THE ECONOMICS OF BIODIVERSITY CONSERVATION: A STUDY IN A COFFEE GROWING REGION OF INDIA

K.N. NINAN
and
JYOTHIS SATHYAPALAN

ECOLOGICAL ECONOMICS UNIT
INSTITUTE FOR SOCIAL AND ECONOMIC CHANGE
BANGALORE-560 072
INDIA
TEL : 0091 - 80 - 3215468
FAX : 0091 - 80 - 3217008
E-MAIL: ninankn@hotmail.com

Contributed Paper Selected for Presentation At The 25th International Conference Of Agricultural Economists, August 16-22, 2003, Durban, South Africa.

THE ECONOMICS OF BIODIVERSITY CONSERVATION: A STUDY IN A COFFEE GROWING REGION OF INDIA

ABSTRACT

This paper analyses the economics of biodiversity conservation in the context of a tropical forest ecosystem in India, where coffee is the main competitor for land use. Using primary data covering a cross-section of coffee growers, the study notes that the opportunity costs of biodiversity conservation in terms of coffee benefits foregone are quite high. Even after including external costs due to wild life damages and defensive expenditure to protect against wild life, the NPVs and IRRs from coffee for all land holding groups were high. Even if the expected benefits were to decrease by 20% and costs rise by a similar proportion, still the IRRs from coffee were quite high (19.5 to 20.1 per cent). The study notes that the external costs accounted for between 7 to 15 per cent of the total discounted costs of coffee cultivation, and smaller holdings proportionately incurred higher external costs as compared to large holdings. The study also notes high transaction costs incurred by the growers to claim compensation for wild life damages. Notwithstanding these disincentives, the study notes that the local community were willing to pay in terms of time for participatory biodiversity conservation, and they preferred a decentralized government institution for this purpose.

KEY WORDS

Biodiversity conservation, Coffee benefits and costs, External and transaction costs, Wild life damages, Contingent valuation, Participatory conservation.

THE ECONOMICS OF BIODIVERSITY CONSERVATION: A STUDY IN A COFFEE GROWING REGION OF INDIA

INTRODUCTION

Biodiversity conservation is receiving considerable attention in research and policy circles in recent years, especially after the 1992 Rio Earth Summit. This is because biodiversity loss has both human and non-human impacts as well as inter and intra-generational impacts. Hence, the need for conserving biodiversity is obvious. The developing countries are rich in biodiversity, but this is declining at an alarming rate. The divergence between private and social discount rates and the failure to capture the global values of biodiversity, apart from proximate and fundamental causes explain why biodiversity loss is taking place (Pearce and Moran, 1994; Perrings, 2000; Swanson, 1997). Although the benefits of biodiversity conservation accrue to the local and global community at large, the costs are most often borne by the local community who depend on forests for various goods and services (Pearce and Moran, 1994; Shyamsundar and Kramer, 1996; 1997).

Policies for conserving biodiversity, however, depend upon the perceived costs and benefits of biodiversity conservation. This necessitates a comparative assessment of the benefits of biodiversity conservation vis-à-vis the benefits foregone from alternate uses. In the context of tropical forests, which are the most important ecosystem type from the viewpoint of global biodiversity, this involves a comparison of the benefits of biodiversity conservation vis-à-vis the alternate land use options of tropical forests, such as for agriculture, animal husbandry, tourism, recreation, etc. However, an assessment of the benefits of biodiversity conservation as against alternate land use options poses problems since many environmental goods and services are not traded or difficult to measure.

In this paper an attempt is made to analyse some aspects of the economics of biodiversity conservation in the context of a coffee growing region in the tropical forest ecosystem of India. The Western Ghat region in Southern India which is one of the eighteen biodiversity hotspots in the world is the setting for the present study. The

Western Ghats cover an area of 0.16 mil.sq.km. with elevations of 6000m and above. About a third of the geographical area of the Western Ghats is under forests of diverse types – evergreen to semigreen forests, moist to deciduous forests, etc. This region is rich in biodiversity and is a treasure house of several known and unknown flora and fauna, including several in the endangered list such as the lion-tailed macaque, four-horned antelope, fishing cat, etc. Due to demographic and economic pressures, market failures and inappropriate policies, the biodiversity of the region is in various stages of degradation and therefore needs to be conserved through appropriate policies. A knowledge of the incentives and disincentives for biodiversity conservation operating at the local level, will help in devising appropriate strategies for biodiversity conservation.

OBJECTIVES

In the light of the above, the specific objectives of the paper are as follows:-

1. To estimate the opportunity cost of biodiversity conservation in terms of the coffee benefits foregone.
2. To assess the external costs borne by the local community due to wild life conservation.
3. To analyse the households' Willingness to Pay for Participatory Biodiversity Conservation and the socio-economic and other factors influencing the same.

DATA AND METHODOLOGY

The study is based on a sample survey of 125 households located in Maldari village of Kodagu District, India. This village which is located in the vicinity of a reserve forest and also has over a third of its geographical area under forests, and where coffee is dominant (covering 42% of the village area) and human-animal conflicts conspicuous is ideally suited for this study. Households in the village were listed and stratified into four land holding categories (i.e., below 2.5 acres, 2.5 to 5, 5 to 10, and, 10 acres and above) and then 30 per cent of the households in each stratum were selected on random sample basis. Data were collected in the year 2000 through a detailed structured schedule comprising two parts, a socio-economic survey and a

Contingent Valuation survey. For the CVM study, the discrete choice method which seeks simple 'Yes' or 'No' answers to an offered bid is used. The discrete choice method was preferred over other methods (eg. open-ended method) because of its inherent advantages such as this method would be easier for villagers to react to the questions; households could respond keeping some budget or constraint in view, i.e., the upper bounds on bids could be controlled; also this method minimizes any incentive to strategically over-state or under-state WTP (Loomis, 1988; Moran, 1994). Dichotomous choice methods require the use of parametric (typically logit or probit) probability models relating 'Yes' or 'No' responses to relevant socio-economic and other variables. Opportunity cost method and cost-benefit appraisal have been used to estimate the benefits from coffee. In addition, trend analysis, averages and proportions have been used to analyse the data.

THE OPPORTUNITY COST OF BIODIVERSITY CONSERVATION

Coffee is the main competitor for land use in the study region. An idea of the comparative economics of coffee vis-à-vis forest production in the study region is available in Table 1.

Table 1: Trends in Coffee and Forest Area and Coffee and Timber Prices during 1960-61 to 1999-2000: For Kodagu District and All India

Period	Kodagu District (India)			All-India		
	Coffee Area	Forest Area	Ratio of Coffee to Forest Area	Coffee Price	Timber Price	Ratio of Coffee to Timber Price
Pre-1980	2.67*	-0.15^{ns}	2.93*	5.64*	9.06*	-3.48*
Post-1980	3.10*	-0.00003*	3.13*	12.16*	6.71*	5.46*
Overall Period	2.74*	-0.0001^{ns}	2.77*	7.97*	10.70*	-2.74*

Note: 1. Overall Period: 1960-61 to 1999-2000; Pre-1980 period – 1960-61 to 1979-80; Post-1980 period – 1980-81 to 1999-2000

2. * - significant at 1 per cent level of significance; ns – not statistically significant even at 10% level.

Over the forty year period 1960-61 to 1999-2000, while coffee area registered a significant increase in Kodagu district, forest area recorded negative trends. Both coffee and timber prices recorded significant increases during this period with timber prices rising faster than coffee prices. However, the period-wise trends are more revealing. During the post-1980 period, while coffee area rose faster than in the earlier period, forest area recorded a significant decline. More interesting, while during the pre-1980 period coffee prices grew slower than timber prices, in the subsequent period this trend got reversed with coffee prices rising faster than timber prices. It is this factor which acts as an incentive to grow coffee in preference to biodiversity conservation.

To assess the foregone coffee benefits, we need to compute the Net Present Values (NPV) of coffee. In the study area, two varieties of coffee, viz., Arabica and Robusta are grown. Although per acre yields of Arabica coffee are less than that of robusta coffee, prices of arabica coffee are much higher than that of robusta coffee. The establishment costs of coffee include cost of renovation pits, contour drains, planting and cost of seedlings. In addition, there are fixed costs by way of irrigation investments and fencing costs. The recurring costs include material costs such as fertilizers, manure and pesticides, labour costs for applying fertilizers, manure and pesticides, repairs and maintenance, and supervision, etc. After coffee begins to yield (from the sixth year), there are recurring costs towards coffee picking, pruning coffee bushes and drying. Common costs such as irrigation and fencing investments, taxes, etc., have been apportioned in terms of the relative share of coffee in the gross sown area. There are also external costs incurred by the coffee growers by way of wild life damage costs, and defensive expenditure incurred to protect against wild life attacks. These external costs are assumed to arise during the entire life span of the crop. The benefits and costs are expressed in 1999 prices, and the life span assumed for coffee in the analysis is fifty years. NPVs have been computed at three alternate discount rates; 8, 10 and 12 per cents. In addition, we have two sets of estimates, one excludes the external costs incurred by the coffee growers, and the other includes these external costs. Table 2 presents the NPVs and IRRs for coffee by land holding categories.

Table 2: Net Benefits from Coffee *Excluding* and *Including* External Costs in Maldari, India (for cash flows summed up over 50 years at 1999 prices)

Land Holding Class in acres	Excluding External Costs				Including External Costs			
	Net Present Value in 000 Rs. per acre			IRR %	Net Present Value in 000 Rs. per acre			IRR %
	8%	10%	12%		8%	10%	12%	
	(Discount Rates)				(Discount Rates)			
Below 2.5	54.7	36.1	23.7	18.2	44.9	28.1	17.0	16.6
2.5 to 5	59.6	40.3	27.6	20.1	49.4	32.1	20.6	18.2
5 to 10	129.7	90.1	63.7	21.9	123.8	85.3	59.7	21.3
10 and Above	212.1	151.0	110.2	23.3	206.0	146.1	106.1	23.0
ALL	194.9	138.5	100.8	23.2	188.5	133.3	96.4	22.9

Note: External Costs – Wild Life damage costs and defensive expenditures to protect against wild life attacks.

Taking all farmers together the NPVs from coffee excluding external costs range between Rs.100.8 thousand to Rs.194.9 thousand per acre, and Rs.96.4 thousand to Rs.188.5 thousand per acre when external costs are also included. Across land holding categories too these NPVs are positive and high both excluding and including the external costs. Even after including external costs the IRRs from coffee for different land holding categories range between 16.6 to 23 per cent. A sensitivity analysis of the net benefits from coffee under alternative assumptions revealed that even if expected coffee benefits were to decrease by 20 per cent, and costs were to rise by 20 per cent, the NPVs and IRRs from coffee are still quite high and significant, with the IRR ranging between 19.5 to 20.1 per cent (see Table 3). This implies that the opportunity cost of biodiversity conservation in terms of coffee benefits foregone are quite high. The estimates presented above should be considered as a lower bound of the benefits foregone by the coffee growers since coffee is grown along with several other crops like pepper, citrus fruits, etc.

Table 3: Sensitivity Analysis of Net Benefits from Coffee under Alternative Assumptions: Maldari, India (for cash flows summed up over 50 years at 1999 prices)

Assumption	Excluding External Costs				Including External Costs			
	Net Present Value in 000 Rs. per acre			IRR %	Net Present Value in 000 Rs. per acre			IRR %
	8% (Discount Rates)	10%	12%		8% (Discount Rates)	10%	12%	
Full expected Benefits, net of costs	194.9	138.5	100.8	23.2	188.5	133.3	96.4	22.9
Assuming 20% ***increase*** in Benefits	249.9	179.3	132.1	24.3	243.4	174.1	127.7	24.0
Assuming 20% ***decrease*** in Benefits	140.0	97.7	69.4	21.7	133.6	92.4	65.1	21.2
Assuming 20% ***increase*** in Costs	210.9	151.6	111.9	24.5	205.7	147.4	108.4	24.2
Assuming 20% ***decrease*** in Costs	179.0	125.4	89.6	22.0	171.3	119.1	84.3	21.5
Assuming 20% ***decrease*** in Benefits, and 20% ***increase*** in Costs	124.1	84.6	58.3	20.1	116.3	78.3	53.0	19.5

EXTERNAL COSTS

Local communities are affected the most by the costs of conservation (Shyamsundar and Kramer, 1996; 1997). As noted earlier, coffee growers incur costs of conservation due to damages caused by wild life, and defensive expenditures to protect against wild life. On an average these external costs were Rs.527.7 per acre during the reference year (Table 4).

Table 4: Particulars of External Costs (Wild Life Damage costs and Defensive Expenditures to Protect against Wild Life) incurred by Coffee Growers during 1999-2000: Maldari, India

Land Holding Class in acres	Wild Life Damage Costs	Wild Life Preventive Measures (Rs. per acre)	Total External Costs	Total* External Costs (Discounted values at 12%) (Rs. per acre)	Total External* Costs (discounted values) as % of Total Discounted Costs of Coffee Cultivation
Below 2.5	671.8	131.3	803.1	6669.3	15.0
2.5 to 5	631.5	201.2	832.7	6915.7	15.7
5 to 10	332.5	150.4	482.9	4010.8	6.3
10 and Above	290.2	204.8	495.0	4110.5	6.7
ALL	331.2	196.5	527.7	4381.6	7.3

* discounted values for cash flows summed over 50 years

Interestingly, these external costs were higher among smaller holdings upto 5 acres. This is because many small holdings are located either near or within the forest boundary where the intensity of wild life attacks is more pronounced. On an average, these external costs (discounted values) account for about 7.3 per cent of the total discounted costs of coffee and goes upto 15 per cent or more among smaller holdings of upto 5 acres. However, as noted already, the net benefits from coffee even after including these external costs are positive and high among all land holding categories.

In order to give an incentive to local communities to conserve biodiversity the State, i.e., Forest Department, has a mechanism to compensate the local communities for damages caused by wild life. However, as evident from Table 5, the transaction costs to claim this compensation are too high and acts as a disincentive to the local community to support biodiversity conservation efforts.

Table 5: Particulars of Compensation claimed for Wild Life Damages and Transaction Costs Incurred to claim Compensation by Sample Households during 1999/2000: in Maldari, India

Land Holding Class in acres	Per cent of Sample Households who filed claims for compensation	Amount of compensation claimed	Amount received	Transaction Cost for claiming compensation			
		(Rs. per reporting household)		No. of Trips made per reporting household	Cost of Time in terms of income foregone*	Total Expenditure Rs/ reporting household	Total+ Expenditure per Rupee of compensation realized
Below 2.5	5.1	1833	350	7.3	735	450	3.4
2.5 to 5	28.6	7167	20	6.3	877	1392	13.4
5 to 10	26.7	5125	125	4.7	1540	1175	21.7
10 and Above	50.0	16733	1167	4.1	2239	1504	3.2
ALL	22.4	11429	685	5.0	1163	1320	3.6

* Assuming that one trip to the local forest office requires one humandays work

\+ Total Expenditure here includes total expenses actually incurred plus cost of time in terms of income foregone for trips made to pursue the compensation claims.

The average amount of compensation claimed was Rs.11429 per reporting household. The amount actually received at the time of the survey was only Rs.685 per reporting household (i.e. 6% of the total amount claimed) for which the coffee grower incurred an average expenditure of Rs.1320 plus an average of five trips per reporting household valued at Rs.1163 in terms of the income foregone, to visit the local forest office to pursue their compensation claim. In other words, for every rupee of compensation actually realized, the coffee grower spent Rs.3.6 including the value of time (trips made) in terms of the income foregone. Interestingly, while large holding with 10 acres and above spent Rs.3.2 per rupee of compensation realized, among holdings of below 10 acres these expenditures are considerably higher, i.e., Rs.3.4 to Rs.21.7 per rupee of compensation actually realized, which suggests that the costs of conservation borne by smaller holdings in this respect is much more than larger holdings. However, it may be noted that small farmers in particular, get tangible benefits like non-timber forest products which is an incentive for conservation.

VALUING PREFERENCES FOR BIODIVERSITY

Notwithstanding the disincentives and costs borne by the local community for biodiversity conservation it is heartening to note that a majority of the sample households had a positive attitude towards biodiversity conservation in general and wild life protection in particular. Asked to rank the reasons for biodiversity conservation, majority of the households (i.e., 36%) assigned first rank to its importance for future generations, followed by its livelihood function (26%), and its ecosystem functions (25%). Asked to rank the reasons why elephants, a keystone and threatened species in the study region need to be conserved, majority of the households emphasized its existence rights, its aesthetic value, its livelihood functions and option value (eg. develop new drugs). Contingent Valuation Method (CVM) has been widely used to value public goods like biodiversity. What it really measures is people's value preferences for biodiversity conservation. Hence, an attempt is made here to estimate the local community's Willingness to Pay (WTP) in terms of Spending Time for Participatory Biodiversity Conservation. For the CVM study, elephants, a keystone and threatened species in the study region was taken up for an indepth case study. They have a significant impact on plant composition due to their large and varied diet, their physical impact on their surroundings, and their ability to move large distances (Mendelssohn, 1999). From the conservationist's perspective, this focus is rationalized by the frequently inseparable nature of the subject good from its biosphere and supporting species links. In other words, the purchase of a good offered in a CV exercise often implies purchase of a complementary bundle of biodiversity (Moran, 1994). In conducting the CVM survey all the guidelines suggested by the NOAA Panel (1993) in the USA were taken into account (i.e., pre-testing of schedules, canvassing through personal interview, sufficient sample size, etc.). The respondents in the sample village were asked (using discrete choice method) to indicate the time they were willing to spend for Participatory Elephant Conservation like participating in environmental awareness campaigns, voluntary labour for elephant trenching, etc. Table 6 indicates that, on an average, the sample households were willing to spend 25.8 humandays per household annually for participatory elephant conservation. In terms of the income foregone this worked to over Rs.6000 per household per annum. This figure varied positively with farm size due to income differentials across different land holding group.

Table 6: Willingness to Pay in Terms of Time for Participatory Elephant Conservation: Maldari, India

Land Holding Class in acres	Willingness to Pay in terms of time for Participatory Elephant Conservation		Opportunity Cost of Time in terms of Income Foregone
	Hours per week per household	Humandays per household per annum	(Rs/household/ annum)
Below 2.5	3.81	24.76	2491.84
2.5 to 5	4.90	31.85	4435.08
5 to 10	3.67	23.85	7817.16
10 and Above	3.76	24.44	13346.32
ALL	3.97	25.80	6003.40

To evaluate the variables influencing the respondents 'Yes' or 'No' responses, a logit model was used. The definition and summary statistics of the variables used in the logit function are indicated in Table 7.

Table 7: Definition and Summary Statistics of Independent Variables used in Logit Function

Variable	Minimum	Maximum	Mean	Standard deviation
Land Holding in acres	0.03	82.00	7.13	12.83
Household Size	1.00	11.00	5.12	2.18
Settler (dummy variable where settler = 1; otherwise 0)	0.00	1.00	0.52	0.50
Age of Respondent	15.00	86.00	44.38	13.62
Education of Respondent	1.00	6.00	2.95	1.50
Decentralised Government Institution – DGO (dummy variable where DGO = 1; otherwise 0)	0.00	1.00	0.68	0.47

Table 8 which presents the Maximum Likelihood Estimates of the parameters in the logit function suggests that land holding and educational levels are negatively and significantly related with the dependent variable. This indicates that bigger land holdings have less probability to say 'Yes' to spending time for participatory conservation, and so also educated people. As noted earlier, the (external) costs of conservation and transaction costs incurred by smaller holdings was higher than for larger holdings which explains why they are more likely to say 'Yes' to the WTP bid. Interestingly, the settler variable is positive and significant which indicates that settlers (unlike migrants) have high probability to say 'Yes' to spend time for participatory elephant conservation. The results also show that there is a clear preference for decentralized government organizations (DGO) for participatory conservation among the respondents as against other institutional alternatives, possibly because they feel that transparency, accountability and sense of participation is better under a decentralized government set up for participatory biodiversity conservation. The estimated model is highly significant with a likelihood ratio test of the hypothesis that the 6 coefficients are zero based on a chi-square value of 24.94. The likelihood ratio index is 0.22 (analogue to R^2 in OLS) which is a good fit for cross section data. The per cent correct prediction is 86.29.

Table 8: Maximum Likelihood Estimates Using Logit Model of Willingness to Pay (i.e., Spend Time) for Participatory Elephant Conservation: Maldari, India

Variable	Coefficient	Standard Error	t-ratio
Constant	2.835***	1.480	1.916
Land Holding	-0.042***	0.022	-1.894
Household Size	-0.029^{ns}	0.135	-0.213
Settler	1.398**	0.607	2.303
Age of Respondent	-0.009^{ns}	0.020	-0.464
Education of Respondent	-0.452**	0.199	-2.270
DGO	1.016***	0.585	1.737

Likelihood Ratio Index	-	0.22
Chi-squared (6)	-	24.94
Per cent Correct Prediction	-	86.29
Significance Level	-	0.0003
No. of observations	-	124

Note: **, ***, - indicates statistically significant at 5 and 10 per cent levels of significance; ns – not statistically significant at the above levels of significance.

CONCLUSION

The opportunity costs of biodiversity conservation in terms of coffee benefits foregone is quite high. Even after including external costs, the net benefits from coffee are high, with the IRRs ranging between 16 to 23 per cents. If expected benefits were to fall by 20 per cent and costs rise by a similar percentage the NPVs and IRRs from coffee are still quite high and significant with the IRRs ranging between 19.5 to 20.1 per cent. The study shows that the external costs incurred by the coffee grower due to wild life conservation are quite significant and account for between 7 to 15 per cent of the total discounted costs of coffee. Interestingly, smaller holdings incurred higher external costs than larger holdings. Though the State has been operating a scheme to compensate farmers for wild life damage costs, the analysis shows that not only are the transaction costs to claim this compensation too high but also holdings below 10 acres proportionally incurred higher transaction costs for claiming this compensation, which acts as a disincentive to biodiversity conservation. The fact that coffee prices have risen faster than timber prices after 1980 is a further disincentive to biodiversity conservation. Notwithstanding these disincentives, it is heartening to note that the local community had a positive attitude towards biodiversity conservation and expressed their Willingness to Pay in terms of time for Participatory Elephant Conservation. Most interesting is that the local community expressed a clear preference for decentralized government institutions for participatory biodiversity conservation. This suggests that a decentralized and participatory based strategy for biodiversity conservation promises to be more effective than other institutional alternatives.

REFERENCES

Loomis, John B., 1988, Contingent Valuation using Dichotomous Choice Models, *Journal of Leisure Research*, Vol.20, No.1, pp.46-56.

Mendelssohn, Gaie, 1999, The Relevance of Economic Valuation for Species Conservation Policy: The Case of the African Elephant, in O'Connors, Martin and Spash, Clive, eds. *Valuation and the Environment – Theory, Method and Practice*, Edward Elgar, Cheltenham, U.K.

Moran, Dominic, 1994, Contingent Valuation and Biodiversity: Measuring the User Surplus of Kenyan Protected Areas, *Biodiversity and Conservation*, Vol.3, pp.663-684.

Ninan, K.N., Jyothis S, Babu P, and Ramakrishnappa V. 2001, Economic Analysis of Biodiversity Conservation: The Case of Tropical Forests in the Western Ghats, India, ISEC, Bangalore.

Pearce, David and Moran, Dominic, 1994, The Economic Value of Biodiversity, *Earthscan*, London.

Perrings, Charles (ed.), 2000, *The Economics of Biodiversity Conservation in the Sub-Saharan Africa-Mending the Ark*, Edward Elgar, Cheltenham, U.K.

Shyamsundar, P. and Kramer, R.A., 1996, Tropical Forest Protection – An Empirical Analysis of the Costs Borne by Local People, *Journal of Environmental Economics and Management*, Vol.31(2), U.S.A.

Shyamsundar, P. and Kramer, R.A., 1997, Biodiversity Conservation – At What Cost? A Study of Households in the vicinity of Madagascar's Mantadia National Park, *Ambio*, Vol.26, No.3, May, pp.180-184.

Swanson, Timothy, 1997, Global Action for Biodiversity , *Earthscan*, London, U.K.