Methodology for profitability and risk analysis of agroforestry systems

J. C. Santos[1] and R. T. Campos[2]

Key words: Monte Carlo, probability, cost pro rata, simulation.

Introduction

The agroforestry systems (AFSs) can be defined as the deliberate association of woody species with agricultural crops or with animals in the same land, in a simultaneous way or in temporary sequence (Catie, 1986).

Since the eighties, AFSs started to receive larger attention from the the scientific community, as they were considered as good land use alternatives to slash and burn agriculture and extensive cattle ranching in tropical areas. The importance of AFSs grew in the same proportion as the awareness of current environmental and social problems resulting from the adoption of the traditional land use models, especially on the remaining native forests.

The complexity of AFSs, due to their characteristics of policultivo and plurianualidade of production cycle makes it difficult to evaluate their profitability, especially in identifying the individual behavior of the species that compose them. On the other hand, the most common profitability analyses procedures consider the maximização of income as the only approach in the producers decision making process. However, it is known that these farmers, especially the small ones, are averse to the most risky alternatives. The models that take into account the risk factor, offering answers in terms of probability of success and failure of a certain enterprise, certainly result in more complete and reliable information to the entrepreneurs. Walker **et al.** (1994, p.38) stress the fact that " while the theoretical literqature recognizes the adoption of AFSs as an investment decision, the risk aspects and uncertainties that affect the proprietor's behavior, have been given less consideration".

This work establishes a methodology for evaluation of the profitability and risks of agroforestry systems and of each one of its crop components.

Methodology

The methodology consists basically of the combination of the Monte Carlo technique, commonly used for evaluation of risks in investments, with a method of pro rata of the common costs among the crop components, facilitating the analysis of the system as a whole and isolated analysis of each one of these components. The bioclimáticos or economic risks are related to the occurrence of pests, diseases, excess or humidity shortage and problems of market of input and products, among other, that influence in the economic or financial results of an agricultural investment. The approach can be public or private, according to the appropriation of values of the components of benefits and costs.

[1] Embrapa Acre, Brazil

[2] Universidade Federal do Ceará, Brazil (Author for correspondence: Post office box 392, Zip Code 69908-970, Rio Branco, Acre, Brazil; e-mail: jair@cpafac.embrapa.br)

The Monte Carlo technique, proposed by Hertz, in 1964, is a relatively simple and efficient process, of easy analysis of risk of investments through simulation, based on the fact that the relative frequency of occurrence of a certain event, in this case the variables approach the mathematical probability of occurrence of the same phenomenon, when the experience is repeated a great number of times (Biserra, 1991). The technique consists of the following stages:

a) Initially the variables of larger weight in the determination of the costs and revenues are identified. These variables, denominated as more rellevant are considered as probabilistic and the others as determinant (of constant value), what facilitates the processing in the analyses, due to the big numbers of variables that usually compose a cash flow. Noronha (1987) recommends the use of sensibility analysis in this determination.

b) In the case of the important variables a distribution of probability is attributed, using the " Portraid Method ", of the Attempt and Mistake and the " Judgemental Fractile ". The most common and important of the distribution of probability types are: normal, trapeziodal, discreet, triangular, beta and rectangular step. In research works the subjective estimates of probability established with base in the technicians' experience, farmers and other tomadores of decision, has been the most used procedure for determination of the intervals of values of the variables and its respective occurrence probabilities, with aid of historical series of prices of input and products and physical revenue of cultivations. Pouliquen (1970) affirms to be convenient the use of the distribution of the triangular type, when there is not enough knowledge on the variables. In that distribution it is necessary to define the medium or modal levels, minimum and maximum waited for the variable.

c) In the next step, the calculation of the profitability indicators is proceeded, with aid of a computer. In Brazil there is a software called "ALEAXPRJ ", that was developed to execute those simulations, and that can be used for analyses of economic or financial approach. The simulations should be made with at least 200 repetitions, to obtain enough dispersion of values for estimation of the distributions of probability of the indicators (Azevedo Filho, 1988).

In the analysis of AFS as a whole, the benefits and the costs of all the crops are considered. As profitability indicators can be used the net present value (NVP), the internal rate of return (IRR), the relationship benefits cost, the time of capital recovery, among others.

Since it is a consortium of cultivations, that is to say, several exploration lines that are used on the same cultivated area, there are common costs to all or some crops and specific costs of each one of them. For the individual analyses those common costs need to be divided among the respective crops, what can be done proportionally at its specific cost, gross revenue, area efectively used for the system (Hoffmann et al., 1987 and Noronha, 1987). After the pro rata of the common costs and its aggregation at the respective specific costs, the referring profitability indicators are calculated for each culture, using the Monte Carlo techinique. In these individual analyses, the same indicators of the system can be used and also indicators such as the unitary cost of production.

Results

For evaluation of the consistency of the methodology, the results obtained by Santos (1996) were considered in the analysis of a model of AFS adopted for producing cocoa in the area of Transamazon Highway, in the State of Pará, Brazil (Table 01). The AFS is composed of rice, banana, cocoa and forest species. The analysis was made considering a 25 year temporary horizon, 8% as discount rate, pro rata of costs for the gross revenue and a total of 350 simulations. As the demonstration is just to verify the consistency, the crops and indicators are presented partially.

Table 1. Profitability Indicators, in risk conditions, of AFS. Pará, Brazil. 1996.

Indicators	AFS		Rice		Cocoa	
	IRR	NPV	IRR	NPV	IRR	NPV
Mean	10.10	4,664.88	6.90	- 10,332.98	9.40	3.091,96
Limit (L)[1]	8.00	0.00	8.00	0.00	8.00	0.00
P ($I \leq L$)[2]	22.90	22.60	82.30	82.30	33.70	33.40
N. S.[3]	0	0	0	0	0	0

[1]Minimum limit previously established for the indicative I; [2] probability of the value of the indicator to be smaller or equal to the limit L (%); [3] Number of times that was not possible to obtain the indicator in the simulations.

NOTE: Mean/IRR value in %; Mean/NPV value in U$ (U$ = local currency, R$0,955, october 1995).

Discussions and conclusions

For AFS and for cocoa the profitability indicators IRR and NPV came with medium value above the minimum established as acceptable, what indicates that the total revenues weere superior at the total costs and, consequently, had positive profitability. The probabilities of its indicators be placed below the established minimum were all smaller than 40%, indicating relatively low risk of occurrence. AFS and the monoculturereculture of cocoa presented positive profitability and low financial risk (banana and forest essences presented similar results).

The rice crop presented medium values of the profitability indicators below the minimum limits established and high probability, above 50%, of being below of these limits. The culture was shown unviable and of high financial risk inside of AFS, contributing to reduction of its profitability performance.

The different profitability and risk indicators presented similar results for AFS and for the component crops, especially in regard to the occurrence probability (P), which has the same unit of measure (%) for different indicators. This confirms the consistency of the results obtained in the evaluation of the AFS model, with the use of the proposed methodology.

References

AZEVEDO FILHO, A.J.B.V. (1988) Análise econômica de projetos: software para situações determinísticas e de risco envolvendo simulação. Piracicaba: ESALQ/USP. 127p. (Dissertação de Mestrado).

BISERRA, J.V.(1991) Rentabilidade da irrigação pública no Nordeste sob condições de risco - o caso do perímetro de Morada Nova. Fortaleza: UFC. 73p. (Tese - Professor Titular).

CATIE (1986) Manual sobre curso de sistemas agroflorestais. Turrialba, Costa Rica: CATIE. 40p. (mimeo).

HOFFMANN, R. et al. (1987) Administração da empresa agrícola. 3 ed. São Paulo: Pioneira. 325p.

NORONHA, J. F (1982) O sistema de avaliação econômica de projetos agropecuários na política brasileira de crédito rural. Piracicaba: ESALQ/USP. 120 p. (Tese –Livre docência).

POULIQUEN, L.Y. Risk analysis in project appraisal. Baltimore: Jonhs Hopkins Press, 1970. 79p.

SANTOS, J. C. dos (1996) Análise da rentabilidade, sob condições de risco, de um sistema agroflorestal adotado por pequenos produtores de cacau na região da Transamazônica, Pará. Fortaleza: UFC. 129 p. (Dissertação - Mestrado).

WALKER, R.T. et al. (1994) Sistemas agroflorestais como processo evolutivo: o caso dos agricultores da rodovia Cuiabá-Santarém, no Estado do Pará. In: CONGRESSO BRASILEIRO SOBRE SISTEMAS AGROFLORESTAIS, 1, 1994, Porto Velho. Anais... Colombo: EMBRAPA-CNPF. p.29-42.