Extraction process:

Is the conveyance of cut trees from the location of cutting inside the forest to the road sides or to accumulation areas inside the forest and then to be conveyed to manufacturing and consumption sites.

Extraction means:

1- Manpower.
2- Animals (horses, elephants).
3- Hydraulic or wire cranes.
4- River transportation.
5- Air transportation (helicopter, ballons).
6- Trucks.
7- Transportation by gravity.
8- Skidders.
9- Developed equipment's (machines cut and convey trees).
10- Tractors.

Factors that affecting the selection of extraction means

1- Availability of extraction means: We must choose the mean which achieves the least cost for production unit (m^3, ft^2.)

2- Workers: When the worker s wages increased, we need to use mechanization; yet we should not Ignore the experienced workers.

3- Extraction s distance: Extraction means vary according to the length of extraction distance.

4- Extraction's slope and direction: Wire cranes are suitable at slope location either in downward or upward, but other means are suitable for plain or little slope locations towards downward only.

5- Availability of cash.

6- climatic and environmental conditions: Summary work is preferable than wintery work as less breakdowns of extraction means, also extraction means should be of less environmental damages.
7- Soil bearing capacity: dry solid land (has ahigh bearing capacity) is suitable for all extraction means, but a land that contains a layer of decayed organic surface has a low bearing capacity.
8- The need for accumulation areas: extraction means vary according to its need for accumulation areas.
9- Timber production quantity: Large timber production requires the use of mechanization.
10- Timber production quality: Extraction means are specified according to timber pieces volumes and trunks lengths.

Extraction's costs: Is the sum of terminal costs and movement costs.

Terminal costs: is the cost that result from collecting and loading timbers by a pulling mean at the beginning of the pulling distance and unloading the timbers at the end of the pulling distance

Movement costs: is the traffic cost of the extraction mean from the starting Point of pulling to the end of the pulling distance, this cost Increases when the pulling distance increase.

In general, extraction cost is too high as compared with transportation cost on public roads, therefor attention should be taken when deciding the maximum distance of extraction.

Note: extraction cost is calculated for the volume unit / distance unit.

(e.g. extraction cost is (2) I.D./m^3/100 m.

$$Extraction\ cost = \frac{Time\ of\ load\ transporting\ for\ (100)m.}{Amount\ of\ load\ (m^3)} * one\ minute\ cost\ for\ extraction\ mean\ and\ its\ operator.$$

Example: calculate the extraction cost by using tractor according to the Following data:

- Time of load transporting for (100) m. = (4) minutes.
- The average load of the tractor = (10) m².
- Tractor s cost = 7.5 I.D./hour.
- Tractor s driver cost = (1.5) I.D./hour.

Solution:

$Extraction\ cost = [\left(\frac{4}{10}\right) * \left(\frac{7.5+1.5}{60}\right)]$ = 0.06 I.D./m²/100 m.

Extraction distance: is the straight direct distance from the stand to the edge of the forest road which can be known by maps.

Extraction distance depends on three factors as follows:

1- Road distance from trees location.
2- Topography and land barriers.
3- Type of extraction mean.

Cases of calculating the Extraction distance:

1- When the forest is located directly on forest s road:

The shortest extraction distance = Zero

The maximum extraction distance = Average of forest distance from the road edge.

Then

$$Average\ of\ Extraction\ distance = \frac{The\ Shortest\ Ext.distance + The\ maximum\ Ext,distance}{2}$$

2- When the forest is located directly between two roads:

The shortest Ext. distance = Zero

The maximum Ext. distance = ½ the distance between two roads.

Example: A stand is located directly on the forest road, its maximum distance from the edge of the road is between (100 to150) m. calculate the Ext. distance.

$Shortest\ Ext.Distance\ =\ Zero$

$Maximum\ Ext.distance\ = \frac{100+150}{2}$ = 125 m.

$Average\ of\ Ext.distance\ = \frac{0+125}{2}$ = 62.5 m.

3- When the forest is not located directly on the forest road:

Example: A stand where its side nearby the road edge with a distance ranging Between (50-150) m., and its side away from the road edge is ranging (150-350) m.

Solution:

$Average\ of\ nearly\ side = \frac{50+150}{2}$ = 100 m.

$Average\ of\ distant\ side = \frac{150+350}{2}$ = 250 m.

$Average\ of\ Ext.distance\ = \frac{100+250}{2}$ = 175 m.

Important notes:

1- If the forest is located directly on forest s road and the extraction process has One-way direction, the value of extraction distance = 1/2 distance between two roads.

2- If the forest is located directly on forest s road and the extraction process has the Two-way direction, the value of extraction distance = 1/4 distance between two roads.

3- A constant factor of (1.3) is applied for all extraction means except wire cranes Where (1.1) as the unstraightness of extraction line from the beginning to the end.

4- A constant factor of (1.35) is applied for all extraction means as the unperpendicular of extraction line with forest roads due to land nature (curves).

5- Extraction process on steep slope is directed downwards for all extraction means Except wire cranes (Ext. Process is directed downwards and upwards), Therefore a constant factor of (2) is applied for (one-way extraction) and A constant factor of (1) for (Two-way extraction).

Example: A pine forest where the direct straight distance between two parallel adjacent Road is (800) m., and extraction process would be done by skidders. Calculate the average of extraction distance.

Solution:

$Minimum\ of\ Ext.distance\ = zero$

$Maximum\ of\ Ext.distance\ = \frac{800}{2}$ = 400 m.

$Average\ of\ Ext.distance = \frac{0+400}{2}$ = 200 m.

Average of ext. distance = 200 x 1.3 x 1.35 x 2 = 702 m. (in case of one-way extraction)

But in case of two-way extraction:

Average of ext. distance = 200 x1.1 x 1.35 x 1297 m. (in case of two-way extraction).

Factors affecting the Extraction costs

1- Volume of timber production. (direct).
2- Costs of Extraction means. (direct).
3- Length of Extraction distance. (direct). But ext. costs are decreased for a single distance Unit when the length of ext. distance increases because charging and discharging costs are constant. As in the following example:

we have (10) m². of timber, transport cost for a distance (200) m. is (1) dinar/m². Charging. (8.5) dinar/m². Transporting, (0.5) dinar/m². Discharging.

$$Cost\ of\ a\ single\ distance\ unit\ = \frac{10(1+8.5+0.5)}{200}$$ = 0.5 dinar/one meter.

But in case of increasing the transporting distance to (400) m. then:

$$Cost\ of\ a\ single\ distance\ unit\ = \frac{10\ [1+(2x8.5)+0.5]}{400}$$ = -0.46 dinar/ one meter.

Calculating the Extraction costs/production unit (m³.)

$$Extraction\ cost/m^2.of\ product = \frac{1.3\ x\ S\ x\ H}{200}\ (extraction\ in\ one-way)$$

$$Extraction\ cost/m^2.of\ product = \frac{1.3\ x\ S\ x\ H}{400}\ (extraction\ in\ two-way)$$

S= distance between roads (m.)

H= extraction cost/m³. /100 m.

The extraction cost/m³. of product in two-ways is less than that of one-way Because the distance is less. Whereas:

Average of ext. distance = ½ the distance between two roads (ext. in one way).

Average of ext. distance = ¼ the distance between two roads (ext. in two way).

Calculating the road cost/m², of products

$$Road\ cost/m^2.of\ products = \frac{10\ x\ R\ xW}{S\ x\ V}$$

R; road cost/km.

W; constant factor (1.35)

S; distance between roads. (m.)

V; product volume (m³/hectare).

Total costs/product unit = Ext. costs/product unit + Road costs/product unit.

Forest's roads density:

Are the total lengths of roads in one area unit of the forest land, Such as: km/km² or m./hectare. Forests road density has a reverse relationship with ext. distance. The distance between forest roads is the inverse of density value, it means that we can calculate the distance between forest roads by knowing forest roads density.

e.g.: Forest roads density is (25 m/hectare), it means:

$$The\ distance\ between\ forest\ roads = \frac{10000}{25} = 400\ \text{m.}$$

Optimum road density: is the road density in which the total costs (ext. costs/product unit + road costs/product unit) are as less as possible.as in the figure below:

The optimum road density = 8 mile /mile^2.

It means the optimum road density should achieve the minimum cost/product unit.

Factors that affecting the value of optimum forest roads density

1- Roads cost: indirect relationship.
2- Extraction cost: indirect relationship.
3- In mountain areas roads density is more than that of plain areas as topography and slopes which need additional roads.

The optimum forest road density in Britain = 2.5 km./km².

The optimum forest road density in France 1-1.3 km./km².

The optimum forest road density in Germany 2 km./km².