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ECONOMIC POTENTIALS OF RUBBER (*Hevea brasiliensis*) MONOCULTURE AND RUBBER-AGROFORESTRY SYSTEM: A CASE STUDY OF NORTHERN BANGLADESH

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Abstract: A financial analysis of rubber (*Hevea brasiliensis*) plantation was made in February 2003 to determine economic profitability of rubber monoculture and rubber-agroforestry system in a rubber plantation of Sherpur district of Bangladesh. Rubber was intercropped with ginger (*Zingiber officinale*), turmeric (*Curcuma longa*), paddy (*Oryza sativa*), eggplant (*Solanum melongena*), different types of vegetables and fruits. Output was calculated on the basis of present market price. Financial indicators used were Net Present Value (NPV), Internal Rate of Return (IRR) and Benefit-Cost Ratio (BCR). Level of profit was determined at the 15th year of the economic life of the plantings while average profit was increasing. Using 6% nominal interest rate NPV was found to be *Taka* 57751 for rubber-agroforestry and *Taka* -78043 (negative) for monoculture of rubber, IRR was 9% for rubber-agroforestry and -12% (negative) for monoculture and BCR was 1.43 for rubber-agroforestry and 0.22 for monoculture. Higher profit in rubber plantation can be achieved by practicing agroforestry. Agroforestry practice in rubber gardens has great potential in terms of profitability and enhanced environmental amelioration.

Keywords: Rubber-Agroforestry; Rubber-Monoculture; Financial Analysis.

Introduction

Rubber (*Hevea brasiliensis*) is an economic tree species widely planted all over the world as well in Bangladesh (southeastern, northeastern and central region). Establishment and management of rubber plantation need large investment and there is no return for eight to ten years. In order to make full use of the land, a large scale intercropping practice in rubber is indispensable. The rubber-agroforestry system is the most widespread complex agroforestry system combining production and environmental benefits (decrease runoff and soil erosion; increase soil moisture, soil organic matter and the number of beneficial soil microorganisms), as well as certain biodiversity conservation (Young, 1997).

The rubber-agroforestry system involves practice of agricultural crops under bands of rubber trees in spatial arrangement. Further, the rubber-agroforestry provides income for the farmers from the intercrops even if any damage transpired to the rubber trees. Numerous other benefits increase to the farmers and the natural environment by practicing the rubber-agroforestry. The income per unit area of the rubber agroforestry system is significantly higher than that of rubber monoculture (Juriprik, 1996).

In Bangladesh, with the increase in population the land became the scarcest resource. So we should make optimum use of that resource. And from this outlook rubber-agroforestry has great potential. Approximately 22,672 ha of land area are covered with rubber plantation in Bangladesh of which 12,146 ha under Bangladesh Forest Industries Development Corporation (BFIDC), 3,239 ha under Chittagong Development Board and 7,287 ha under private enterprise (Sattar, 1995). The introduction of agricultural crops or fruit trees along with the rubber plantation would be economically a profitable practice in all the rubber gardens, which will ultimately preach benefits to the people by uplifting the socioeconomic condition of the country. Considering these points in view, the study was conducted to compare the economic potentials between rubber-monoculture and rubber-agroforestry practices.

Research Methods

Most of the rubber gardens in Bangladesh are managed for monoculture rubber plantation. Only a few of them are practicing intercropping (rubber-agroforestry) of which the present garden is the pioneer and attained a considerable stage, which creates a scope to assess the profitability of rubber-agroforestry, thus it was selected purposively. Input and output data was collected in February 2003 from the records of the garden.

The analysis was made based on the yield data and operation cost upto 15th year (1987-2002) from establishment. Labor cost includes establishment (such as site preparation, field planting etc), intercultural operations (weeding, irrigation, application of fertilizer and pesticides) and harvesting (collection of latex and intercrops). Capital includes seeds, seedlings, equipments or tools, fertilizer, pesticides, tapping materials and other cost. The cost of land was not taken into account because only monetary cost were considered, where land has its shadow price that reflects opportunity cost (opportunity cost is not considered in case of financial analysis and in this study economic potentials have been determined based on financial analysis) (Anon,

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1991). After getting the total cost it was compounded at nominal interest rate 6%, because with a high discount rate, a greater relative value is placed on the earlier years of a system, this can bias the design toward this earlier period can cause the design to be suboptimal in the latter years (Wojtkowski, 1998). For benefits, item such as rubber shits, intercrops include zinger, turmeric, paddy, vegetables etc have been considered. After calculating the total benefits, it was then compounded at the same rate. Finally, the Benefit-Cost Ratio (BCR) was calculated by dividing the compounded benefit by compounded cost. The Net Present Value (NPV) and Internal Rate of Return (IRR) have also been calculated following the technique that includes mainly the financial profitability of the two systems in the area. The calculation has been made on the basis of per hectare per annum and the amount in *Taka.*

There are three techniques of appraisal traditionally used to measure economic Cost-Benefit are (Gittinger, 1974):

- Net Present Value (NPV)
- Benefit-Cost Ratio (BCR)
- Internal Rate of Return (IRR)

Results and Discussion

Costs and benefits of rubber monoculture and rubber-agroforestry have been presented in Table 1 and Table 2 respectively. Labor and capital cost of monoculture and rubber-agroforestry are shown separately and in combination also. Labor cost of 1st year for monoculture and rubber-agroforestry was *Taka* 7896 and *Taka* 10528 respectively. For the other years labor cost ranging from *Taka* 1147 to *Taka* 4310 for monoculture and *Taka* 2232 to *Taka* 5264 for rubber-agroforestry. Capital cost of 1st year for monoculture and rubber-agroforestry was *Taka* 16000 and *Taka*16110 respectively and for the other years *Taka* 135 to *Taka* 515 for monoculture and *Taka* 271 to *Taka* 812 for rubber-agroforestry. There was no return from latex upto 11th year in monoculture and it gets started from the 12th year. On the other hand benefit from intercrops were coming from the very beginning.

Table 1: Results of monoculture of rubber

Costs (*Tk*/ha)	Year															Total
	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th	
Labor	7896	1147	1195	1229	1405	1381	1512	1352	1545	1665	1523	4122	4310	4265	4305	38852
Capital	16000	135	152	163	118	210	165	153	185	196	189	485	450	496	515	19612
Total	2386	1282	1347	1392	1523	1591	1677	1505	1730	1861	1712	4607	4760	4761	4820	58464
Compounded cost	54309	2728	2694	2626	2720	2697	2662	2246	2471	1481	2167	5485	5348	5065	4820	100519

Benefit (*Tk*/ha)	Year															Total
	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th	
Latex	-	-	-	-	-	-	-	-	-	-	-	2638	4161	5321	8000	17120
Compounded benefit	-	-	-	-	-	-	-	-	-	-	-	3140	4675	5661	8000	22476
BCR	-	-	-	-	-	-	-	-	-	-	-	0.57	0.87	1.11	1.66	0.22
Average BCR = 0.22																

(Source: Field study, 2003)

The BCR of the 12th, 13th, 14th and 15th years of rubber-agroforestry system, when the collection of latex was started, were much higher (1.84, 2.36, 2.58 and 3.92) than the BCR of those similar years in the monoculture (0.57, 0.87, 1.11 and 1.66) respectively. However the other years (1st to 11th) when the latex collection was not yet started a considerable worth of BCR were obtained in the rubber-agroforestry system, which were by no means possible in the monocropping.

The BCR for rubber-agroforestry was 1.43, which can be considered very satisfactory while for monoculture it was only 0.22. The BCR of monoculture was much less than the former one, because the analysis was executed at the half-life of the rotation. If the study could be conducted at the end of the rotation the BCR of monoculture might be found more than that of present time. Sutardi (1976) found BCR of 0.54 for monoculture of rubber from an economic analysis of rubber estates of Indonesia, which was made, at the end of the economic life (29 years) of the plantings when average profit was maximum. It reveals that the BCR (0.22) of monoculture for the present study is reasonable.

From the Table 3 it is clear that the profitability criterions of rubber-agroforestry are much higher between the two systems. The NPV was *Taka* 57751 for rubber-agroforestry and *Taka* –78043 (negative) for

monoculture of rubber in the study area. The IRR of rubber-agroforestry was 9% where as at the same time it was found to be negative for monoculture of rubber (-12)%.

Table 2: Results of rubber-agroforestry

Costs (*Tk*/ha)	Year															Total
	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th	
Labor (rubber + intercrops)	10528	2232	2265	2350	2410	2490	2554	2561	2557	2628	2642	5048	5097	5154	5264	55780
Capital (rubber)	16000	135	152	163	118	210	165	153	185	196	189	485	450	496	515	19612
Capital (intercrops)	110	136	189	151	208	208	192	269	336	178	210	271	280	316	240	3294
Total	26638	2503	2606	2664	2736	2908	2911	2983	3078	3002	3041	5804	5827	5966	6019	78686
Compounded Cost	60541	5326	5212	5026	4886	4929	4621	4452	4397	4003	3849	6910	6547	6347	6019	133065

Benefits (*Tk*/ha)	Year															Total
	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th	
Latex	-	-	-	-	-	-	-	-	-	-	-	2638	4161	5321	8000	20120
Intercrops	2150	3929	6530	7628	7820	8908	5665	7326	9188	7335	8048	8021	9617	10101	15461	115577
Total	2150	3929	6530	7628	7820	8908	5665	7326	9188	7335	8048	10659	13778	15422	23461	135697
Compounded Benefit	4886	8360	13060	14392	13964	15098	8992	10934	13126	9780	10187	12689	15481	16406	23461	190816
BCR	0.08	1.57	2.51	2.86	2.86	3.06	1.95	2.46	2.99	2.44	2.65	1.84	2.36	2.58	3.92	1.43

Average BCR = 1.43

(Source: Field study, 2003)

Table 3. Comparison of financial attribute between rubber-agroforestry and rubber monoculture

System	Compounded Costs (Tk)	Compounded Benefits (Tk)	Profitability Criteria		
			BCR	NPV (Tk)	IRR (%)
Monoculture of Rubber	100519	22476	0.22	-78043	-12
Rubber-Agroforestry	133065	190816	1.43	57751	9

Conclusion

The study shows the comparative profitability of the two mentioned systems where rubber-agroforestry shows its great economic potentiality over monoculture of rubber. In this study the costs and benefits of fifteen years were taken into account after establishment of rubber plantation. It was found that collection of latex was started from 12th year of plantation while production is mounting every year. The production of latex would be higher than that of these days toward its rotation age. In this condition the BCR of rubber-agroforestry is 1.43, which is very satisfactory. So it is recommended that rubber intercropping (agroforestry) should be practiced in all the rubber gardens in Bangladesh that could lead to increased income and optimum use of scarce land resources.

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