**ECONOMICS OF RUBBER PRODUCTION IN JHAPA DISTRICT,**

**NEPAL**

**MOUSAMI POUDEL**

**JULY 2019**

**ECONOMICS OF RUBBER PRODUCTION IN JHAPA DISTRICT, NEPAL**

**MOUSAMI POUDEL**

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This research report entitled **“ECONOMICS OF RUBBER PRODUCTION IN JHAPA DISTRICT, NEPAL”** prepared and submitted by **Ms. MOUSAMI POUDEL,** under Learning Entrepreneurial Experience Program as an integral part of Bachelor of Science in Agriculture.

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# ACRONYMS

%: Percentage

ADS: Agriculture Development Strategy

AFU: Agriculture and Forestry University

AICC: Agriculture Information Communication Centre

APP: Agricultural Perspective Plan

CBS: Centre Bureau of Statistics

DADO: District Agricultural Development Office

̊ C: Degree Celsius

FAO: Food and Agriculture Organisation

FDD: Fruit Development Directorate

FGD: Focus Group Discussion

GDP: Gross domestic product

GON: Government of Nepal

Ha: Hectare

HDI: Human Development Index

INGOs: International Non-Governmental Organization

KII: Key Informant Interview

Kg: Kilogram

Km: Kilometer

LEE: Learning by Entrepreneurial Experience

Masl: Meters above sea level

Mm: Millimeter

MOALD: Ministry of Agriculture and Livestock Development

MT: Metric ton

MS-Excel: Microsoft Excel

NARC: Nepal Agricultural Research Council

NGOs: Non-Governmental organization

NHPC: Nepal Horticulture Promotion Centre

No.: Number

NPC: National Planning Commission

NRs. Nepali Rupees

PM-AMP: Prime Minister Agriculture Modernization Project

RM: Rural Municipality

SPSS: Statistical Package for Social Science

Sq. km: Square Kilometer

TU: Tribhuwan University

UNDP: United Nations Development Program

VDC: Village Development Committee

# 

**ABSTRACT**

Name: Mousami Poudel Reg. No.

Semester and year of admission: First, 2014 Degree: B.Sc.Ag.

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A study was conducted to analyze economics of rubber production in Jhapa district. It also aimed to assess the determinants of increment in acreage of rubber cultivation and major problems involved in production and harvesting of rubber cultivation in the study area. A total of sixty two growers were selected by simple random sampling technique and interviewed with pre-tested semi structured interview schedule. Descriptive statistics, chi-square test, independent sample t-test and Probit model were used for data analysis using SPSS, MS- Excel and Stata software. Farmers were categorized into large scale (n=31) and small scale (n=31) category based on the area under rubber farming. The average area under cultivation was 1.94 bigha and overall average rubber yield was 1062.7 kg/bigha. Rubber farming was found to be a profitable farm enterprise with benefit cost ratio 1.5, Net Present Value of NRs. 4,63,882 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 could increase probability of acreage increment by 36.9 percent. Similarly, membership of the farmer in community organizations could increase the probability by 43.1 percent. Unavailability of skilled tappers, poor technical knowledge, unavailability of quality inputs, lack of infrastructures, loss due to improper processing and problem of insects, pests were the major production problems of rubber cultivation in Jhapa district. Similarly, high price fluctuation, non-remunerative price, presence of middlemen, delay in payment and poor marketing infrastructures were the major marketing problems of rubber in the study site.

Asst. Prof. Surya Mani Dhungana Mousami Poudel

Major Supervisor Author

# 1. Background Information

## 1.1. Introduction

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. Originally collected from Amazonia’s old growth forests, it is nowadays mainly produced in Asian plantations (Min *et. al.*, 2019).

Natural Rubber is a vital agricultural commodity, which is used for manufacturing a wide range of products (Rao, 2012). It is used in automotive, consumer good, manufacturing, and medical industries. Rubber market is centered in the Asia-Pacific region (George & Chandrashekhar, 2014). Thailand is the world's leading producer of natural rubber accounting for nearly 34% of the total output followed by Indonesia and Malaysia. In 2017, China was the world’s largest importer of natural rubber with import value of USD 684.8 thousand; it was also the largest consumer of natural rubber, consuming around 40% of the total global output (Hayashi, 2009). According to Association of Natural Rubber Producing Countries (2019), the [world consumption of natural rubber](http://www.anrpc.org/html/news-secretariat-details.aspx?ID=9&PID=39&NID=1984) increased to 5.82 million metric ton during the period from January to May 2018,  It was a 6.2%, year-on-year, increase in the global consumption.

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, 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. Survey reports of Indian Rubber Board Expert team (1994) and Department of Agriculture, National Industrial Crop Development Program, Harihar Bhawan, Lalitpur (2012) indicate that the rubber plantation in the eastern Nepal have the prospects of generating more than 15,000 direct jobs and contribute significantly towards poverty alleviation. Thus, it is an urgent need to promote the potential of rubber commercial farming in Nepal and its export of surplus and commercialization in the globe

## 1.2 Statement of Problem

Rubber planting was introduced in Nepal in the early 1970s but never achieved a great success (PMAMP, 2018). Despite the climatic suitability of rubber cultivation in Jhapa, the production and productivity of this region is marginally low. The economic importance of rubber plantation in Nepal hardly needs any emphasis. Rubber plantations supply raw materials for the production of many industrialized goods required for automobiles, aircrafts, railways, textile industries, sports goods, and engineering goods and even for building roads. On account of the multifarious uses to which rubber can be put to, the consumption of rubber in the world as well as in Nepal has been increasing steadily.The factors responsible for less production and productivity of rubber in Nepal and subsequent measures to rectify these problems are yet to be identified.

Rubber farming is a profitable enterprise. However, it is difficult for barely trained Nepalese farmers to understand the technicalities of rubber production. Tapping is the most costly activity in natural rubber production and the shortage of skilled tappers is a serious problem in rubber plantations in Jhapa. Also, rubber cultivators in Jhapa are mainly small growers and any financial constraints, fluctuations in price or backwardness in technology affect the growers considerably.

Lack of infrastructures for processing of latex such as unavailability of smoke house, rolling machine, anticoagulants is one of the major bottlenecks for this sub-sector development. Lack of improved and high yielding varieties also hinders commercialization of rubber growers. Due to these problems, farmers are not able to trap the opportunity although there has been much prospect on rubber cultivation. To cope this problem, there is need for studying the different aspects of rubber plantation. Government intervention in terms of separate policy amendment addressing needs of rubber farming, rubber market promotion as well as networking and proper extension services is necessary to increase profitability of farmers and promotion of agribusiness enterprise.

But, no groundwork has yet been laid in Nepal to initiate systematic research work on rubber plant in particular. This study intends to bridge this information gap on production aspect of rubber plantation.

## 1.3 Rationale of Study

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.1,82,07,000 in 2018 while total imports of the same year was worth NRs.8,30,78,15,000. Thus, Nepal suffered a trade deficit of NRs.8, 28, 96, 08,000 in the year 2018. So, there is scope of fulfilling this gap by expanding rubber plantation in suitable areas.

The climatic condition of Jhapa district is best suitable for many agricultural crops. The Terai belts of this region have huge potential for rubber production and rubber-based agri-enterprises. Survey reports of Indian Rubber Board Expert team (1994) and Department of Agriculture, National Industrial Crop Development Program, Harihar Bhawan, Lalitpur (2012) indicate that the rubber plantation in the eastern Nepal have the prospects of generating more than 15,000 direct jobs and contribute significantly towards poverty alleviation. However, the comparative advantage of rubber for this region is not yet seriously exploited. PM-AMP has prioritised rubber in Jhapa district and established rubber zone in Bhadrapur municipality (PM-AMP, 2018). Rubber plantation in eastern Nepal have the prospects of generating more than 15,000 direct jobs and contribute significantly towards poverty alleviation (NICDP, 2012). The efforts for commercialisation of rubber in Jhapa are still lacking and researches are very limited despite the strong domestic demand.

From the foregoing information, it can be inferred that research study covering economics of rubber plantation is absolutely lacking in Nepal. A better understanding of the economics of rubber farming in terms of cost, return, productivity and marketing is essential for efficient planning and programming. Therefore, a study has been undertaken to know various aspects of rubber cultivation and to provide vital information about the prospects of rubber cultivation in Jhapa district. In this context, the present study would be a pioneering attempt at analyzing the economics, determinants and problems of the rubber plantation industry in the country. Present findings will be useful as a guide to producers, planners, investors, project implementers to understand scope as well as identify bottlenecks of rubber subsector development and make necessary amendments for maximizing rubber production and profitability of farmers.

## 1.4 Objectives of the study

### 1.4.1 General objective:

a. To assess the economics of rubber plantation in Jhapa district**.**

### 1.4.2 Specific objectives:

a. To examine the cost structure and financial feasibility of rubber plantation.

b. To find out major problems and practices involved in rubber plantation.

c. To investigate the determinants of acreage increment in rubber plantation.

# 2. Review of Literature

Natural rubber (cis-1, 4-polyisoprene), a secondary metabolite, is synthesized in at least 2,000 species of plants belonging to 300 genera. However, the rubber tree (*Hevea brasillensis*) is the only economically viable source of natural rubber due to its good yield of rubber and the excellent physical properties of the rubber products. In the rubber tree, latex is produced in the highly specialized cells, called laticifers in phloem. When the bark is tapped the cytoplasmic contents of these laticifers are expelled in the form of latex (Zhu & Zhang, 2009).

The latex is a renewable resource that can be sustainably tapped without harming the tree. Rubber is water-resistant, does not conduct electricity, is durable and most importantly, is highly elastic. These useful properties are due to the large and complex molecular structure of rubber (Rogers, 1981).

Natural rubber is a highly valuable and strategically important biomaterial; unlike most other biopolymers, it cannot be replaced by synthetic materials in many of its applications. For example, heavy-duty tires for trucks, buses, and airplanes, as well as many latex products for the medical profession, cannot be made exclusively from synthetic rubber, or only at a significantly higher cost (Perumal *et. al*., 2013). The natural rubber produced is processed to convert into a storable and marketable form. The basic property of rubber is that it comes back of its original shape if it is twisted or stretched but if heat is applied to the rubber, it won’t return to its original shape easily (Duke, 1983).

The rubber industry produces wide range of products like auto tire, auto tubes, automobile parts, footwear, belts, balloons, gloves, cables and wires, battery boxes etc to engineering and industrial applications. Felled plantation trees are used for timber - rubber wood - which has important uses in the furniture industry. The seeds contain oil that can be used in making paints and soaps (Bhowmik, 2002).

Rubber generally has a high viscosity which, for freshly prepared natural rubber, ranges from 55-90 centipoise. In storage and during transit, the viscosity of natural rubber increases to 70-100 centipoise depending on the duration (Karunakaran, 2017).

Owing to its high structural regularity, natural rubber tends to crystallize when stored at low temperature or when stretched. The strain-induced crystallization behaviour gives natural rubber its unique high tensile strength in pure gum or in non-reinforcing filler vulcanisates.

Natural rubber has an intrinsic density of about 0.92 g/cm3and a bulk density of 0.85 g/cm3. It has a tendency to cold-flow unless restricted by physical constraints (Tatek *et. al*., 2018).

## 2.1. Properties of rubber latex

Properties of rubber depend on the processing of the raw product after collection in the field. Properties of latex concentrate are specifically defined by the dry rubber content (d.r.c.), the volatile fatty acid number (V.F.A.), mechanical stability time (M.S.T.), the KOH number, alkalinity and colour (Arifin, 2005). The properties for latex concentrate specify that the dry rubber content (%) should have a minimum of 60, the difference between d.r.c. and t.s.c. (total solid content) should not exceed 2%; the volatile fatty acid number should not exceed 0.20 but a typical latex concentrate can be kept at a low level of V.F.A. (e.g. <0.05) with good preservatives; the minimum requirement of mechanical stability time is 650 seconds; the KOH number (g), which determines the ionic content in latex, should not exceed 1.0, although immediately after production it is usually 0.4-0.5; the alkalinity of the latex with low ammonia type is 0.2% and with high ammonia type 0.6%; the coagulum content (%) should not be equal to or greater than 0.05; the dried latex film should be pale in colour (Ghani & Wessel, 2016).

## 2.2. Botany of rubber tree

The rubber tree (*Hevea brasillensis*) is a fast growing, deciduous, medium to tall tree (25 m high in plantations and up to 40 m in the wild), with deep tap-roots. The trunk is smooth and straight with a grayish bark. It is known for its laticiferous system from which latex is extracted by tapping the trunk. Leaves are trifoliate, 10 to 15 cm long and 3 to 6 cm broad. Flowers are small with no [petals](https://keys.lucidcentral.org/keys/v3/eafrinet/weeds/key/weeds/Media/Html/glossary.htm#petals), bright or cream-yellow in color and extremely pungent. They are monoecious and borne in panicles with apical flowers being female and lateral ones male (Opeke, 1982).

The rubber tree starts bearing fruit at four years of age. Each fruit contains three or four seeds, which fall to the ground when the fruit ripens and splits up to 15 m. from [tree](https://keys.lucidcentral.org/keys/v3/eafrinet/weeds/key/weeds/Media/Html/glossary.htm#tree). Seeds are variable in size, 2.5-3 cm long, [mottled](https://keys.lucidcentral.org/keys/v3/eafrinet/weeds/key/weeds/Media/Html/glossary.htm#mottled) brown, lustrous. Each tree yields about 800 seeds (1.3 kg) twice a year. The seed consists of a thin hard shell and a kernel containing oil used in various industries (Purseglove, 1968).

The economic life of a rubber plantation is expected to last for 20-25 years and the plantation would start its yield from 6th year onwards (Morshed *et al.*, 2018).

## 2.3. Distribution of rubber tree

The rubber tree is native to the tropical rainforest of the Amazon basin and the Guiana. *Hevea* grows best between 15°N and 10°S and from sea level up to 600 m, with the optimal altitude being below 200 m. It is not very tolerant to soil erosion on hill slopes nor to strong winds. It performs well with a day temperature between 26 and 28°C, and with annual rainfall ranging from 2000 to 3000 mm (Hauser *et. al*., 2015). It can withstand drought and water logging for a while, but prefers well drained soils with good moisture storage capacity. It can grow on acidic soils, volcanic soils and even peaty soils (Mondal, 2017).

On the basis of past researches and experiments, Terai belts of eastern Nepal such as Jhapa, Morang, Illam and Sunsari are found to be favorable for rubber cultivation (Bhandari, 2015)

## 2.4. Harvesting of rubber tree

Tapping begins when trees are 5–8 years old, depending on the area, and increases every year until a maximum at about 20 years, then yield sustained for 40–50 years or more. Tapping consists of removal by excision of a thin cut of bark about 1 mm deep at regular intervals, thus opening the latex vessels in the bark, which are arranged in concentric cylinders and run in counter-clockwise spirals up the trunk. Usually the cuts run half-way around the trunk, but may encircle the tree. Several types of cuts are used. It is generally economic to begin tapping when 70 percent of the trees in the selected area attain the standard girth of 50 cm at a height of 125 cm from the bud union for budded trees. For seedling trees, 55 cm at a height of 50 cm for beginning panel and at 100 cm for subsequent panels is the standard (Joseph & Kumar, 2016).

It is necessary to commence tapping early in the morning. Exudation of latex is highest during morning due to high turgor pressure; it decreases with temperature and usually ceases in about 3 hours. The best yield is obtained by tapping to a depth less than 1 mm close to the cambium (Govt. of India, 2010).

Exploitation of latex (tapping) is the most costly operation in the rubber crop and in the plantation sector. It contributes to about 1/3 of the cost of production (Karunakaran, 2016). In addition, it requires greater level of skill and this is partly associated with the problem of skilled tapper shortage. This problem is aggravated under poor market prices of rubber when any increase in tappers' wages cannot be afforded and also under unfavorable weather conditions offering interrupted working days. Ultimate effect is such that large extents of productive rubber clearings have been left without tapping. Further, to overcome this issue, unskilled tappers are also being employed lowering the long-term yield potential of rubber trees (Rodrigo, 2007).

## 2.5. Marking while harvesting

Panels are marked on the trees selected for tapping, using a template and marking knife. After deciding the position of the panel, a vertical line, called front channel line is drawn. On this line, the opening height is marked. Another vertical line, called back channel line, is marked on the half spiral point above the opening height. With the aid of the template placed between these two lines, at the opening height, ensuring a high left to low right, the line for tapping cut and a few guidelines are marked through the grooves. Subsequent lines are marked every year before the commencing of tapping (Dey, 2011).

## 2.6. Tapping slope

The tapping cut of the budded trees should have a slope of about 30° to the horizontal (Govt. of India, 2010). For seedling trees, the cuts need to have a slope of only about 25°, since the bark is fairly thick. The latex vessels in the bark run at an angle of 3-5° to the right and therefore, a cut from high left to low right will open greater number of latex vessel (Binang *et. al.*, 2017).

## 2.7. Implements used in harvesting

The main implements used for tapping and collection of latex are knives, spouts, cup hangers, collection cups, collection baskets and scrap baskets. An average tapper can tap 200–300 trees in 3 hours. Then the tapper starts back through the grove and empties the cups into large pails or buckets, sometimes adding a few drops of dilute ammonium solution or formic acid to prevent coagulation. Rubber yield can be increased treating the bark below the tap with yield-stimulating mixtures containing plant hormones and selective weed-killers with hormone properties (Duke, 1983). During refoliation and flowering of rubber trees, the yield is comparatively poor and trees are given rest if the soil is very dry and yield is uneconomic (Sharma, George K., & Dey, 2014).

## 2.8. Rolling and smoking of rubber latex

Ribbed smoked sheets are produced by passing coagulated latex through a series of rollers to produce thin sheets, which are embossed with a ribbed pattern. The ribbed pattern serves mainly to increase the surface area of the material and aid its drying (Morshed *et. al*., 2018). Smoked rubber is a type of crude natural rubber in the form of brown sheets obtained by coagulating latex with an acid, rolling it into sheets, and drying over open wood fires at 40-60°C for about 36 hours. Smoking enables the sheets to absorb creosotic and other antiseptic substances which provide a preservative effect and anti-oxidant effect on to the rubber (Giroh & Mesike, 2011).

## 2.9. Yield of Natural Rubber

Yield of rubber is largely dependent on the cultivar planted and the agro-management inputs given to the trees during the periods of immaturity and production. Because of the superior management and better inputs, yields are normally higher on estates than on smallholdings.

In general, latex yield is expressed in kg/ha per year. In South-East Asia, average estate yield is about 1500 kg/ha per year, ranging from 1200-2000 kg/ha per year. The average yield from a smallholding is about 800 kg/ha per year and ranges from 400-1500 kg/ha per year. In Malaysia, the average national yield is about 1150 kg/ha per year (Ghani & Wessel, 2016).

## 2.10. International Scenario of Natural Rubber

Asian countries dominated the natural rubber sector occupying 93 percent of the total area under rubber cultivation in the world. Thailand is having the largest area under rubber cultivation followed by Indonesia, Malaysia, China and finally India is in fifth position. Globally about 81 percent of the world natural rubber production is in South East Asia i.e. Thailand, Indonesia, Malaysia, India, China and Vietnam (Chandrashekhar, 2014).

A study from FAO depicts that there occurs rubber business of 23,84,47,00,000 US$ globally in a year. 1, 00, 04,206 mt. of natural rubber was produced in cultivation area of 96, 24,577 ha. in the world (FAOSTAT, 2012). The world production and consumption status of rubber and rubber related goods is presented in the Table 1 and 2.

Table 1. World Rubber Production status

|  |  |  |  |
| --- | --- | --- | --- |
| Year | Natural Rubber  (‘000 MT) | Synthetic Rubber  (‘000 MT) | Total Rubber |
| 2012 | 11,658 | 14,042 | 25,700 |
| 2013 | 12,281 | 14,199 | 26.480 |
| 2014 | 12,115 | 14,179 | 26,294 |
| 2015 | 12,314 | 14,460 | 26,774 |
| 2016 | 12,604 | 14,887 | 27,491 |
| 2017 | 13,551 | 15,108 | 28,659 |
| 2018 | 13,869 | 15,264 | 29,133 |

Source: (RRIM, 2016)

Table 2. World Rubber Consumption status

|  |  |  |  |
| --- | --- | --- | --- |
| Year | Natural Rubber  (‘000 MT) | Synthetic Rubber  (‘000 MT) | Total Rubber |
| 2012 | 11,046 | 13,964 | 25,009 |
| 2013 | 11,430 | 14,148 | 25,578 |
| 2014 | 12,181 | 14,159 | 26,340 |
| 2015 | 12,134 | 14,663 | 26,796 |
| 2016 | 12,670 | 14,876 | 27,547 |
| 2017 | 13,203 | 15,234 | 28,437 |
| 2018 | 13,813 | 15,342 | 29,156 |

Source: (RRIM, 2016)

## 2.11. Domestic scenario of Natural Rubber

Nepal’s climatic diversity is hospitable to rubber plant cultivation. However, rubber plantation in Nepal is of very recent history. 2027 B.S. marks the genesis of rubber by an Entrepreneur JP Dhakal as he introduced rubber seeds in Sanischare-3, Jhapa. It was followed by establishment of Gorakhkali Rubber Udhyog Ltd. in 2041 B.S., establishment of first Pilot Project Plantation in 30 hectares land by Gorakhkali Rubber Udhyog in collaboration with Sudhafalras Pvt. Ltd., Sanischare, Jhapa in 2047 B.S. and then formation of Rubber Board, Nepal for study and research in 2050 B.S. The growth and expansion of rubber industry in Nepal is marred by political, social and economic barriers.

Table 3. Import situation of natural rubber in Nepal

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Details | 2009 | 2010 | 2011 | 2012 |
| Natural rubber (in metric tons) | 1605 | 1576 | 1132 | 1076 |
| NRs. | 20,08,14,959 | 29,93,34,089 | 27,70,72,973 | 20,58,01,636 |

Source: (MoAD, 2013)

Table 4. Import of rubber and rubber goods in Nepal

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Year | 2009 | 2010 | 2011 | 2012 |
| NRs. | 3,32,73,42,666 | 3,98,10,89,348 | 5,77,15,12,655 | 6,51,60,51,096 |

Source: (NETPC, 2013)

**2.12. Investment appraisal**

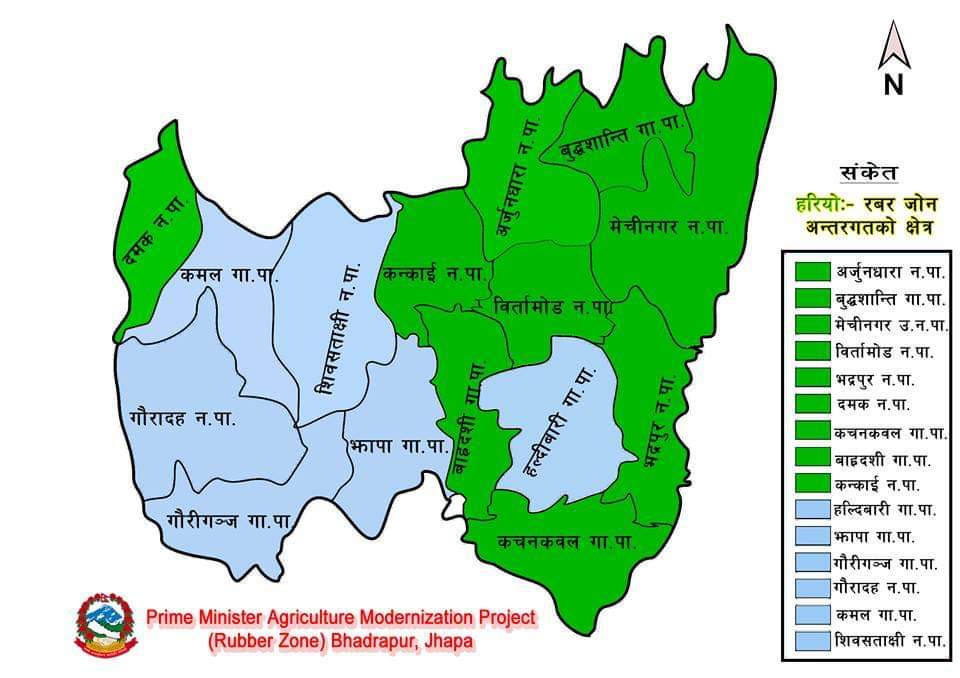
The findings from study on economics of smallholder rubber plantations in West Garo Hills District of Meghalaya by Goswami and Challa (2007)shows thatbenefit cost ratio was 2.41 with Net Present Value of the stream of returns from one hectare of rubber plantations was IRs. 55,014 at discount rate of 12 percent. Internal Rate of Return was computed to be 14.4 percent. A study on economic feasibility of small-scale rubber plantations in Assam conducted by Maibangsa, Subramanian and Nadu (1993) found the B/C ratio to be 1.71 with net present worth IRs. 2642.1 and Modified Internal Rate of Return 17.58 percent.

The study on financial feasibility of investment in rubber plantations by (Dey, 2011) in West Tripura revealed B/C ratio 12 percent discount rate to be 2.04 in small and 2.02 in large plantations respectively. Similarly, NPV for the entire life period of the rubber plantation was found to be IRs. 5, 22,115.47 for small plantation and Rs. 5, 00,858.18 for large plantation. Internal rate of returns were found to be 27.79 and 28 percent in the small and large plantations respectively.

# 3. Methodology

## 3.1. Selection of study site

The study will be conducted in Jhapa district of Nepal. Jhapa occupies a pivotal position in Nepal’s rubber map in terms of relative shares in area, production as well as potential area identified for natural rubber cultivation. PM-AMP has designated Jhapa as rubber zone since 2018 and rubber is a prioritized commodity for commercialization and rural development of Jhapa district. Data will be collected from 5 municipalities of Jhapa district namely Kankai, Arjundhara, Mechi, Bhadrapur, Damak and 3 rural municipalities namely Buddhashanti, Barhadarshi and Kachanakawal. These areas are purposively selected based on area coverage of rubber production and majority of rubber farmers i.e. about 80% are from these areas and contribute about 230 hectares of land.



## 3.2. Sample size and sampling technique

On the basis of registered list of rubber cultivating farmers acquired from PM-AMP Implementation unit- Rubber zone, a sampling frame was prepared for drawing representative samples. Sampling framework comprised of 89 rubber plant growers. Among them, farmers who were in their first year of rubber latex harvest were discarded and total of 62 sample households of the zone area were surveyed for collecting information.

## 3.3 Data collection methods

Both primary and secondary data were collected for the study. The primary data was collected by conducting field survey using pre- tested household interview schedule, focus group discussions and key informant interviews.

Secondary data were collected from various publications of Agriculture Knowledge Centre, Agriculture Information and Communication Centre (AICC), Central Bureau of Statistics (CBS), Prime Minister Agriculture Modernization Project (PM-AMP), Ministry of Agriculture and Livestock Development (MoALD), various NGO/INGO’s, journals, proceedings, books and websites.

## 3.4. Data collection procedure

### 3.4.1. Reconnaissance survey

Several preliminary field visits were carried out to be familiar with different notable features of the study area like topography, land use, agricultural infrastructures, government/non- government service providers and community based organizations. The information obtained from these observations acted as a vantage point for preparation of interview schedule and checklists for systematic data collection.

### 3.4.2. Interview schedule design

A semi-structured interview schedule was prepared to collect information from rubber growers. Various questions were designed to meet the objectives of the study. Similarly, checklists were prepared for focus group discussion and key informant interview. The interview schedule used in the survey is given in Appendix.

### 3.4.3. Pre- testing of interview schedule

The interview schedule was pre-tested with 6 households (10% of total sample size) for its validity and efficacy. The final interview schedule, after necessary modifications, was used to interview the sampled households.

### 3.4.4. Field survey

The field survey was carried out in April-March, 2019. Farmers were personally visited and interviewed by face-to-face interview. The objective behind the survey was clearly stated and their permission was sought. A good rapport was built before starting the interview to ensure that the information given by them is reliable and unbiased.

## 3.5. Data collection techniques

### 3.5.1. Household interview

All randomly selected households were visited and interviewed with the help of interview schedule. All the necessary data was collected on socio-economic and demographic characteristics, cost of cultivation, return from rubber production, major production and marketing problems of rubber as well as perception of farmers towards rubber farming.

### 3.5.2. Focus group discussion

A total of four focus group discussions were conducted using FGD checklist with progressive farmers, ward representatives, presidents of farmers group and members of zone management committee. They were asked a series of questions on the present scenario of rubber production, marketing structure and economics involved in rubber cultivation.

### 3.5.3. Key Informants Interview (KII)

KII was done with representative of farmers’ group, executives of cooperatives for cross verification of the responses of respondents.

## 3.6. Methods and techniques of data analysis

Large and small farmers were categorized on the basis of the area of their rubber orchards. The average of the area of rubber orchard of the total sampled households was calculated and found to be 1.94 bigha. Farmers having rubber orchard area greater than the average were kept in category of large scale farmers and farmers having rubber orchard area lower than the average were kept in category of small scale farmers.

### 3.6.1. Analysis of socio-economic data from survey

The data collected from the socio-economic survey was coded, tabulated and analyzed using Microsoft excel and Statistical Package for Social Science (SPSS). For the analysis of socio-economic data, simple descriptive statistics like mean, standard deviation and percentage along with the independent sample t-test and chi-square tests were used. Results from the survey were presented in tables, bar diagrams and pie-charts.

### 3.6.2. Conceptual issues in estimating cost of production of NR

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 (Brian *et. al*., 2004). 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. 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 for all the age group was collected. All cost items are considered including the initial plantation development costs as well as the routine agro-management costs like the costs for weeding, fertilizers application, tapping etc.

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 maintenance was estimated based on the data collected from the sample farmers having eighth-year-old rubber plantations. It remains more or less the same from the eighth year onwards. To carry out the feasibility analysis, it was assumed that cost and returns of rubber would remain the same as that of the eleventh year in the remaining years as indicated by Okorie and Ugwu (1992) in his research of oilpalm.

Yield and returns were calculated on per bigha basis. Prices received for rubber at the time of data collection was considered to compute the incomes from plantations. Also, depreciation rate of 12% for implements per year as per straight line method and rental value of land was considered to calculate the cost incurred per year.

### 3.6.3. Benefit-cost analysis

BCR is the ratio of discounted cash flows to discounted investment. It is calculated to determine whether the investment made on the resources yield the reasonable return or not (Kumar, 1990). It is assumed to be quick and one of the easiest methods for evaluating the economic performance of any business/firm. The BCR must be unity or more for a project investment to be considered worthwhile. The Benefit Cost Ratio (BCR) was worked out by using following formula:

BCR= Discounted net cash flows / Initial investment

3.6.4. Net Present Value:The NPV of cash flows have been computed as given by Yogish (2017):

NPV = ……….. (1)

Where, B t = benefit from rubber plantations in each year,

C t = Cost of rubber plantationsin 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

3.6.5. Internal Rate of Return (IRR): It is used here to evaluate the overall feasibility of rubber plantations in the study area. 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 =  ……… (2)

### 3.6.6. Total cost of production

The inputs used in rubber farming are categorized as variable inputs and fixed inputs. Therefore, total cost of production is summation of total variable cost and total fixed cost incurred in the production process.

TC = TFC+ TVC

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

### 3.6.7. Total Variable Cost

Variable cost refers to recurring type of costs and is also called operational costs or working cost. In the study, following variable costs are undertaken.

TVC = Clabour + Cmanure + Cfertilizers + Cothers

Where,

Clabour = Total cost of labour in NRs.

Cmanure = Total cost of manure in NRs.

Cfertilizers = Total cost of fertilizer in NRs.

Cothers = Total cost of saplings, pesticides, weedicides, rubber coat and anticoagulants

### 3.6.8. Total Fixed Cost

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 and interest on total investment were included under fixed cost.

TFC = Cland rent+ Cdepreciation +Cinterest rate

Where,

Cland rent = Total land rent per year in NRs.

Cdepreciation = Total depreciation cost per year in NRs.

Cinterest rate = Interest value of total investment per year in NRs.

### 3.6.9. Gross returns

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.

## 3.7. Indexing and scaling

Scaling technique provides the intensity of respondents towards the propositions. Farmer’s perception towards the production, problems of production and marketing, expectations from PM-AMP were ranked. Forced ranking scale was used for scaling by giving score of 1 to the most severe problem and ascends the score on less severe problems. It was computed using the following formula.

Mathematically,

Iimp = Ʃ (*Sifi / N*)

Where,

Iimp = Index of importance

Si = Scale value at ith severity

Fi = Frequency of importance given by respondents

N = Total number of respondents

## 3.8. Probit regression model

Probit regression model can be used to assess the factors affecting adoption of agricultural practices. 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 cultivation area.

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.

### 3.8.1. 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) = b0 +b1X1 + b2X2 + b3X3 +b4X4 +b5X5 + b6X6 + b7X7 + b8X8 + b9 X9 + b10X10 +ei

Where,

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

X1 = Age of respondent (years)

X2 = Ethnicity of household (Dummy)

X3 = Major Occupation of household head (Dummy)

X4 = Economically active family members (Dummy)

X5 = Family type (Dummy)

X6 = Membership in organization (Dummy)

X7 = Total owned land (bigha)

X8 = Experience in rubber farming (years)

X9 = Training (Dummy)

X10 = Subsidy (Dummy)

b1, b2……b12 = Probit coefficient

b0 = Regression coefficient

Table 6. Description of variables used in the Probit model

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variables | Type | Description | Value | Expected sign |
| Dependent variable Yi | 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 | **+** |

# 4. Results and Discussion

## 4.1. Socio-economic and demographic characteristics (continuous) of the sampled households

The socio-demographic information regarding age of the respondents, age of household head, number of family members and economically active members of the sampled household was collected. Regarding age, the average age of large scale growers was 48.94 and that of small scale growers was 41.35. However, the mean difference in age between large scale and small scale growers was found statistically significant (p<0.05). The age ranged from 23 to 72 years in the survey area.

The average age of the household head (with minimum age obtained to be 32 and maximum 82 years of total respondents) was found to be 57.81 of large scale growers and 58.42 among small scale growers with non-significant mean difference as shown in Table no.7, which depicts that the age of household heads between two categories is uniform. Average number of male members in the family was found to be 3.39 and 2.58 of large scale and small scale growers respectively with number ranging from 1 to 6. The difference was found to be statistically significant (p<0.05) between large scale and small scale growers.

Similarly, average number of female members in the family was found to be 3.29 and 2.97 of large scale and small scale growers respectively with number ranging from 2 to 8. Average number of economically active members was found to be 4.03 and 3.32 of large scale and small scale growers respectively with number ranging from 2 to 6. However, neither average number of female members nor economically active members in the family was found statistically different between large scale and small scale growers.

Livestock Standard Unit (LSU) was calculated to study the livestock holding of the household by a common unit. All the livestock were converted into a single input using the following formula:

LSU = 1 (number of cow/ox) + 1.5 (number of buffalo) + 0.6 (number of swine/pig) + 0.4 (number of sheep/goat) + 0.02 (number of poultry)

The LSU obtained was 2.19 and 7.34 for large scale and small scale growers respectively in the study area. The mean difference 5.15 was found statistically significant at 10% level of significance. Average LSU of the area was found to be 4.76.

Dependency ratio is the ratio of economically inactive members (less than 15 years and above 59 years) to economically active members (15-59 years age group). It was found to be 0.37 and 0.35 for small scale and large scale growers respectively. However, the mean difference 0.016 was statistically insignificant.

Table 7. Socio-economic characteristics (continuous) of the sampled households

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Variables | Large scale  (n=31) | Small scale  (n=31) | Overall  (N=62) | Mean difference | t- value |
| Age of respondent  (Min: 23, Max: 72) | 48.94(13.988) | 41.35 (8.069) | 45.15(11.95) | 7.581\*\* | 2.614 |
| No. of male members  (Min:1, Max: 6) | 3.39 (1.476) | 2.58 (1.205) | 2.98(1.39) | 0.806\*\* | 2.357 |
| No. of female members  (Min: 2, Max :8) | 3.29 (1.901) | 2.97 (0.752) | 3.13(1.44) | 0.323 | 0.879 |
| Economically active members (Min:2, Max:6) | 4.03 (1.402) | 3.32 (1.326) | 3.68(1.4) | 0.71 | 2.047 |
| Age of household head  (Min: 32, Max: 82) | 57.81 (13.497) | 58.42(12.211) | 58.11(12.76) | -0.613 | -0.187 |
| Dependency ratio | 0.35 (0.039) | 0.37 (0.042) | 0.36(0.028) | -0.016 | -0.289 |

Note: Figures in parentheses represent standard deviation \*\* indicates significant at 5% level

## 4.2. Land holding characteristics

Land is the important component of any farming system. Land ownership within the agrarian economy of the study area provides a major source of income for the farming family. The study revealed that the average landholding of large scale (4.28bigha) and small scale (2.85 bigha) was significantly different (p<0.01). The overall khet land, forest land and cultivated land of large scale and small scale growers was 2.16 bigha and 1.68 bigha, 2.16 bigha and 0.97 bigha and 4.22 bigha and 2.35 bigha respectively. The mean difference in forestland and total land holding of small and large scale growers was statistically significant (p<0.01) whereas Khetland holding of large scale and small scale growers was not found statistically different.

Leased in land was greater in small scale growers than large scale growers which is statistically significant (p<0.01). It shows that small scale rubber growers in Jhapa have less land holding than large scale growers and thus their leased land holding is greater for rubber cultivation.

The average farm size under rubber cultivation of large and small scale growers was 2.67 bigha and 1.21 bigha respectively. Maximum and minimum area for both types of growers was 0.48 bigha and 4 bigha respectively. Overall mean difference of 1.46 bigha was found statistically significant (p<0.01) as shown in Table no.8. The mean difference in initial and expanded area for rubber cultivation was found statistically significant between large scale and small scale rubber growers (p<0.01). It reveals that large scale growers have largely expanded rubber cultivation area compared to small scale growers.

Table 8. Land holding characteristics of the sampled households

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Variables  (in bigha) | Large scale (n=31) | Small scale  (n=31) | Overall  (N=62) | Mean difference | t- value |
| Khetland  (Min: 0, Max: 5.49) | 2.16 (1.94) | 1.68 (1.12) | 1.92(1.61) | 0.475 | 1.165 |
| Forestland  (Min: 0, Max: 4) | 2.16 (1.59) | 0.97 (0.87) | 1.57(1.4) | 1.18\*\*\* | 3.625 |
| Total land  (Min: 0.73, Max: 9) | 4.28 (2.03) | 2.85 (1.5) | 3.57(1.91) | 1.42\*\*\* | 3.143 |
| Cultivated land  (Min: 0.73, Max: 8.49) | 4.22 (1.87) | 2.35 (1.18) | 3.29(1.81) | 1.25\*\*\* | 4.666 |
| Leased in land  (Min: 0, Max: 2.36) | 0.41 (0.87) | 0.43 (0.24) | 0.22(0.66) | -0.307\*\* | -2.282 |
| Initial area for rubber cultivation  (Min: 0.24, Max: 4) | 2.07 (1.14) | 0.78 (0.39) | 1.42(1.07) | 1.29\*\*\* | 5.923 |
| Expanded area for rubber cultivation  (Min: 0.48, Max: 4) | 2.67 (0.85) | 1.21 (0.34) | 1.94(0.98) | 1.46\*\*\* | 8.805 |

Note: Figures in parentheses represent S.D. \*\*\* and \*\* indicates significant at 1% and 5% level

## 4.3. Socio-economic and demographic characteristics (categorical) of the sampled households

The respondents of the sampled households were categorized based on their gender. The male respondents were 59 (95.2%) while female were 3 (4.8%) of the sampled 62 households. Significant results were not obtained based on the gender for the large scale and small scale growers.

The ethnicity was categorized into Brahmins, Chhetri, Adibasi/Janajati and Dalit. Out of the 62 respondents in the study area, majority of the respondents were Brahmins/ Chhetris (63%) followed by Adibasi/Janjati (27.5%) and Dalit (9.5%). Comparing the ethnicity of large scale and small scale growers, significant difference (p< 0.01) was reflected.

Occupation of the area reflects the nature of micro-economy and also determines the well-being of the living standard. The study revealed that agriculture was the primary occupation in the study area i.e. 75.8% being involved in agriculture as major occupation which is higher than the national scenario of 60.4% (CBS, 2011). Similarly, the households involved in government service were 17.7% followed by business (4.8%) and abroad (1.6%). There was no significant difference in major occupation between the large scale and small scale growers.

A joint family is an extended family arrangement consisting of many generations living in the same household, all bound by the common relationship while a nuclear family is a family group consisting of two parents and their children. In overall, 38.7% of the households among the sampled households had joint family and 61.3% had nuclear type of family.

Education plays vital role in socio-cultural and economic change in society. The respondents were identified with seven different educational backgrounds. Out of 62 sample households, 3 household heads (4.8%) were found to be illiterate followed by 24.2% household heads being literate. Similarly, 6.5% of the household heads were found to study upto primary level, 24.2% upto secondary level, 14.5% upto SLC, 11.3% upto higher secondary level and 14.5% had completed bachelor’s level of education. However, neither family type nor education status of respondents was found significantly different between large scale and small scale growers.

Out of 62 sample households, 59 respondents (95.2%) were married and 3 households (4.8%) were unmarried. Comparing the marital status of large and small scale growers, significant difference (p<0.05) was observed as shown in Table no. 9.

Table 9. Socio-demographic information (categorical variables) of the sampled households

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variables | Large scale (n=31) | Small scale (n=31) | Overall (N=62) | Chi-square value |
| Gender of the respondents |  |  |  |  |
| Male | 29 (93.5) | 30 (96.8) | 59 (95.2) | 0.35 |
| Female | 2 (6.5) | 1 (3.2) | 3 (4.8) |
| Ethnicity of the respondents |  |  |  |  |
| Brahmins/ Chhetris | 14 (45.2) | 25 (80.6) | 36 (63) | 27.33\*\*\* |
| Janjati | 17 (54.8) | 0 | 17 (27.5) |  |
| Dalit | 0 | 6 (19.4) | 6 (9.5) |  |
| Education of the respondents |  |  |  |  |
| Illiterate | 0 | 3 (9.7) | 3 (4.8) |  |
| Literate | 6 (19.4) | 9 (29) | 15 (24.2) |  |
| Basic education | 17 (54.8) | 11(35.5) | 28 (45.2) | 10.063 |
| Higher education | 5 (16.1) | 2 (6.5) | 7 (11.3) |  |
| University | 3 (9.7) | 6 (19.4) | 9 (14.5) |  |
| Primary Occupation of the respondents |  |  |  |  |
| Agriculture | 27 (87.1) | 20 (64.5) | 47 (75.8) |  |
| Business | 0 | 3 (9.7) | 3 (4.8) | 5.861 |
| Government service | 4 (12.9) | 7 (22.6) | 11 (17.8) |  |
| Abroad | 0 | 1 (3.2) | 1 (1.6) |  |
| Type of family |  |  |  |  |
| Nuclear | 16 (51.6) | 22 (71) | 38 (61.3) | 2.447 |
| Joint | 15 (48.4) | 9 (29) | 24 (38.7) |  |
| Marital status |  |  |  |  |
| Married | 28 (90.3) | 31 (100) | 59 (95.2) | 3.153\*\* |
| Unmarried | 3 (9.7) | 0 | 3 (4.8) |  |

Note: Figures in parentheses represent percentage \*\* and \*\*\* indicate significance at 5% and 1% level

## 4.4. Rubber plants holding characteristics

Total plants per bigha were found to be 318 and 297.88 in large scale and small scale growers respectively with plants ranging from 200 to 466. It might be because of different spacing followed by rubber farmers. Spacing of 12\*12 ft or 14\*14 ft or 16\*16 ft was found to be followed by rubber growers. However, the mean difference in total plants per bigha between large and small scale growers was statistically insignificant.

Experience in rubber cultivation was found to be 9.58 years and 14.71 years in large scale and small scale growers respectively with minimum and maximum ranging from 3 to 27 years. Its mean difference was found statistically significant (p<0.05) as shown in Table no. 10. It impedes that rubber plant was grown since many years by farmers in small scale in Jhapa.

Average daily latex yield per plant was found to be 190.87 ml. and 172 ml. in large scale and small scale growers. Minimum and maximum for both type of growers was 60 ml and 300 ml per day respectively. However, the mean difference in daily yield was not found statistically significant.

Table 10. Rubber plants holding characteristics of the sampled households

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Variables | Large scale  (n=31) | Small scale  (n=31) | Overall  (N=62) | Mean difference | t-value |
| Total plants per bigha  (Min:200, Max:466) | 318(70.18) | 297.88(68.58) | 308 (69.63) | 21.12 | 1.19 |
| Years since rubber  cultivation began  (Min:3, Max:27) | 9.58 (3.25) | 14.71 (8.69) | 12.15 (7.0) | -3.07\*\* | -3.077 |
| Average daily latex yield per plant (Min:60, Max:300) | 190.87  (58.92) | 172  (41.93) | 181.04  (51.02) | 2.90 | 0.128 |

Note: Figures in parentheses represent S.D. \*\* indicates significant at 5% level

## 4.5. Land utilization pattern before rubber farming

The presented table reveals that 46.8% of the respondents started rubber farming by leaving cultivation of rice along with other cereals on the land. Similarly, 25.8% of the respondents started rubber cultivation on fallow land followed by 16.1% growers leaving tea cultivation for rubber plantation. 6.5% and 4.8% of the respondents discontinued vegetables and medicinal plants cultivation and began rubber farming on the very land. Overall mean difference between large scale and small scale growers on the use of land before rubber farming was found significant (p<0.01) as presented in Table 11.

Table 11. Land utilization pattern before rubber farming in the study site

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Land utilization | Large scale (n=31) | Small scale (n=31) | Overall (N=62) | Chi- square value |
| Fallow land | 3 (9.7) | 13 (41.9) | 16(25.8) |  |
| Rice and other cereals | 11 (35.5) | 15 (48.4) | 29(46.8) |
| Vegetables | 4 (12.9) | 0 | 4 (6.5) | 14.88\*\*\* |
| Medicinal plants | 3 (9.7) | 0 | 3(4.8) |
| Tea cultivation | 7 (22.6) | 3 (9.7) | 10(16.1) |

Note: Figures in parentheses represent standard deviation \*\*\* indicates significant at 1% level

## 4.6. Access to agricultural services and extension

### 4.6.1. Membership in community based organization

Community based organizations like farmer’s group, cooperatives are the assets of the community that strengthen the unity among the farmers and provide economic and social helps. Participation in social groups enhances the capital allowing trusts, dissemination of idea and exchange. The community based organization can provide trainings and the successful farmers in the group can share their farming techniques and hence such groups can be a valuable source of knowledge about improved rubber cultivation practices.

Among the 62 sampled households, 19.4% of the respondents were found to be involved in cooperative followed by 16.2% of respondents involved in farmer’s group. Similarly, 25.8% of respondents were involved in forest committee and cooperative, 20.9% in both farmer’s group and cooperative, 4.8% in forest committee while 12.9% of the respondents had not membership of any community organization.

Sole membership of farmer’s group and cooperative was higher in small scale growers. Whereas, involvement in farmer’s group as well as cooperatives was higher in large scale growers. The difference in the status of membership of the large scale and small scale growers was found significantly different at 1% level of significance as shown in Table 12.

Table 12. Membership in community- based organization

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Type of organization | Large scale  (n=31) | Small scale  (n=31) | Overall (N=62) | Chi-square value |
| Farmer’s group (Yes) | 1 (3.2) | 9 (29) | 10 (16.2 ) |  |
| Forest committee (Yes) | 3 (9.7) | 0 | 3 (4.8 ) |  |
| Cooperatives (Yes) | 1 (3.2) | 11 (35.5) | 12 (19.4 ) |  |
| Both forest committee and cooperative(Yes) | 16 (51.6) | 0 | 16 (25.8 ) | 37.9\*\*\* |
| Both farmer’s group and cooperative (Yes) | 7 (22.6) | 6 (19.4) | 13 (20.9) |  |
| None | 3 (9.7) | 5 (16.1) | 8 ( 12.9) |  |

Note: Figures in parentheses represent percentage \*\*\* indicates significant at 1% level

### 4.6.2. Training status

The major objective of the training is to enhance the knowledge level of the participants and also to promote the adoption of improved technology. The response (yes/no) of the respondents about the training received by any member of the household was collected and described in table. It is evident from the table below that 87.1% of the respondents had access to training regarding rubber cultivation and harvesting while rest of them were not in access of trainings. The difference in training receiving members between large scale and small scale growers was statistically insignificant.

The type of training received by respondents was interviewed and recorded. Altogether, 64.5% of the respondents had received training on tapping practice. 12.9%, 8.1% and 1.6% of the respondents had training on all rubber cultivation practices, both tapping and nursery and both tapping and processing activities respectively. It was observed that greater percentage of large scale growers had received training on tapping technique and all rubber cultivation practices compared to small scale growers as per the table 13 and was thus found statistically significant at 5% level of significance.

Table 13. Training status of the sampled households

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Particulars | Large scale (n=31) | Small scale (n=31) | Overall (N=62) | Chi-square value |
| Training received |  |  |  |  |
| Yes | 26 (83.9) | 28 (90.3) | 54(87.1) | 0.574 |
| No | 5 (16.1) | 3 (9.7) | 8(12.9) |  |
| Type of training received |  |  |  |  |
| Tapping | 24 (77.4) | 16 (51.6) | 40(64.5) |  |
| Tapping and nursery | 0 | 5 (16.1) | 5(8.1) | 9.539\*\* |
| Tapping and processing | 0 | 1 (3.2) | 1(1.6) |  |
| All rubber cultivation practices | 2 (26) | 6 (19.4) | 8(12.9) |  |

Note:Figures in parentheses represent percentage\*\* indicates significant at 5% level

## 4.7. Variety

The varieties cultivated by growers in the study area were RRIM 600, RRII 105 and GT1 as presented in Table 14. In overall, 50% of the farmers cultivated both RRIM 600 and RRII 105 varieties followed by 27.4% cultivating only RRIM 600 variety. Likewise, 12.9% of the growers cultivated all the three varieties namely RRIM 600, RRII 105 and GT1 followed by 9.7% cultivating only RRII 105 variety of rubber. Comparing the varieties cultivated by large scale and small scale growers in the study area, results were found statistically significant (p<0.05).

Table 14. Rubber varieties cultivated in the study area

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Particulars | Large scale (n=31) | Small scale (n=31) | Overall (N=62) | Chi-square value |
| Variety cultivated |  |  |  |  |
| RRIM 600 | 11 (35.5) | 6 (19.4) | 17 (27.4 ) |  |
| RRIM 105 | 6 (19.4) | 0 | 6 (9.7 ) |  |
| Both RRIM 600 and RRII 105 | 10 (32.3) | 21 (67.7) | 31 (50 ) | 11.374\*\* |
| RRIM 600, RRII 105 and GT1 | 4 (12.9) | 4 (12.9) | 8 ( 12.9) |  |

Note:Figures in parentheses represent percentage\*\* indicates significant at 5% level

### 4.7.1. Farmers’ preference on variety

The respondents were interviewed regarding their preference for variety and their response was recorded. RRII 105 was most prone to wind lodging according to 67.7% of the sampled households. 58.1% of the respondents said that RRII105 was more susceptible to diseases. Likewise, RRIM 600 was higher yielding compared to RRII105 and GT1 according to all respondents. Thus, it can be generalized that RRIM600 variety is more suitable for rubber cultivation in Jhapa as it is higher yielding and less prone to diseases and wind-lodging as per the table 15.

Table 15. Farmers' preference on rubber variety in the study area

|  |  |  |  |
| --- | --- | --- | --- |
| Particulars | RRIM 600 | RRII 105 | GT1 |
| Prone to wind lodging | 0 | 42 (67.7) | 20 (32.3) |
| Disease susceptible | 8 (12.9) | 36 (58.1) | 18 (29) |
| High yield | 62 (100) | 0 | 0 |

Note:Figures in parentheses represent percentage

## 4.8. Technology adoption

There are various technologies that can be used in rubber cultivation that will help to modernize the current practices resulting in subsequent increase in returns. Rolling of coagulated rubber latex in a series of rollers is an important procedure that adds value to rubber latex and increases its market price. Only 21 (67.7%) among the large scale growers and 14 (45.2%) among the small scale growers possess rolling machine. Among small scale growers, 9 (29%) of them practice rolling in cooperative form and 9.7% of large scale growers practice rolling of latex under rent. There was significant difference in possession of rolling machine between large scale and small scale growers (p<0.05) as shown in Table no.16.

Similarly, only 4.8% of the growers had rolling machine which is run by motor. While, 72.6% of the growers had conventional manual rolling machine. The difference was statistically significant (p<0.05) in terms of large scale and small scale growers.

Smoke acts as a preservative, prevents mould on the rubber sheet and also increases its tensile strength (Morshed et al., 2018). Although smoking of rubber sheets has many advantages, only 20% of the growers had smoke house and been subjecting their rubber sheets to smoke. 67.7% of the growers used to sell rubber sheet without smoking them. Ownership of smoke house was seen to be greater in large scale growers however; there was no significant difference in smoke house possession between large and small scale growers.

Bark treatment with ethephone (ethylene releaser) is known to increase the latex yield by 1.5–2 folds in rubber tree. Ethylene treatment increases the activity of invertase resulting in glycolysis acceleration, leading to improving the supply of carbon source (such as Acetyl coenzyme A) for rubber biosynthesis (Zhu & Zhang, 2009). Only 16.1 % of the respondents had the practice of using ethephone as yield stimulator. Large scale growers were more found to be using ethephone for yield stimulation and the difference was statistically significant at 10% level.

Table 16. Technology adoption in rubber cultivation in the study area

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Particulars | Large scale(n=31) | Small scale(n=31) | Overall (N=62) | Chi-square value |
| Own rolling machine |  |  |  |  |
| Yes(personal) | 21 (67.7) | 14 (45.2) | 35 (56.5) | 11.086\*\* |
| Yes(in group/cooperative) | 1 (3.7) | 9 (29) | 10 (16.1) |  |
| Rolling on rent | 3 (9.7) | 0 | 3 (4.8) |  |
| Type of rolling machine |  |  |  |  |
| Local manual | 22 (71) | 23 (74.2) | 45 (72.6) | 2.944\*\* |
| Run by motor | 3 (9.7) | 8 (25.8) | 11 (4.8) |  |
| Own smoke house |  |  |  |  |
| Yes | 11 (35.5) | 9 (29) | 20 (32.3) | 0.295 |
| Use of yield stimulators |  |  |  |  |
| Yes | 8 (25.8) | 2 (6.5) | 10 (16.1) | 4.292\* |

Note: Figures in parentheses represent percentage. \* and \*\* indicate significant at 10% and 5% level

## 4.9. Tapping

Tapping is a periodically renewed cut incised in the bark of the trunk, which generates latex flow (the cell cytoplasm containing rubber particles) throughout the year (Govt. of India, 2010). Rubber is produced year round, with great fluctuations month to month. Average number of tappings per year is 120–140 in India, 160 in Malaysia. Rubber trees are given rest during refoliation and flowering as the yield becomes comparatively poor and uneconomic. In Jhapa, 27.4% of the respondents suspended tapping from Poush 1st till Chaitra 30th while 25.8% of the respondents discontinued tapping from Poush 15 till Chaitra 15. Likewise, tapping was halted from Mangsir to Chaitra by 11.3% of the respondents and 12.9% discontinued from Poush 15 to Baisakh 15. Alternate date tapping was followed by almost all the rubber growers and average tapping per year was 150 days.

Respondents were interviewed regarding their selling form of produce. 50% of the respondents sold rubber in the form of sheet. Sheet is prepared by passing coagulated latex through a series of rollers to emboss with a ribbed pattern. Likewise, 27.4% of the respondents sold both latex and sheet. Comparing the form of produce sold between large scale and small scale growers, difference was found statistically significant at 5% level as shown in Table 17.

Table 17. Months of tapping rest in the study area

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Particulars | Large scale(n=31) | Small scale (n=31) | Overall (N=62) | Chi-square value |
| Leave tapping in which months |  |  |  |  |
| Poush 1st-Chaitra 30th | 9 (29) | 8 (25.8) | 17 (35.41) |  |
| Poush 15- Chaitra 15 | 7 (22.6) | 9 (29) | 16 (33.34) | 6.022 |
| Mangsir 1st to Chaitra 30th | 2 (6.5) | 5 (16.1) | 7 (14.58) |  |
| Poush 15 to Baisakh 15 | 7 (22.6) | 1 (3.2) | 8 (16.67) |  |
| Selling form of produce |  |  |  |  |
| Sheet | 13 (41.9) | 18 (58.1) | 31 (64.58) | 3.612\*\* |
| Both latex and sheet | 12 (38.7) | 5 (16.1) | 17 (35.41) |  |

Note:Figures in parentheses represent percentage\*\* indicates significant at 5% level

## 4.10. Labour use

Harvesting of rubber latex is labor intensive activity. Human labour used as input in the field was calculated in monetary terms. It was found that 85.5% of the farmers used home labour for different field operations followed by 14.5% of farmers who used hired labour in their rubber orchard. Use of family members as home labour was found to be greater in large scale farmers. It might be due to greater family size in large scale growers however, result was not statistically significant.

Table 18. Labour type in rubber orchard in the study area

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Labour type  (tapping) | Large scale | Small scale | Overall | Chi-square value |
| Home labour | 27 (87.1) | 26 (83.9) | 53 (85.5) | 0.13 |
| Hired labour | 4 (12.9) | 5 (16.1) | 9 (14.5) |  |

Note: Figures in parentheses represent percentage

The average number of labour required per bigha was found to be 1.37. The average number of labour required by large scale and small scale growers per bigha was 1.26 and 1.48 respectively with significant mean difference of 0.22 at 5% level.

Table 19. Labour number required per bigha in rubber orchard in the study area

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Labour number  (tapping) | Large scale  (n=31) | Small scale  (n=31) | Overall  (N=62) | Mean difference | t-value |
| Labour  (Min:1,Max:2) | 1.26(0.44) | 1.48 (0.50) | 1.37 (0.48) | - 0.22\*\* | -1.86 |

Note: Figures in parentheses represent percentage, \*\* indicates significant at 5% level

## 4.11. Diseases

It was found that leaf fall, spots in leaves and Tapping Panel Dry disease were the most prominent diseases of rubber plant in the study area.

Figure 1. Diseases incident in rubber plants in study area

## 4.12. Insects

It was found that major insects of rubber plant in the study area were scrapping beetle, rats and mouse and termites. While, 79% of the sampled households responded that there was no any serious problem of insects, pests in their rubber orchard.

Figure 2. Insects incident in rubber orchard in the study area

## 4.13. 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.30, 93,980. The variable cost and fixed cost was accounted to be NRs. 20, 60,210 (66 percent of total cost) and NRs.10, 33,770 (34 percent of total cost) per bigha respectively.

The benefit cost ratio was estimated to be 1.5. Thus, rubber farming is a profitable farm enterprise. The Net Present Value of the stream of returns from one bigha of rubber plantations worked to Rs.4, 63,882 at a discount rate of 12 per cent. 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 total description of per year cost, returns and BCR of rubber plantation in one bigha is elaborated in Appendix.

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 20. Capital productivity in rubber plantation in the study area

|  |  |
| --- | --- |
| Particulars | Value |
| Present Worth of cost (NRs./bigha) | 14,15,011 |
| Present Worth of returns (NRs./bigha) | 18,78,894 |
| Net Present Value (NRs./bigha) | 4,63,882 |
| Internal Rate of Return | 18% |
| B/C ratio | 1.5 |

### 4.13.1. Establishment cost per bigha of rubber

The details of expenditure during first year of establishment of rubber orchard are presented in the Table. The per bigha total cost of establishment incurred by large and small scale farmers are NRs. 145614.66 and NRs. 161702 respectively. The major expenditure among the investment cost was on planting materials (NRs. 66282 and NRs. 76685 for large scale and small scale growers respectively). The analysis of different factors of production suggested that cost of planting materials, plantation cost and manuring were found statistically significant at 1% while depreciation of implements was found statistically significant at 10% level.

Table 21. Establishment cost per bigha of rubber (NRs.)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Particulars  (per bigha) | Farmer’s category | | Mean difference | t- value |
| Large scale growers (n=31) | Small scale growers (n=31) |
| **Fixed costs** |  |  |  |  |
| Land rent | 30587.1 (1253.72) | 29494.54 (4549.85) | 1092.56 | 1.28 |
| Depreciation of implements | 3861.56 (2632.27) | 5200.73 (3189.50) | -1339.17\* | -1.80 |
| Total Fixed Cost | 34448.65(3230.37) | 34695 (5623.44) | -246.61 | -0.21 |
| **Variable costs** |  |  |  |  |
| Cost of saplings | 66282 (9992.85) | 76685(17284.6) | -10413.06\*\*\* | -2.9 |
| Land preparation | 36100.08(5916.95) | 38336.4 (15291.53) | -2236.32 | -0.75 |
| Planting cost | 7556.24 (2332.92) | 10271.13 (1164.72) | -2714.88\*\*\* | -5.79 |
| Manure | 1227.48 (641.40) | 1703.94 (725.17) | -476.45\*\*\* | -2.74 |
| Total Variable Cost | 111166.0(13619.77) | 127006.73 (24368.58) | -15840.72\*\*\* | -3.15 |
| Total Cost (TFC + TVC) | 145614.66(15364.98) | 161702(24512.12) | -16087.33\*\*\* | -3.09 |

Note: Figures in parentheses represent S.D. \* and \*\*\* indicates significant at 10% and 1% level

### 4.13.2. Costs during 2nd to 6th year of establishment

Costs that occur during 2nd to 6th year of establishment in rubber orchard are presented in Table 21.

Table 22. Costs per bigha during 2nd to 6th year of establishment

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Particulars  (per bigha) | Farmer’s category | | Mean difference | t – value |
| Large scale growers (n=31) | Small scale growers (n=31) |
| **Fixed costs** |  |  |  |  |
| Land rental value | 30587.1 (1253.72) | 29494.54(4549.85) | 1092.56 | 1.28 |
| Depreciation of implements | 3861.56 (2632.27) | 5200.73(3189.5) | -1339.17\* | -1.80 |
| Total fixed cost | 34448.65 (3230.37) | 34695(5623.44) | -246.61 | -0.21 |
| **Variable cost** |  |  |  |  |
| Manure | 1227.48 (641.4) | 1703.94 (725.17) | -476.45\*\*\* | -2.74 |
| Total cost  (TFC + TVC) | 35,676.13(3225.73) | 36398.94(5558.27) | -723.06 | -0.62 |

Note: Figures in parentheses represent S.D. \* and \*\*\* indicates significant at 10% and 1% level

### 4.13.3. Cost per bigha per year of rubber during Bearing period

The details of maintenance cost incurred by the rubber growers during the bearing period presented in Table revealed that total cost was NRs. 1, 14383.09 and NRs. 1, 16, 403 for large and small scale growers respectively. The share of variable cost was NRs.79934.44and NRs. 81707.74 which accounted nearly 69.8 percent and 70.2 percent of maintenance cost for one year during bearing period for large scale and small scale growers respectively. The share of fixed cost was NRs. 34448.6 and NRs. 34695 which accounted nearly 30.2 percent and 29.8 percent of maintenance cost for one year during bearing period for large scale and small scale growers respectively. The share of labour cost for tapping was found to be highest (92%) among the variable costs.

Table 23. Costs per bigha during bearing period of rubber orchard

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Particulars  (per bigha) | Farmer’s category | | Mean difference | t- value |
| Large scale growers (n=31) | Small scale growers (n=31) |
| Fixed cost |  |  |  |  |
| Land rental value | 30587.1 (1253.72) | 29494.54(4549.85) | 1092.56 | 1.289 |
| Depreciation | 3861.56 (2632.27) | 5200.73 (3189.50) | -1339.17\* | -1.8 |
| Total fixed cost (TFC) | 34448.6(3230.37) | 34695 (5623.44) | -246.61 | -0.21 |
| Variable cost |  |  |  |  |
| Manure | 1479.11 (769.77) | 2732.00 (1001.14) | -1252.88\*\*\* | -5.52 |
| Chemical fertilizer | 1495.45 (231.94) | 1680.26(131.265) | -184.81\*\*\* | -3.86 |
| Chemicals1 | 2024.61 (125.83) | 2238.58 (611.35) | -213.97\* | -1.9 |
| Tapping cost | 74935.27 (65540.91) | 75056.9 (62512.65) | -121.62 | -0.007 |
| Total variable cost (TVC) | 79934.44 (65652.53) | 81707.74 (62843.95) | -1773.3 | -0.10 |
| Total cost  (TFC +TVC) | 114383.09(67276.33) | 116403.01 (61597.21) | -2019.91 | -0.12 |

Note: Figures in parentheses represent S.D. \* and \*\*\* indicates significant at 10% and 1% level

### 4.13.4. Comparison of costs of production (per year)

The cost of rubber production included both maintenance cost and establishment cost (Goswami & Challa, 2007). Fixed cost included the rental value of land and depreciation on fixed assets. Variable costs included cost of manures, chemical fertilizers, plant protection chemicals rubber coat, formic acid; cost of labour for weeding, tapping, plant protection. The cost of production computed for one bigha of rubber plantation is presented in Table 24. The table revealed that the variable and fixed cost constituted 87.1 per cent and 12.9 per cent of total cost of production of Rs. 2, 67. 585. Of the total cost of production, tapping charges (28.07 percent) and cost of planting materials (26.7 per cent) took the major share. It could be seen from the table that cost of saplings, land preparation, plantation cost, manure, chemical fertilizers and tapping cost was significant at 1% level. Comparing overall variable cost and total production cost of large scale and small scale rubber growers, significant difference was reflected (p<0.01).

Table 24. Comparison of costs of production per bigha of rubber orchard

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Particulars  (per bigha) | Farmer’s category | | Overall  (N=62) | Mean difference | t-value | Percentage  Share |
| Large scale growers (n=31) | Small scale growers  (n=31) |
| Fixed cost |  |  |  |  |  |  |
| Land rental value | 30587.1 (1253.72) | 29494.54  (4549.85) | 30040.82 (3355.18) | 1092.56 | 1.289 | 11.2 |
| Depreciation | 3861.56 (2632.27) | 5200.73  (3189.50) | 4531.14 (2977.65) | -1339.17\* | -1.8 | 1.6 |
| Total fixed cost (TFC) | 34448.6  (3230.37) | 34695 (5623.44) | 34571.96 (4549.96) | -246.61 | -0.21 | 12.9 |
| Variable cost |  |  |  |  |  |  |
| Cost of saplings | 66282 (9992.85) | 76685  (17284.6) | 71488.74 (14953) | -10413.06\*\*\* | -2.9 | 26.7 |
| Land preparation | 36100.08  (5916.95) | 38336.4 (15291.53) | 37218.24 (11553.69) | -2236.32 | -0.75 | 13.9 |
| Planting cost | 7556.24 (2332.92) | |  | | --- | | 10271.13  (1164.72) | | 8913.69 (2284) | -2714.88\*\*\* | -5.79 | 3.3 |
| Manure | 1479.11 (769.77) | 2732.00  (1001.14) | 2105.56 (1087.75) | -1252.88\*\*\* | -5.52 | 0.78 |
| Fertilizers | 1494.45  (231.94) | 1680.26  (131.26) | 1587.86  (208.31) | -184.81\*\*\* | -3.86 | 0.59 |
| Chemicals1 | 2024.61  (125.83) | 2238.58  (611.35) | 2131.59  (450.81) | -213.97\* | -1.9 | 0.79 |
| Tapping cost | 74935.27 (65540.91) | 75056.9 (62512.65) | 74996.09 (63517.58) | -121.62 | -0.007 | 28.02 |
| Total variable cost (TVC) | 224321.62 (69093.62) | 241705.81 (68314.53) | 233013.71 (68700.87) | -17384.18 | -0.99 | 87.1 |
| Total cost  (TFC +TVC) | 199699.73 (73056.95) | 253737.05 (71431.37) | 267585.67 (76656.92) | -54037.32\*\*\* | -2.94 | 100 |

Note: Figures in parentheses represent S.D. \* and \*\*\* indicates significant at 10% and 1% level

## 4.14. Motivating factors for rubber cultivation

Six major motivating factors for rubber plantation in the study area were identified through focus group discussions with leading farmers, key informant interviews with extension officers and reconnaissance survey. Those major factors were suggestion of other people, potential good returns, easy for cultivation and maintenance, unutilized land, low cost of cultivation and influence of Gorakhkali. Farmers were asked to rank these factors from 1 to 6, 1 for the most important factor and increasing onwards for less important factors. Forced ranking scale was used and index value was calculated. Finally, the factors were ranked by on the basis of high rank value.

On an overall study, the most important factor that motivated farmers towards rubber cultivation was potential good returns. Selling rubber latex and sheet earns them good cash. Although, the quantity, quality of sale and revenue collected from rubber is not satisfactory, farmers believe that the scenario will soon change. A slight increment in present rubber price and their improvement in quality of produce could benefit them. So, farmers had planted rubber trees for their increased potentiality of gaining good returns when those trees reach their productive age.

Rubber farmers in the study area ranked easy for cultivation and maintenance as second most important motivation factor for rubber cultivation. Rubber plant requires less labour and maintenance compared to other cereals and commercial crops.

Similarly, suggestion of other people, low cost of cultivation, influence of Gorakhkali tyre factory and unutilized land were ranked as 3rd, 4th, 5th and 6th most important factors for rubber cultivation. Under the joint venture of Gorakhkali rubber Industry and Sudha Falrus Pvt. Ltd., three large rubber gardens were established for research in 1990. The trial signified the potential performance of rubber plants in Eastern Terai of Nepal and thus has been motivating factor for many farmers of Jhapa for rubber plantation.

Table 25. Motivating factors for rubber cultivation in the study area

|  |  |  |  |
| --- | --- | --- | --- |
| Factors | Weightage | Index | Rank |
| Suggestion of other people | 36.133 | 0.5828 | III |
| Potential good returns | 53.775 | 0.8673 | I |
| Easy for cultivation and maintenance | 42.927 | 0.6924 | II |
| Unutilized land | 22.274 | 0.3593 | VI |
| Low cost of cultivation | 33.598 | 0.5419 | IV |
| Influence of Gorakhkali tyre factory | 27.921 | 0.4503 | V |

## 4.15. 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 25.

Table 26. Factors affecting farmer' decision in acreage increment of rubber plantation

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Factors | Coefficients | Std. Error | z | P>ǀZǀ | dy/dxb |
| 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 chi2 (11) | | | 47.64 | | |
| Prob>chi2 | | | 0.0000 | | |
| Pseudo R2 | | | 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 R2 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, 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.

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 percent. 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 other studies (Besley & Case, 1993).

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.

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 percent level of significance. Rubber farming is a less prioritized farm enterprise by Brahmin/Chhetri households of the study area.

## 4.16. Expectation from PM-AMP

Farmer’s responses on expectations from PM-AMP in form of subsidy in the study area:

Table 27. Farmers' expectations from PMAMP in form of subsidy

|  |  |  |  |
| --- | --- | --- | --- |
| Particulars | Weightage | Index | Rank |
| Implements | 34.7 | 0.559661 | IV |
| Agriculture loan | 34.95 | 0.563774 | III |
| Smokehouse | 47.78 | 0.770758 | I |
| Training | 20.30 | 0.327532 | VI |
| Nursery | 45.41 | 0.732419 | II |
| Marketing | 33.47 | 0.539855 | V |

### 4.16.1. Type of training necessary to farmers:

54.8% farmers opined that there is pressing need of providing training to farmers on all rubber cultivation practices. However, the necessity of training was found to be greater in small scale farmers 58.1% followed by 51.6% of large scale farmers. Proper knowledge on technique of raising nursery plants on their own and scientific way of tapping was necessary in present condition according to 33.95% of rubber farmers. Likewise, 9.7% and 12.9% of the large scale farmers felt the need of training on nursery management practices and good grade rubber sheet production respectively. Comparing the necessity of type of training required by large scale and small scale farmers, significant difference was reflected at 5% as shown in Table 28.

Table 28. Type of training necessary to farmers in the study area

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Particulars | Large scale  (n=31) | Small scale  (n=31) | Overall  (N=62) | Chi-square  Value |
| Nursery | 3 (9.7) | 0 | 3(4.8) |  |
| Tapping and nursery | 8 (25.8) | 13 (41.9) | 21(33.9) | 8.308\*\* |
| Good grade rubber sheet production | 4 (12.9) | 0 | 4(6.5) |  |
| All of them | 16 (51.6) | 18 (58.1) | 34(54.8) |  |

Note: Figures in parentheses represent percentage \*\* indicate significance at 5% level

## 4.17. Production problems

Based on the direct field observation and informal talks with leading farmers, major problems associated with rubber cultivation in the district were identified and included in the interview schedule. The major seven problems are listed in the table below. Farmers were asked to rank these problems. Forced ranking scale was used for scaling by giving score of 1 to the most severe problem and ascends the score on less severe problems. The index value was obtained and ranking was done based on high value index.

Majority of the farmers responded that unavailability of skilled taper was the major problem for them. The index value for this problem was highest (0.95) and was ranked as the most serious problem of that area. The lactiferous vessels are little tubes that produce latex. In tapping, these little tubes containing latex should be cut taking care not to cut the cambium. Knowledge on proper tapping technique is very less in farmers and unscientific tapping reduces the yield of latex and damages the plant also.

Poor technical knowledge was ranked 2nd problematic by majority of the farmers with index value of 0.75. Proper knowledge on use of yield stimulating mixtures such as ethephon, 2, 4-D, copper sulfate along with weed killers was found to be very less among farmers of the district. Value addition practices such as proper rolling and dying in hot chamber (smoke-house) for a definite time period increases its market price. Due to lack of abundant technical knowledge on such practices and good package of production, farmers are not able to produce high grade rubber sheets and thus they do not fetch good market price.

Unavailability of inputs such as lack of good clonal nursery was ranked 3rd problematic by the respondents with an index value of 0.67. Lack of infrastructures such as harvesting implements (Zebong knife, CUT knife), rolling machine and smoke house was ranked 4th problematic by majority of the respondents with an index value of 0.58. Rolling of latex on conventional manual rollers and drying on sun was practiced by farmers of the district.

Wind lodging of the trees was ranked 5th problematic by the respondents with an index value of 0.58. Tree height, unbalanced branches, heavy canopy load and additional weight from rain water deposited on the leaves together with poor girth increment on tapping contribute significantly to crown heaviness with high turning movement around the trunk which can easily predispose the trees to snapping and toppling. It is reported that parts of tree with structural crotches, as well as those having maximum girthing and canopy development are more easily damaged by wind. Remedial approaches to wind damage such as planting of wind breaks like the fast growing and wind resistant *Acacia* species, *Eucalyptus* and *Camellia oleifera* can be employed to counteract wind damage (Vijayakumar et al., 2000).

Loss due to improper processing and infestation of pests and diseases were 6th and 7th problem respectively associated with rubber plantations.

Table 29. Problems in rubber production in the study area

|  |  |  |  |
| --- | --- | --- | --- |
|  | Weightage | Index | Rank |
| Non-availability of skilled tapper | 59.28 | 0.95 | I |
| Loss due to improper processing | 17.14 | 0.27 | VI |
| Unavailability of inputs | 41.85 | 0.67 | III |
| Problem of insects and pests | 10.14 | 0.16 | VII |
| Poor technical knowledge | 46.71 | 0.75 | II |
| Lack of infrastructure | 36.42 | 0.58 | IV |
| Wind damage | 36.42 | 0.58 | V |

### 4.17.1. Reason behind no tapping

During survey, many of the respondents who had not started harvesting latex were found. Their reasons behind not harvesting were recorded. 19.4% of the respondents did not start tapping because their rubber plants had not reached proper harvesting age. Constant fall in prices of natural rubber, coupled with high labour cost has forced many of the growers (4.8%) to keep away from tapping. It might be due to cheap imports of rubber latex and finished rubber products. Also, 3.2% of the growers did not practice tapping due to unavailability of skilled tappers. It impedes that extension services in terms of training on rubber cultivation practices and tapping technique are quite less in Jhapa.

Table 30. Reasons behind no tapping in the study area

|  |  |  |
| --- | --- | --- |
| Particulars | Frequency | Percentage |
| Not reached proper harvesting age | 12 | 19.4 |
| Unavailability of skilled tapers | 2 | 3.2 |
| Poor market price | 3 | 4.8 |

## 4.18. Marketing problems

High price fluctuation was the major problem in rubber marketing in the district with an index value of 0.92. The market price of rubber varied and farmers always need to search about the current market price.

Respondents opined that they were not getting remunerative prices what they were expecting because of high cost of labour and inputs. It was 2nd most problematic with an index value of 0.82. Presence of middlemen in rubber marketing was the 3rd major problem according to the respondents with an index value of 0.57. Middlemen get high margins and are thus responsible for farmer’s low share in the consumer rupee.

Delay in payment and less quality of the produce was 4th and 5th major problem according to the respondents with an index value of 0.52 and 0.5 respectively. The local traders delay to pay amount to growers due to which resource poor growers face problems. Also, farmers fetch fewer prices than expected due to poor grade of rubber sheets produced.

Different infrastructures like collection centers, storage house, processing facility and many more are influential to the farmers to lure them for crop cultivation and extension. Absence of such infrastructures in marketing was 6th major problem according to the respondents.

Other problem associated with marketing of rubber was post harvest loss due to improper curing (smoking). Thus, sheets are attacked by mould and their quality as well as storability decreases.

Table 31. Problems in rubber marketing in the study area

|  |  |  |  |
| --- | --- | --- | --- |
| Problems | Weightage | Index | Rank |
| High price fluctuation | 57.57 | 0.92 | I |
| Delay in payment | 32.71 | 0.52 | IV |
| Non-remunerative price | 51.14 | 0.82 | II |
| Poor marketing infrastructure | 30 | 0.48 | VI |
| Post harvest loss | 9.571 | 0.15 | VII |
| Less quality | 31.14 | 0.50 | V |
| Middlemen | 35.85 | 0.57 | III |

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# 5. SUMMARY AND CONCLUSION

The study was carried out to find out the socio-economic characteristics, estimate of the cost of production, returns and profitability of rubber farmers. Altogether 62 rubber growing farmers were sampled using random sampling technique. Descriptive analysis and various statistical tests like chi-square test, t-test along with probit model were used to draw the results using MS- Excel, SPSS and Stata software.

The average land holding was 3.57 bigha of which 92 percent was cultivated land. The average rubber farm size was 1.94 bigha out of which average land area under large scale growers and small scale growers was 2.67 bigha and 1.21 bigha respectively. The experience in rubber farming among small holder farmers was significantly more than that among large holder farmers. Average daily latex yield per rubber plant was 181 ml.

Majority of the respondents had begun rubber farming by discontinuing cultivation of cereal crops and significant difference at 1% level was observed among large scale and small scale growers. Small scale growers were found to be more involved in community organizations with significant difference at 1% level. Overall 87.1 percent of the growers had received training regarding rubber and the major training provider was PM-AMP, PIU, Rubber zone, Jhapa. The major varieties grown were RRIM 600 and RRII 105, out of which, most preferred by farmers was RRIM 600 due to its high yield, disease and wind lodging resistant attributes.

Adoption of technology in rubber farming such as ownership of rolling machine, smoke house, use of yield stimulators was found to be very less among farmers. However, large scale farmers were more found to adopt technology with significant difference at 5% level. Majority of the farmers adopted tapping rest during Poush 1st – Chaitra 30th during which soil is very dry and yield is uneconomic. Alternate date tapping was followed by most of the growers and average tapping per year was 150 days. Major selling form of produce was sheet by 50% of the respondents. Use of family members as labour in their rubber orchard was greater (85.5%) than hired labour (14.5%) and the average number of labour required per bigha was 1.37.

The total cost of rubber production in one bigha of orchard for thirty years considering farmer’s practices was estimated to be NRs.30, 93,980. The variable cost and fixed cost was accounted to be NRs. 20, 60,210 (66 percent of total cost) and NRs.10, 33,770 (34 percent of total cost) per bigha respectively. The share of labour cost for tapping was found to be highest (92%) among the variable costs per year during bearing period.

The benefit cost ratio was estimated to be 1.5. Thus, rubber farming is a profitable farm enterprise. The Net Present Value of the stream of returns from one bigha of rubber plantations worked to Rs. 4, 63,882 at a discount rate of 12 per cent. 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 per cent 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. 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.

The most important factor that motivated farmers towards rubber cultivation was potential good returns followed by easy for cultivation and maintenance, suggestion of other people, low cost of cultivation, influence of Gorakhkali tyre factory and unutilized land. 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 could increase probability of acreage increment by 36.9 percent. Similarly, membership of the farmer in community organizations could increase the probability by 43.1 percent. Experience in rubber farming of farmers was also found significantly (p<0.1) affecting farmers’ decision in expanding rubber cultivation area with probability of 1.4 percent. Extension services like training, farmers’ field school, farm visits should be intensified for expansion of rubber cultivation area.

Unavailability of skilled tapers, poor technical knowledge, unavailability of quality inputs, lack of infrastructures, loss due to improper processing and problem of insects, pests were the major production problems of rubber cultivation in Jhapa district. Likewise, high price fluctuation, non-remunerative price, presence of middlemen, delay in payment and poor marketing infrastructures were the major marketing problems of rubber in the study site.

However, major conclusion of this research is enlisted below:

* Natural rubber production enterprise is a profitable venture with B/C ratio 1.5 and IRR 18% but the profitability can still be increased
* Strengthening of extension services, subsidization and more trainings on scientific tapping procedure are essential needs of the study area
* Unavailability of skilled tapper is the major production problem in rubber in Jhapa
* 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.

# 6. Suggestions

* Cooperatives should be empowered in the study site.
* Government should launch programs to improve package of production through research activities
* Breeding and development of high yielding clones
* Mechanization is necessary to reduce the production costs.
* Further research on resource use efficiency
* Multi-Location and multi-dimensional research should be done which can be generalized across the country

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# Appendices

Investment appraisal of rubber enterprise during 30 years using Predictability method

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| date | production(kg/bigha) | revenue | variable cost | gross profit | Discounted cost | Discounted benefit | Discounted  profit |
| 2013 | 0 | 0 | 86801.35 | -86801.4 | 171330.474 | 0 | -171330 |
| 2014 | 0 | 0 | 1465.7 | -1465.7 | 2583.06421 | 0 | -2583.06 |
| 2015 | 0 | 0 | 1465.7 | -1465.7 | 2306.30733 | 0 | -2306.31 |
| 2016 | 0 | 0 | 1465.7 | -1465.7 | 2059.20297 | 0 | -2059.2 |
| 2017 | 0 | 0 | 1465.7 | -1465.7 | 1838.57408 | 0 | -1838.57 |
| 2018 | 0 | 0 | 1465.7 | -1465.7 | 1641.584 | 0 | -1641.58 |
| 2019 | 337.5406 | 64132.71 | 80566.6 | -16433.9 | 80566.6 | 64132.70925 | -16433.9 |
| 2020 | 599.8286 | 113967.4 | 80566.6 | 33400.84 | 71934.4643 | 101756.6423 | 29822.18 |
| 2021 | 672.9647 | 127863.3 | 80566.6 | 47296.7 | 64227.2003 | 101931.8366 | 37704.64 |
| 2022 | 788.3673 | 149789.8 | 80566.6 | 69223.19 | 57345.7145 | 106617.4118 | 49271.7 |
| 2023 | 1005.889 | 191118.9 | 80566.6 | 110552.3 | 51201.5308 | 121459.5113 | 70257.98 |
| 2024 | 1129.865 | 214674.4 | 80593.57 | 134080.9 | 45730.956 | 121812.0451 | 76081.09 |
| 2025 | 1332.69 | 253211.1 | 80620.54 | 172590.6 | 40844.8746 | 128284.6235 | 87439.75 |
| 2026 | 1538.283 | 292273.7 | 80647.51 | 211626.2 | 36480.8379 | 132209.7973 | 95728.96 |
| 2027 | 1599.814 | 303964.7 | 80674.48 | 223290.2 | 32583.0694 | 122766.2403 | 90183.17 |
| 2028 | 1663.807 | 316123.3 | 80701.45 | 235421.8 | 29101.7519 | 113997.2232 | 84895.47 |
| 2029 | 1730.359 | 328768.2 | 80728.42 | 248039.8 | 25992.3907 | 105854.5644 | 79862.17 |
| 2030 | 1799.573 | 341918.9 | 80068.32 | 261850.6 | 23017.7287 | 98293.52407 | 75275.8 |
| 2031 | 1871.556 | 355595.7 | 80068.32 | 275527.4 | 20551.5435 | 91272.55806 | 70721.01 |
| 2032 | 1957.452 | 371915.9 | 80068.32 | 291847.6 | 18349.5924 | 85233.5206 | 66883.93 |
| 2033 | 2121.414 | 403068.6 | 80068.32 | 323000.3 | 16383.5646 | 82475.8191 | 66092.25 |
| 2034 | 2285.375 | 434221.3 | 80068.32 | 354153 | 14628.1827 | 79330.60761 | 64702.42 |
| 2035 | 1932.632 | 367200.1 | 80068.32 | 287131.8 | 13060.8774 | 59898.28669 | 46837.41 |
| 2036 | 1579.889 | 300178.9 | 80068.32 | 220110.5 | 11661.4977 | 43719.35155 | 32057.85 |
| 2037 | 1289.601 | 245024.3 | 80068.32 | 164955.9 | 10412.0515 | 31862.85356 | 21450.8 |
| 2038 | 1213.846 | 230630.8 | 80068.32 | 150562.5 | 9296.47457 | 26777.79797 | 17481.32 |
| 2039 | 1138.091 | 216237.3 | 80068.32 | 136169 | 8300.42372 | 22416.6246 | 14116.2 |
| 2040 | 944.0456 | 179368.7 | 80068.32 | 99300.35 | 7411.09261 | 16602.29403 | 9191.201 |
| 2041 | 750 | 142500 | 80068.32 | 62431.68 | 6617.04697 | 11776.55774 | 5159.511 |
| 2042 | 600 | 114000 | 80068.32 | 33931.68 | 5908.07765 | 8411.826954 | 2503.749 |