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INVESTMENT AND RETURN ANALYSIS OF NATURAL RUBBER PLANTATIONS IN KERALA

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ABSTRACT— Natural rubber (Hevea brasiliensis) has a long gestation period and considerable investments. The regression co-efficient of the small holdings and the estate sector reveals that among the five inputs variables, three variables namely, human labour, plant protection and the number of bearing trees have influence on the gross income of the natural rubber in small holdings and estate sector. The Chow's test inferred that there is a structural difference in production relation between the two farms in the study area. The test of the stability of intercept and slope revealed that the structural difference existed only at slope level between small holdings and estate sector and not at intercept level. With regard to the marginal value productivity, the marginal value productivities of all factor inputs are found to be positive in both plantations. Hence, it indicates that there is a scope for further increasing the input with profit. The resource use efficiency the ratio of marginal value products to their respective cost, it has been found out that the variables human labour and cost of cultivation practices are under utilised whereas in the case of plant protection, plantation of both the farms have been found to be rational in its use. With regard to the return on the investment of capital the net present value indicated the soundness of investment of the natural rubber cultivation in both the plantations. The investment on the natural rubber in the estate sector has been economically more feasible than in the small holdings. The benefit cost ratio reveals the profitability of natural rubber cultivation in both the plantation in the study area.

KEYWORDS: Natural rubber, Small Holdings, Estate Sector, Perennial crop, Cost, Return, Investment, Income, marginal value,

1. INTRODUCTION

Natural rubber is a raw material of considerable commercial importance in the world. India is sixth largest producer of the natural rubber in the world having a share of 5 percent of the global output. Rubber industry is primarily predominated by small growers. Hence, rubber cultivation has a great significance in income and employment generation. Rubber Board is increasing its area of production every year and hence it is fast achieving significance area wise. The development of natural rubber cultivation has given a long awaited boost to the Indian Economy by setting up infrastructural facilities and by generating employment to the unemployed millions in Kerala. An analysis of the cost components and the return is essential to evaluate the profitability. The crop requires huge cultivation and maintenance cost and therefore an attempt has been made in this paper to estimate the cost of the production and the return on investment of the natural rubber.

2. Statement of Problem

The estate sector with a heavy burden at establishment expenditure including the maintenance of a cost managerial staff is always keen on reducing labour per unit area and the number of permanent workers. In addition to these, the smallholdings may also consider revision of wage rates of tappers with an incentive component, adoption of optimum plant density, engagement of female labour to the maximum possible extent and group collection and processing of rubber under the co-orientations of the rubber producers' societies

(RPS). The three major factors affecting the viability of the natural rubber are the steady increase in the cost of inputs, the instability in price and the shortage of labour. Moreover, a realistic and transparent strategy to certain the challenges arising from the globalisation shall have two important components. There are cost reduction at the farm level and linking the downstream manufacturing segment to the production sector so as to maximize the returns through value addition. The Indian rubber industry passed through many vicissitudes and attained a fairy significant position in the global area.

3. Review of Literature

[7] point out that rubber is an important plantation crop cultivated in Kerala. The state holds a dominant position both in area and production. It is the main source of income for majority of farmers. Any volatility in the price of rubber put them in a miserable situation. Recent years witnessed unprecedented volatility in rubber price. Declining trend in the prices of rubber has pushed natural rubber production the lowest in the country. The study revealed that prices were so low so that the rubber cultivators cannot even pay workers' wages and the recent unprecedented volatility in prices declined rubber production leads to the falling standard of living of the rubber farmers in Kerala. Rubber cultivators in Kerala are mainly small growers and any financial constraints, fluctuations in price or backwardness in technology will affect the growers considerably.

[9] their research reveals the production of natural rubber plays a most important role in the economic development of Tripura. The state is the second-largest contributor to the total production of natural rubber in India. Over the last two decades, there is a shift in cropping pattern towards the production of natural rubber in the state from food crops and from other commercial crops. The natural rubber is the second-largest crop in Tripura after rice and area under natural rubber has registered a phenomenal increase during this period. The rubber growers of Tripura suffer from problems like low productivity, poor quality of processing and weak marketing system. The study examines the present status of natural rubber in Tripura in respect of growing trend in the area, production and productivity. The result shows that increasing growth trend of both expansions of area and production of rubber. The elasticity of production of rubber w.r.t. the matured area of rubber plantation is 1.18, that means for a 1 % increase in matured area, there is a 1.18% increase in production of rubber i.e. it is elastic in nature. There is no statistically significant mean difference of productivity between Kerala and India but mean productivity of Tripura is lower than both at all India level as well as state level.

[8] point out the economic evaluation of the production of perennial crop biomass for energy use. Statistical analysis of the bibliographic data was carried out, as well as an assessment of methods and values of economic indicators of the production of perennial crops. The crops most commonly selected for production cost analysis were willow, poplar, and Miscanthus. The cost of production of willow and poplar were similar, 503 EUR ha−1 year−1 and 557 EUR ha−1 year−1, respectively, while the cost of Miscanthus production was significantly higher, 909 EUR ha−1 year−1 on average. By analogy, the distribution of revenue was similar for willow and poplar, at 236 EUR ha−1 year−1 and 181 EUR ha−1 year−1; Miscanthus production reached the value of 404 EUR ha−1 year−1. The economic conditions of perennial crop production differed in terms of geography; four areas were identified: Canada, the USA, southern Europe, and central and northern Europe.

4. Objective of the study

The specific objectives of the present study are:

To measure and compare the cost and return from the natural rubber plantations between small and estate rubber plantations.

To estimate the resource productivity and to examine the resource-use efficiency in natural rubber cultivation in the study area.

To analyse the return on investment of the natural rubber cultivation.

5. Research Methodology

Designing a suitable methodology and selection of analytical tools are important for the meaningful analysis of any research problem. This section is devoted to a description of the methodology which includes choice of the study area, sampling procedure, collection of data, period of study, method of analysis, tools of analysis and measurement of variables.

5.1 Importance of The Study Area:

Kerala is a major and traditional natural rubber producing state in India. Further, there are many marketing centres exclusively for the natural rubber in all the districts of Kerala. The soil and climatic conditions are highly suitable and favourable for natural rubber cultivation in the state of Kerala. Hence, this state is chosen as the study area.

5.2 Sampling Procedure:

Kerala consists of 14 districts which are arranged in a descending order of area under the natural rubber. The first 7 districts are selected which amount for more than 60 per cent of the natural rubber cultivation in Kerala. Certain percentage of sample were selected was been 367 sample have been selected (338 for small holdings and 29 for estate sector) from the seven districts for the study.

5.3 Collection of Data:

The study has used both primary and secondary data. The primary data have been collected from small holdings and estate owners. The researcher has used two separate interview schedules, one for the cultivators and another one for the market intermediaries. The secondary data have been collected from the official publications of the central and state governments.

5.4 Method of Analysis:

In order to achieve the objectives of the study, the total sample plantation of 367 is stratified into two categories namely small holdings and estate sector. The farmers who have less than 20 hectare are grouped as small holdings and the farmers who have 20 or more than 20 hectare are grouped as estate sector. Out of 367 sample farms, 338 (92.10 per cent) came under the category of small holdings and the remaining 29 (7.90 per cent) came under the group of estate sector.

6. Cost structure of natural rubber plantation in Kerala

6.1 Cost of Establishment:

Establishment cost included all the expenses incurred during the first seven years i.e till the plantation comes to commercial yielding. The total establishment cost comprised expenditure on clearing and lining of land, pit preparation, planting material, labour wages, weeding, cover-crop establishment, shading and propping, lime wash, vaccancy filling, fertilizer application, plant protection and implements and these are presented in table 1

Table 1 Cost of Establishment of Natural Rubber Plantation (Rs.Per ha)

Item of works	**Small Holding**		**Estate Owners**	
	Rs	**In Per cent**	**Rs**	**In Per cent**
Clearing and Lining	2848	2.65	2032	2.12
Pit Preparation	14242	13.25	13342	13.94

Planting Material	18600	17.30	18600	19.44
Planting – Labour Wages	4137	3.85	3236	3.38
Weeding	17719	16.48	13624	14.24
Cover-Crop Management	5260	4.89	4325	4.52
Shading and Propping	6541	6.08	6156	6.43
Lime Wash	2762	2.57	2088	2.18
Vaccancy Filling	618	0.58	608	0.64
Fertilizer Application	16917	15.73	15325	16.02
Plant Protection	5506	5.12	5070	5.31
Implements and Utensils	12367	11.50	11276	11.78
Total	**107517**	**100.00**	**95682**	**100.00**

Source: Primary Data

6.2 Cost of annual maintenance of natural rubber plantation:

Annual maintenance cost included all the expense incurred during the mature periods. The total maintenance cost comprised expenditure on tapping, manuring, weeding, processing expenses and supervision. The annual maintenance cost computed is presented in table 2

Table 2 Cost of Annual Maintenance of Natural Rubber Plantation (Per.ha)

Items of work	**Small holding (Rs)**	**Per cent**	**Estate (Rs)**	**Per cent**
Tapping	35692	58.40	34428	60.57
Supervision	10786	17.65	9826	17.29
Manuring, Weeding and Processing Expenses	14634	23.95	12584	22.14
Total	**61112**	**100.00**	**56838**	**100.00**

Source: Primary Data

7. Labour requirement

7.1 Immature Period

The operation wise labour requirement during the immature period is given in table 3. Altogether 662 man-days per hectare are required during the first seven years of planting out of which 265 man-days are to be engaged during the first year itself. The operation wise labour requirement may vary widely depending upon the terrain and topography and the previous crop status of the land.

Table 3 Labour Requirement During The Immature Period

Item of Works	**First Year**	**Subsequent Year of The Immature Phase**
Clearing and Lining	10	Nil
Pit Preparation	71	Nil

Planting	10	Nil
Weeding	80	316
Cover-Crop Management	13	3
Shading and Propping	10	Nil
Lime Wash	10	Nil
Vaccancy Filling	47	2
Fertilizer Application	2	16
Plant Protection	12	60
Total	265	397

Source: Primary Data

7.2 Mature Period

The annual labourer requirement during the mature period depends mainly on the tapping system followed, system of processing, and adoption of rain guarding, application manuring and weeding activities. In a mature rain guarded plantation under 1/2s d/2 system of tapping, the annual requirement of labourer per hectare is around 180 man-days (table 4) female labourer can be substantially involved in all the activities including tapping.

Table 4 Annual Labour Requirement During The Mature Period

Item of work	**No.of man days required**
Manuring and Weeding	15
Tapping Process	150
Rain Guarding	4
Others	11
Total	**180**

Source: Primary Data

8. The Analytical Framework

8.1 Cobb-Douglas production function

The production function is purely a technical relationship which connects the factors such as input and output. Cobb-Douglas type production function is used to compute the relation between the various input factors and the gross income from the natural rubber. This type of production function has been found to be the best fit for such perennial crop study and the variable chosen. In the linear regression model, one dependent and six independent variables are included in the form given below:

$$\text{Log } Y = \beta_0 + \beta_1 \text{Log} X_1 + \beta_2 \text{Log} X_2 + \beta_3 \text{Log} X_3 + \beta_4 \text{Log} X_4 + \beta_5 \text{Log} X_5 + \beta_6 \text{Log} X_6 + e$$

Y = Gross income in rupees
X_1 = Cost of fertiliser
X_2 = Labour in mandays
X_3 = Miscellaneous costs which included pesticides and processing charges
X_4 = Number of bearing trees per farm

X_5 = Age of the farm
X_6 = Planting material, a dummy variable with a value 0 or 1 (0 for clonal and 1 for budded grafts)
β0…..β6 = Parameter to be estimated (i = 1 to 6)
e = Random error term
Y = Gross income referred to the total amount received by the grower by the sale of rubber sheet and scrap rubber.
X_1 = Indicated the amount spent of fertilizer.
X_2 = Number of labour used in mandays for cultural operations and tapping.
X_3 = Miscellaneous cost included the amount spent on pesticides and processing rubber into sheet.
X_4 = Total number of tappable trees available in the farm.
X_5 = Age of the plantation referred to the present age of the farm in years from the date of planting in the garden. It does not include the time spent in nursery.
X6 = Planting material was used as a dummy variable by giving a score of 0 for clonal seedling and 1 to the budding seedling.

The estimated results of linear regression equation for small and estate plantation have been depicted in table 5

Table 5 Estimated Results of Regression Co-efficient of Small And Estate Natural Rubber Plantations

	Size of the Sample	**β0**	**β1**	**β2**	**β3**	**β4**	**β5**	**β6**	**R^2**	**F**	**Σ**
	338	2.27	0.41* (0.93)	0.60 (0.43)	0.077 (1.79)	0.067* (3.43)	0.77 (1.14)	0.96* (4.13)	0.92	113.67	0.0
e	29	2.76	0.67* (3.43)	0.87 (0.52)	0.090 (2.23)	0.097* (6.79)	0.83 (1.82)	1.36* (3.16)	0.96	143.71	0.0

Figures in parentheses are t-value
*indicates that the co-efficient are significant at 5 per cent level Source: Computed Data

As per the F-value given in table 5 the regression model has been significant at one per cent level in the analysis. In the estate sector, the regression co-efficient of independent variables are positive and the value of R^2 indicates that all the explanatory variables jointly account for about 96 per cent of variations in gross income from natural rubber. The co-efficient of human labour, plant production and number of trees are statistically significant at 5 per cent level. It is inferred that by one per cent increase in these variable, the gross income could be increased by 0.97, 0.090 and 1.36 per cent respectively. Among these three influencing input factors, number of bearing trees in the rubber plantation has greater influence on the gross income determination. The co-efficient of all the variables are positively related to the gross income is the case of the small holdings plantation. The R^2 value indicates that nearly 92 per cent of variation in gross income from

natural rubber is explained by the variables included in the regression model. The co-efficient of plant protection in a number of bearing trees are found to be significant at 5 per cent level. Thus, one per cent increase in these variables is capable of increasing the gross income by 0.077 and 0.96 per cent respectively. The F-test value reveals that the regression model is statistically at one per cent levels. Let us take the hypothesis that there is no significant difference between the number of trees and production of natural rubber.

8.2 Structural Differences in Production Relations

Prior to the measurement of the resource use efficiency, structural differences in production relation between the small holdings and the estate sector are tested. For this, the above model is fitted separately for the selected farms of the selected districts in Kerala. In order to test the structural difference between two farms the analysis of Co- variation (Chow's F-Test) is carried out

$$F = \frac{\sum e^2 - (\sum e12 + \sum e22/ K}{\sum e12 + \sum e22/n_1+n_2 - 2K}$$

Where,

$\sum e^2$ = Unexplained or residual sum of squares of the pooled sample of both plantations.

$\sum e1^2$ = Unexplained or residual sum of squares of the sample corresponding small holdings.

$\sum e2^2$ = Unexplained or residual sum of square of the sample corresponding the estate sector.

n1 = Number of observations in small holdings n2 = Number of observation in estate sector

K = Number of parameters included in the regression equation.

The computed value of F* is less than the table value of F at appropriate level of significance for $(n_1+n_2 - 2K)$ degrees of freedom. Thus, the hypothesis that there is no structural difference in production relation between the two farms has been accepted. In this case, the structural differences in their production relation existed between the two farms, dummy variable may introduced both at the intercept and slope levels in order to find out whether at the intercept level or the slope level or in both the levels, the structural difference occurred or not.

The estimated results of structural difference in production relation for small and estate plantation have been depicted in table 6

Table 6 Equality Test Between Small And Estate Plantations Production Relation

$\sum e^2$	$\sum e1^2$	$\sum e2^2$	n1+n2-2K	F*	F at 1 % level
0.486	0.092	0.087	438	52.81	4.98

Source: Computed Data

Table 1.6 reveals that the computed F-value is found to be greater than its table value of F one per cent level with degrees of freedom. The computed value and table F value are 52.81 and 4.98 respectively. Thus, the null hypothesis has been rejected. Hence, it can be concluded that there are structural differences in production relation between the small holdings and the estate holders in the study area.

The regression model has been computed in order to study the structural differences in production relation between the small holdings and the estate sectors of the selected districts of Kerala.

$$\text{Log } Y = \alpha 0 + \sum_{i=1}^{6} \beta i \log Xi + \sum_{i=1}^{6} \gamma j \, D \log Xj + u$$

D in this equation is the dummy variable representing 0 and 1 for small and estate farms respectively. The regression equations and have been estimated by using the principle of least squares. The regression equation has been further fitted to find out whether the structural differences in production relation between the two farms existed at slope level and/or the intercept level. The results of the regression model have been furnished in table 7

Table 7 Test of the Stability of Intercept and Slop Between Small and Estate Plantations

Variable	Parameter Estimate	t-value
Size of the sample	367	-
α1	3.34	-
α1	3.83	2.62
β1	0.38	0.93
β2	0.20	3.28
β3	0.29*	6.64
β4	0.36	2.71
β5	0.46	3.63
β6	0.68*	4.02
γ1	-0.24	-0.62
γ2	0.23	1.86
γ3	0.34*	1.44
γ4	-0.32	-0.98
γ5	-0.33	-1.23
γ6	-0.29*	-3.78
R^2	0.96	-
F	143.81	-
$\sum e^2$	0.512	-

Source: Computed Data

*Indicates that the co-efficient are statistically significant at 5 per cent level

Table 7 infers that the co-efficient of dummy variable at the intercept level is not significant. It indicates that there is no difference with regard to technical change in production relation between both the farms. In estate sector, all the explanatory variables are positively related to the gross income. The co-efficient of plant protection number of bearing trees are statistically significant at 5 per cent level. It indicates that an additional percentage of these variables could increase gross income by 0.39 and 0.68 per cent respectively. The

structural differences in production relation between both plantations at the slope level are caused by the variables namely plant protection and number of bearing trees in the plantations. This indicates that an addition made to this variable is capable of increasing the gross income by 0.63 (0.29+0.34) per cent in estate sectors and 0.39 (0.68-0.29) per cent in the small holdings. It has been found out from the sample respondents that the numbers of bearing trees per hectares in the small holdings are in the range between 470 and 480 trees, where as in estate sector they have been 450 and 460 trees.

8.3 Estimating the marginal value productivity

The changes in gross income resulting from a change of a factor, keeping all the other factors constant, has been defined as the marginal value product of a factor, with the input-output ration and the marginal value productivity directly varies. The following equation has been derived to measure the marginal value products of the inputs.

$$MVP\ X1 = \beta_1 \frac{\overline{Y}}{\overline{X_1}}$$

$$MVP\ X2 = \beta_2 \frac{\overline{Y}}{\overline{X_2}}$$

$$MVP\ X3 = \beta_3 \frac{\overline{Y}}{\overline{X_3}}$$

$$MVP\ X4 = \beta_4 \frac{\overline{Y}}{\overline{X_4}}$$

$$MVP\ X5 = \beta_5 \frac{\overline{Y}}{\overline{X_5}}$$

$$MVP\ X6 = \beta_6 \frac{\overline{Y}}{\overline{X_6}}$$

Where,

$\overline{Y}$ and $\overline{X1}$ ..... $\overline{X6}$ are the geometric mean level of gross income and input factor respectively.

8.4 Marginal Value Productivity (MVP) of the Factors

The marginal value productivity of an input would indicate that an increase of input variable by one unit would

lead to an additional to the gross income concerned. The computed marginal value productivities by using the formula for the input variables are furnished in table 8

Table 8 Marginal Value Productivities of Factor Inputs at The Geometric Mean Level

Sl.No	Variables	Small Holdings	Estate Sectors
1	Human Labour	9.28	10.18
2	Cost of Cultivation Practices	6.72	8.13
3	Plant Protection	10.08	12.48
4	Age of the Plantation	569.42	843.62
5	Number of Bearing Trees	211.12	183.21

Source: Primary data

Table 1.8 infers that the marginal value products of all factor inputs are positive in both the small and the estate farms. This implies that income could be raised by employing an additional unit in these variables. A comparison of marginal productivities of inputs between the small holdings and the estate sectors revealed that the marginal value productivities of the variables human labour, age of the plantation, cost of the cultivation practices and plant protection are in the estate sector than in the small holdings. Whereas the marginal value productivities of other one variables namely number of bearing trees have been higher in small holdings than in the estate sectors. Thus the marginal value productivity analysis indicates the scope further augmentation of inputs with profit in general.

8.5 MVP and Acquisition Cost of Factor Inputs

The marginal value products of the input variables have been compared with their respective factor costs, in order to examine the resource use efficiency. The equality of marginal values product to factor cost is the basic condition to be satisfied in order to obtain efficient resource use for only controllable variables such as human labour, cultivation and plant protection, the resource use efficiency has been calculated. As there has been conceptual problems in the case of the age of the plantation and the number of bearing trees, the factor inputs such as human labour, cultivation practices and plant protection alone have been taken into consideration for examining the resource use efficiency in the study. At the price of Rs.300 and Rs.400 per man day the cost of human labour is calculated which is the prevailing wage rate in small holdings and estate sector during the period of the study. The cost of cultivation practices per day has been calculated at the price of Rs.400 and Rs.450 in small holdings and estate sector respectively. The actual amount spent by the plantations towards the cost of the plant protection is considered. The ratios of marginal value products to the respective cost of the factor inputs have been depicted in table 9

Table 9 Ratios of Marginal Value Products of Factor Costs

Sl.No	Holdings	Human Labour	Cost of Cultivation	Plant Protection
1	Small	0.73	0.32	10.08

2	Estate	0.92	0.47	12.48

Source: Computed Data

From table 1.9 it has been observed that the marginal value productivity and factor price ratio of plant protection have been greater than unity in both the factors. It infers that the natural rubber cultivation in both the plantations is found to be rational in the use of plant protection. The ratio of marginal value productivity to its cost of human labour and cost of cultivation practices has been unity in both the plantations. It infers that these variables are not being used efficiency by the natural rubber cultivation in these plantations. Estate sectors are found to be rational in the use of all the three input factors than in small natural rubber plantation in the districts of Kerala. Let us take the hypothesis that there is no significant difference between the annual and establishment cost of small holding and estate sector in natural rubber plantation. The correlation results is confirmed by the results of the analysis shown table 10

Table 10 Correlation Result of Annual And Establishment Cost of Natural Rubber Plantation in Small Holding and Estate Sector

Particular	**Cost of Estate Sector**	**Cost of Small Holding Sector**
Cost of Estate SectorCorrelation Pearson	1.000	.986**
Sig.(2-tailed)		.000
N	26.000	26
Cost of Small Holding Sector PearsonCorrelation	.986**	1.000
Sig.(2-tailed)	.000	
N	26	26.000

Source: Calculated Data

It is seen from table 10, that, there exists a positive correlation. Hence it may be concluded that the cost prevailing in the natural rubber plantations both small holding and estate are different. There is a linear relationship between the associated variables. Hence the null hypothesis is rejected at 5 per cent level of significance.

8.6 Size- Productivity Relationship

In order to study the nature of the relationship between the farm size and the productivity, the relationship equation has been fitted in the following form.

Log Q = Log C + B Log A

Where,

Q = Gross value of output in rupees at individual farm level

A = Size of the operational holding in hectares, and

C and B are parameters to be estimated.

The method of least square has been estimated from the equation for the existence of inverse of direct relationship between the farm size and productivity, the requisite condition is that the co-efficient of log A,

i.e,. B should be less than or greater than unity. In order to examine whether the co-efficient are statistically different from unity, the t-test has been computed.

8.7 Relationship Between Plantation-Size And Productivity

Economists have debated for over three decades, on the relationship between the plantation size and the productivity. The relationship observed between the farm size and productivity provoked economists to offer several explanations. An attempt has been made in this contest to examine the relationship between size and the productivity of the perennial crop of the natural rubber. Let us take the hypothesis that there is no significant difference between the farm size and the productivity of the natural rubber in small holding and estate sector. The equation has been estimated and the results have been revealed in table 11

Table 11 Estimated Regression Results of The Size Productivity Relationship in The Natural Rubber Cultivation

Sl.No	Farm	Sample Size	Log C	B	R^2
1	Small	338	6.03	2.63* (5.86)	0.89
2	Estate	29	6.47	2.98* (3.73)	0.93

Figures in Brackets are F-values

*Indicate that the co-efficient are statistically significant at 5 per cent level

The estimated regression results in table 1.10 reveals that the co-efficient is statistically significant for both the small holdings and the estate sectors. The t-test results reveal that the co-efficient has been statistically different from unity which confirms the existence of direct relationship between the farm size and the productivity. So the null hypothesis is rejected. To put it in other words, whenever the size of the farm increases the productivity of natural rubber also increases. The economics of estate sector operation has been attributed to the reason for the existence of such relationship.

9. Return on Capital Investment in Natural Rubber Plantations

Productivity measurement assumes importance as it facilities studying the efficiency of resource use. The problems of investment in perennial crops unlike the annual crops, the demand consideration in depth as its economic life span is more than a generation and once investments are made and the resources are committed no retrieval is possible. The magnitude of the problem further demands vast resources and the flow of income spreads over a number the years. In this section, productivity of the capital is measured by using i) Net Present Value (NPV), ii) Benefit-Cost (BC) Ratio. iii) Internal Rate of Return (IRR) and iv) Pay-Back Period.

9.1 Net Present Value (NPV)

The net present value tries to project the feasibility of cultivation. It is the difference between the present worth of benefits and the present worth of costs. The positive net present value indicated worthiness of investment in rubber plantation. This has been expressed as follows:

$$NPV = \sum_{n} \frac{Bn - Cn}{- - - - - - - -}$$

$$t=1 \qquad (1+i)^n$$

Bn = Benefits in n^{th} year
Cn = Costs in n^{th} year
n = number of years (1 to 26 years); and
i = Discount rate (15 per cent)

The estimated annual margin depends upon the discount rate used in the computation. The discount rate should be equal to the opportunity cost of capital. The National Bank for Agricultural and Rural Development (NABARD) considered agricultural projects which yields a return of 15 per cent as an economically viable project. From the analysis, the net present value of returns from one hectare of natural rubber cultivation has been found out to be Rs.263310.06 for small holdings and Rs.289322.86 for estate sector at a discount rate of 15 per cent that indicated the soundness of investment of natural rubber plantation in both the sectors. Investment of the natural rubber in estate farm is economically more feasible than in the small holdings.

9.2 Benefit-Cost Ratio (BCR)

It shows how much benefits can be generated per rupee of investment. The benefit-cost ration is the ratio of the sum of discounted net benefits with the sum of discounted capital costs. The benefit-cost ratio is mathematically expressed as

$$BCR = \frac{\sum_{t=1}^{n} \frac{Bn}{(1+i)^n}}{\sum_{-t=1}^{n} \frac{Cn}{(1+i)^n}}$$

When the benefit-cost ratio exceeds one, the investment is considered viable. To test the worthiness of the investment the other indicator used is the benefit cost ratio. This reveals the amount of benefit that can be generated per-rupee of cost. In small holdings benefit cost ratio is 2.53 and it is 2.57 for estate sector. This demonstrates the profitability of the natural rubber both in the small and the estate sectors in the study area.

9.3 Internal Rate of Return (IRR)

It is the discount rate which just makes the net present worth of the cast flow equal to zero i.e,. the benefit-cost ratio calculated at internal rate of return is unity. Internal rate of return is that discount rate 'i' such that

$$IRR = \sum_{t=1}^{n} \frac{Bn - Cn}{(1+i)^n} = 0$$

when the calculated internal rate of return is more than that of the market rate of investment than the investment is considered viable. In small holdings and estate sector farm the internal rate of return has been 27.62 per cent and 29.43 per cent respectively which has been greater than the prevailing interest rate of 15 per cent. It has been observed that the investment made in natural rubber cultivation is profitable.

9.4 Pay-Back Period

Pay-back period is an undiscounted measure of worthiness of an endeavour which measured the efficiency of

cultivation by indicating the period within which returns offset the investment. The length of time required to pay back period is known as pay-back period. The payback period for the investment made in small holding and estate sector of natural rubber cultivation has been worked out to 13.59 years and 12.32 years respectively. Thus, it is inferred that the estate sector cultivation will recoup the investment earlier than the small holdings.

10. Conclusion

The results of regression co-efficient of the small holdings and the estate sector reveals that among the five inputs variables, three variables namely, human labour, plant protection and the number of bearing trees have influence on the gross income of the natural rubber in small holdings and estate sector. The Chow's test inferred that there is a structural difference in production relation between the two farms in the study area. The test of the stability of intercept and slope revealed that the structural difference existed only at slope level between small holdings and estate sector and not at intercept level. With regard to the marginal value productivity, the marginal value productivities of all factor inputs are found to be positive in both plantations. Hence, it indicates that there is a scope for further increasing the input with profit. The resource use efficiency the ratio of marginal value products to their respective cost, it has been found out that the variables human labour and cost of cultivation practices are under utilised whereas in the case of plant protection, plantation of both the farms have been found to be rational in its use. With regard to the return on the investment of capital the net present value indicated the soundness of investment of the natural rubber cultivation in both the plantations. The investment on the natural rubber in the estate sector has been economically more feasible than in the small holdings. The benefit cost ratio reveals the profitability of natural rubber cultivation in both the plantation in the study area.

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