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Research Article

Economics of Rubber Production in Jhapa, Nepal

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ABSTRACT

A study was conducted to examine cost structure and economic feasibility of rubber production in Jhapa district. It also aimed to assess determinants of increment in acreage of rubber cultivation in the study area. A total of sixty two rubber growers were selected by simple random sampling and interviewed with pre-tested semi structured schedule on the month of March, 2019. Study revealed that the total cost of natural rubber production per hectare of rubber orchard was 499774.8 NRs. /year. It was found to be economically viable and cost effective as indicated by satisfactory values of Benefit Cost Ratio (1.5), Net Present Value of NRs. 686547 at a discount rate of 12 percent and Internal Rate of Return 18 percent. Probit model revealed that trainings received, experience of rubber farming, ethnicity and membership in community organizations were significant factors that positively affected farmers' decision in expanding rubber cultivation area. Received trainings solely could increase probability of acreage increment by 36.9 percent. Thus, it is recommended that extension services like training, farmers' field school, and farm visits should be intensified for increment of profitability from rubber farming in Jhapa, Nepal.

Keywords: Benefit Cost Ratio; Internal Rate of Return; Net Present Value; Probit model; Rubber

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INRODUCTION

The natural rubber obtained from Para rubber tree i.e. *Hevea brasillensis Mull. Arg*. is one of the most important renewable resources of modern times, being a pillar of industrialization and classified as a strategic resource (Puttarudraiah, 1983). Originally collected from Amazonia's old growth forests, it is nowadays mainly produced in Asian plantations (Min et al., 2019).

Natural Rubber is an important agricultural commodity, which is used for manufacturing a wide range of products (Fox & Castella, 2013). It is used in automotive, consumer good, manufacturing, and medical industries. Rubber market is centered in the Asia-Pacific region. Rubber planting was introduced in Nepal in the early 1970s but never achieved a great success (PMAMP, 2019). Despite the climatic suitability of rubber cultivation in Jhapa, the production and productivity of this region is marginally low. In Nepal, consumption of rubber is always higher than the production and the production- consumption gap is likely to widen as the rate of increase in consumption is faster than that of production. This calls for larger quantities of import of both natural and synthetic rubber. According to Central Bureau of Statistics (2018), the export of rubber and rubber related goods was worth NRs.18207000 in 2018 while total imports of the same year was worth NRs.8307815000. Thus, Nepal suffered a trade deficit of NRs.82896 08000 in the aforesaid year. So, there is scope of fulfilling this gap by expanding rubber plantation in suitable areas.

According to the different feasibility studies and pilot projects conducted by Gorakhkali Rubber Udhyog Ltd. and Sudha Falras Private Ltd., together with the Department of Agricultural surveys in Nepal in the year 2047 B.S., more than 15,000 hectares of marginal productivity areas are potential for commercial rubber farming in Jhapa, Morang, Sunsari and lower parts of Ilam districts. As a high value -cash crop, value-added enterprise and demanding domestic market, Nepal needs more than 12,000 metric ton of raw material and rubber related consumption if the rubber industries are allowed to run full scale. Though, it is an urgent need to promote the potential of rubber commercial farming in Nepal, no comprehensive study has been done yet on the economics of rubber growers. The information generated in this study will throw light to the planners, policy makers and financial institutions to formulate suitable policy package for rubber plantation programmes.

MATERIALS AND METHODS

Study area

The study was carried out in Jhapa district, Nepal where Prime Minister Agriculture Modernization Project (PM-AMP), Project Implementation Unit, Rubber zone has been implementing. The study site is one of the eastern Terai districts and a part of Province No. 1 of Nepal. The district covers an area of 1606 square kilometers with total population of 812,650 (CBS, 2011).

Data collection and sampling procedure

For the study purpose, 5 municipalities of Jhapa district namely Kankai, Arjundhara, Mechi, Bhadrapur, Damak and 3 rural municipalities namely Buddhashanti, Barhadarshi and Kachanakawal were selected by simple random technique. Altogether 62 households were taken under consideration by simple random sampling technique.

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Primary data were collected through administering pre-tested semi-structured interview schedule, Focus Group Discussion (FGD) and Key Informant Interview (KII). FGD was conducted in a group of 8 progressive rubber farmers during preparation of checklist and KII's were conducted with representative of farmers' group, executives of cooperatives for cross-verification of data. Likewise, secondary data sources were Central Bureau of Statistics, various journals, reports from Ministry of Agriculture and Livestock Development, Agriculture Knowledge Centre, Jhapa and PM-AMP, Jhapa.

Data analysis
Qualitative and Quantitative analysis was done using SPSS version 25, Ms-Excel 2007 and STATA version 12.1.

Costs, Returns and Profitability
Total costs are the sum of total fixed cost and total variable costs (Babu, 1989). When no variable input is used, TC=TFC. Symbolically,

$$TC = TFC + TVC$$

Where, TC = Total cost, TFC = Total Fixed Cost, TVC = Total Variable Cost

Variable cost refers to recurring type of costs and is also called operational cost or working cost. Total variable cost is computed by multiplying the amount of variable input by per unit price of input. In the study, following variable costs were undertaken:

$$TVC = C_{labour} + C_{manure} + C_{fertilizers} + C_{others}$$

Where, C_{labour} = Total cost of labour in NRs., C_{manure} = Total cost of manure in NRs., $C_{fertilizers}$ = Total cost of chemical fertilizers in NRs., C_{others} = cost of saplings, pesticides, weedicides, rubber coat, formic acid in NRs.

Fixed cost refers to the cost that remains unchanged irrespective of the level of output produced. In this study, land rent, depreciation of tools, equipments, machineries were included under fixed cost.

$$TFC = C_{land\ rent} + C_{depreciation}$$

Where, $C_{land\ rent}$ = Total land rent per year in NRs. and $C_{depreciation}$ = Total depreciation cost in NRs.

Depreciation was computed using straight line method at the rate of 10% per annum on an average for different equipments used in rubber orchards such as tapping knives, latex bowl, wire, bucket, drum, motor, pump set etc.

Benefit-Cost Ratio (BCR) refers to the ratio of discounted benefit to discounted cost. BCR greater than 1 indicates the investment yields profit and feasibility of business (Rae, 1977) . BCR was worked out by using following formula:

BCR= Discounted Benefit / Discounted cost

Net Present Value (NPV): NPV is the present worth of the benefit less the present worth of the cost. The NPV of cash flows have been computed as given by Yogish (2017):

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$$NPV = \sum_{n=0}^{t} \frac{Bt - Ct}{(1+r)t} \quad \text{……….. (1)}$$

Where, B_{t} = benefit from rubber plantations in each year,
C_{t} = Cost of rubber plantations in each year,
r = discount rate,
t = 1, 2, 3 …….n, the entire plantation across the study region (comprising six years of immaturity period, followed by 23 years of rubber production cycle)
n = number of years

Internal Rate of Return (IRR): IRR is the discount rate that would be required to make the present value of the costs of farming operations equal to the present value of benefits accrued from rubber plantations (Goswami & Challa, 2007). Derivation of the IRR is analogous to solving for 'r' in the equation 1, as:

$$0 = \sum_{n=0}^{t} \frac{Bt - Ct}{(1+r)t}$$

Gross return of a particular enterprise is the total revenue earned from the enterprise. It was obtained by multiplying quantity of rubber produced with average price per kg of rubber.

Conceptual issues in estimating cost of production of Natural Rubber

Rubber plant has a gestation period of 6-7 years followed by 15-30 years of yielding phase (varies with the type of cultivars, level of crop management and type and skill of tapping). However, for adopting a uniform accounting procedure, its economic life span was assumed to be 24 years based on the opinion of experts and farmers. For estimating economics and investment analysis, perennial crops like rubber require inter-temporal analysis (Rae, 1977). Hence to account for the value of time and to include the concept of time preference, a cash-flow analysis of rubber plantations is attempted following the undiscounted and discounted cash flow approach as suggested by (Predo, 2003) and (Binang et al., 2017). Since the collection of time series data pertaining to single farm holding is difficult, the analysis of the life cycle data was made based on the cross sectional information from rubber holdings of different ages to approximate the entire plantation life cycle (Bastian et al., 2004). Sample of farmers was selected in such a way that all the age group is represented and thus, the data on cost and returns for the year 2018-19 was collected.

To carry out the feasibility analysis, it was assumed that cost and returns of rubber would remain the same as those of the eleventh year in the remaining years as indicated by Aja & Ugwu (1992) in his research of oil palm. Yield and returns were calculated on per hectare basis. A discount factor of 10% and current prices were used to work out the present worth of costs and benefits.

Probit regression model

Probit regression model can be used to assess the factors affecting adoption of agricultural practices (Eugene, 1989). In this study, Probit model was used to identify the factors influencing
farmers' decision in expanding rubber cultivation area. This model was used to identify the determinants (regressors) of increment in rubber acreage.

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Let us suppose, Yi is the binary response of farmer where Yi = 1 if farmer expands rubber cultivation area and Yi = 0 if farmer doesn't expand rubber cultivation area.

Model specification

The Probit model specified in this study to analyse farmers' decision in increment in acreage of rubber plantation was expressed as follows:

Status (yes = 1) = $b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 + b_8X_8 + b_9X_9 + b_{10}X_{10} + e_i$

Where,

Status (yes = 1) = Probability score of famers' decision to expand rubber cultivation area

X_1 = Age of respondent (years)

X_2 = Ethnicity of household (Dummy)

X_3 = Major occupation of household head (Dummy)

X_4 = Economically active family members (Dummy)

X_5 = Family type (Dummy)

X_6 = Membership in organization (Dummy)

X_7 = Total owned land (bigha)

X_8 = Experience in rubber farming (years)

X_9 = Training (Dummy)

X_{10} = Subsidy (Dummy)

$b_1, b_2 \ldots\ldots b_{12}$ = Probit coefficient

b_0 = Regression coefficient

Table 1. Description of variables used in Probit model

Variables	Type	Description	Value	Expected sign
Dependent variable Y_i	Dummy	Farmers' decision in expanding or not rubber cultivation area	1 if farmer decides to expand, otherwise 0	
Independent variables				
Age	Continuous	Age of the respondent	Number	+/-
Ethnicity	Dummy	Ethnicity of the respondent	0 if Brahmin/ Chhetri, 1 otherwise	+/-
Occupation	Dummy	Major occupation of the respondent	0 if agriculture, 1 otherwise	+/-
Economically active family members	Continuous	Number of economically active (15-59) family members	Number	+/-
Family type	Dummy	Family type	0 if nuclear, 1 otherwise	+/-
Membership	Dummy	Membership in community organizations	0 if yes, 1 otherwise	+
Total owned land	Continuous	Total owned land in bigha	Number	+
Years of rubber cultivation	Continuous	Experience in rubber farming in years	Number	+
Training	Dummy	Whether farmer has received training about rubber cultivation practices	O if yes, 1 otherwise	+
Subsidy	Dummy	Whether farmer has received subsidy in any form regarding rubber plantation	O if yes, 1 otherwise	+

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RESULTS AND DISCUSSION

Socio-economic characteristics

The average age of respondents was 45.15 years with 12.15 years of rubber farming experience. The average household (HH) size was found to be 6.11 and majority of the respondents were Brahmins/ Chhetris (63%) followed by Adibasi/Janjati (27.5%). 93.55% of the respondents were male and 6.45% were female. Likewise, 95.2% of the respondents were literate and remaining 4.8% were still illiterate in the study area. Livestock Holding Unit was 4.76 and Dependency Ratio was 0.36. The average rubber orchard holding area was found to be 1.31 hectare.

Cost of Establishment

Economics play a major role on the sustainability and development of rubber farming enterprise. Though technical efficiency is mandatory in rubber farming, if the farm is uneconomical in commercial aspect, it is of no use (Dey, 2011). Table 2 presents the cost of establishment per hectare per year in the study area. The cost of establishment was estimated by taking into account the actual physical units of inputs used and the prevailing market price. The data was collected from the selected sample farmers having immature rubber plantations. Cost of establishment comprised of expenditure incurred during the first year and maintenance cost subsequently up to the seventh year. This cost was estimated at NRs. 499774.8/ha. Cost of establishment showed that planting materials formed the single largest component of cost accounting for 53% of the total establishment cost. This result is in conformity with the findings of Anuja (2012). The next important item was expenditure on land rental value which constitutes 21.15% in the total cost of establishment. Other components of establishment cost were depreciation of farm implements (8.5%), planting cost (2%) and FYM cost (3.74%).The breakup of establishment cost showed that the cost incurred during the first year was the highest (35.45%). This was due to the initial cost of planting materials, increased utilization of labour in land preparation, planting etc. The costs incurred during the rest of the years declined as the period passed on.

Table 2. Establishment cost of rubber plantations in Jhapa (per hectare)

Operations	Amount invested by years (NRs./ha)							
	Year I	Year II	Year III	Year IV	Year V	Year VI	Total	Percentage share
Fixed cost								
Land rental value	44460.38	44460.38	44460.38	44460.38	44460.38	44460.38	266762.3.	53
Depreciation	6706.08	6706.08	6706.08	6706.08	6706.08	6706.08	40236.52	8.5
TFC	51166.47	51166.47	51166.47	51166.47	51166.47	51166.47	306998.82	61.5
Variable cost								
Planting materials	105803.33						105803.33	21.15
Land preparation	55082.93						55082.93	11.61
Planting cost	13192.26						13192.26	2
FYM	3116.22	3116.22	3116.22	3116.22	3116.22	3116.22	18697.28	3.74
TVC	177194.7	3116.22	3116.22	3116.22	3116.22	3116.22	192775.9.	38.5
Total Cost							499774.8	100

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Cost of Maintenance

The cost of maintenance was estimated based on the data collected from the sample farmers having eighth-year-old rubber plantations. The cost of maintenance for rubber plantations remains more or less the same from the eighth year onwards. The cost of maintenance of rubber plantations in Jhapa is shown in Table 3. From the table, it could be seen that the cost of tapping is the major item of the maintenance cost. The tapping cost formed NRs. 499774.8/ha/Yr constituting 64.96% of the total maintenance cost. Expenditure on manure and its application was the next important variable cost accounting for 1.85% of the total maintenance cost, followed by chemicals[1] (1.85%) and chemical fertilizers (1.37%). Similar results were found in study of Joseph and Kumar (2016).

Table 3. Maintenance cost of rubber plantations in Jhapa (per hectare per annum)

Operations	Cost (NRs.)	Percentage share
Fixed costs		
Land rental value	44460.38	26
Depreciation of implements	6706.08	4
TFC	51166.47	30
Variable costs		
Manure	3116.22	1.82
Chemical fertilizers	2350.03	1.37
Chemicals[1]	3154,75	1.85
Tapping cost	110994.2	64.96
TVC	119615.22	70
TC (TFC + TVC)	170781.7	100

Chemicals[1] = rubber coat, formic acid, weedicides

Cost and return analysis

The total cost of rubber production in one bigha of orchard for thirty years considering farmer's practices was estimated to be NRs.499774.72. The variable cost and fixed cost was accounted to be NRs. 329851.31 (66% of total cost) and NRs.169923.4 (34% of total cost) per hectare respectively. The average yield of rubber sheet in the study area was 1062.7 kg/bigha. The average price of sheet rubber was NRs. 180/kg and latex was NRs.55/L. The gross return was estimated at NRs.749662.08/ha/Yr. The net return over total cost of production was NRs. 249887.36.

The data presented in Table 4 showed that the present worth of cost and returns were NRs. 2094216 and NRs. 3141324/ha respectively. The benefit cost ratio was estimated to be 1.5. The Net Present Value of the stream of returns from one hectare of rubber plantations worked to NRs. 686547/ha at a discount rate of 12%. The high positive Net Present Value indicates the soundness of the investment. It could be seen from the table that the Internal Rate of Return was 18 percent for the expected life span of 30 years. The Internal Rate of Return value was above the market rate of interest which clearly illustrates the 'high pay off' nature of the investment.

The result was in line with Goswami and Challa (2007) and Maibangsa et al. (1993). Similar results were found by Dey (2011) where BCR from rubber plantations at 12 percent discount rate was found to be 2.03 indicating rubber farming as a profitable farm enterprise and NPV

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for the entire life period was IRs. 500858.18 in West Tripura. Overall, the analysis indicates that rubber plantation as prevalent in the study region brings out that rubber as a single crop is a resilient system provided the price remain remunerative and marketing practices transparent and effective.

Table 4. Capital productivity in rubber plantations in Jhapa

Particulars	Value
Present Worth of cost (NRs./hectare)	2094216
Present Worth of returns (NRs./hectare)	3141324
Net Present Value (NRs./hectare)	686547
Internal Rate of Return	18%
B/C ratio	1.5

Determinants of acreage increment in rubber plantation

To identify the factors affecting farmers' decision on area expansion of rubber farming in Jhapa district, Probit regression model was used. Respondents were found either expanding rubber cultivation area or not expanding at all. The respondents expanding rubber cultivation area were designated as expanders (1) and else were designated as non-expanders (0). The regression coefficients and other details of factors considered in the model are shown in Table.

Table 5. Factors affecting farmers' decision in acreage increment of rubber plantations in Jhapa

Factors	Coefficients	Std. Error	Z	P>|Z|	dy/dx[b]
Age of respondent (years)	0.0112	0.257	0.44	0.662	-0.001
Ethnicity (Brahmin = 0, Janjati =1)	1.214*	0.726	1.67	0.095	0.194
Major Occupation (Agriculture = 1, else = 0)	1.416	0.98	1.45	0.148	0.177
Economically active member (number)	-0.204	0.281	-0.07	0.942	-0.003
Family (0 = nuclear, 1= joint)	-0.041	0.695	-0.06	0.952	-0.006
Organisation membership (0=Yes, 1=No)	2.016**	0.84	2.4	0.016	0.431
Total owned land (bigha)	0.075	0.255	0.29	0.768	0.111
Experience in rubber farming (years)	0.101*	0.060	1.66	0.097	0.014
Training(Yes=0, No=1)	1.598**	0.753	2.12	0.034	0.369
Subsidy (Yes=0, No=1)	0.641	0.607	1.05	0.292	0.109
Summary statistics					
Number of observation			62		
LR chi^2 (11)			47.64		
Prob>chi^2			0.0000		
Pseudo R^2			0.6001		
Log likelihood			-15.87		

** Significance at P<0.05, * Significance at P<0.1
[b] Marginal change in probability (marginal effect after Probit) evaluated at the sample means

The Pseudo R^2 was 0.6001 which implies that the variables included in the model are able to explain 60% of probability of household decisions to expand or not expand rubber farming. The Log-likelihood Ratio (LR) was found to be significant at 1% level. This means that all the explanatory variables included in the model jointly influence farmer's probability of expansion of rubber cultivation area. Thus model can be said consistent and meaningful.

The dependent variable i.e. increment in acreage of rubber cultivation was regressed upon the ten independent variables namely age of respondent, ethnicity, major occupation, family type,

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membership in community organization, total owned land, years of rubber farming, training and subsidy status. Among these factors, four factors considered in the model were found to be statistically significant for the acreage increment in rubber plantation. Training received by farmers and membership in community organization were found to be statistically significant at 5% level of significance while ethnicity of farmers and experience in rubber farming were found to be significant at 10% level of significance. The other factors like age, occupation, family type, total owned land, economically active population and subsidy status of farmers were found to have no any significant effect on area increment in rubber plantation.

The coefficient of training status was positive and significant at 5% level. It means that if a farmer has received training about rubber cultivation practices, the probability of area expansion of his rubber orchard increases by 36.9 percent keeping other factors constant. This reveals that rubber farming is technology intensive and farmers need training to enhance skill to grow rubber plant. This result is in line with the findings of Panta (2001) and Doss (2006).

Membership in community organization was found positively significant at 5% level. Participation in social groups enhances the capital allowing trusts, dissemination of idea and exchange, which increases probability of expanding rubber cultivation area. Access to information through community organization membership reduces the uncertainty about a technology's performance and hence may change individual's assessment from purely subjective to objective over time thereby facilitating adoption. Membership in community organization was also found to be positively related to the expansion in rubber cultivation area with probability of 43%. This means that farm households are more likely to expand rubber cultivation if they have membership in community organizations. This finding is in conformity with findings of Besley and Case (1993), Subedi and Dhakal (2015), and Kunwar et al. (2015). The sign of years of rubber farming was as expected and positively significant ($p<0.1$) which implies that famers' decision in increment in rubber cultivation area increases with the increase in years of rubber cultivation. The more the experience of farmers in rubber farming more is the level of increment in rubber cultivation area. This result is in line with the findings of Kunwar et al. (2015).

Similarly, ethnicity of the household was also found a significant factor to influence farmer's decision on expansion of rubber cultivation area in the study area. If a farmer is Janjati, probability of the household to increase their rubber cultivation area increases by 19.4% which was statistically significant at 10% level of significance. Rubber farming is a less prioritized farm enterprise by Brahmin/Chhetri households of the study area. Similar results were found in studies of Kafle (2010) and (Timsina et al., 2019).

CONCLUSION

This study showed that natural rubber production enterprise is a profitable venture with B/C ratio 1.5, IRR 18% and Net Present Value of NRs. 686547 but the profitability can still be increased. Strengthening of extension services, subsidization and more training on scientific tapping procedure are essential needs of the study area. Membership in community organizations, training status, experience of rubber farming and ethnicity are found to be determinants in influencing farmers' decision to expand rubber cultivation area. Government intervention in terms of separate policy amendment addressing needs of rubber farming,

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rubber market promotion as well as networking and proper extension services is necessary to increase profitability of farmers and promotion of agribusiness enterprise.

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Author Contribution

M.P designed and performed experiments; M.P, P.A, A.B, S.P and K.T analyzed the data and M.P. prepared the manuscript in consolation with S.D. and R.M.; S.D approved the final manuscript.

Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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