IUFRO Managerial Economics and Accounting

International Symposium

Socio-Economic Analyses of Sustainable Forest Management

Prague 15-17 May, 2013

http://sfm.fld.czu.cz

1.2 Methods that integrate functions

Cost-Benefit Analysis of Forestry Instruments

Patrice A. Harou, European Forest Institute (EFI), Observatory of European Forests (OEF), Nancy, France.

Dietmar Rose, Prof. Emeritus University of Minnesota, USA

Antonello Lobianco, Università Politecnica delle Marche, Ancona, Italy

Forests have been managed under the concept of multiple uses since the sixties. However, timber was supposed to pay for providing the non-market, ecological and social benefits. Today, in certain forests, non-timber products such as annual hunting fees dwarf timber income. In the future, non-timber ecological and social services could find markets also. We want to transit toward a more sustainable economic development. Should we speed up the transition process by offering public incentives to reward owners for providing goods and services for which they may not be rewarded financially today but for which a market could appear or be created in the future? A method for tailoring possible forest instruments for this transition period will be presented and the way to operationalize the method discussed. The method relies on the dual financial and economic analyses of forest investments.

Keywords: cost-benefit analysis, environmental valuation, social valuation, forestry instruments

Patrice Harou 8 rue Baron Louis Nancy 54 000 France ; patrice.harou@efi.int

Dietmar Rose 6624 High Ridge Pl NE, Albuquerque, NM 87111, USA; dwrose@comcast.net

Antonello Lobianco. Dipartimento di Scienze Economiche e Sociali, Università Politecnica delle Marche P.le Martelli 8, 60131 Ancona, Italy. a.lobianco@univpm.it

Introduction

The analysis of forest investments has become more challenging as the various demands on the forest resources are evolving and the environmental and socio-economic contexts are changing rapidly. Reflecting on the new socio-environmental values of forest investments, a question arises: should forest investments benefit from special help while new values are not yet marketed?

Forests have been managed under the concept of multiple uses since the seventies. However, timber was supposed to pay for providing the non-market, ecological and social benefits. Today, in certain forests, non-timber products such as annual hunting fees dwarf timber income. In the future, non-timber ecological and social services could find markets also. We want to transit toward a more sustainable economic development. Should we speed up the transition process by offering public incentives to reward owners for providing goods and services for which they may not be rewarded financially today but for which a market could appear or be created in the future?

An approach is proposed in this paper to decide on the necessity of forest investment instruments in Europe after reviewing the basic concept of the benefit-cost analysis of investments in general and of forest investments in particular. A new tool to systematize the approach is then presented with an application example.

Cost-Benefit Analysis

Cost-Benefit Analysis (CBA) simply said is the comparison of the advantages and disadvantages of a certain course of action which could be a new investment, project or policy. The History of CBA goes back to the French engineer and economist Jules Dupuit and was popularized by the US Army corps of Engineers for water projects initially (see box).

Box 1: History of CBA

> The concept of CBA dates back to an 1848 article by Jules Dupuit and was formalized in subsequent works by Alfred Marshall. The Corps of Engineers initiated the use of CBA in the US, after the Federal Navigation Act of 1936 in the US effectively required cost–benefit analysis for proposed federal waterway infrastructure (History of Benefit-Cost Analysis, Proceedings of the 2006 Cost Benefit Conference http://home.gwu.edu/~scellini/CelliniKee21.pdf). The Flood Control Act of 1939 in the US was instrumental in establishing CBA as federal policy. It demanded that "the benefits to whomever they accrue [be] in excess of the estimated costs".

CBA compares the costs and benefits of different courses of action duly accounting for the opportunity costs of the inputs used in the context of a marginal or *with-without analysis*. It identifies the choices that maximise welfare from an utilitarian perspective and so doing be Pareto efficient action, one that makes some better off and nobody worst off.

Recognising all future costs and benefits of a given course of action has become risky and uncertain in today´s world, this is especially the case for forest investments that span over decades and even centuries. This brings the question of the value of time which links with all the debates about the proper discount rate to use. Forest investments are also peculiar in that they are characterised by frequent externalities and option values.

A number of classical references dating to the 60-70s introduce the classical CBA. Mishan (1973) is the most often quoted academic. For the practitioners the OECD and UNIDO guidelines brought the application of CBA to the economic development field. More recently, and specifically for Europe, the 2008 *Guide to Cost-Benefit Analysis of Investments Projects* (http://ec.europa.eu/regional_policy/sources/docgener/guides/cost/guide2008_en.pdf) is particularly relevant to explain the approach to decide on public forestry investments and instruments by the European Commission to the Regions.

Cost-Benefit Analysis in Forestry

The literature on CBA as it relates to Forestry is not extensive even if the cash flow type of analysis is found in the forest economics literature since practically the time of Dupuit. More recently the forest economics literature has enthusiastically followed the environmental valuation field to attempt valuing the numerous non-timber and non-market goods and services derived from the forest.

The first manual to guide public forest investment in forestry using the CBA dates back only to 1979 with the FAO Forestry Paper No 17, titled *Economic Analysis of Forestry Projects*. The FAO Manual was one of the most frequently quoted and used in that Forestry Paper collection. In those days, the environmental dimension of forest investments was not considered as important as today. The manual does not cover at all the environmental valuation of the non-market goods and services provided by the forest cover. It discusses the social and developmental dimensions of these investments.

A book, *Essays in Forestry Economics: Appraisal and Evaluation of Forestry Investments, Programs and Policies* (Harou, 1987a), covers some specific topics related to the use of CBA in the forestry sector such as the social discount rate, the shadow exchange rate and the shadow price of labour. The environmental values such as the value of biodiversity and fuelwood shadow prices are introduced in the investment analysis of forestry investments. It also introduces the notion of equity in forestry project appraisal.

More recently, the Observatory for European Forests of EFI has undertaken the elaboration of different working papers related to the CBA in forestry in its program of Microeconomics. In the future, these different working papers will serve as material to prepare a Manual on CBA in forestry.

In order to present the approach followed to decide on the needs of instruments to incentivise forest investments, let´s define some terms which will be used in the following section of the paper. The first aspect to clarify is the point of view from which the investment is prepared. The analysis of an investment can be made from different points of view: a private concerns such as a forest landowner or an industrialist or a public concern such as a commune or the forest service of a country. The CBA concerns typically public investments. These investments costs and benefits are seen from Society´s point of view and typically do not include taxes and incentives considered as transfer payments. They used the social discount rate and not the opportunity cost of capital prevalent in the sector. They used the true opportunity costs of the inputs and outputs used in the project often referred to as shadow price by opposition to the market prices used for private investments.

As in the FAO guidelines, we will call the private investment analysis a *financial analysis* by opposition to the same investment made from the point of view of Society which we will call an *economic analysis*. The economic analysis is what is understood as Cost-Benefit Analysis and is covered in public finance literature. The financial analysis is part of the broad field of finance by opposition to the accounting field. The mechanic of the calculation of the profitability of the forest investments made in the financial and economic analyses are

identical. The prices, discount rates and transfer payments marks the differences between the two cash flows of a same investment. Differences are also more trenched when we consider the environmental and social dimensions of the forest investments. The economic analysis will have to incorporate to a larger degree many of the new elements brought by the environmental and social impacts assessments.

Instruments for Private Forests

In this paper, the decision on public forest investments is tantamount to the decision to provide public instruments for the private sector or not. In Europe, where an important part of the forest area is privately owned, most countries offer some kind of instruments to help forest long term investments. It is in this perspective that we refer to public instruments for forestry. In the case where forests are owned by the State partially or completely as in Russia and Canada, the problem becomes one of general public investments. CBA has been designed especially for public decisions. However, we will see in a moment that in addition to the economic analysis of public investments, the financial analysis of the private investors is also relevant to decide on the necessity to provide incentive to guide forest investments in the proper direction required for a greener economy.

The approach is simple to explain in theory but more difficult to apply in practice for the forestry sector. The approach consists in analysing a standard private investment in a given region susceptible to benefit from a public help from both a financial and economic analysis. First, the analyst will have to show that the financial profitability from managing the private property in a certain way desired by Society is not possible. In a second step, the analyst will have to clearly demonstrate that the type of forest management desired by Society is economically profitable. If indeed the financial analysis is negative but the economic analysis positive, an argument exists to eventually use an instrument to entice the private landowner to follow the forest management desired by Society.

To be efficient, an economic instrument will have to help the private owners so that she just breakeven in the financial analysis. Any amount of money transferred over and above that breakeven point would be inefficient from an economic standpoint. It would not be Pareto optimum.

The EC CBA Guide (EC 2008)suggests the same approach to decide if the European Investment Bank for instance should help financially some private investments that could generate positive green growth. The approach described above is summarized in figure 1 below.

Figure1 Steps in deciding to invest under EU funding

1. Context Analysis and Project Objectives
2. Project identification
3. Feasibility and option analysis
4. Financial analysis
5. If NPVf greater than zero: no EU investment
6. If NPWf is lower than zero perform an economic analysis
7. If NPWe is lower than zero: no EU investment
8. Il NPWe is positive. Eventual EU funding
9. If the sensitivity analysis and risk assessment is acceptable invest

The approach proposed to decide on the necessity of public expenditures to help private forestry follows the same logic. A guide to help prepare the terms of references for analysing forestry project has been prepared by EFI (Snowdon and Harou, 2013) and distinguishes similar steps listed in Figure 2.

Figures 2 Steps to present the appraisal of forestry investments

1. Define the issues, the rational for actions and objective
2. Identify options
3. Identify costs and benefits of selected options
4. Make tax and subsidy adjustments
5. Adjust costs and benefits for future changes in values and prices
6. Identify risks and uncertainty
7. Assess distributional impacts

The steps are similar than for the EU guidelines but more effort is made to adjust for environmental externalities, risks and social impact of forestry investments before comparing the financial and economic analyses of the same investment.

Shadow pricing forestry projects can be a difficult task. We will not cover these aspects here, they can be found elsewhere (Markandya et al.2001). The first step is to define the scope of Society: a commune, country or Europe (Harou, 1987b). Shadow pricing consists in finding the proper opportunity costs of using the inputs and the benefits derived from all aspects of the standing forests in addition to its timber and non-timber products. For forestry the discount rate and labor costs are important elements that vary the profitability of forest investments especially in small scale forestry and the differences between the financial and economic analysis of a project. National Governments often will provide these values to the analysts since it implies a value judgement that the analyst is not entitled to make. For non-market values, a data base of previously estimated values could be useful to ease possible value transfers (Stenger et al. 2009 and Cost E 45, 2012)

Many different instruments are used in forestry (Cubbage et al. 2009). The instruments we are more concerned with here are the economic instruments but the command and control options and extension activities may be better instruments depending on the context. Each and every of these instruments involve a cost from the public treasury. So the benefits of these public expenditures need to be assessed to justify the budget of forest institutions to their finance ministries. How to prepare these analysis in a systematic way is the purpose of the following section

CBA and Database on Forest Investments

To provide forest instruments with public financing for a greener economy, we said the financial analysis needs to show negative returns while the economic analysis should show a positive return to Society. To obtain information to assess the profitability of private investments is not easy. To facilitate the task an open-source software has been developed to record and store these cash flows and create a data base with the underlying biophysical and prices information, both market and shadow prices. Such a system would be particularly important also to monitor these public expenditures since the forestry sector as well as many other sectors of the economy are in increasing flux derived from the globalisation and climate change among others. This has an impact on the economics of the forestry sector and forest investments (Harou et al 2013).

Two software are being prepared to facilitate that task. One of which is a web based software, FInWEB, *Forest Investment Web Application* (Lobianco, 2013). The other is a computer base software with the same capability and outputs. Both are derived from the software CASH (Rose, 1994). They are generic cash flow and sensitivity analysis programs. Both will be downloadable from the EFI website shortly.

FInWeb is an online version of the cash flow software described by Rose (1994). The idea behind the web version is that while forest professionals can use it to pursue their own needs of evaluating a forest investment, the structured information they fill can at the same time be used to build a public database of forest investments. In that way, typical forest costs and benefits could be compared across regions and species.

In order to achieve this objective, an editorial workflow has been set that while allowing users to immediately receive a feedback on the profitability of their investment project, the information feeds the public repository only after editorial approval.

Profitability indicators are given for both financial and economic analysis. A distinctive characteristic of FInWeb is its full transparency over the computations of the outputs. For each variable, users are exposed with a first “descriptive” level that can then be deepened up to the source code that actually generates the variable.

FInWeb, currently in private testing status, will soon be accessible through a web browser from the EFI web site and will require users to register. Once registered, users can either start a new forest investment project from scratch or clone an existing public project and perform over them their own modifications. Within the newly created or cloned project, they are asked to provide project specific information (e.g. species, location, currency and discount rate) as well as any activities that generate a positive or negative cash flow during the project life.

Among the project information users can specify if they want to keep their project private or leave the default option of making it public. In either cases, while they receive an immediate feedback on the project profitability, the project would require an editorial approval before becoming public and entering the data base.

Computation is done in real terms. It does not consider inflation and use a real discount rate. It assumes that each future cost or revenue will be proportionally impacted by inflation. However, to account for possible relative price increases, users can specify a rate of increase for relevant activities.

Each cash flow activity can span different time periods on which different quantities or price can be specified so to avoid duplications when entering the information. If a project needs to be modified, a new revision will be made. Revisions allow comparing different versions of the project, hence representing a simple way to test the importance on profitability of various components of the project itself.

The main financial indicators of the investment (Net Present Value, Equivalent Annual Income, Soil Expectation Value, Benefit-Cost Ratio, Internal Rate of Return) are provided for both the financial and economic analysis. To help the forest professionals to correctly judge the investment, the output is completed with a cash flow table that details for each period the individual and cumulative cash activity of the investment (total and by activity). Two sensitivity analysis tables are produced. One highlights the importance of each individual activity to the overall project profitability. The other shows the influence of the discount rate on profitability of long term forest investments. The revision system itself is a way to implement a sensitivity analysis over *any* characteristic of the project.

The construction of the data base is an important feature of FInWEB. While providing structured information for their own project, users contribute with a bottom-up approach to the building of a public repository of forest investment information. The key element here is the *structured* level of the information. To each forest project is assigned a given location trough a point-and-click visual map from which, trough reverse geo-coding, the country and region are determined. Projects can be tagged with up to five species. Individual activities are free-tagged. This information can then be used to browse projects by species and country, compare activities and compute averages values.

Users can directly contact the author of the investment analysis on the system and leave a comment on their projects. Borrowing from the experience of internet blogs and forums, each project can be seen as the first post of a new thread over which a discussion on the project can develop.

While still roughly implemented and not the primary goal of this project, the possibility of cloning existing projects, handling of projects-as-a-forum implementation and dividing users into different groups, all implement an idea of communities of practice within forest professionals. That community could be further expanded with successive projects.

An example

The original study attempts to compare the relative profitability of Pine Plantations in Aquitaine France and the South Brazil (Fereira 2013). Here we will refer only to the plantation of maritime Pine (Pinus Pinaster) representing an area of close to one million hectare in the South West part of France: Pine plantations in Aquitaine are well suited to sandy and acid soils with some water deficit. Soil varies from rendzimas limestone to podzolic soils. The mean annual temperature ranges from 11 to 14°C. Precipitation is well distributed all year around from 600 to 1.200 mm per year, with possibility of drought periods between spring and summer.

The example is for one hectare of standard characteristics and site index. The forest yield has been modeled using the Capsis platform http://capsis.cirad.fr/capsis/models and average 11 m3 per hectare and per year. The soil are poor but genetic improvements have allowed a doubling of the yield in the last fifty years

The financial and economic cash flows provided in annex will help us illustrate the approach discussed above and the software calculation and database construction explained in the precedent section.

The private forest owner considered here has an opportunity cost of capital of 3%. If she does not invest in the forestry plantation and sell the land, she can get a 3% on that capital.

The financial cash flow, CF1 in the annex, shows that the investment is not profitable (Figure3) at a 3% discount rate which corresponds to the landowner opportunity cost of capital. The internal rate of return is 2.6%, i.e. below the acceptable rate of return. In that case, the landowner could neglect forest management on that land as happens often on the small forest estates encountered in Europe. Note that in Aquitaine the medium property size of 8 hectare is well above the average forest area size of 3 hectares in France. The owner could also change the use of that land or sell it.

Figure 3. Profitability indicators for the financial analysis (CF1)

Variable	ir -1%	Value	ir +1%
Net Present Value (NPV)	605.508	-301.724	-938.312
Equivalent Annual Income (EAI)	23.7467	-13.6331	-48.3387
Soil Expectation Value (SEV)		-468.068	
Benefits-Costs ratio (BC ratio)		0.901421	
Internal Rate of Return (IRR)		2.62662 %	

If we want the owner to plant in order to supply the numerous forest products mills of the region, we will want to help the landowners to invest in their forests. An economic analysis of the same investment needs to be done now to gauge the profitability of the investment but from a societal standpoint this time. This analysis is found in the CF2 of the annex and now

the public investment is clearly profitable (Figure 4). The social discount rate is given at 2%. The difference between the two analyses resulted also from shadow pricing labor and carbon. Unemployment is high not only because of the ongoing economic crisis but is structural in the region. It was estimated that the true opportunity cost of the unskilled worker used in forest plantation could be half the wage paid in the private sector which is the minimum wage. In addition a value is attached to the fact that extra carbon is fixed by the plantation and is worth approximately €30/ha/year (Zhang, 2011 p.368).

Figure 4. Profitability indicators for the economic analysis (CF2)

Variable	ir -1%	Value	ir +1%
Net Present Value (NPV)	3283.08	1855.47	842.892
Equivalent Annual Income (EAI)	110.531	72.7674	38.0851
Soil Expectation Value (SEV)		3711.14	
Benefits-Costs ratio (BC ratio)		1.68772	
Internal Rate of Return (IRR)		4.20749 %	

The financial analysis has thus showed that the investment by the private owner is clearly not profitable in this case. However, from a Society stand point it is a good investment. Using this dual analysis, the analyst has build an argument to provide an instrument to entice forest investments by the private sector.

Which instruments to choose is another matter. As said earlier, a panoply of possible instruments exist. We have to choose the one that is most efficient, easy to manage and equitable. A CBA for each possible instrument has to be run and their NPV compared. The instrument with the highest NPV, *ceteribus paribus*, is retained.

A payment for fixing carbon has been found the most appropriate and efficient instrument in this case. A payment of € 30 per hectare and per year to fix the carbon on one hectare is proposed. It is the same value as used to shadow price carbon in the economic analysis. Using this shadow price for carbon as the incentive to the private forest owner, the financial analysis shows the investment profitable (figure 5 and CF3 in the annex).

Figure 5 Financial analysis indicators with a carbon payment of €30/ha/year (CF3)

Variable	ir -1%	Value	ir +1%
Net Present Value (NPV)	1355.47	342.892	-378.374
Equivalent Annual Income (EAI)	53.1585	15.4932	-19.4926
Soil Expectation Value (SEV)		531.932	
Benefits-Costs ratio (BC ratio)		1.11203	
Internal Rate of Return (IRR)		3.43379 %	

However, is this instrument, consisting in a payment of €30/ha/year for carbon fixing, efficient? To be efficient, the private forest investment in the financial analysis should just breaks even with the carbon payment and no more. Any payments over and above that point represent an inefficient transfer since it was not necessary to entice the private owner to

invest. It was fond that a carbon payment of half that amount, or €15/ha/year was just enough to break even. The instrument recommended is thus a payment for carbon of just €15/ha/year.

Figure 6. Financial analysis indicators with a carbon payment of €15/ha/year (CF4)

Variable	ir -1%	Value	ir +1%
Net Present Value (NPV)	980.487	20.5838	-658.343
Equivalent Annual Income (EAI)	38.4526	0.930055	-33.9156
Soil Expectation Value (SEV)		31.9319	
Benefits-Costs ratio (BC ratio)		1.00673	
Internal Rate of Return (IRR)		3.02575 %	

Conclusion

We have shown a simple approach to decide on the need for forestry instruments, the type of instruments and the amount of transfer needed to be efficient in administering the instrument chosen. A new web based software developed at OEF has been introduced to handle the dual financial-economic analysis of forest investments on which the approach is based. The approach has illustrated the usefulness of using the dual financial and economic analysis defined in the literature on public expenditure, public finance and CBA.

The Cash Flow approach is still very approximate in forestry. The production functions are difficult to quantify and subject to the vagaries of nature. Prices can change faster now as international trade expands. The sensitivity analysis built in FInWEB needs to be carefully considered and the sensitive variables analysed in more depth. The monitoring of the investments are crucial during the life of the project.

The Alternative Test to monitor forest investments is particularly relevant in an ever changing world (Harou et al. 2013). While one may think that one will never abandon a forest project after few years because most of the costs are incurred at the beginning of the project and only benefits have to be received in the future, in fact the situation is often more complex. If past costs are indeed sunk, the opportunity cost of the land can be changing suddenly with a change in policy or natural events making the abandonment of the forest use or the forest land a financial necessity.

Literature cited

Cubbage F., P.A. Harou and E. Sills. 2009 Policy. Instruments to enhance multifunctional forest management. J. of Forest policy and Economics.9 (7): 833-851

Rose D., 1994. A General Cash flow and sensitivity analysis- Cash-Version 5.1. University of Minnesota, Department of Forest Resources. Staff Paper Series No 94

EU, 2008. Guide to Cost Benefit of Investment Projects. 257p. http://ec.europa.eu/regional_policy/sources/docgener/guides/cost/guide2008_en.pdf

European Cooperation in Science and Technology. Action 45 EUROFOREX http://www.cost.eu/domains_actions/fps/Actions/E45

Gregersen H. and A. Contreras. 1979. Economic Analysis of Forestry Projects. FAO Forestry Paper No17. Rome, Italy. 193p.

Gittinger J.P. 1983. Economic Analysis of Agriculture Projects. Jhon Hopkins University Press Baltimore, MD. 503 p.

Harou, P. A. 1987a. Essays in Forestry Economics: Appraisal and Evaluation of Forestry Investments, Programs and Policies. Wissenschaftsverlag Vauk. Kiel Germany 195 p.

Harou P.A. 1987b. The European Context for Private Forestry Incentive Evaluation. Silva Fennica. 20(4): 366-372.

Harou, P. A., Chinlong Zheng and Daowei Zhang. 2013. The Alternative Test in Forestry. J. of Forest Policy and Economics. *in press*

Ferreira, Alan. 2013. Master Trainee Report. OEF Mimeo. A financial comparison of pine plantation in Aquitaine and the States of Parana and Santa Catharina Brazil. 35 p.

Lobianco, A. 2013. FInWEB Users Manual EFI-OEF Working Paper No 3 *in Preparation*

Markandya, A., P.A. Harou, L. Bellu and V. Cistulli. 2002. Environmental Economics for Sustainable Growth. Edward Elgar. Cheltenham, UK; Northampton USA.567p.

Mishan, E. J. and E. Quah. 2007 Cost-Benefit Analysis. 5th edition. New York: Routledge.

OECD, 1968. Manual on Industrial Project Analysis. Paris, France. 468 p.

Stenger, A., P.A. Harou and S. Navrud. 2009. Environmental Valuation for European Forests. Editorial of the Special Issue. J. of Forest Economics. 15(09): 1-5

UNIDO, 1972. Guidelines for project evaluation. UN NY. 383 p.

Zhang D. and Pearce P.H. 2011 Forest Economics. University of British Colombia University Press. 390 p.

Annex 1 Cash flow Aquitaine Plantation

Financial Analysis of a standard private hectare (i=3%) CF1

Activities	Unit	Periods															
		0	1	2	3	4	5	6	7	18	23	24	25	26	27	28	35
Costs																	
- Soil preparation	€/ha	-500.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
- Seedlings	€/ha	-500.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
- Pre thinning maintenance	€/ha	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
- Administrative and management cos	€/ha	0.00	-29.13	-28.28	-27.45	-26.65	-25.88	-25.12	-24.39	-64.61	-15.20	-14.76	-52.54	-13.91	-13.51	-13.11	-28.43
- Cost of land	€/ha	-1,250.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Period Costs		-2,250.00	-29.13	-28.28	-27.45	-26.65	-25.88	-25.12	-24.39	-64.61	-15.20	-14.76	-52.54	-13.91	-13.51	-13.11	-28.43
- economic analysis		-2,250.00	-29.13	-28.28	-27.45	-26.65	-25.88	-25.12	-24.39	-64.61	-15.20	-14.76	-52.54	-13.91	-13.51	-13.11	-28.43
Cumulative Costs		-2,250.00	-2,279.13	-2,307.40	-2,334.86	-2,361.51	-2,387.39	-2,412.52	-2,436.91	-2,772.75	-2,853.45	-2,868.21	-2,920.75	-2,934.66	-2,948.16	-2,961.28	-3,060.74
- economic analysis		-2,250.00	-2,279.13	-2,307.40	-2,334.86	-2,361.51	-2,387.39	-2,412.52	-2,436.91	-2,772.75	-2,853.45	-2,868.21	-2,920.75	-2,934.66	-2,948.16	-2,961.28	-3,060.74
Revenues																	
- Thinning 1	€/m3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	177.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00
- Thinning 2	€/m3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	308.06	0.00	0.00	0.00	0.00
- Clear Cut	€/ha	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1,829.34
- land sales	€/ha	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	444.23
Period Revenues		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	177.39	0.00	0.00	308.06	0.00	0.00	0.00	2,273.57
- economic analysis		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	177.39	0.00	0.00	308.06	0.00	0.00	0.00	2,273.57
Cumulative Revenues		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	177.39	177.39	177.39	485.45	485.45	485.45	485.45	2,759.01
- economic analysis		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	177.39	177.39	177.39	485.45	485.45	485.45	485.45	2,759.01
Period Net Revenues		-2,250.00	-29.13	-28.28	-27.45	-26.65	-25.88	-25.12	-24.39	112.78	-15.20	-14.76	255.52	-13.91	-13.51	-13.11	2,245.13
- economic analysis		-2,250.00	-29.13	-28.28	-27.45	-26.65	-25.88	-25.12	-24.39	112.78	-15.20	-14.76	255.52	-13.91	-13.51	-13.11	2,245.13
Cumulative Net Revenues		-2,250.00	-2,279.13	-2,307.40	-2,334.86	-2,361.51	-2,387.39	-2,412.52	-2,436.91	-2,595.36	-2,676.06	-2,690.82	-2,435.30	-2,449.21	-2,462.71	-2,475.83	-301.72
- economic analysis		-2,250.00	-2,279.13	-2,307.40	-2,334.86	-2,361.51	-2,387.39	-2,412.52	-2,436.91	-2,595.36	-2,676.06	-2,690.82	-2,435.30	-2,449.21	-2,462.71	-2,475.83	-301.72

Economic Analysis shadow pricing labor and carbon at €30/ha/year (i=2%) CF2

Activities	Unit	Periods													
		0	1	2	3	4	5	6	7	18	25	32	33	34	35
Costs															
- Soil preparation shadow price	€/ha	-250.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
- Seedlings shadow price	€/ha	-250.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
- Pre thinning maintenance	€/ha	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
- Administrative and management	€/ha	0.00	-29.41	-28.84	-28.27	-27.72	-27.17	-26.64	-26.12	-77.02	-67.05	-15.92	-15.61	-15.30	-40.00
- Cost of land	€/ha	-1,250.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Period Costs		-1,750.00	-29.41	-28.84	-28.27	-27.72	-27.17	-26.64	-26.12	-77.02	-67.05	-15.92	-15.61	-15.30	-40.00
- economic analysis		-1,750.00	-29.41	-28.84	-28.27	-27.72	-27.17	-26.64	-26.12	-77.02	-67.05	-15.92	-15.61	-15.30	-40.00
Cumulative Costs		-1,750.00	-1,779.41	-1,808.25	-1,836.52	-1,864.23	-1,891.40	-1,918.04	-1,944.16	-2,324.05	-2,508.76	-2,627.10	-2,642.71	-2,658.01	-2,698.01
- economic analysis		-1,750.00	-1,779.41	-1,808.25	-1,836.52	-1,864.23	-1,891.40	-1,918.04	-1,944.16	-2,324.05	-2,508.76	-2,627.10	-2,642.71	-2,658.01	-2,698.01
Revenues															
- Thinning 1	€/m3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	211.45	0.00	0.00	0.00	0.00	0.00
- Thinning 2	€/m3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	393.15	0.00	0.00	0.00	0.00
- Clear Cut	€/ha	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2,573.89
- land sales	€/ha	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	625.03
- carbon price	€/ha	0.00	29.41	28.84	28.27	27.72	27.17	26.64	26.12	21.00	18.29	15.92	15.61	15.30	15.00
Period Revenues		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	211.45	393.15	0.00	0.00	0.00	3,198.93
- economic analysis		0.00	29.41	28.84	28.27	27.72	27.17	26.64	26.12	232.45	411.43	15.92	15.61	15.30	3,213.93
Cumulative Revenues		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	211.45	604.60	604.60	604.60	604.60	3,803.52
- economic analysis		0.00	29.41	58.25	86.52	114.23	141.40	168.04	194.16	661.21	1,190.30	1,308.65	1,324.25	1,339.55	4,553.48
Period Net Revenues		-1,750.00	-29.41	-28.84	-28.27	-27.72	-27.17	-26.64	-26.12	134.43	326.10	-15.92	-15.61	-15.30	3,158.92
- economic analysis		-1,750.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	155.44	344.38	0.00	0.00	0.00	3,173.93
Cumulative Net Revenues		-1,750.00	-1,779.41	-1,808.25	-1,836.52	-1,864.23	-1,891.40	-1,918.04	-1,944.16	-2,112.60	-1,904.16	-2,022.51	-2,038.12	-2,053.42	1,105.51
- economic analysis		-1,750.00	-1,750.00	-1,750.00	-1,750.00	-1,750.00	-1,750.00	-1,750.00	-1,750.00	-1,662.84	-1,318.46	-1,318.46	-1,318.46	-1,318.46	1,855.47

Financial Analysis with Carbon payment of €30/ha/year CF3

Activities	Unit	Periods													
		0	1	2	3	4	5	6	7	18	25	32	33	34	35
Costs															
Soil preparation	€/ha	-500.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Seedlings	€/ha	-500.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
- Pre thinning maintenance	€/ha	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
- Administrative and managem	€/ha	0.00	-29.13	-28.28	-27.45	-26.65	-25.88	-25.12	-24.39	-64.61	-52.54	-11.65	-11.31	-10.98	-28.43
- Cost of land	€/ha	-1,250.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Period Costs		-2,250.00	-29.13	-28.28	-27.45	-26.65	-25.88	-25.12	-24.39	-64.61	-52.54	-11.65	-11.31	-10.98	-28.43
- economic analysis		-2,250.00	-29.13	-28.28	-27.45	-26.65	-25.88	-25.12	-24.39	-64.61	-52.54	-11.65	-11.31	-10.98	-28.43
Cumulative Costs		-2,250.00	-2,279.13	-2,307.40	-2,334.86	-2,361.51	-2,387.39	-2,412.52	-2,436.91	-2,772.75	-2,920.75	-3,010.02	-3,021.33	-3,032.31	-3,060.74
- economic analysis		-2,250.00	-2,279.13	-2,307.40	-2,334.86	-2,361.51	-2,387.39	-2,412.52	-2,436.91	-2,772.75	-2,920.75	-3,010.02	-3,021.33	-3,032.31	-3,060.74
Revenues															
- Thinning 1	€/m3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	177.39	0.00	0.00	0.00	0.00	0.00
- Thinning 2	€/m3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	308.06	0.00	0.00	0.00	0.00
- Clear Cut	€/ha	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1,829.34
- land sales	€/ha	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	444.23
- carbon price	€/ha	0.00	29.13	28.28	27.45	26.65	25.88	25.12	24.39	17.62	14.33	11.65	11.31	10.98	10.66
Period Revenues		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	177.39	308.06	0.00	0.00	0.00	2,273.57
- economic analysis		0.00	29.13	28.28	27.45	26.65	25.88	25.12	24.39	195.02	322.38	11.65	11.31	10.98	2,284.23
Cumulative Revenues		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	177.39	485.45	485.45	485.45	485.45	2,759.01
- economic analysis		0.00	29.13	57.40	84.86	111.51	137.39	162.52	186.91	590.00	1,007.84	1,097.11	1,108.42	1,119.40	3,403.63
Period Net Revenues		-2,250.00	-29.13	-28.28	-27.45	-26.65	-25.88	-25.12	-24.39	112.78	255.52	-11.65	-11.31	-10.98	2,245.13
- economic analysis		-2,250.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	130.40	269.85	0.00	0.00	0.00	2,255.80
Cumulative Net Revenues		-2,250.00	-2,279.13	-2,307.40	-2,334.86	-2,361.51	-2,387.39	-2,412.52	-2,436.91	-2,595.36	-2,435.30	-2,524.57	-2,535.88	-2,546.86	-301.72
- economic analysis		-2,250.00	-2,250.00	-2,250.00	-2,250.00	-2,250.00	-2,250.00	-2,250.00	-2,250.00	-2,182.75	-1,912.90	-1,912.90	-1,912.90	-1,912.90	342.89

Financial Analysis with a carbon payment of €15 per hectare CF4

Activities	Unit	Periods											
		0	1	2	3	4	5	6	7	8	18	25	35
Costs													
- Soil preparation	€/ha	-500.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
- Seedlings	€/ha	-500.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
- Pre thinning maintenance	€/ha	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-63.15	0.00	0.00	0.00
- Administrative and management costs	€/ha	0.00	-29.13	-28.28	-27.45	-26.65	-25.88	-25.12	-24.39	-23.68	-64.61	-52.54	-28.43
- Cost of land	€/ha	-1,250.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Period Costs		-2,250.00	-29.13	-28.28	-27.45	-26.65	-25.88	-25.12	-24.39	-86.84	-64.61	-52.54	-28.43
- economic analysis		-2,250.00	-29.13	-28.28	-27.45	-26.65	-25.88	-25.12	-24.39	-86.84	-64.61	-52.54	-28.43
Cumulative Costs		-2,250.00	-2,279.13	-2,307.40	-2,334.86	-2,361.51	-2,387.39	-2,412.52	-2,436.91	-2,523.74	-2,772.75	-2,920.75	-3,060.74
- economic analysis		-2,250.00	-2,279.13	-2,307.40	-2,334.86	-2,361.51	-2,387.39	-2,412.52	-2,436.91	-2,523.74	-2,772.75	-2,920.75	-3,060.74
Revenues													
- Thinning 1	€/m3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	177.39	0.00	0.00
- Thinning 2	€/m3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	308.06	0.00
- Clear Cut	€/ha	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1,829.34
- land sales	€/ha	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	444.23
- carbon price	€/ha	0.00	14.56	14.14	13.73	13.33	12.94	12.56	12.20	11.84	8.81	7.16	5.33
Period Revenues		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	177.39	308.06	2,273.57
- economic analysis		0.00	14.56	14.14	13.73	13.33	12.94	12.56	12.20	11.84	186.20	315.22	2,278.90
Cumulative Revenues		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	177.39	485.45	2,759.01
- economic analysis		0.00	14.56	28.70	42.43	55.76	68.70	81.26	93.45	105.30	383.70	746.65	3,081.32
Period Net Revenues		-2,250.00	-29.13	-28.28	-27.45	-26.65	-25.88	-25.12	-24.39	-86.84	112.78	255.52	2,245.13
- economic analysis		-2,250.00	-14.56	-14.14	-13.73	-13.33	-12.94	-12.56	-12.20	-74.99	121.59	262.68	2,250.47
Cumulative Net Revenues		-2,250.00	-2,279.13	-2,307.40	-2,334.86	-2,361.51	-2,387.39	-2,412.52	-2,436.91	-2,523.74	-2,595.36	-2,435.30	-301.72
- economic analysis		-2,250.00	-2,264.56	-2,278.70	-2,292.43	-2,305.76	-2,318.70	-2,331.26	-2,343.45	-2,418.45	-2,389.05	-2,174.10	20.58