

A term paper on

Economic Analysis of Resin Tapping



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Abstract

This term paper entitle “economic analysis of resin tapping” was done by literature review and writer’s own field experience. Millions of people worldwide, especially in developing countries, depend on the collection of gums, resin and latex for their livelihoods. In Nepal around 35 hill districts are involving in resin tapping work. Pinus roxburghii is only one species use for the tapping in Nepal. Despite of rill method is comparatively good but new bore hole method are need to be apply in Nepal for economic benefit. China, Brazil and Indonesia are now more resin producing country in the world. Yield of the resin tapping is varies to species, season, climatic condition, method of tapping and topographic factors. For the economic analysis of the resin tapping preliminary /pre setting cost, tapping cost and processing cost should be calculated. All invested cost of resin tapping can divide into; total fixed cost and total variable cost. Cost benefit analysis would be done by using NPV, BCR, IRR methods. Resin tapping activities create so many economic advantages both in nation as well as in local level .It generate employment to local level, apart form this government, local village committee, community forestry user group earning regular revenue. Research carried out in Darchula district shows that resin tapping company has been running in profitable situation. Implementation of new bore hole method. New bore hole method of tapping and mechanization in work should be help to save time and money in tapping.

Key words: resin tapping, rosin, turpentine, yield, fix cost, variable cost

1. Introduction and historical background

Resin Tapping is an important forest based industry having a bearing on the rural economy and its products; resin and turpentine serve as raw material for soap, paper, paints and variety of other chemical industries (Nimkar et al.,2007). Millions of people worldwide, especially in developing countries, depend on the collection of gums, resin and latex for their livelihoods. Tapping is the common method of harvesting the resin from the resin yielding trees. In Nepal, resin industries require annual about 1260 ton of resin derivatives. At an annual growth rate of 5%, about 6600 ton of resin would be needed by 2010-11(MPFSN, Main Report,1988).

Resin tapping system was started in 1606 as a Noval stores industries in America. American used resin for sealing the crack or hole in the boat. Tapping work in India was started in 1896 (Chaudary,1995).In Nepal, Laxmi Tapping industry started tapping in western Nepal during 1973 and totally supplied in India without any processing. In 1983, first Resin Company was started in Nepal as a private sector that is Laxmi Rosin and Terpentine industries. After that in 1986 government of Nepal established Nepal Rosin

and Turpentine in Geda of Kailali district of Nepal (GRTI, EIA, 2061) and till now there are more than 15 big and small rosin tapping company in Nepal.

Resin tapping are now doing in around 35 district of Nepal. *Pinus roxburghii* (Chir pine) is the only species tapped in Nepal. This species is widely distributed mid hills of Nepal in the elevation of 900-1950 meter and some times up to 2700 meter (Jackson, 1994).

Resin is obtained by tapping the tree by making a cut, which expose the surface of the wood. The resin which is contained in resin canals which are either large longitudinal ducts in wood and or small ducts in the ray at tight angles to the larger ducts. The maximum flows of resin is from the top of the incision, where both the horizontal and vertical ducts are cuts. The resin tapping is based on this principle (Meheta, 1981).

2. Sources of resin collection

Resin produce from pines are commonly called naval storages. Today three classes of naval stores are recognized based on their source

1. Gum Naval Storage- these are obtained by tapping the trunk of living pine trees. This is the traditional source of resin and is a labor intensive process. It covers 60% of total production.
2. sulphate naval storage- are obtained during the conversion of pine wood chips to pulp via the sulphate of kraft pulping process. Sulphate turpene is condensed from the cooking vapors. Product known as tall oil or liquid rosin. The output of tall rosin keep stable in recent year, it takes about 35% of world total output.
3. Wood naval stores- are obtained from resin saturated pine stumps long after a tree has been felled. Pine stump was grinded and extracted in wood resin factory, US is the world biggest wood naval stores. At present it takes 5% of total output.

3. World's tapping tree Species

The family pinaceae have 120 species in the world and divided in to 3 sub genera.

Most pines species yield resin of some sort upon tapping, the question of whether it is economical to do so depend on its quality and the quantities that are produced.

Those species of pinus that are currently tapped, and the countries that are known to utilize them for this purpose, are listed below.

Table showing world tapping tree species (Coppen and Hone,1995)

S.N	Species	Countries
1	<i>Pinus elliotii</i>	USA, Brazil, South Africa, Zimbabwe, Kenya
2	<i>Pinus pinaster</i>	Portugal
3	<i>Pinus massoniana</i>	China
4	<i>Pinus merkusii</i>	Indonesia, Thailand
5	<i>Pinus caribaea</i>	South Africa, Kenya
6	<i>Pinus roxburghii</i>	India, Pakistan, Nepal
7	<i>Pinus oocarpa</i>	Mexico, Honduras
8	<i>Pinus sylvestris</i>	Russia
9	<i>Pinus radiata</i>	Kenya
10	<i>Pinus halepensis</i>	Greece
11	<i>Pinus brutia</i>	Turkey
12	<i>Pinus kesiya</i>	China

Resins from other pinaceae

Abies Spp:- *Balsamea*- Canada balsam, *Abies grandis*, *Abies spectabilis*,

Picea spp:- *Picea abies*, *Picea smithiana*, *Picea glauca*,

Others:- *Tsuga Canadensis*, *Pseudotsuga menziesii*, , *cedrus libani*

4. Production and Trade

Coppen and Hone,1995 reported today world wide production of rosin is about 1.2 million tones and turpentine is 330000 tones from all sources. The United States and China are currently the world largest producer and consumers of turpentine. The job of tapping, gum naval stores production has declined and its centres of production have shifted. During the early 1960s, the United States and former USSR were leading producers of resin and several European countries were major producers (Chaudari, 1995). Presently, china and Indonesia are leading producers. This is fact due to labor expensive more in developed countries. In 1993, Chinese gum naval stores production accounted for approximately 430000 tonnes (60%) and Indonesia accounted for an additional 69000 tonnes (10%) world production. Table below.

Major crude resin, rosin and turpentine producing countries, 1990-1993

S.N.	Country	Crude resin (%)	Rosin (%)	Turpentine (%)
1	China	59	60	50
2	Indonesia	10	10	12
3	Russia	9	9	9
4	Brazil	7	6	8
5	Portugal	3	3	5
6	India	3	3	4
7	Argentina	3	3	4
8	Mexico	3	3	4
9	Honduras	<1	1	1
10	Venezuela	<1	<1	<

5. Factors affecting the yield and quality of Resin Production

Mean annual yield of resin should be more than 2 kg per tree if tapping is to be economically viable. Around 3-5 kg resin per tree per year is recommended in condition of Nepal (GRTI, 2061). This means that for an operation aimed at producing 1,000 tonnes of resin per year, 0.3-0.5 million trees are required. Distillation of this quantity of resin will produce approximately 650-700 tonnes of rosin and 150 tonnes of turpentine.

For the economic production of the resin we need manage it on the sustainable basis, yield and quality of resin affect the economic aspect of the resin tapping work. The yield of the resin depends on the following;

- I. **Species to species** and also within a species- inherited capacity of individuals, seed origin for example *Pinus roxburghii*, *P. elliottii*, *P.merkusii*, *P. carabaea* gives good yield of resin then *Pinus petula*, *P. kesiya*.
- II. **Locality factors** and **environmental factors**- soil, rainfall, humidity, air and soil temperature. More yield in a warm than on a cool climate
- III. **Technique of tapping**: cup and lip method<rill method< bore hole method
- IV. **Tree morphology**; Stem diameter, Tree crown size, crown height, Twist
- V. **Part of the trees**-The yield of resin is largest in the resin of the root column, less in the clean part of the bole and least in the vicinity of the branches.
- VI. **Collection cup quality**- made of polythene

- VII. **Use of chemical stimulation-** sulphuric and hydro-chloride acids caused dark of color and clouding the resin.
- VIII. **Side of stem:** more resin is secreted on the south than on the north side of the stem
- IX. **Aspect:** more resin secreted on a warm aspect than on cool aspect
- X. **Soil:** resin produce more in dry, warm, loose and sandy soils than in moist places, stiff and cold soil.
- XI. **Nature of forest:** more resin producer tree in open forest than in crowded forest
- XII. **Nature of ground:** more resin on hilly or sloping than on level ground

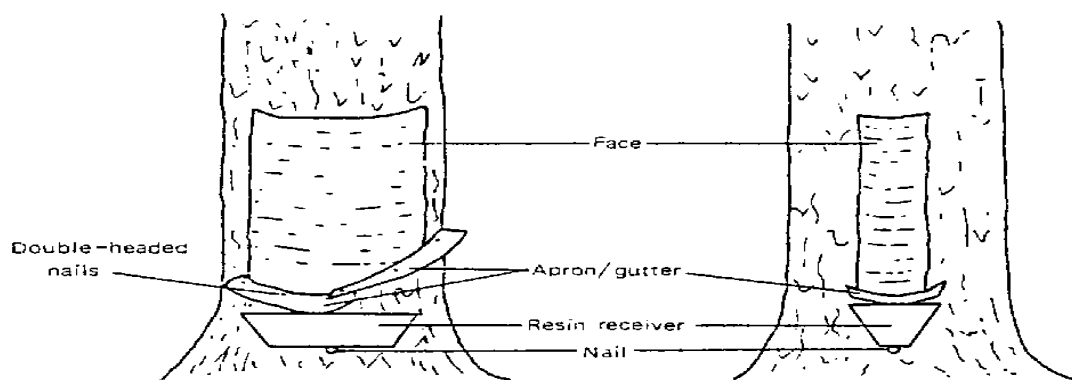
6. Method of tapping

Various method of tapping has been adopted by different countries in accordance with development of new technology, availability of labor and tapping trees. Tapping involves causing of physical injury to the cambium layer and sapwood of the tree by making a blaze with an adze and collection the exuded resin in a metal or plastic pot (Chaudari,1995). There may be two kinds of tapping;

- 1. Light and continuous tapping:** This is done in all trees above 0.9 m in girth. Trees between 0.9-1.8 m in girth are tapped in one channel and above 1.8 m girth in two channels for five years. And at the end of five years, a new channel is tapped leaving 10 cm space from old channels.
- 2. Heavy tapping:** this is tapping to death, and common in developed countries. In this method maximum possible quantity of resin is exuded by making many possible channels at 10 cm space. It is generally initiated five years in advance of main felling.

There are different methods of tapping the stem of living trees. These are;

1. Cup and lip method
2. Silva hill basula method
3. Bark chipped method
4. Rill method
5. Bore hole method*



Among these methods Rill method has been practice in Nepal.

The rill method of tapping has consider as a more economical than other method due to fact that (Chaudhary,1995).

- I. There is minimum cutting depth that save heart wood from the damage does not reduce the economic value of the wood.
- II. Fast healing of blaze reduces the tapping cycle and increase tapping life of tree and forest.
- III. Provide safe from the fire and wind comparatively.
- IV. Stimulant use makes prolonged flow and increase resin production.
- V. It yields about 50% more resin per tree per season.
- VI. It generates more employment due to 8 moths tapping period and then transportation period.

7. New Bore-hole method of tapping resin (cover page figure)

Alarmed at the large-scale drying of pine trees, the Himachal Forest Corporation of India has decided to switch over to the new “**bore-hole**” technique from the rill method for tapping resin.

The experience of the past 15 years has shown that the modern rill method, which was introduced in 1983 to replace the traditional “cup-and-lip” method, was no better as far as damage to trees was concerned. Intensive tapping has resulted in drying of thousands of pine trees over the past decade. It has also been observed that the application of higher concentration of acid, used as freshener, had adversely affected the growth of trees.

Under the new technique only a 2-cm deep bore is made on the tree which suffices for seven to eight weeks. Just three bores are required to tap resin during a season and thus

the exercise is completed in 20 to 22 weeks as against eight months in the case of the rill method. The yield is almost the same.

The biggest advantage of the new method is that resin is tapped after the fire season around June 15, thus the tapped trees are not exposed to the fire hazard. It would also save labour and thus bring down the cost of resin tapping by about 25 per cent.

Besides, the quality of resin will be much superior and without dust and other impurities as it would be collected in a polythene bags attached to the bore. The quality of rosin, turpentine oil and other products manufactured from it will also be much better and fetch higher prices.

The turpentine contents were found to be significantly higher in borehole method of tapping than rill method, the relative flow rate was higher in borehole turpentine as compared to rill method.

TAPPING TECHNIQUES TODAY

The three major producing countries of crude gum use three different tapping techniques (Newsletter, 2008).

BRAZIL:

Tapping technique: **Bark chipping**

Methodology: A horizontal streak to remove the bark and the phloem is done every 15 days. A stimulant is applied to enhance the production of crude gum.



CHINA:

Tapping technique: **Wood chipping**

Methodology: A streak to remove the bark, phloem and the first rings of wood in the xylem is done almost every day. No stimulant applied.



INDONESIA:

Tapping technique: **Wood chipping**

Methodology: Streaks in V form are applied regularly to remove the bark, phloem and the first rings of wood in the xylem. Each streak is separated from the other by a thin space on unremoved bark. The physiological response of the pine tree to these different techniques is hidden in the genetic code of the plant. The production of crude gum (oleoresin) in response to a wound is a response that the pine tree has acquired to defend from its natural enemy, the bark beetle.



8. Procedure of resin and tapping

8.1 Preliminary procedure

1. Resource Survey and data collection of pine trees: To establish a project of resin tapping, the first work is to find out where resources are available. All work related to this will be done by proponent with own cost.
2. Data analysis and report preparation: In this step, average stand size and density of crown is calculated and classified. Total amount of sustainable harvested resin is calculated and a report is prepared for submission to the forest department.
3. Area selection and Environmental study: The resin collection area is selected on a Village Development Committee wise or Community Forest User Groups wise. And on the basis of environmental conservation act-2053 and regulation-2054, an environmental study report (Initial environmental examination, IEE) is prepared.

8.2 Tree enumeration and blocking

1. Enumeration of trees: This is the procedure of counting the tappable tree. This work is repeated in every 5 years.
2. Blocking: In the blocking of pine forest, in an average 10,000 trees are kept in one compartment (GoN, 2007). And each block is again divided into sub-blocks, one sub-block is provided for one worker for tapping.

8.3 Harvesting process of trees

1. Selection of tapping tree: the tree equal or more than 30 cm diameter at breast height is selected for tapping.
2. Clear the leaf litter around the trees
3. Bark shaving
4. Marking of blaze frame and central groove
5. Groove cutting
6. Fixing the lip and resin pot
7. Freshening
8. Resin collection
9. Closing of tapping
10. Transportation of collected resin



8.4 Processing of resin in plant

1. Treatment in hot chamber for purification
2. Distillation
3. Cooling
4. Grading
5. Storage
6. Marketing

9. Social and economic benefit in resin tapping

9.1. Create employment opportunities

People in rural area have been engaged in work, including women. In Vietnam, resin tapping is often a women's enterprise. In addition to providing a source of income for women, local resin tapping enterprises also provide an incentive to not over-exploit pine plantations for fuel wood, which is a scarce commodity in this country. In case of Nepal about 10,000 people are involved in the resin tapping work (author own observation). In an average one person can earn up to 30,000 in eight months of tapping period (Upadhyay, 2014).

9. 2. Enhancement of business and other economic activities

Due to increase in the activities of labor, supervisors, foresters in the rural area, local tea shops, hotels and other daily item's consumptions has been increase. Transportations activities also increase by the movement of resin carrying trucks.

9. 3. Provide raw material for other industries

Rosin and turpentine are the ingredients of other products like paper, rubber, paints etc

9.4. Revenue for the government

Government gets revenue at the rate of Nrs 3 per kg as a royalty. Report show that one company of mid western development resion paid Nrs. 465, 00000 with in 8 years(GRTI,2004). In the fiscal year 060/61 Nepal government earn Nrs. 1,15,00000 as a revenue for the resin. (HHG/N, 2005). A part from this revenue VDC tax, VAT and export tax has been paid by the company.

9.5. Income of community forest user groups:

Rosin and tapping work now become the source of income of the CFUGs. Til pahara CFUG of kalimati, Salyan earn NRs. 77,469 in the year 2006 only by resin collection (GRTI, 2007).

9.6. Source of foreign currency:

Now a day in Nepal, it is estimated that about 95-98% of total production has been export in Indian market. So resin tapping work becomes a good source of foreign currency.

9.7. Handing over the technology:

In the beginning of tapping, training has been provided by the company. This process helps to transfer technology of tapping in the people of rural area.

9.8. Reduction in forest crime:

Resin tapping activities would provide regular supervision of tapping work which control the activities like; illicit felling, forest fire, poaching, illegal collection of NTFPs, collection of diyalo.

9.9. Increase per unit land productivity by multiple productions of timber, pulpwood, and resin on the same land.

10. Economic Uses or important of pine resin

Resin tapping has become an important industry in a number of developing countries where labour costs are low. Resin is now considered as prime raw material for the different industries. Uses of resin can be categorized in two headings

1 Uses of unprocessed resin

Unprocessed resin has a number of traditional uses. People of karnali zone of Nepal use resin of *Pinus roxburghii* to relieve the symptoms of a cough and resin from *Pinus wallichiana* is used as a plaster for bone fractures. In India resin was applied to boils, heel cracks. In Greece, the addition of pine resin to white wine (retsina) is a national tradition. For many years resin used in an unprocessed form in the manufacture of soaps, papers, paints and varnishes.

2 Uses of Processed rosin and Turpentine

By processing in the distillation method in the plant resin gives two main products that are Rosin and Turpentine. In the normal condition oleo pine resin processing gives 76% rosin, 18% turpentine.

Rosin is the major product obtained from pine. It is a volatile residue. Rosin is a brittle, transparent, glassy solid insoluble in water but soluble in a number of organic solvents. Most rosin is used in a chemically modified form rather than in the raw state in which it is obtained. It consists primarily of a mixture of abietic⁻ and pimaric⁻ type of acids with smaller amount of neutral compounds. It can be converted to a large number of downstream derivatives that are used in a wide range of applications.

Synthetic rubber, Paint, Foodstuff, Adhesive, Printing oil, Electrical equipment, Papermaking, Soap, Construction material, linoleum and floor covering, Metal processing, Bactericide, Fine chemical, Plastic, Oils and greases, Rubber, Printing inks, Shoe polish and related materials.

Turpentine is a clear liquid with a pungent odor and bitter taste and is composed of a number of organic compounds, primarily a series of volatile fractions known as terpenes. The chemical composition of turpentine can vary significantly depending on the species of *Pinus* from which it is harvested. Turpentine is used as; Solvent, Synthetic borneol, Synthetic camphor, Synthetic resin, Synthetic terpinol, Synthetic spic, Elastomeric composites, Pesticide, Military use, Shoe polish and related materials, Rubber, printing inks, Adhesives and plastics, Asphaltic products, Furniture, Insecticide and disinfectants

11. Financial and economic aspects of resin tapping and processing

It is impossible to compete in world markets if crude resin costs are markedly higher than those of the largest three exporters, the People's Republic of China, Indonesia and Brazil. The international trade in crude resin has expanded over the last five years, particularly from Brazil to Portugal and India, but it still represents a very small percentage of the total volume of rosin and turpentine traded.

Total Cost of Production in resin and tapping

1. **Preliminary cost:** These cost include the cost of the plan preparation, preparation of Term of reference making, scoping the wanted area, Initial Environmental Examination, Environmental Impact Assessment to its final submission and its approve.
2. **Field cost/ cost in the resin collection:** It include; marking of the tree for tapping, pre-setting operation, setting of the crop, tapping and collection, Storage in forest depot, Transportation to main depot and storage, Transportation to processing plant
3. **Processing cost:** Processing of resin, Fuel wood, Chemicals, Labor, Repairs, Equipment, Building, Administrative overhead, package and storage of products, packing case, labor, equipment, storage shade, administrative overhead

11.1. Resin tapping operations

Tapping is a labor-intensive operation and labor costs will therefore greatly influence production costs and, hence, profitability. The tapping operation itself can be carried out by contractors or pieceworkers who are paid according to the amount of clean resin they produce. A much smaller, permanent work force is required to supervise and manage the tapping operation, arrange for purchase, storage and transport of crude resin, and maintain stores and accounts. However, it is essential for management to undertake periodic checks to ensure that correct tapping procedures are being followed.

The major capital cost when establishing a tapping operation are the purchase of gutters and cups, a range of tools, and items of protective clothing and footwear for the tapers. The gutters and cups may be manufactured specifically for the purpose, or they may be made using suitable secondhand materials. Other major items of expenditure include pre-

production and start-up costs transport within the forest and to the processing plant, and license fees payable to the owner of the trees for tapping rights.

Although it is impossible to provide accurate costs of a tapping operation

- 1. Pre-production and start-up costs:** Manpower recruitment and training; initial management and administrative expenses; materials for training Contingencies (10%)
- 2. Fixed investment costs:** Site preparation, civil works and loading bay, Buildings: staff housing and office, Production equipment: bark shavers, gutters; cups, tapping tools, acid applicators, buckets, funnels, drums, acid-proof aprons, rubber boots Auxiliary equipment: vehicles, workshop and office equipment, Contingencies (10%)
- 3. Working capital costs:** raw materials labour and staff costs, exploitation fees, vehicle, licences and insurance.
- 4. Annual production costs:** Manpower: wages and salaries to permanent labour force, Raw materials, Contractors' payments , Production materials: Nails Sulphuric acid Transport: fuel, licences and insurance paste Equipment: maintenance and replacement, General stores, Contingencies (10%, all items except manpower/raw materials)

11.2 Resin processing operations

The overall capital costs of a resin processing plant cover machinery and equipment, freight of all imported items, and installation and start-up. Pre-production costs such as manpower recruitment and training and all initial management and administrative expenses also have to be included. It is assumed that the training element will be provided by a foreign technical expert. Additional provision must be made for land costs and civil works, buildings, utilities, auxiliary equipment and spares.

- 1. Pre-production and start-up costs:** Technical expertise, Manpower recruitment; training and administration; materials for trial runs, Contingencies (10%)
- 2. Fixed investment costs:** Site preparation and civil works, Buildings: Factory Workshop and staff housing Contingencies (10%), Plant and equipment: Boiler

(imported) All other production equipment (made locally) Manager's 4WD vehicle; workshop and office equipment; clothing and tools Contingencies (5%).

3. **Annual production costs:** Manpower: wages and salaries to permanent labour force Raw materials, Production materials: filters, filter aid and oxalic acid, Transport: truck hire; fuel, licences and insurance for own vehicles, Equipment: maintenance and replacement, Packaging: paper lining, tins, drums, office telephone, fax, etc., Contingencies

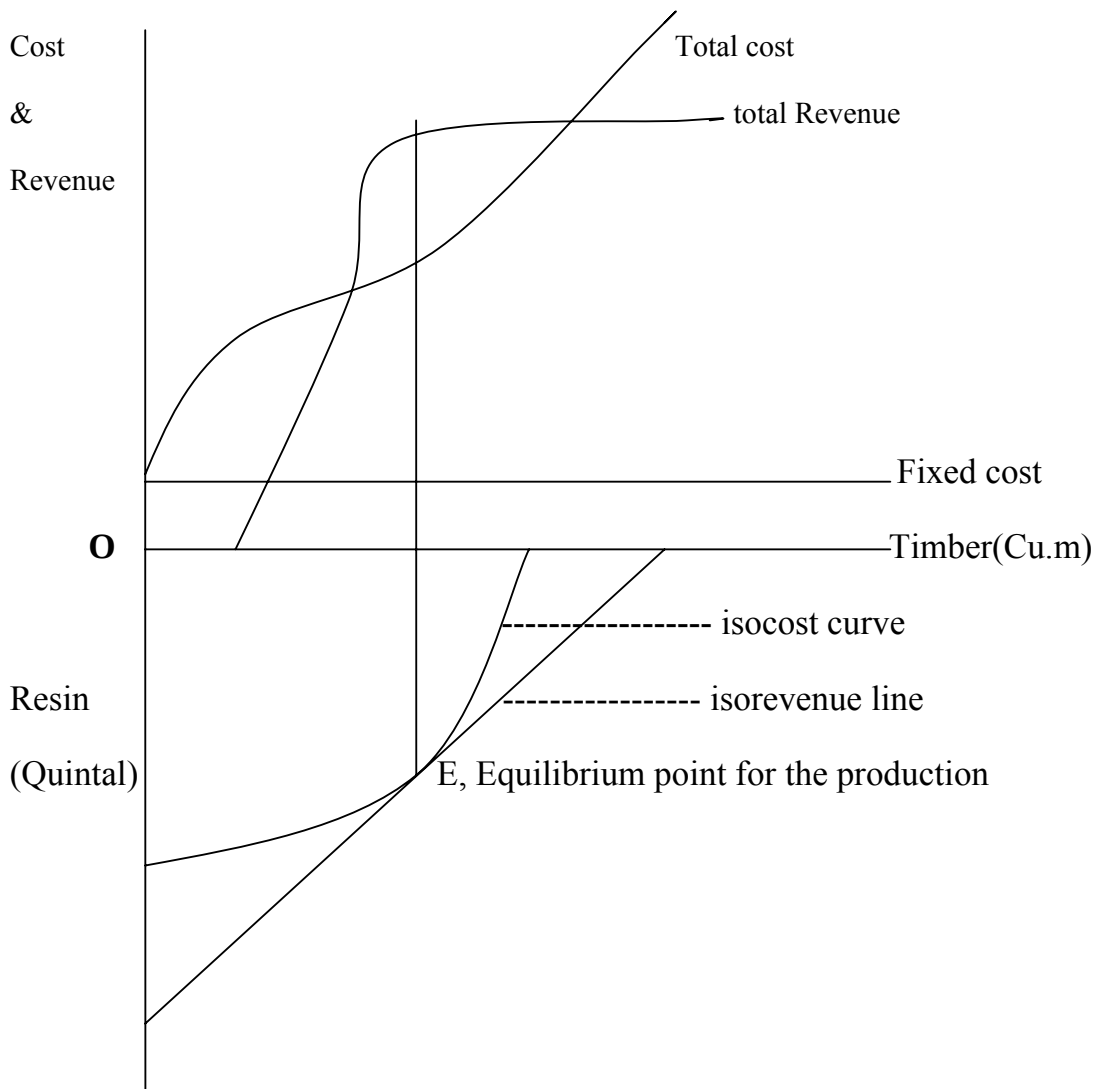
12. Economic criteria for multiple production (Timber and resin)

Resin is one of the several products of pine tree. A pine tree yields net income from resin for 20-35 years, depending on the rotation and minimum tappable diameter, before it is felled for saw logs and pulpwood (Pant,1986). Gragory, 1972 “ the same production facility –the came factory” is used to produce resin, saw logs and pulpwood, etc, “ and the entire group of fixed factors are jointly used”, there is no ways of linking most inputs in pine tree production with particular unit of outputs, or of determining a meaningful average coat of production of each particular product.

For assessing the profitability of growing pine forest as an investment, whole annual cost, planting costs, land rental, thinning, supervision, fire protection etc, must be estimated as and similarly benefit from resin, thinnings and final yield etc. Once a set of total coat and total revenue curves is established the profit maximizing output combination of wood and resin can be determined. Suppose timber is produced in technically fixed proportions from R hectare of pine forest in horizontal axis. (R is the number of years in the rotation period). Resin production for a given level of tapping frequency, and represent in Y axis.

But in reality it is difficult to determine production of both due to external factors. The rotation is determine primarily form its effect on timber production and tapping activy is undertaken so long as the revenue from resin exceed the operating cost of tapping. The effect on tree/forest growth is ignored (Pant,1986). Producer chose equilibrium point when different between benefit and cost is maximum and when Iso-revenue curve tangent to Iso -cost line. Which are shown by point E in figure below.

Curve showing point of maximum output of timber and resin from same unit of land.



13. Cost Benefit Analysis

Economic analysis of resin tapping can be carried out using any standard economic formulae. The Benefit and Cost Analysis was carried out by computing Benefit Cost Ratio (BCR), Net Present Value (NPV), Internal Rate of Return (IRR) and Discounted Cash Flow by the formula of compounding given below

$$V_o = V_t / (1+i)^t$$

Where V_t =Future value
 V_o =Present value (discounted value)
 i =Interest rate
 t = Year in which cashflow occurs

Interest rate is taken, as 12%. Because 12% is an average rate of interest charged by commercial bank when it flows the loan and also the World Bank has recommended an interest rate of 12% for developing countries.

Thus, the three tools of economic analysis can be shown.

1. Net Present Value (NPV). Net Present Value of a project is present value of its revenue minus the present value of its cost.

$$NPV = \sum_{t=0}^n (B_t - C_t) / (1+i)^t$$

Where, B_t = Revenues or positive cash flows in year t .

C_t = Costs or negative cash flows in year t .

t = year in which the cash flow occurs

i = interest rate

Decision criteria,

If $NPV > 0$, the project is in profit, accept the project, if $NPV < 0$, the project is in loss so reject the project and If $NPV = 0$, there is indifference, reject the project.

2. Benefit cost Ratio (B/C ratio): A project benefit cost ratio is the present value of benefit divided by the present value of cost, using investor MAR (Minimum acceptable rate of return)

$$B/C \text{ ratio} = \frac{\sum_{t=0}^n B_t / (1+i)^t}{\sum_{t=0}^n C_t / (1+i)^t}$$

Where, BCR=Benefit cost ratio

B_t = Revenues or positive cash flows in year t

C_t = Costs or negative cash flows in year t .

t = year in which the cash flow occurs

i = interest rate

Decision criteria, If $BCR < 1$, the project is in loss, reject the project.

If $BCR > 1$, the project is in profit, accept the project. And If $BCR = 1$, there is indifference, reject the project.

3. Internal Rate of return (IRR): The internal rate of return is the discount rate at which the present value of revenue minus present value of cost equal to zero. It can be calculated by using the following equation:

$$\sum_{t=0}^n \frac{B_t}{(1+i)^t} - \sum_{t=0}^n \frac{C_t}{(1+i)^t} = 0$$

Where, B_t = Revenues or positive cash flows in year t

C_t = Costs or negative cash flows in year t .

t = year in which the cash flow occurs

i = interest rate = IRR in above equation.

In case of mutually exclusive projects that project should be selected which has the highest rate of return.

Study done by H.B. Acharya, 2005 in the Darchula district showed that total Discounted Cost at B.S. 2050 (C_0) is NRs. 15085082 and Total Discounted Revenue at B.S. 2050(B_0) is NRs.21812504

So, NPV = NRs 6727422 that is more than Zero

$BCR = 1.445$ that is more than 1 and

IRR by iterative process = 70.51%

So we can concluded that company of darchula district is running is profit situation.

14. Measurement of environment damage

It is now says the resin and tapping can cause the environment reduction of the pine forest. To counter back this challenge we can do further analysis of environment valuation. If we wish to measure the damage done to the environment by the resin and tapping project, we would want to calculate the total economic value (TEV), the TEV that is lost by the development. Damage and benefit are obverse sides of the same concept. The relevant comparison when looking at a decision on a development project is between

the cost of the project, the benefit of the project, and the TEV that is lost by the development. We can use the basic rule as:

i) proceed with the development if

$$(B_D - C_D - B_P) > 0 \text{ and}$$

ii) Do not develop if

$(B_D - C_D - B_P) < 0$ where B_D refers to the benefits of development, C_D refers to the costs of the development and B_P refers to the benefits of the preserving the environment by not development the area.

15. What should be done to make more profitable?

Literature review and field observation report suggest the following point to maximizing the profit in resin tapping work in case of Nepal.

- ❖ Back shaving and cutting manually takes a lot time so, mechanization of work should be help to save time and money.
- ❖ Field observation shows that are local labour did not do as work as haired labor because of local's engaged in other agricultural and social activities.
- ❖ Metal pots (Tin) are leakage. And they contaminated with the resin and degrade the quality, so it should be better use polythene pot.
- ❖ Labor has misconception that “more using of acid mixture more the product”, so they should be proper train in mixing and using of acids.
- ❖ Possibilities of forest fire should be minimized.
- ❖ New technique like bore hole method should be practice in Nepal.
- ❖ Transportation cost should be minimized by establishing processing plant in the local area.

16. Conclusions

From above literature we can conclude there is high economic potential of resin tapping in Nepal. Tapping system in pine has been helping a lot in the rural economy so we need to encourage this activities but the environmental concern also taken to be considered. Efficiency in the tapping can be increase by introducing new tapping method like bore hole method. The benefit cost analysis of the tapping can be calculated considering the environmental aspect .Further overheads cost may be reduced by minimizing the distance between tapping and processing plant.

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