far exceed the discounted benefits of sustainable use of forests.

According to IDB el at (1992), grazing and livestock lands in the Peruvian Amazon extend to some 208,000 ha with a cattle population of 228,000 head (10% of the national population). The productivity per hectare (1.1 head) is very low and is associated to a high volume of misused forestry resources, which are sacrificed when the land is converted. This cattle population produce 9,000 MT of meat, far less than the 31,000 MT consumed in the region.

Preliminary studies for these activities held in an extension of 200 ha of floodplain land show that the net present value (NPV) of the profits, discounted at 10% during 10 years, amount

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[3] Integrating sustainability and project appraisal is related to the improvement of welfare without disregarding the availability and quality of natural capital (K_n), defined in a broad sense in order to take account of the depletion of natural resources and the degradation of the reproductive and assimilative capacity of the environment. If natural capital's quantity or quality is reduced, then next generations will have less consumption possibility and hence a lower level of welfare. This discussion exceeds the goals of our work. A good review of the subject will be found in Pearce et al (1991), Pezzey (1992), and von Amsberg (1993).

[4] Taking social costs in a broad sense in order to allow for environmental costs, etc.. Pearce and Moran (1994) present a summarised discussion of the problem of Total Costs.

to $ -433,576, i.e., $ -2,168/ha, if the costs incurred as a result of losing timber and non-timber products in the land conversion process are added up to the private costs (Benjamin Palomares, Agricultural Ministry officer, personal communication).

Conversely, an integral use, including agroforestry, silviculture and game hunting, for a plot of similar dimensions located in the same region (floodplain), and discounted under similar conditions, would yield a NPV of $ 635,554, i.e., $ 3,178 /ha.

The question then arises why do cattle-ranchers exist in the Peruvian Amazon if the NPV of their economic activities indicate that they are losing money.

The answer lies on the fact, previously stated, that only the private costs are incorporated in the decision process of those entrepreneurs. So, if we applied the cost benfit analysis on the basis of the private costs only, the NPV for the preceding example would be $ 8,889, i.e., $ 45/ha.

These results would imply that one solution to the problem of deforesting the Amazon, at least in Perú, would be, as discussed in the next chapter, to perform a correct valuation of the total costs and convince the entrepreneurs that their gains, and those of the society, can be multiplied if the forest lands are used to support forestry activities.

The problem of land use is quite critical in Perú, where a reported 4'612,000 ha of agricultural potentiality exist, and only 440,000 (less than 10%) are effectively used for that purpose.

Some of the data above are only rough estimates and have to be considered carefully, however, they consitute a good starting point for the analysis presented in the following chapters.

1.3. Outline of the dissertation.-

In Chapter 2 we will formalise some of the points raised in the previous section, regarding the decision process of the individual entrepreneurs in the context of the forestry activity. The nutrient mining theory, and the simple forestry economics will be discussed and will give form to our approach to examining the Strip Shelterbelt System.

Chapter 3 will offer a description of selected aspects of the Pichis-Palcazu Project, in general, and the forestry componet in particular. The selection has been done in order to make the application of the economic concepts and tools presented in Chapter 2 as smooth as possible.

The economic appraisal of the Palcazu experience is carried out in Chapter 4, where all the information on input and output levels, prices, and costs for the 1991 operations is used to assess the achievement of the goals formulated by the designers of project in the middle 1980's.

Theoretically, the dissertation shows that the standard forestry economics (summarised in Chapter 2), conveniently extended, can help to cope with the analysis and the design of

possible solutions to the problem of sustainable management of Amazonian forests.

The practical implications concern the criticism of the ex-ante evaluation of the Strip Shelterbelt System expressed by the designers of the project, and the assessment of the System as put into practice by the Yanesha Forestry Cooperative. The test of the ex-ante estimates permits to affirm that the system's profitability would have been enhanced should some basic economic principles had been applied. These findings are the subject of section 4.1. Overestimated productivity and understimated extraction costs are cucial to understand the lack of accuracy of the projections expected by the Palcazu System's designers.

The main outcomes of the ex-post analysis are introduced in section 4.2. We will see that the 1991 operations (the only year when the System was applied effectively), yielded quite stimulating results, namely $ 1,392 from forestry activities in some 4 ha, i.e., $ 348.03/ha. These figures were obtained from an analyisis of the archives of COFYAL, and the institutions and individuals who were more closely connected to the cooperative. These results constitute the basis for the projection of benefits and costs over a 40-year rotation cycle and the corresponding Cost Benfit Analysis.

2. CONCEPTUAL FRAMEWORK

Some of the issues mentioned in the Introduction about the problems rising from the non-sustainable use of the Peruvian Amazon forest can be formally dealt with making use of some approaches developed by economists. In this chapter we will introduce two of such approaches.

In first place, we present a summarised version of the nutrient mining theory, which concentrates on the loss of soil nutrients as a result of deforestation, and its implications on the decision process whether to make a sustainable or non-sustainable use of the forest. Next, we draw an abridged exposition of forestry economics, which delves deeper into the decision process whether to cut or not to cut, and hence complements the nutrient mining theory. Both aproaches constitute the core of the conceptual framework with which we will tackle the economic analysis of the strip shelterbelt system.

2.1. A rapid review of the Nutrient Mining Theory.-

This section focuses on the discussion and analysis of the problems raised by the non-sustainable use of the Amazonian forests, and highlights the fact that the costs associated to the non-sustainable use exceeds the benefits. We will argue that the short-run gains from this use disappear when total costs are properly accounted for.

Most of the land conversions in the Amazon have resulted in unsustainable uses. The conversion process begins with clearing and burning the forest so that the nutrient matter contained in the biomass is converted into ash, which will briefly support (generally no more than 3-5 years) the crops in the plot. The nutrients are exhausted after that period. If the plot were used to support pastures, the problem would arise even quicker because the soils would now be uncovered from the rainfall and the nutrients would easily be leached. As a consequence, what used to be a renewable resource system would become a non-renewable one.

The result of this process is that the declining returns of the land would force the individual to leave the plot and replicate the mining process elsewhere in the forest. If the cleared land left behind were large enough or if it were then turned to cattle-ranching activities, the deforestation would be irreversible and the opportunity to make a sustainable use of the forest will be lost.[5]

One of the most appealing approaches used to understand the economic problem of land use in the Amazon is the nutrient mining theory, which we will next present concisely following Pearce and Moran (1994).

The question to be addressed is whether to use sustainably an area of tropical forest or to clear it for non-sustainable use. From the individual standpoint, a rational decision would

[5] This analyis does not apply to the traditional shifting cultivation strategy practised by indigenous populations. In this case, their plots are really small and are open in such a way that when it is no more suited for agricultural uses, it will allow the natural regeneration of the forest and will still be visited by people in search of game.

weigh the net benefits of both options.

The sustainable use includes agro-forestry, non-timber production (e.g., medicinal plants), eco-tourism, and sustainable management of forests (like the Palcazu system). Non-sustainable use would, on the other hand, includes agricultural livestock activities in lands unsuited for such activities, giving rise to the loss of forests.

The individual entrepreneur would favour a sustainable use if its private benefits (NB) were greater than those from non-sustainable use. To allow for intertemporal decisions, we introduce discounting and obtain the net present value (NPV) of both flows. The condition to favour sustainable use would then require that the PV of net benefits from sustainable use be greater than PV of net benefits from non-sustainable use, or more formally,

$$\text{NPV (NB of SUF)} > \text{NPV (NB of UUF)} \qquad (1)$$

where

$$\text{NPV (NB)} = \Sigma_{tT}\, NB_t\, (1+r)^{-t}$$

r = discount rate

SUF = sustainable use of forests

UUF = unsustainable use of forests

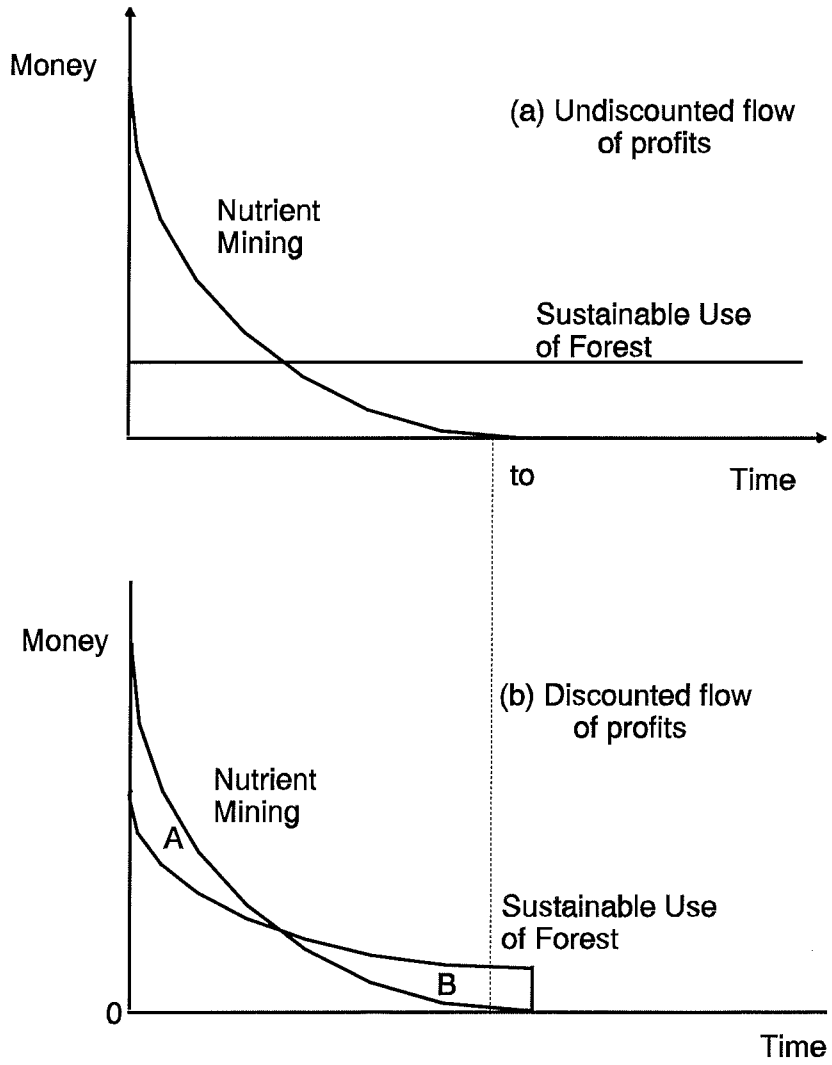
This is the key relationship underlying any rational decision about whether using the forest in a sustainable fashion or deforesting. If the present value of SUF were low or took the form of an *intangible* the individual would prefer to deforest. Since SUF expand over a long period of time, it will be affected by the discount factor, unlike the UUF, which renders benefits mainly in the short-run.

As a consequence, it will be necessary to make a thorough valuation of the sustainable practices and use a correct discount factor in the process of analysisng costs and benefits. Otherwise, a bias would exist against SUF.

Figure 2.1. illustrates this analysis. In phase a) we show hypothetical cash flows for SUF and UUF. It can be seen that UUF has a higher short-term net benefits but they become very low and null quite rapidly. SUF has a lower short-term net benefit but a sustained net return over time. On the other hand, phase b) of this figure illustrates the effect of discounting. The Net Present Values (NPV) of UUF and SUF are represented by the areas denoted A and B respectively. The decision criterion would be expressed now in terms of the area of each region. In other words, if A were greater than, the individual woul prefer SUF.

The implications are straightforward. To avoid bias in the decision whether to favour SUF or UUF, a correct valuation of benefits and costs has to be done, and an adequate discounting factors has to be used.

Figure 2.1
Illustration of the Nutrient Mining Theory



In this context, the present dissertation will conduct the economic appraisal of a particular sustainable management experience in a Peruvian Amazon forest and will hence try to contribute to the process of producing a more accurate valuation of the sustainable use of the forest.

2.2. A Visit to the Simple Forestry Economics.-

Economic theory provides a useful approach for analysing the allocation of forest resources. In this section we will present a rapid review of this approach in a nontechnical fashion[6]. We will focus on the economic decision of private timber owners, assuming well defined property rights,[7] and show how these decisions are influenced by a set of factors including input costs, price, interest rate, and tax policy.

Let us consider in first place, the decision about the cutting age, i.e., how long to wait before harvest. This problem can be examined from two different standpoints, namely, the biological management approach, and the economic approach.

The biological management approach is interested in keeping a non-declining harvest while the economic viewpoint considers the standing trees an asset that yields return according to the rate of interest. Under this approach, the objective is to maximise sustainable yield, which means harvesting when cumulative growth per year, also known as mean annual increment, is largest. Let **t** be the age of the tree, and f(t) be the volume of wood in year **t**. The maximum sustainable yield (MSY) approach would recommend to harvest when f(t)/t is maximised. Formally,

$$MAX_t \quad f(t)/t \qquad (2)$$

This problem has got a straightforward solution if $f'(t) > 0$ and $f''(t) < 0$, which corresponds to the typical growth of forestry as represented by Figure 2.2.

Solving (2) leads to

$$f'(t) = f(t)/t \qquad (3)$$

i.e., current annual increment (f'(t)) equals mean annual increment (f(t)/t). Graphically, this is depicted by setting the slope of growth function equal to the line expressing the ratio of the volume of wood $f(t^s)$ and the age of the stand being harvested (t^s). If $f'(t) > f(t)/t$, the current increment will lead to net increase in the mean annual increment. In other words, the sustainable yield will be higher if we wait. Conversely if $f'(t) < f(t)/t$ the annual increment will decrease the mean, and the yield lower.

This approach, however has no economic support since no account is taken of prices, costs

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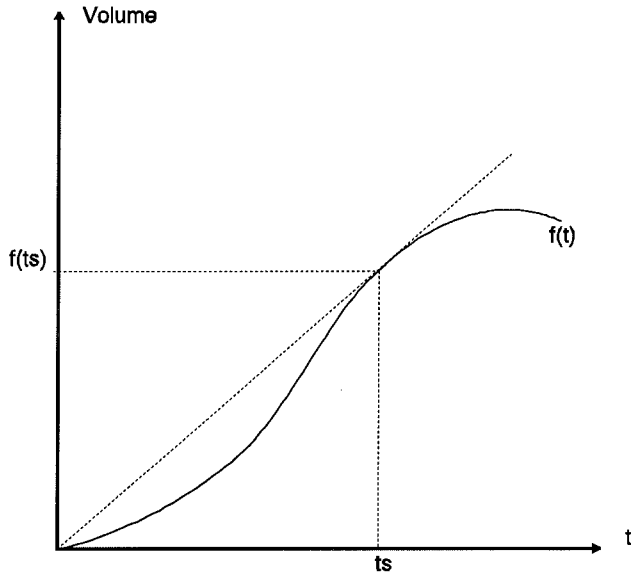
[6] A more detailed presentation is available in Deacon (1985) and Hartwick and Olewiler (1986).

[7] As is the case with the Yanesha Indians of the Palcazu valley, as will be seen in the next chapter.

and interest rate.

Figure 2.2
Typical Growth Pattern of Trees



The economic approach treats forest as an asset which may yield interests if the money obtained from selling the timber harvested is invested, and hence includes a new dimension into the analysis of the trade-off between cutting now or waiting. The benefits of waiting are given by the value of saleable timber grown during the waiting time, which amounts to the increment in volume times the timber price.

The costs of waiting are represented by the value of receipts foregone during the waiting period and consist of two components: i) the foregone return of investing the money obtained if the trees would have been harvested and the timber sold; and ii) the opportunity cost of the land supporting the forestry activities, i.e., the highest alternative value of the land. A rational economic agent would choose to harvest when the marginal cost of waiting (MC) equals the marginal benefit (MB). The following notation will be used to formalise the decision process analysis introduced above.

p = net-stumpage price, initially constant,

c = fixed harvest cost,

r = rate of interest, and

$\mathbf{V_f}$ = the opportunity cost of the forestlands

R = rental price of the forestland. It can be shown that $R = rV_f$.

Now we can express MC and MB more concisely as

$$MC = r\,(pf(t) - c) + R \qquad (4)$$

and

$$MB = pf'(t) \qquad (5)$$

V_f and R need additional clarifying. Firstly, V_f denotes the present value of future earnings obtained from harvesting and selling timber. For a single rotation it is defined as

$$V_f = [pf(t) - c]\,(1+r)^{-t} \qquad (6)$$

Secondly, if the forest were allowed to grow for an additional year, it would occupy the land and hence the entire stream of future receipts would be reduced by an amount equal to the receipt corresponding to one year. In other words, we would have lost the opportunity to earn the annual return (r) of the future stream (V_f). Accordingly, the opportunity cost of the land as a result of waiting an additional time period is given by

$$R = rV_f \qquad (7)^{8}$$

With all this in mind the optimal cutting age, t*, can be found now by solving MB = MC, i.e,

$$pf'(t) = r\,(pf(t) - c) + R \qquad (8)$$

(8) can also be obtained by maximising the present value of harvest profits, i.e.,

$$MAX_t \;\; [pf(t) - c]\,(1+r)^{-t} \qquad (9)$$

for discrete time, or,

$$MAX_t \;\; [pf(t) - c]\,e^{-rt} \qquad (10)$$

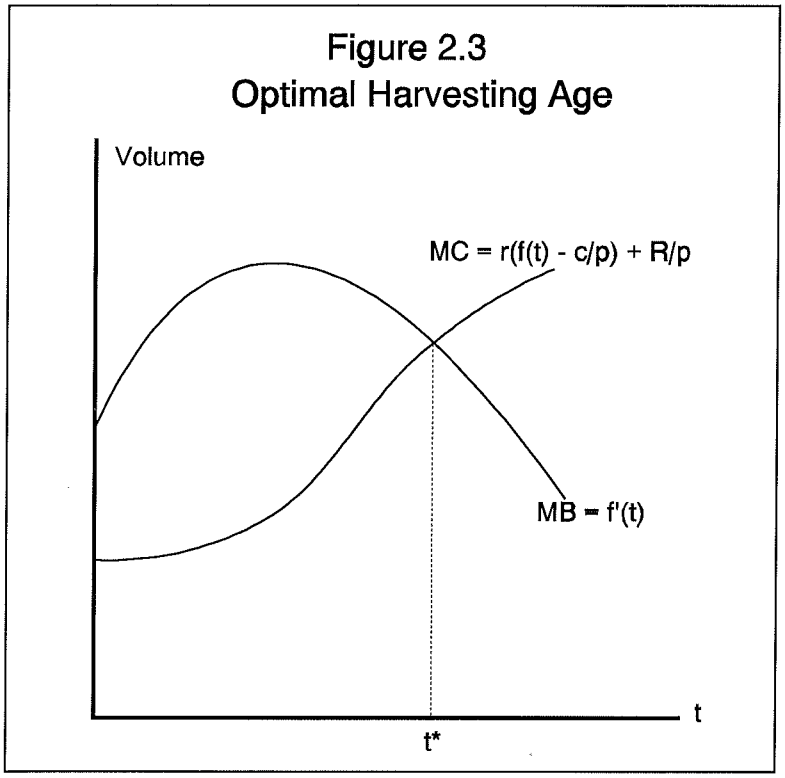
for continuous time.

Dividing left-hand side (LHS) and right-hand side (RHS) of (8) by p (price) yields

$$f'(t) = r\,(f(t) - cp^{-1}) + Rp^{-1} \qquad (8')$$

which expresses MC and MB in physical values. The previous analysis is portrayed in Figure 2.3, which is derived from Figure 2.2. The curve f'(t) shows the annual increment in volume, i.e., the marginal benefit of waiting (MB) in physical units.

[8] See Deacon for a deeper discussion of this equality.



The curve $r\,(\,f(t) - cp^{-1}\,) + Rp^{-1}$ represents the marginal cost of waiting (MC) measured in physical units. The harvesting age is given by the intersection of both curves, which occurs at t*.

As can be seen in Figure 2.3, the solution of the cutting age problem depends crucially on cost, price, interest rate and the rental value. Let us discuss, for instance, the effects of an increase in constant unit costs, c.

The first effect of an increase in c is straightforward. We can see that this will lead to a decrease in the first component of the RHS of (4), the MC. The second effect is explained through (6). There we observe that the RHS will be reduced and so will the present value of land (V_f). A decrease in V_f will, in turn, reduce R as can be seen through (7).

The net effect of an increase in c will therefore be a reduction in the marginal cost, which is depicted in Figure 2.4 as a downward shift of the curre denoted MC. As a result, the cutting age will be increased and the harvest will occur at a later time.

Similar reasoning will lead us to explain the effect of changes in net-stumpage price and interest rate on the solution of the harvesting age. Table 1 summarises these relationships.

The model can easily be extended to analyse the effect of different types of tax. For instance, a tax levied as a percentage of the net-stumpage price will have the same effect as a reduction in price, while a tax imposed as a percentage of the forestland alone will have no

effect[9].

TABLE 2.1

RELATIONSHIPS BETWEEN SOME ECONOMIC AND FORESTRY VARIABLES

	Net price of timber (p)	Fixed costs of harvesting (c)	Interest rate (r)
Rental Value of Forestland (R)	+	-	+
Harvesting age (t)	-	+	-

A further extension is possible in order to allow for the analysis of other functions that the forests fulfill like flood control, biodiversity protection, recreation, etc.. The money value of all these functions can be represented by B and added up to the benefits of waiting. These functions' valuation will therefore increase the marginal benefit of waiting. The graphical representation would be given by a upward shift of the curve denoted MB. Clearly, if the standing value of forest, B, is large enough, this could lead the economic agent to chose not to harvest at all.

Carrying out the empirical work of the present dissertation involves, as stated before, the use of the standard forestry economics and economic data necessary to apply this approach to the Palcazu model. The crucial equation of the basic forest economics (one rotation) model is given by (6), which we reproduce below

$$V_f = [p\ f(t) - c]\ \ (1+r)^{-t} \qquad (6)$$

An extension of the simple model above sketched will allow us to carry out the empirical work that the dissertation involves. In first place, there is not only one product but three of them, and they are sold in four different markets. This is certainly not a big problem and can be solved by working out a price index, given that we have got both production and prices data.

Secondly, there is not only a fixed cost but a variable one, as well. Again, this is an easy problem to be solved, and can be coped with by introducing a slight modification into the basic equation.

[9] A detailed analysis of all these effects and additional changes on the timber supply can be found in Deacon (1985) and Hartwick and Olewiler (1986).

$$V_{fm} = [pf(t) - c] / [1-(1+r)^t] \quad (12)$$

An enquiry into the effects of applying the multiple rotation model to the Palcazu system is missing, and so is the introduction of the non-timber values. The former will be dealt with in this dissertation. The latter will be left behind for the moment given the lack of information, although we have recently learnt that some medicinal plants are currently being extracted from the Palcazu valley and sold at quite favourable prices.

3. THE PALCAZU MODEL

Before presenting the calculations for the economic appraisal of the Palcazu System, it is necessary discuss in some depth the main aspects sorrounding the Pichis-Palcazu Project and The Yanesha Forestry Cooperative (COFYAL).

3.1. An Overview of the Origins of the Project .-

President Belaúnde's two elections to the power were supported by its long-wished colonisation project of the Peruvian Amazon Basin. He viewed the region as an infinite stock of resources from where agricultural products would flow endlessly to nourish large demads of industrialised cities located far away from the Amazon.

During his second government, he received financial and technical support from USAID to carry out his Amazonian projects. One of them was known as Proyecto Especial Pichis-Palcazu (PEPP), originally designed to promote the colonisation of the Pichis and Palcazu valleys (northeast of Lima) with some 150,000 peasants coming from the impoverished highlands.

This project faced a breathless resistance from social scientists and environmentalists who knew the region. They demanded to turn the attention towards the native population needs, especially those of the Yanesha Indians, and management of the area's natural resources. An american consultancy appointed by USAID gathered a group of outstanding social and environmental professionals to carry out technical studies leading to the reformulation of the original project. As a result, USAID agreed to provide the support only in the Palcazu Valley and decided no to back colonisation.

In June 1982 the agreement was signed for the financing and technical assistance of development and sustainable resource management in the Palcazu Valley. Significantly, the name of the project was officially changed to Central Selva Resource Management Project (CSRMP). Thirty million US dollars were allocated to the project, of which 22 million were funded by the US government.

The new approach aimed at promoting an integral development of the Palcazu valley with special emphasis on four components: i) the environmental protection, which had the formulation of the land use plan as its main objective; ii) the agricultural and livestock promotion taking into account the environmental constraints identified by the first component; iii) the health promotion of the valley's population, consisting mainly of indigenous people; and iv) the forestry component, which was based upon the Strip Shelterbelt System formulated by the Tropical Science Center, based in Costa Rica.

In spite of the fact that no 'social component' was present in the redesigned project, USAID placed a singular precondition that the Yanesha native communities had to be granted legal property rights to their lands.

3.2. A Brief Description of the Palcazu's Ecological and Social Context[10].-

The Palcazu valley is located in east central Perú and has an extension of 140,000 hectares (ha). The valley's base elevation ranges from 270 to 350 metres. 85% of the lower valley is classified as tropical wet forest life zone and the rainfall average is around 6,300 mm/year, one of the most humid areas ever reported.

Three quarters of the lower valley land consists of primary forest. At the end of 1980's some researchers in botanic had estimated in 1,000 the number of native trees and reported a high richness of native plant species of pharmaceutical or medicinal importance. Significantly, some projects are currently being held to export ***uña de gato*** (*uncaria tomentosa*), a plant whose properties to treat some forms of cancer have been widely recognised and which is intensively being tested in experiments to treat AIDS.

The terrain is mainly of the rolling-to-steep type and is hence highly sensitive to erosion factors. The red clay soils are extremely acidic (pH 3.8 - 4.5) and leached, with abundant aluminium, and devoid of major nutrients.

The whole range of conditions mentioned previously makes most of the valley unsuited for conventional agriculture and livestock production.

Studies carried out in the early 1980's showed that 19% of the land should have to be kept as protection forest; 35% could be used for agricultural and livestock production; and 46% for short-term and permanent forest activities. The land suitable for permanent forestry activities amounts to 44,000 ha. /1410,100

As for the population, 1990 estimates indicated it was around 6,200 inhabitants, with 3,500 Yanesha Indians. The Yaneshas live in 12 communities and still practice traditional shifting cultivation of manioc, maize, and upland rice on small holdings. As a result of the reaction to the first draft of the Pichis-Palcazu Project, the Peruvian government was forced to grant legal property rights to these communities.

The remaining 3,000 people was made up of *mestizo* settlers, some Campa (Ashaninka) Indians, and a significant number of foresters, cattle ranchers, and farmers of German, Swiss, and Austrian descent. The total number and composition of the population must have changed since 1989, when the guerrilla activities began. As a result of these events, many settlers were forced to move away, and was the USAID technical staff.

3.2. The Palcazu Forestry Model.-

A plan was formulated by the Tropical Science Center aimed at facing the problems commonly associated to managing heterogeneous tropical forests. Leslie (1987) and Hartshorn (1989) have grouped the main sources of these problems as follows:

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[10] This section is mainly based on Hartshorn (1989), Hartshorn et al. (1989), Simeone (1990), INADE-APODESA (1990), and IDAHO STATE UNIVERSITY (1990).

i) The low volume of wood extracted per unit area. As mentioned before, in the Palcazu valley no more than 15 m^3/ha is extracted, while inventories report a 150 m^3/ha average of saleable wood. It should be noted that to extract the 15 m^3 the whole hectare is cleared by conventional loggers in order to ease logging and transport activities.

ii) Very high costs of extraction. This is connected with the necessity of clearing all the area. These costs, as will be seen bellow can represent more than 50% of total costs of production.

iii) Lack of knowledge about the tropical rainforest dynamics, and the regeneration process.

iv) Inadequate government policies that discourage sustainable management of forests.

v) Absence of land use plans to promote an appropriate use of forest lands.

Put in few words, the conventional practice of exploiting heterogeneous tropical rainforests is based on extracting selective species, and even selected pieces, at a very high cost.[11] The high extraction costs are therefore a major constraint in the process of maximising profits from harvesting tropical forests, and is the main reason why most experiences of managing tropical forests focused on a few highly valued species have failed, giving rise to the widespread attitude that management of these type of forests is both ecologically and economically unfeasible.

This attitude was contested by designers of the project. Their plan was inspired by the new trends in conservation that tried to make ecological and economics goals compatible. Thus the strip shelterbelt system sought to exploite tropical forests in a sustainable fashion trying to maximise the use of biomass productivity, and simultaneously, enhance the socio-economic conditions of local populations in the Palcazu valley.

According to TSC's management plan, timber exploitation had to be limited to long, narrow interspersed clear-cuts, 30 to 40 m wide, and 200 to 500 m in length, depending on the topographic conditions.

Each strip is an elongated gap, bordered by primary forest which constitutes the source of seeds for natural regeneration. As a result of this so-called gap-phase dynamics principle, trees would regenerate on their own. (Hartshorn, 1989). In successive years, the new strips would be located at least 100 m from recently cut strips.

The management plan also included silvicultural treatments in order to favour regeneration of particularly desirable individuals, or to eliminate undesirable ones. In order to promote an adequate regeneration, the strips had to be clear-cut so as to allow sunlight to reach the forest floor. All the biomass then had to be cut and all trunks and large branches extracted, leaving behind only the small pieces to provide nutrients for the regeneration process.

[11] Hartshorn (1989) indicates that these highly valued timbers are scarce even in undisturbed primary forests.

4. ECONOMIC APPRAISAL

The economic analysis of the forestry activities carried out by COFYAL are presented in this chapter. We star off with an evaluation of the projections done by the designers of the Palcazu System (TSC), which is shown in section 4.1. The only ex-ante estimates that we have are for production from the interventions proposed originally (INADE et al., 1986). We use that information along with actual data for costs and prices in order to calculate net benefits and hence the profitability of the original model. We do the calculations for a single rotation (40 years) and then for multiple rotations in order to illustrate the advantages and disadvantages of applying the simple forestry economics model presented previously.

The findings of the ex-ante evaluations indicate, amongst other important facts, that the original management plan's profitability would have been improved ~~should~~ had some basic economic criteria (like those presented in Chapter 2) ~~had~~ been applied. This can be seen, for instance, when the plan of silvicultural interventions (shown in Table 4.1.1) delays the main harvest until the last year of the rotation cycle (year 40). Since the contribution of the main harvest is significant in money terms, this deferral reduces its present value, as was suggested theoretically in Chapter 2 and will be shown empirically in section 4.1.

Section 4.2 contains the results of the ex-post evaluation. It must be emphasised, firstly, that, in spite of all the unfavourable conditions existing in the valley during the late 80's and early 90's, the members of COFYAL did not abandon the project and in 1991 harvested 5 strips with some 4 ha altogether. The information relative to levels of output, costs, and prices are used to conduct a Cost Benefit Analysis of their performance and draw some lessons.

Some of the most important results regarding the ex-post evaluation are that: the net benefits of COFYAL's activities in 1991 were positive, namely $ 1,392 from the 4 ha harvested, which represents $ 348/ha. On the basis of these outcomes, we project a flow of costs and benefits and find a NPV of profits equal to $ 4,722.2 for a single rotation scheme, and $ 4,681.06 for a multiple rotation scheme, given a 10% discount rate. The IRR was calculated in 21.53%. These are really good financial indicators and can support the promotion of similar experiences of sustainable forestry management in the region. Significantly, these indicators were produced by a conventional Cost Benefit Analysis, i.e., taking account only of private costs and benefits.

4.1. "Ex-ante" evaluation.-

The project's designers estimated that the portfolio of goods to be produced by COFYAL under the Palcazu system would consist of:

i) Sawmilled Timber.- accounting for an average of 150 m^3/ha. This timber would be sold at prices based upon their specific properties. Early in the 1980's, an increasing scarcity of highly valued hardwoods, like mahogany, led to an opening of markets to wide range of Amazonian hardwoods which had traditionally been ruled out from commercial purposes. This situation created a room for experiences aimed at managing tropical forests as an alternative to the conventional selective logging.

ii) Fence and Utility Poles.- 90 m^3/ha of smaller dimension timber were estimated to be extracted from the strips to produce fence and utility poles. The roundwood extracted would receive a special treatment with preservatives in order to increase its longevity and commercial value.

iii) Fuelwood and charcoal.- a non-specified amount of timber not suitable for sawmilling or production of poles would be sold as fuelwood or, alternatively, converted in charcoal, for which a considerable demand had been projected by the designers of the Palcazu system.

Although most of the information regarding current and projected prices and costs at the time of the planning phase are not available, results of the financial projection are found in different publications mainly by Hartshorn (1989), Simeone (1986), and Hartshorn et al. (c.1986).

The net present value of the forestry activities carried out by COFYAL were estimated around $ 3,500/ha of forest harvested and processed locally, at the processing centre located in Shiringamazú, one of the Yanesha communities[9]. This NPV was estimated for the levels of production mentioned above for each of the main items produced under the Palcazu system. An extension of the producing capacity of the processing centre considered a diversification and expansion of the infrastructure which would yield, under full development, a net present value of $ 27,500 per hectare harvested.

An official document of the Pichis-Palcazu Project by INADE et al. (1986) with information concerning the interventions in the strips after the main harvest shows that these interventions were thought of in order to obtain products before reaching the second harvest age (39 years after the first harvest) and to help the natural regeneration process of the forests.

On the basis of this document, we have built a table with projections of saleable timber obtained from each intervention.

For year 3, we have assumed that the average diameter of the fence poles is .05 metres (2 inches), and the average length is 2.2 metres (m). These are the minimum commercial dimensions for poles to be used as fences in agricultural and livestock activities. With these dimensions the volume amounts to 4.31969 x 10^{-3} m^3 per unit fence pole. Given that the original projection estimated a production of 30,000 units "harvested and produced", the volume of saleable timber was 129.591 m^3/ha.

The dimensions of the fence poles produced in year 6 are 0.1 m (4") in diameter and an average length of 2.4 m, which correspond to a volume of 1.88496 x 10^{-2} m^3 per unit fence pole, which multiplied by the estimated units produced (10,000) yields a volume of saleable timber equivalent to 188.496 m^3/ha.

The dimensions of utility poles produced from intervention at year 10 are 0.2 m (8") in

[9] The processing centre consisted mainly of a portable sawmill and a bank for preserving roundwood. Its value was contestedly reported in a range from $140,000 to $500,000.

diameter and an average length of 8 m, which means a volume of .25 m^3 per unit pole. Since 7,000 utility poles were projected to be produced at that time, the total volume of saleable timber was 1,750 m^3. The utility poles expected to be produced at year 15 are assumed to have the same dimensions, i.e., .25 m^3 per unit, but since the units produced at this time were expected to be 700, the total volume of saleable timber was estimated in 175 m^3. The volume of each mature tree is estimated in 1.5 m^3.

TABLE 4.1.1

SILVICULTURAL INTERVENTIONS PER HECTARE HARVESTED UNDER THE PALCAZU SYSTEM, 1986.

Year after Main Harvest	Maximum Possible Production (units)	Type of Product (volume per unit)	Maximum Saleable Production (m^3)(1)
3	30,000	Fence poles ($4.31969*10^{-3}$ m^3)	129.5907
6	10,000	Fence poles ($1.88496*10^{-2}$ m^3)	188.4956
10	7,000	Utility poles (.25 m^3)	1,750.0000
15	700	Utility poles (.25 m^3)	175.0000
40 (2nd Harvest)	160	Fence poles ($1.8849*10^{-2}$ m^3)	3.0159
	100	Utility poles (.25 m^3)	25.0000
	40	Sawmilled timber (1.5 m^3)	60.0000

(1) Whenever possible we will use four decimals when dealing with figures representing cubic metres (m^3).

As for the prices, we are using the prices observed in September 1992 and January 1993. For fence poles, produced either at year 3 or 6, we use a price of \$ 59.24/m^3. For utility poles, produced either at year 10 or 15, the price is \$ 200/m^3.

Finally, three markets existed in 1991 for COFYAL's sawmilled timber at three different levels:

i) Local market.- located around the Palcazu valley with a price of \$ 88.98/m^3.

ii) National market.- including Lima and other coastal Peruvian cities, where the price was \$135.59/m^3.

iii) Export market.- given by sales to companies in UK and USA specialised in selling

timber coming from managed tropical forests. In 1991 a British company bought sawmilled timber produced by COFYAL at a unit price of $508.47/m^3 [10]

All the information and assumptions mentioned in the preceding paragraphs underly the figures in table 4.1.3.

We can now use the theory of forest management to criticise this programme. Any textbook, for instance, any of the ones mentioned above (Deacon, 1985; Hartwick and Olewiler, 1986) would suggest that harvest should take place sometime between years 6 and 10. This can seen with the help of table 4.1.2, where two columns have been added to take account of the mean annual increment (MAI), defined as the volume in year t (m^3) divided by the age (t), and the current annual increment (CAI), defined as volume in current year minus the volume in year corresponding to the previous intervention, this difference divided by the time elapsed between these two interventions[11].

TABLE 4.1.2

DYNAMICS OF PALCAZU'S FORESTS AS A RESULT OF SILVICULTURAL INTERVENTIONS

Year (t)	Volume (m^3)	MAI (1) (vol/t)	CAI(2)
3	129.5907	43.1969	19.6331
6	188.4900	31.4150	390.3775
10	1,750.0000	175.0000	-315.0000
15	175.0000	11.6667	-3.4794
40	88.0160	2.2004	

MAI.- Mean Annual Increment = (Volume in year t) / year t.

CAI.- Current Annual Increment = (Volume in current year - Volume in previous intervention) / (time elapsed between the two interventions).

Biological criterion would dictate to harvest sometime between year 6 and 10.

Equations (2) and (3) in chapter 2 indicate that the optimal cutting age would have to be around year 10, when MAI is maximum. Accordingly, all the efforts would have to be addressed to producing utility poles. This would be a rational decision only if the market would not be satiated of this type of commodity, and if all the data used to arrive at this conclusions were correct.

As for the market conditions, a great deal of effort should have to be given to try and expand

[10] Although this was the price received by COFYAL, an additional cost was incurred due to transaction costs in sending the products from Perú (mainly due to paying export taxes, and export broker's service) which reduced the net price to $ 427.60.

[11] This would correspond to the marginal increment in continuous time analysis.

the demand for utility poles. This would lead to an increase in administrative costs and could eventually bring the profitability down.

Before proceeding any further, let's hightlight two important aspects related to the previous discussion. Firstly, we have to mention that the former analysis depends to a high extent on the prices we used, which correspond not to the year of the projection (1986), but to 1992-1993. And, secondly the assumption we have made that the intervention plan can be taken as a proxy of the growth function of the trees.

As for the reliability of the estimates of production in units of tree per intervention, the former Executive Director of a government institution supporting the project[12], Oscar Pérez argues (personal communication) that those figures were highly inflated, and that any production could hardly be expected before year 15 after the main harvest. This would mean a slight change in the optimal cutting age from 10 to 15 years if we keep to estimates shown in table 4.1.1 and follow the condition that MAI should be maximised.

TABLE 4.1.3

PALCAZU'S PRODUCTION VALUE PER HECTARE (US$/ha) AS ESTIMATED BY ACTUAL DATA (1991) ASSUMING ESTIMATES OF PRODUCTION FROM INTERVENTIONS PROPOSED BY PROJECT DESIGNERS (1986), r= 10%

Year (t)	Revenues (US$)	Costs (US$)	Profits (US$)	Present value of Profits ($)
3	7,677.08	20,527.03	-12,849.94	-9,654.35
6	11,166.67	29,857.50	-18,690.83	-10,550.49
10	350,000.00	332,709.11	17,290.89	6,666.39
15	35,000.00	33270.91	1,729.09	413.93
40	19,718.17	15,349.54	4,368.63	96.53
Net Present Value of Profits from single rotation (40 years) =				-$13,027.99
Net Present Value of Profits from multiple rotations =				-$13,322.34

Even in this case, however, no complete information has been found necessary to apply with a high degree of confidence the simple model introduced in chapter 2 (?). The main point is, we must insist, that the silvicultural interventions plan does not necessary correspond to the growth function of the trees in the Palcazu area, and it could be the case that all the interventions suggested by the plan be necessary in order to obtain the results projected to the

[12] National Institute of Development - Support to the Sustained Developmnet of the High Jungle, known in Perú as INADE-APODESA.

next harvest[13], i.e., to allow for the regeneration of strips harvested.

As shown in Table 4.1.3, all those interventions would give a chance to get additional income (from processing and selling the products of each intervention) at earlier periods and will hence be discounted by a lower discount factor making the NPV of the forestry activities higher.

In this respect, an additional comment is necessary regarding the postponing of the main harvest (which yields considerable profits) until the end of the rotation cycle (year 39). By doing so, these profits are discounted by a large discount factor and, therefore their present value is reduced. This is against a well-known economic principle that dictates that whenever possible one should anticipate positive benefits in order to increase their present value or, alternatively, postpone costs so as to reduce their present value.

We show in Table 4.1.4 how the results on the profitability of the model are modified by only changing the sequence in order to start the cycle by harvesting at year t= 0.

TABLE 4.1.4

PALCAZU'S PRODUCTION VALUE PER HECTARE (US$/ha) AS ESTIMATED WITH ACTUAL DATA (1991), CHANGING SEQUENCE OF EXTRACTION, AND ASSUMING ESTIMATES OF PRODUCTION FROM INTERVENTIONS PROPOSED BY PROJECT DESIGNERS (1986), r= 10%

Year (t)	Revenues (US$)	Costs (US$)	Profits (US$)	Present Value of Profits (US$)
0	19,718.17	15,349.54	4,368.62	4,368.63
3	7,677.08	20,527.03	-12,849.94	-9,654.35
6	11,166.67	29,857.50	-18,690.83	-10,550.49
10	350,000.00	332,709.11	17,290.89	6,666.39
15	35,000.00	33,270.91	1,729.09	413.93
Net Present Value of Profits from single rotation (40 years) =				-$8,755.89
Net Present Value of Profits from multiple rotations =				-$8,953.72

A review of the last two tables (4.1.3 and 4.1.4) shows that producing fence poles from interventions at years 3 and 6 are economically irrational. For this reason, in Table 4.1.5 we have ruled out this production, reducing this way the associated loss. The negative values in years 3 and 6 are now connected to the thinning costs necessary to allow for the regeneration process and the figures are based on estimated thinning costs by INADE-APODESA (1990).

[13] Dr. Howard Clark, former USAID officer, was opposed to any kind of intervention since the natural regeneration process of the forests is independent of human intervention, and no sufficient evidence existed about the effects of such intervention on the regeneration of the strips harvested.

TABLE 4.1.5

PALCAZU'S PRODUCTION VALUE PER HECTARE (US$/ha) AS ESTIMATED WITH ACTUAL DATA (1991), CHANGING SEQUENCE OF EXTRACTION, AND MODIFYING ESTIMATES OF PRODUCTION FROM INTERVENTIONS PROPOSED BY PROJECT DESIGNERS (1986), r = 10%

Year (t)	Revenues (US$)	Costs (US$)	Profits (US$)	Present Value of Profits (US$)
0	19,718.17	15,349.54	4,368.63	4,368.63
3	0.00	55.50	- 55.50	- 41.70
6	0.00	55.50	- 55.50	- 31.33
10	350,000.00	332,709.11	17,290.89	6,666.39
15	35,000.00	33,270.91	1,729.09	413.93
Net Present Value of Profits from single rotation (40 years) =				$11,375.92
Net Present Value of Profits from multiple rotations =				$11,632.95

In summary, the results presented in this section are rather different from those projected by the designers of the Palcazu system. Hartshorn (1989) and Simeone (1986) reported a NPV of $3,500/ha for the infrastructure existing at the beginning of the activities (late 80's). Keeping to the schedule of interventions proposed by the designers (see Table 4.1.1) and using actual data for prices and costs during 1991, the NPV of harvest per hectare is highly negative for either simple or multiple rotation, -$13,027.996 and -$13,322.353 respectively, as shown in the Table 4.1.3.

Things do not change dramatically if the schedule is changed in order to start the analysis with the main harvest at year t = 0 (instead of postponing it until the end of the rotation cycle), which is absolutely possible given the existence of wide extensions of primary forests in the Palcazu valley. In this case, the NPV for single and multiple rotation schemes per hectare are -$8,755.89 and -$8,953.72 respectively (see Table 4.1.4). The projections turn to be highly encouraging if no fence poles would have been planned to be extracted and produced (from interventions in years 3 and 6) and only thinning would have been proposed, and if additionally, the schedule would have considered the main harvest at the beginning (t = 0) instead of the end of the rotation. In this situation, the NPV would have suffered a dramatic change and become highly positive, over $ 11,000/ha for either single or multiple rotation as shown in Table 4.1.5.

4.2.- "Ex - post" Evaluation.-

Unlike the preceding section, we will use now actual data for COFYAL's activities during 1991, the only year when the Strip Shelterbelt System (or Palcazu System) was put into practice.

It is significant that the project was not abandoned after USAID's sudden withdrawal, which

was due mainly to the guerrilla activity in the valley, carried out by the two guerrilla groups existing in that then (Sendero Luminoso and Movimiento Revolucionario Túpac Amaru). No settler of valley was free of the bad consequences brought about by the political violence, and it must be asserted that the native communities were neither taking part into nor supporting these activities.

The Yanesha Forestry Cooperative stuck to the Strip Shelterbelt System in spite of the fact of technical and financial shortage[14] and the political violence in the area, and 1991 they harvested 5 strips with an approximate total extension of 4 ha[15].

TABLE 4.2.1

PALCAZU'S PRODUCTION PER STRIP, 1991 (m^3)

Strip (Area)	Sawmilled Timber (m^3)	Utility Poles (m^3)	Fence Poles (m^3)	Total Production per Strip (m^3)
1 (1.32 ha)	33.5498	20.7500	1.6588	55.9586
2 (1.05 ha)	20.0718	12.5000	5.5795	38.1513
3 (0.5 ha)	1.7110	6.50000	2.9782	11.1892
4 and 5 (n.a.)	15.4816 (1)	11.0000	9.4436	35.9252
Total Production per item	70.8142	50.7500	19.6601	141.2243
Notes:				
(1) This is default value in order to match data in this Table with the data colected				
(2) Areas of strips # 4 and #5 are not avalaible. Total area has been estimated c. 4 ha.				

Next, we are going to present the financial results of these activities. All the information regarding harvesting, processing, and marketing operations was collected from COFYAL's headquarters in the Palcazu valley, USAID offices in Lima, FPCN, Agricultural Ministery offices in Lima and near Palcazu valley, private forestry entrepreneurs in the Palcazu valley, and numerous individuals closely related to the Pichis-Palcazu Project, and COFYAL.

Before presenting the results of the economics analysis, it would be convenient to take a close

[14] USAID's support was never fully replaced by the subsequent aid received from WWF and FPCN.

[15] Previous calculations overestimated the total extension of these strips and hence created a bias in the financial results (Southgate and Elgegren, 1995).

look at the outline of COFYAL's flow of benefits and costs, as shown is Table 4.2.2. where we present all the components of costs and benefits at highly disaggregate level.

TABLE 4.2.2

FLOW OF COSTS AND BENEFITS OUTLINE (40 YEARS)

YEAR	TRAIL COSTS	THINNING COSTS	EXTRACTION COSTS	PROCESSING COSTS	REVENUE
0	CTO	0	CEH_0	CPH_0	RH_0
1	CTM	0	CEH_1	CPH_1	RH_1
2	CTM	0	CEH_2	CPH_2	RH_2
3	CTM	CTh_3H_0	CEH_3	CPH_3	RH_3
4	CTM	CTh_3H_1	CEH_4	CPH_4	RH_4
5	CTM	CTh_3H_2	CEH_5	CPH_5	RH_5
6	CTM	$CTh_6H_0+CTh_3H_3$	CEH_6	CPH_6	RH_6
7	CTM	$CTh_6H_1+CTh_3H_4$	CEH_7	CPH_7	RH_7
8	CTM	$CTh_6H_2+CTh_3H_5$	CEH_8	CPH_8	RH_8
9	CTM	$CTh_6H_3+CTh_3H_6$	CEH_9	CPH_9	RH_9
10	CTM	$CTh_6H_4+CTh_3H_7$	$CEU_{10}H_0+CEH_{10}$	$CPU_{10}H_0+CPH_{10}$	$RU_{10}H_0+RH_{10}$
11	CTM	$CTh_6H_5+CTh_3H_8$	$CEU_{10}H_1+CEH_{11}$	$CPU_{10}H_1+CPH_{11}$	$RU_{10}H_1+RH_{11}$
12	CTM	$CTh_6H_6+CTh_3H_9$	$CEU_{10}H_2+CEH_{12}$	$CPU_{10}H_2+CPH_{12}$	$RU_{10}H_2+RH_{12}$
13	CTM	$CTh_6H_7+CTh_3H_{10}$	$CEU_{10}H_3+CEH_{13}$	$CPU_{10}H_3+CPH_{13}$	$RU_{10}H_3+RH_{13}$
14	CTM	$CTh_6H_8+CTh_3H_{11}$	$CEU_{10}H_4+CEH_{14}$	$CPU_{10}H_4+RH_{14}$	$RU_{10}H_4+RH_{14}$
15	CTM	$CTh_6H_9+CTh_3H_{12}$	$CEU_{15}H_0+CEU_{10}H_5+CEH_{15}$	$CPU_{15}H_0+CPU_{10}H_5+CPH_{15}$	$RU_{15}H_0+RU_{10}H_5+RH_{15}$
16	CTM	$CTh_6H_{10}+CTh_3H_{13}$	$CEU_{15}H_1+CEU_{10}H_6+CEH_{16}$	$CPU_{15}H_1+CPU_{10}H_6+CPH_{16}$	$RU_{15}H_1+RU_{10}H_6+RH_{16}$
17	CTM	$CTh_6H_{11}+CTh_3H_{14}$	$CEU_{15}H_2+CEU_{10}H_7+CEH_{17}$	$CPU_{15}H_2+CPU_{10}H_7+CPH_{17}$	$RU_{15}H_2+RU_{10}H_7+RH_{17}$
18	CTM	$CTh_6H_{12}+CTh_3H_{15}$	$CEU_{15}H_3+CEU_{10}H_8+CEH_{18}$	$CPU_{15}H_3+CPU_{10}H_8+CPH_{18}$	$RU_{15}H_3+RU_{10}H_8+RH_{18}$
19	CTM	$CTh_6H_{13}+CTh_3H_{16}$	$CEU_{15}H_4+CEU_{10}H_9+CEH_{19}$	$CPU_{15}H_4+CPU_{10}H_9+CPH_{19}$	$RU_{15}H_4+RU_{10}H_9+RH_{19}$
.....					
.....					
.....					
36	CTM	$CTh_6H_{30}+CTh_3H_{33}$	$CEU_{15}H_{21}+CEU_{10}H_{26}+CEH_{36}$	$CPU_{15}H_{21}+CPU_{10}H_{26}+CPH_{36}$	$RU_{15}H_{21}+RU_{10}H_{26}+RH_{36}$
37	CTM	$CTh_6H_{31}+CTh_3H_{34}$	$CEU_{15}H_{22}+CEU_{10}H_{27}+CEH_{37}$	$CPU_{15}H_{22}+CPU_{10}H_{27}+CPH_{37}$	$RU_{15}H_{22}+RU_{10}H_{27}+RH_{37}$
38	CTM	$CTh_6H_{32}+CTh_3H_{35}$	$CEU_{15}H_{23}+CEU_{10}H_{28}+CEH_{38}$	$CPU_{15}H_{23}+CPU_{10}H_{28}+CPH_{38}$	$RU_{15}H_{23}+RU_{10}H_{28}+RH_{38}$

TABLE 4.2.2					
FLOW OF COSTS AND BENEFITS OUTLINE (40 YEARS)					
YEAR	TRAIL COSTS	THINNING COSTS	EXTRACTION COSTS	PROCESSING COSTS	REVENUE
39	CTM	$CTh_6H_{33}+CTh_3H_{36}$	$CEU_{15}H_{24}+CEU_{10}H_{29}+CEH_{39}$	$CPU_{15}H_{24}+CPU_{10}H_{29}+CPH_{39}$	$RU_{15}H_{24}+RU_{10}H_{29}+RH_{39}$

NOTATION FOR TABLE 4.2.2

CTO = Costs of Trail Openning. Costo de apertura de trochas o caminos forestales

CTM = Costs of Trail Maintainance. Costo de mantenimiento

CEH_i = Costs of extraction of products obtained from strips (Fence Poles, Utility Poles, Sawmilled Timber) harvested in year ***i***.

CPH_i = Costs of processing products obtained from strips (Fence Poles, Utility Poles, Sawmilled Timber) harvested in year ***i***.

RH_i = Revenue of selling production obtained from strips harvested in year ***i***.

CTh_jH_i = Costs of thinning ***j*** years after harvesting in year ***i***. Costos de raleo "j" años después de cosechar en el año "i"

CEU_jH_i = Costs of extraction of roundwood to be used as utility poles ***j*** years after harvesting in year ***i***.

CPU_jH_i = Costs of producing utility poles ***j*** years after harvesting in year ***i***.

RU_jH_i = Revenue of selling utility poles produced ***j*** years after harvesting in year ***i*** .

It is also necessary to highlight the difference between actual production and the ex-ante estimates. As we can see in Table 4.2.1, five strips harvested in 1991, with a total extension of 4 ha yielded a total output of 141.2243 m^3 of timber, which means c. 35.31 m^3/ha[16] while of the project designers expected a total output of at least 240 m^3/ha (Hartshorn, 1989; Hartshorn et al. c. 1986). As mentioned before (section 4.1) they expected 150m^3/ha to produce sawmilled timber and 90 m^3/ha to produce preserved poles. The experience showed that the overall production of five strips (c. 4 ha) was hardly over 70.8142 m^3 of sawmilled timber, i.e., 17.70 m^3/ha which means almost no difference from conventional selection logging; and 70.41 m^3/ha of preserved poles, i.e., 17.60 m^3/ha.

Altogether, these results question severely the attainment of one of the ecological goals of the experience, since the use of the biomass was far from being maximised as expected by the project designers. Nevertheless, these finding have to be taken carefully because of a series of reasons involving a dubious accuracy of the data observed in primary references. Our experience in the Palcazu valley showed us that the collection of data on production, costs and prices was not done in a systematic fashion. For instance, Table 4.2.1 shows highly disproportionate figures for sawmilled timber produced in strip 3 relative to the volume produced in strips 1 and 2. In addition, the volume of sawmilled timber corresponding to strip 4 and 5 is a default value, since that information was not available and hence was estimated as a residual of total sawmilled timber production, 70.8142 m^3 (See Appendices) and the

[16] Some reports, though estimate an average output of 45 m3/ha4.

volume produced in the rest of the strips.

Additional problems of lack or inconsistence of information had to be overcome in order to arrive at the results we are now presenting, and this is to be borne in mind when discussing our findings. Two individual strips (numbers 2 and 3, see Table 4.2.1) show a high level of total production (considering all these products). Strip 1 produced 55.9586 m^3 in a extension of 1.32 ha, which means 42.3929 m^3/ha (close to the level of production reported by personnel of FPCN), and strip 2 yielded 38.1513 m^3 in 1.05 ha, i.e., 36.3346 m^3/ha. These results are quite encouraging, since they do represent a dramatic departure from the maximum 15 m^3/ha extracted under predominant selective logging practices in the Amazon.

Based on the information we collected and the modified intervention schedule discussed in the previous section, we have prepared a projection of costs and benefits which will lead us to calculate NPV of single and multiple rotation schemes.

Table 4.2.2 shows the outline of the different components of total costs. Trails costs are the cost of building and maintaining roads and trails connecting the blocks of strips to the processing centre. These costs are based on information provided by INADE-APODESA (1990: 129) and are only rough estimates. The cost of opening trails is denoted CTO and the cost of trail maintainance is represented by CTM.

The next component refers to costs of thinning the trees in order to help the regeneration process of the strip[17]. Thinnings in years 10 and 15 are designed to help the regeneration process and simultaneously to extract and produce utility poles of .25 m^3 volume each. These costs are denoted CTh_jH_i, i. e., cost of thinning in year j after having harvested in year i.

Another component is related to extraction costs, which have been separated from processing costs. As can be seen in Tables 4.2.3 and 4.2.4, the cost of extracting timber from 4 ha was $14,877.59, which corresponds to 60.41% of total production costs, which in turn amounted to $24,628.79, i.e., $6,157.2/ha. These costs are denoted CE.

It's revealing that these costs amount to $105.35/$m^3$ while other enterprises being held in the vecinity of the Palcazu valley show extraction costs of $22.91/$m^3$ [18]. This difference is alarming and gives rise to a diverse set of speculations about COFYAL's operations, relative to management capacity, costs accounting, inadequate use of the equipment, or even to think that the geographical conditions in the Palcazu valley constitute an insurmountable limiting factor to any kind of forest mangement.

[17] As mentioned before we have ruled out any production from these two interventions.

[18] This is the case of INFOMAR, a private enterprise owned by one of the most distinguished forestry entrepeneur, Mr. Fernando Razetto, who is also President of the National Forestry Chamber.

The next column, Processing Costs, includes all the costs incurred in processing each type of product. the detailed figures are presented in Appendices. These costs are denoted CP.

TABLE 4.2.3

SUMMARY OF TOTAL COSTS (US$) OF EXTRACTION AND PROCESSING FROM PALCAZU'S STRIPS, 1991.

	Unit Cost (US$/m^3)	Production (m^3)	Cost of Production (US$)	Fix Cost (US$)	Variable Cost (US$)	Unit Cost (US$/m^3)
Extraction	105.35	141.2243	14,877.50	6,181.23	8,696.36	105.35
Processing:						
Sawmilling	62.22	70.8142	4,406.01	2,899.73	1,506.28	62.22
Utility Poles	84.77	50.7500	4,302.19	3,767.43	534.76	84.78
Fence Poles	53.06	19.6601	1,043.00	913.36	129.65	53.05
Total Cost of Production =			24,628.79			
Cost of Production per m^3 =			174.40			

TABLE 4.2.4

COFYAL'S COSTS OF PRODUCTION INTERNALISING COSTS OF EXTRACTION AND PROCESSING OF TIMBER, 1991.

	Unit Cost (US$/m^3)	Production (m^3)	Cost of Production (US$)	Fix Cost (US$)	Variable Cost (US$)	Unit Cost (US$/m^3)
Sawmilling	62.22	70.8142	11,866.09	7,809.42	4,056.67	167.56
Utility Poles	84.77	19.6601	9,648.56	8,449.25	1,199.32	190.12
Fence Poles	53.05	19.6601	3,114.14	2,727.05	387.09	158.40
Total Cost of Production US$ =			$24,628.79			
Cost of Production per m^3 ($24,561.91/141.21) =			$174.39			

The last column represents the gross revenue obtained from selling the production from the strips harvested and from the thinning activities (years 10 and 15 after the main harvest).[19] The total revenue of harvesting 5 strips in 1991 was $26,020.90. The net benefit was $1,392.11, i.e., $348.03 per hectare. This net benefit is not surprisingly high but it is significantly higher than the net benefit reported by the owner of INFOMAR (see footnote 18) which amounted to -$34.57 in 1989. The circumstances have two main similarities: first, both enterprises are located in comparable areas; secondly, they were both at the begining of their respective operations.

The whole range of information listed above has been used to build COFYAL's costs and benefits flow as a projection based on the 1991 operations (See appendices). This flow is shown in a more concise way in Table 4.2.5, where we can calculate a Net Present Value (NPV) of $ 4,722.20 for a single rotation scheme, and $ 4,681.06 for a multiple rotation scheme given a discount rate to 10%. We obtain an Internal Rate of Return (IRR) of 21.53 %, as shown in Table 4.2.6.

The Cost Benefit Analysis indicates that the Strip Shelterbelt System as it was carried out by COFYAL during 1991 is profitable. The volume produced is, however less encouraging. As we mentioned before, the use of forest biomass to produce sawmilled timber is hardly greater than the volume used by conventional loggers.

Nonetheless, if we take the overall production for all the types of products, then COFYAL's operations would be closer to the goals stated by the original designers of the Palcazu System.

Since the Cost Benefit Analysis (CBA) depends crucially on the estimates of regeneration of the strips (which constitute the raw material for the economic activity), the volume of production actually sold, the prices of the different products (expresed as a Price Index)[20], and the extraction and processing costs, we have carried out a Sensitivity Analysis of COFYAL's profitability to changes in total level of production actually sold, unit variable cost of production, and the Price Index. The results are shown in Table 2.4.7.

TABLE 4.2.5

COFYAL'S COSTS AND BENEFITS FLOW (US$), c 4 ha, 1991.

Year	Total Costs (US$)	Revenue (US$)	Profits (US$)
0	29,628.79	26,020.90	1,392.11
1	25,128.79	26,020.90	1,392.11
2	25,128.79	26,020.90	1,392.11
3	25,350.79	26,020.90	1,170.11
4	25,128.79	26,020.90	1,170.11
5	25,572.79	26,020.90	1,170.11

[19] All prices have been mentioned in section 4.1 and can be found in the Appendix.

[20] This Price Index was calculated using weighted average of prices, and is equivalent to $184.25/m^3.

TABLE 4.2.5			
6	25,572.79	26,020.90	948.11
7	25,572.79	26,020.90	948.11
8	25,572.79	26,020.90	948.11
9	25,572.79	26,020.90	948.11
10	35,221.40	36,170.90	1,449.55
11	35,221.40	36,170.90	1,449.55
12	35,221.40	36,170.90	1,449.55
13	35,221.40	36,170.90	1,449.55
14	35,221.40	36,170.90	1,449.55
15	44,869.90	46,320.90	1,950.98
16	44,869.90	46,320.90	1,950.98
17	44,869.90	46,320.90	1,950.98
18	44,869.90	46,320.90	1,950.98
19	44,869.90	46,320.90	1,950.98
20	44,869.90	46,320.90	1,950.98
21	44,869.90	46,320.90	1,950.98
22	44,869.90	46,320.90	1,950.98
23	44,869.90	46,320.90	1,950.98
24	44,869.90	46,320.90	1,950.98
25	44,869.90	46,320.90	1,950.98
26	44,869.90	46,320.90	1,950.98
27	44,869.90	46,320.90	1,950.98
28	44,869.90	46,320.90	1,950.98
29	44,869.90	46,320.90	1,950.98
30	44,869.90	46,320.90	1,950.98
31	44,869.90	46,320.90	1,950.98
32	44,869.90	46,320.90	1,950.98
33	44,869.90	46,320.90	1,950.98
34	44,869.90	46,320.90	1,950.98
35	44,869.90	46,320.90	1,950.98
36	44,869.90	46,320.90	1,950.98
37	44,869.90	46,320.90	1,950.98
38	44,869.90	46,320.90	1,950.98
39	44,869.90	46,320.90	1,950.98

TABLE 4.2.6	
PROFITABILITIY INDICES	
NPV of Single Rotation	$ 4,722.20
NPV of Multiple Rotation	$ 4,681.06
IRR Single Rotation	21.53%

÷4/ha
÷4/ha

Assuming that the total volume sold (and produced) rise in 10%, the NPV for the single rotation (NPV SR) would increase from $ 4,722.20 to $ 5,194.39 for a programme that would open 4 ha strips each year along 40 years and would follow a schedule of interventions as shown in Table 4.1.1. Similarily, if the annual production were reduced in 10%, the NPV for a single rotation would decrease to $ 4,249.95. As can be observed in Table 4.2.7, the profitability indices do not change dramatically as a result of a change in the annual production from the strips from -20% to +20%. This is true for single and multiple rotation schemes. Δ en x×ν no produce variaciones sustanciales en rentabilidad

Unlike the change in annual production, the indices vary dramatically in response to movements in the unit price of products and unit costs of production. For instance, a reduction of 10% in the price index would imply a substantial reduction in the NPV of either scheme of rotation, from some $ 4,700 to some $ -26,600. Simetrically, an increase in 10% would induce an important rise in the NPV to $ 36,000 under either rotation scheme.
Δ en P sí tiene implicancias sensibles en rentabilidad: ↓ 10% P ⇒ VPN_0 = 4.7K ⇒ -26.K, ↑10% 4.7K→36K

The analysis apply in an analogous way to the change in unit cost. However, we have to state that the results have to be considered tentative for the case of changes in costs, because no information was availabe to allow for a thorough disaggregation of constant unit costs from variable ones.

We tried, instead, to analyse the sensi~~bility~~tivity of the outcomes to changes in extraction costs, which, as already mentioned, were found extraordinarily high relative to those of other enterprises operating in similar regions. The results suggest that if extraction costs were reduced to normal levels (from $ 105.3/m^3 to some $ 25/m^3), the NPV for single and multiple rotation scheme will rise up to over $ 137,000.

Se hizo "sensibilidad" de Δ en costos de extracción ($105.3/m³ a $25/m³) y el resultado fue sorprendente: VPN > $137,000 !!!

⇒ Costos de extracción debían ser un punto central de la gestión.

TABLE 4.2.7		
SENSITIVITY ANALYSIS COFYAL, 1991		
Changes in Variables	**Changes in Profitability Criteria (r = 10%)**	
Annual Production	**NPV SR**	**NPV MR**
-20%	$3,777.74	$3,736.59
-10%	$4,249.95	$4,208.81
+10%	$5,194.39	$5,153.24
+20%	$5,666.60	$5,625.46
Product Price		
-20%	$-57,958.90	$-58,000.05
-10%	$-26,618.37	$-26,659.51
+10%	$36,062.71	$36,021.56
+20%	$67,403.24	$67,362.10
Unit Cost		
-20%	$66,458.84	$66,417.69
-10%	$35,590.52	$35,549.38
+10%	$-26,146.11	$-26,187.26
+20%	$-57,014.43	$-57,055.57

5. CONCLUSIONS

From a theoretical point of view, the findings of the dissertation call for a revision of the consensual opinion that no sustainable management of Amazonian forests is possible. The financial results were drawn on the basis of purely private analysis and they seem to support the idea that income levels can be improved while increasing the use of forest biomass.

Another interesting outcome is that the standard forestry economics can be conveniently extended in order to capture the essence of forestry use even in such complex environments as Amazonia, and help to cope with the analysis and the design of possible solutions to the problem of using them in a sustainable fashion.

The practical implications concern the assessment of the ex-ante estimates of the Strip Shelterbelt System as forecasted by the original designers, and the ex-post evaluation of the System as put into practice by the Yanesha Forestry Cooperative.

The findings of the ex-ante evaluations indicate that the original management plan's profitability would have been improved had some basic economic criteria been applied. This weakness is evident when the plan of silvicultural interventions delays the main harvest until the last year of the rotation cycle (year 40). By so doing, the present value of the profits from the main harvest are spectacularly reduced. That silvicultural proposal also suggests the production of small fence poles from interventions in years 3 and 6. We found that this was not sensible from an economic standpoint.

From the data on production in 1991, it became evident that the projection of 150 m^3/ha of sawmilled timber and 90 m^3/ha of roundwood for preserved poles were excessively optimistic. The overall production from 4 ha hardly exceeded the 70m^3 of sawmilled timber (17.7m^3/ha). The figures are quite similar for the actual production of roundwood for fence poles.

These weaknesses are, however, understandable if we consider the fact that, by the time when the projections were produced, no comprehensive knowledge existed of the dynamics of the forest in the Palcazu valley, and that it was really an innovative approach to the use of forestry resources in the Amazon. Neither had the economic analysis been given the importance it is receiving now as an essential component of the sustainability of develpoment projects.

The main ex-post evaluation results are relative to the profits yielded by the 1991 operations (the only year when the System was applied effectively), namely $ 1,392 from harvesting some 4 ha, i.e., $ 348/ha. On the basis of these figures, we projected a flow of costs and benefits and found a NPV of profits about $ 4,700 for single and multiple rotation schemes, given a 10% discount rate. The IRR was calculated in 21.53%.

These are good financial indicators indeed, and can support the promotion of similar experiences of sustainable forestry management in the region. We must insist that these indicators were produced by a conventional Cost Benefit Analysis, i.e., taking account only of private costs and benefits, collected and processed from actual data from the archives of COFYAL, and the institutions and individuals who were more closely connected to the

4.3) Sensibilidad alta ante Δs en P y CT y GE (muy elevados en comparación con empresas vecinas)

cooperative.

The sensitivity analysis shows a high degree of reaction of the profitability indices as a result of changes in prices and total costs. The results show also a strong response of the indices to changes in the extraction costs, which happened to be for COFYAL rather greater than those reported by other entrepreneurs operating in similar areas.

Abandonment of the CSRMP project does not mean that the efforts of were in vain. The assessment demonstrates that a wider range of timber species, usually ignored by loggers in the western Amazon, can indeed be recovered, manufactured, and sold at advantageous conditions.

Although we have made no mention in the text of the regeneration taking place in the demonstration strips cut early (1985 and 1986), some reports (Pariona, 1992) give evidence that the production and harvesting scheme is biologically feasible.

A broader economic analysis, would take into account the value of wild game as a source of protein for the Yaneshas, given that their hunting success appears to be enhanced by the periodic opening of small clearings, such as the harvested strips. Similarly, the value of medicinal plants should require a special attention to take account of the benefits of the sustainable use of forests. In this respect, late news from the Palcazu valley assert that the Yaneshas are being paid $ 2.22/kg for a medicinal plant known as *uña de gato*, uncaria tomentosa, twice as much as the price paid in Lima. This product is now a 'boom' in Peruvian markets, and is receiving much support from the academic community.

4.6) Un análisis económico del uso potencial del bosque más amplio incluiría el valor de la fauna silvestre como fuente de proteína (barbecho); de las plantas medicinales

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7. APPENDICES

PALCAZU STRIPS' TOTAL PRODUCTION, 1991 (m3)			
Sawmilled Timber (m3)	Utility Poles (m3)	Fence Poles (m3)	Total Production (m3)
70.8142	50.7500	19.6601	141.2243

EXTRACTION COSTS (US$) FROM PALCAZU'S STRIPS, 1991						
		Strip Number				
Inputs	**1**	**2**	**3**		**4 and 5**	
Labour	1,355.560	1,703.700	674.070		770.370	
Diesel	275.760	267.880	172.045	(1)	104.000	
Gasoline	184.250	135.760	34.920		162.910	
Oil	146.670	120.000	20.000		53.330	
'Bueyes'	290.280	373.920	236.160			
'Winche'	882.040	845.630				
Lorry	1,000.000	2,400.000				
'Cargador frontal'	181.820	424.240				
Total	4,316.380	6,271.130	2,002.030	(2)	2,288.050	(3)
Total Costs of Ectraction: US$		14,877.590				
Notes:						
(1) This value has been estimated by setting variable costs (Labour, Diesel, Gasoline, and Oil) equal to 45% of total costs in this strip ($ 2,002.030)						
(2), (3) These figures are rough estimates. The cells in blank account for information which was not available. Therefore, total costs for strips 3 and 4&5 are more than the sum of the numbers in the corresponding column. We have estimated total costs of these strips by multiplying the corresponding labour costs by a coefficient obtained from dividing total cost by labour cost in strip 1.						

COFYAL'S SAWMILLING COSTS (US$), 1991		
	US$	%
Fixed Daily Costs	16.96	65.81%
Variable Daily Costs	8.81	34.19%
Total Dailiy Costs	25.77	100%
Daily Total sawmilling costs / Daily output = $ 25.77 / 0.41418 m3		
Sawmilling Cost per m3 =	$62.21932	
Fixed costs = 65.8129 % = $ 40.94653774 / m3		
Variable costs= 34.1482 % = $ 21.27278719 / m3		

COFYAL'S PRODUCTION COSTS (US$) OF UTILILTY POLES, 1991		
Item	**Cost ($)**	
Operation Costs	88,813.9000	(1)
Financial	6,150.6800	
Depreciation	4,789.4200	
General Costs	3,050.0000	
Annual Average Investment	3,161.2700	
Total Production Cost Of Utility Poles (US$)	105,965.2700	
Total Annual Production of Utility Poles (m3)	1,250.0000	(2)
Cost of Production of Utility Poles (US$/m3)	84.7722	
Notes:		
(1) Operations Costs differ from those stated by other authors (Farfan, FPCN) because we are discounting costs of extraction.		
(2) Total production of poles is greater that production of poles from strips. The latter amounts to 60% of the former.		

PRODUCTION COSTS (US$) OF FENCE POLES, 1991				
Assume price = costs = US$ 53.05 / m3				
Fix costs: $ 46.455777037				
Variable Costs: $ 6.59422963				

COFYAL'S VOLUME OF SALES OF FOREST PRODUCTS, 1991 (m3)							
	Exports	National	Local	In Stock (1)	Total	Total Production	Balance
Sawmilled Timber	24.0720	11.4956	21.0842	13.7305	70.3823	70.8142	- 0.4319
Utility Poles		46.0000		4.7500	50.7500	50.7500	-
Fence Poles		11.3097		4.7312	16.0410	19.6601	- 3.6191
Notes:							
(1) This volume had not been sold when we collected the information, Jan 1993							

PRICES OF PALCAZU'S PRODUCTS, 1991 (US$)					
	Exports		**National**	**Local**	
Sawmilled Timber	427.603	(1)	135.593	88.983	
Utility Poles			200.000		
Fence Poles			53.05164		
			59.24099		
Notes:					
(1) Gross price paid by the buyer abroad was $ 508.47. A discount is needed to include					
transaction costs (taxes, broker's service).					
(2) Blank means that no ptransaction was carried out in that market for the					
corresponding product					

COFYAL'S VALUE OF SALES OF FOREST PRODUCTS, 1991 (US$)					
	Exports	**National**	**Local**	**In Stock (1)**	**Total**
Sawmilled Timber	10,293.2600	1,558.7200	1,876.1400	1,221.7800	14,949.9000
Utility Poles		9,200.0000		950.0000	10,150.0000
Fence Poles		670.0000		251.0000	921.0000
	10,293.2600	11,428.7200	1,876.1400	2,422.7800	26,020.9000
Notes:					
(1) This production had not been sold when we collected the information, Jan 1993.					