Bulletin of Environment, Pharmacology and Life Sciences
Bull. Env. Pharmacol. Life Sci., Vol 2 (11) October 2013: 24-29
©2013 Academy for Environment and Life Sciences, India
Online ISSN 2277-1808
Journal's URL:http://www.bepls.com

ORIGINAL ARTICLE

Analysis and Evaluation of Ground skidding Costs of two Stands with Respect to Production per Hour and Log quality

Mohammad Hejazian[*1], Majid Lotfalian[2], S. Ataollah. Hosseini[2], Asghar Fallah[2]
[*1] Faculty of Natural Resources, Sari Agricultural Sciences and Natural Resources University-Iran
[2] Associate Professor, Faculty of Natural Resources, Sari Agricultural Sciences and Natural Resources University- Iran

ABSTRACT
Knowing the factors affecting the production and costs of skidding have an important role in planning and organizing consumed budgeting as well as arranging expenditures to raise profitability. By increasing capital expenditures and decreasing wood extract from Northern Iran forests, it is a necessity to have some research in skidding expenditures. This study evaluated the effect of production per hour, and log quality differences on the ground skidding on two stands being harvested at an altitude of 200 and 2100 meters above sea level in the area of Neka in northern Iran that were different in terms of tree species and Log quality. The skidding method was ground based with wheeled Timberjack 450C skidder. The results showed that the rate of hourly production of the skidder with an average skidding distance of 550 meters, in area 1 which is located in a low altitude habitat is 6.5 cubic meters per hour and in area 2 which is located in a higher altitude with 46% increase, is 9.52 cubic meters per hour. The average volume per skidding cycle in a high quality stand (Area 2) has increased 46% and the average number of logs per skidding cycle in comparison with Area 1 has decreased 29%. Three factors of repair and maintenance costs, fuel cost and tire cost in both areas had the highest share in variable costs. Hourly cost of skidding in the first and the second area was 26.84 and 31.55 Euros per hour, respectively. The cost of production per unit was calculated 4.12 Euros per cubic meter for Area 1 and 3.3 Euros per cubic meter for Area 2. Log quality influences on the size and number of logs per skidding cycle. Hourly production has a significant difference between two areas but the cost of skidding is not significant.
Keywords*: Forests of northern Iran, Log quality, Hourly production, Skidding cost.*

Received 23/07/2013 Accepted 08/09/2013 *©2013 AELS, INDIA*

INTRODUCTION

Harvesting is a necessary activity in management of forest and includes all steps from cutting trees to delivering logs to factories and if it is planned and performed perfectly, the expected profits will be reached [1]. Forest harvesting is difficult and costly. Multiplicity of activities and extreme environmental conditions in wood extracting make a good portion of the forest management cost to be spent on skidding operations. This process requires machinery and equipment that are usually expensive in order to reach an economical harvesting [2]. Due to decreasing trend of northern Iran forests harvesting, consequently decrease in income resources of contractors, they always try to decrease costs and increase profit of selling woods. Significant portion of the cost management in forestry is the estimation of machinery production that will reduce costs [3]. As far as we have no information of actual cost for each production unit, planning and finding solutions for decreasing cost is impossible. Two of the most important factors in selecting the appropriate machine for each area, are cost and production [4]. For years, ground skidding and the use of wheeled skidders, are the most common ways in extracting logs from northern Iran forests [5]. Calculation of skidding cost in ground skidding of timbers includes hourly machine cost estimation, labor cost, and system cost that consequently by hourly machine cost evaluation, the cost per production will be estimated [6]. Several studies have been done to calculate the cost of skidding in the forest. Pirbavaghar [2] in a study evaluated the cost of extracting logs from Kheyroudkenar forests of northern Iran by two methods of downhill and uphill skidding, which were 106 and 91 Euros per hour, respectively. Naghdi [8] in his study of Nav Asalem forests of northern Iran estimated the cost of extracting logs with two methods of designed and non-designed harvesting, 5.7 and 8.48 Euro for every cubic meter, respectively. Abdul Rahim *et al* [9], in the forests of Malaysia compared skidding costs in the two conditions of conventional and RILP. Results showed that in RILP conditions skidding cost is 46.6% per hectare, and 57.41% for each cubic meter.

Increase in fuel price and other costs will result in future increase of skidding costs. Väätäinen *et al* [10] in the forests of Finland announced that three factors of depreciation cost (24.7%), fuel (20.8%) and Insurance (% 10.7) are the most expensive cost varieties of forested machinery. Jourgholami & Majnounian [11] in an evaluation and comparison of two skidding methods by wheeled skidder Timberjack in Noshahr forests of northern Iran, evaluated cost of extracting logs with short logs method 6.54 Euro and with long logs method 4.46 Euro. Çalışkan [12] in a study of the forested area around the Black Sea in Turkey examined the skidder (MB Trac 900) performance in terms of a pile of pine production and operation costs. Skidding cost per cubic meter of wood, including delay time and without delay time was calculated 3.81dollars and hourly skidding cost 39.80 dollars.

Mousavi *et al* [5] in their study in Mazandaran forest of northern Iran, calculated skidder HSM-904 hourly production in whole cutting method, 7.10 cubic meter per hour and skidding cost per cubic meter, 13.90 dollars.

Northern Iran forests have emerged like a thin band on the northern slopes of the Alborz Mountains. The vertical expansion of forests is started from sea level and continued to a height of 2800 meters [13] This altitude dispersion has led to the emergence of different habitats regarding species and log quality.

By log quality we mean the shape of log. Cylindrical shape is ideal form of logs that the greater the curvature, refraction and lateral branches of logs, the lower the quality will be [14]. Hasanzade*et al.* [15] said that altitude from sea level is the most influencing factor in stand productivity and species variability. In low altitudes hornbeam, Parrotica persicaspecies and oak and in high altitudes beech, are dominant.

MATERIALS AND METHODS

Forests of northern Iran with 1.9 million hectares are located in the south of the Caspian Sea [13]. Several large semi-public companies and small cooperative enterprises are harvesting the forest. The research was performed in two forest areas harvested by a company called Nekachoob.

According to the aim of study, habitat quality impact on costs, we try to select the areas by making the influential factors on skidding which includes, ground slope, topography, depot condition, ground condition and the driver's ability fixed and they are connected to the physical condition of the area, and influenced hourly production and costs. These characteristics are listed in Table (1).

Table 1. Characteristics of the study area

Characteristics	Altitude (m. a.s.l)	Aspect	Average Skidding Distance (m)	Skidding way	Silvicultural system	Distance from company yard (km)
Area 1	200	Northern	550	downhill	selection cutting	20
Area 2	2100	Southern	550	downhill	selection cutting	80

Skidding operation in selected areas is done with Skidder Timberjack 450C, that is common in Iran. This skidder has 177 horsepower and it is six-cylinder. Its winch power has the ability to pull up to 40 tons.Costing was performed according to FAO guidelines [16]. Based on FAO the cost of skidding system is divided to two parts of machinery costs and labor costs. By calculating system costs, the hourly machine costs and skidding costs per unit of performance in each area were estimated.

System CostsTC = MC + PC (1)

Logging CostsLC = $\frac{TC}{PR}$ (2)

LC= Logging Costs PR=Production Rates TC= Total Costs

MC=Machine Rates PC= Personal Costs

Machine Rats

Total Fixed Costs TFC=D+I+T (3)

D= DepreciationI= Interest T= Taxes and insurance

$$D = \frac{(P - S)}{N} \quad (4)$$

Operating Costs OC= MR+F+L+T +C (5)

MR= Maintenance and repair F=Fuel L=Lubricant T=Tiers C=Cable

$$MR = \frac{P - S}{N \times PH} \times f \quad (6)$$

P= Purchase price S= Salvage value N=Economic life f=Coefficient repair cost PH= Program hours

One of the most important factors in determining the cost of forestry machinery is the operation rate of these machines annually. Factors such as machinery technical condition, weather, road conditions, support, timing and labors have an impact on the performance of the machine [15]. To obtain the hourly performance of machine in two areas, a continuous time method was used. This method is common in forest engineering works (Mc Donald & Fulton, 2005). In each area, the number of required samples was calculated using the formula 7 in each area

$$n = \frac{t^2 \times (s_x\%)^2}{(E\%)^2} \quad (7)$$

n = number of samples t = Student coefficient s = standard error E= desired accuracy
According to the comparison between two habitat conditions, it is necessary that other variables affecting two areas to be considered the same. So the maximum skidding distance was considered 550 meters and the maximum winching distance, 20 meters.
Timing operation was performed and simultaneously other required information including: measuring skidding distance, winching length and the number and volume of log per cycle were recorded. For determine of log volume and loading volume was used of Huber's formula (8). [17]

$$V = \frac{\pi}{4} \times d_m^2 \times L \quad (8)$$

d_m^2 = Median Diameter L= Length
Skidder hourly production in each region is calculated using the formula 9.

$$P = \frac{V}{T} \quad (9)$$

P= Hourly production M^3/H V= Volume (M^3) Time= Hours

RESULTS

After calculating 48 skidding cycles on area 1 and 55 cycles on area 2, timing was done and simultaneously the number and volume of logs were also recorded. It is worthwhile to mention that delays and interruptions during the operation were divided in three categories, including operational delays, personal delays and mechanical delays. Delay time has a significant role in skidding costs (Lotfalian, 2011). This study aimed to assess the cost in real terms. So while calculating skidding time, personal and operational delays are eliminated because it can be prevented by proper management, and mechanical delay is calculated as duty cycle.

- **Machine Hourly production**

Table2. The statistics of operational variables of skidding in the study area

Variable	Average		Std. Deviation		Minimum		Maximum	
	A1	A2	A1	A2	A1	A2	A1	A2
Skidding Time (min)	1464	1456	492	527	642	565	3254	3264
Number of logs per cycle	1.9	1.6	0.98	0.87	1	1	4	4
Volume per cycle(M^3)	2.44	3.57	1.12	1.3	1	1.1	6	6
Skidding Distance	365	387	143	186	100	90	550	550
Ground slope (%)	11	12	2.45	3.24	2	6	16	20
Winching distance (m)	18.2	18.6	5.7	5.1	8	9	20	20

The amount of hourly production of the skidder was calculated using the formula 9:
Hourly production in area1= $\frac{117.4}{18.07}$ = 6.50 m^3/h
Hourly production in area2= $\frac{197}{14.7}$ = 9.52 m^3/h
As the results show the amount of hourly production of this skidder on area 1 that is a low altitude habitat, is increased 46% in comparison with area 2 that is located in higher altitude. The reasons for this increased functionality to the extent of this investigation are addressed in the Discussion section. The important point in the section is the impact of performance difference on hourly skidding production that will be discussed later.

Hourly production in two areas was compared using average comparison techniques (ANOVA) that the results have been determined in Tables 3 and 4.

Table 3. The statistics of hourly production in two area

	N	Mean	Std. Deviation	Std. Error	Minimum	Maximum
Area 1	48	6.57	1.22	0.17	4.04	9.33
Area 2	55	9.56	1.39	0.18	7.30	12.40

Table 4. Compare average of hourly production in two area (ANOVA)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	228.86	1	228.86	132.26	0.00
Within Groups	174.77	101	1.73		
Total	403.63	102			

Table 4 shows that the hourly production rates in two areas are significantly different with respect to p-value < 0.05. In this research, quality and species of logs are considered habitat quality criteria. The more desirable and healthier the habitats of the species are, the thicker and healthier the logs would be. Given that forest practices are common to both areas, the selection of trees is in a similar situation. In Area 1, the major harvested trees are hornbeam and Parrotica persica species. The quality of the logs of beech which is the dominant species in Region 2 is at a lower level. These species regarding the quality of logs in comparison with beech that are dominant in Area2 have lower quality. Therefore, this factor can be effective in the skidding with a skidder. The average number and volume of load per cycle is shown in figures 2 and 3. The more the number of logs per cycle, the more skidding time will be, thus hourly production reduces and skidding cost increases. In the area 1, the number of logs per cycle, due to the lower diameter of logs is greater in number than the area 2 which has thicker logs.

- **Costing**

In order to evaluate skidding costs in each area we need primary information, which is gathered from valid resources and shown in Table 3.

The information is relevant to the terms of Iran's northern forests and may be different in other parts of the world

Table 5. Basic Information for costing

Factor	Explanation
Machine price	60000 €
Salvage Price	6000€
Useful life	16000 hours or 20 years
Tire Price	2000€
Cable price (70m)	140€
Useful days	Area1=150 and Area2=120
Coefficient Repair cost	F= 0.90
Interest rate	10%

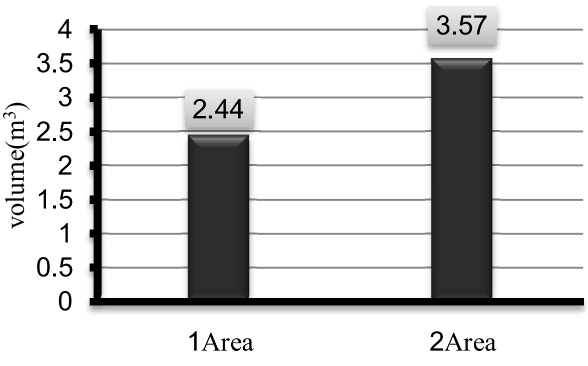


Fig 2. Avrage of loading volume(m^3/cycle)

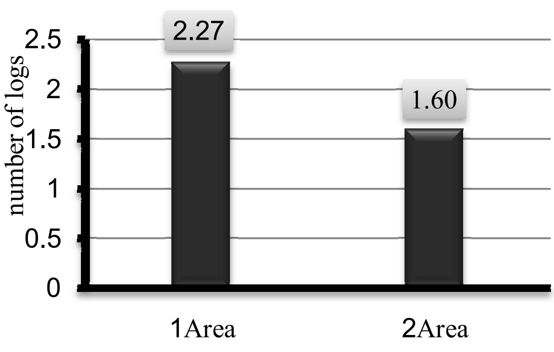


Fig 3. Avrage number of logs per cycle

Useful life of the device Timberjack 450C is 12000 working hours i.e. 1000 hours per year for 12 years. In Iran the average operation of device is considered 800 hours per year. The useful life of device in the country it is made (Canada) and the similar countries is its actual life, but in Iran that the interest cost is more expensive, and maintenance and repair cost, is more economical due to inexpensiveness of labor cost, the useful life of device is more than the nominal life of it, and as you see the skidders are used for 18 years in Iran. So the annual operating of 800 hours and useful life of 20 years are appropriate figures for the condition of Iran. In other words, the operational useful life of device is 16,000 hours [6].

Fixed costs

Fixed costs are those costs which are not related to operation of the machine and must always be paid. So fixed costs are equal in both areas. The company does not pay a fee for parking.

$$D = \frac{65000 - 6500}{20} = 2925€I = 37212 \times 10\% = 3721.2€T = 360€$$

$$TFC = \frac{2925 + 3721.2 + 360}{800} = 8.70\ €\ /h$$

- **Variable costs**

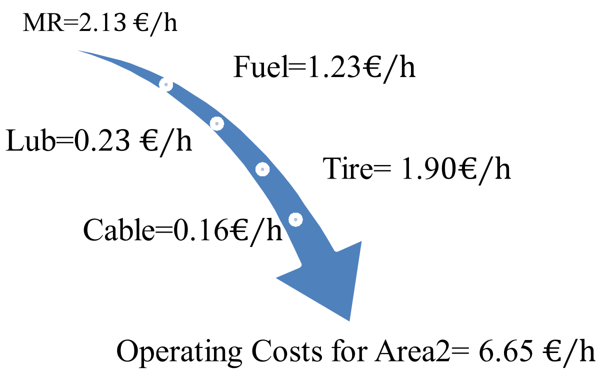
Variable costs are directly associated with the operation of the machine. The lower operating leads to the increase of the costs per annually work hour.

Table 6. Calculate of operation costs in two area

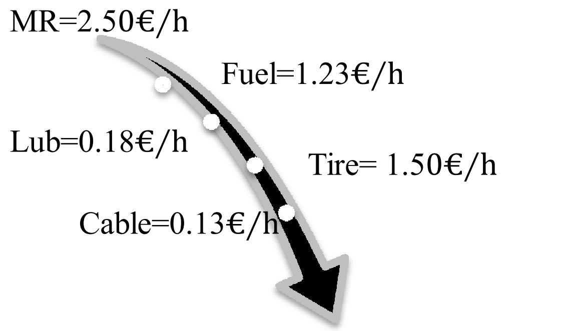
Operating costs item	Area 1	Area 2
Maintenance and Repair	$MR = \frac{65000 - 6500}{20 \times 1050} \times 0.9 = 2.5\ €/h$	$\mathbf{MR} = \frac{\mathbf{65000 - 6500}}{\mathbf{20 \times 840}} \times \mathbf{0.9} = \mathbf{3.13\ €/h}$
Fuel	Hourly Fuel cost is fixed in both of area	→ 1.23 €/**h**
Lubricant	$L = \frac{196}{1050} = 0.18\ €/h$	$\mathbf{L} = \frac{\mathbf{196}}{\mathbf{840}} = \mathbf{0.23\ €/h}$
Tire Cost	$T = \frac{\frac{4 \times 2000}{5}}{1050} = 1.50\ €/h$	$\mathbf{T} = \frac{\frac{\mathbf{4 \times 2000}}{\mathbf{5}}}{\mathbf{840}} = \mathbf{1.90\ €/h}$
Cable cost	$C = \frac{140}{1050} = 0.13\ €/h$	$\mathbf{C} = \frac{\mathbf{140}}{\mathbf{840}} = \mathbf{0.16\ €/h}$

.

Hourly maintenance and repair cost in Area 2 for every hour, is 0.63 Euro. Hourly cost of fuel did not change for the fixed kind of machine. Oil cost 0.05 Euros, tire 0.4 Euros and cable 0.3 Euros per hour has increased in Area 2. Tire costs are a significant portion of the hourly cost of wheeled machines that varies depending on the work conditions, useful life of the tire and the cost [18].



 ©2013 AE LS, India



According to the evaluation of the above costs sum, the total costs will be variable that is calculated in the area.

Variable costs in Area 2 that are located at a higher altitude from the sea level have risen by 23% percent. The main reason for the increase is the lower annual operating costs in the area. Figure 2 compares the variable costs on two areas.

The total hourly cost of a machine is achieved by the sum of fixed and variable costs that in area1it is equal to 14.10 € / h and in Area 2 it is 15.35 € / h. The important point in this discussion is skidder performance in one hour. The more the capacity of skidder, more load volume will be extracted, the cost increases and the cost per volume decreases. (Sarikhani, 1991).

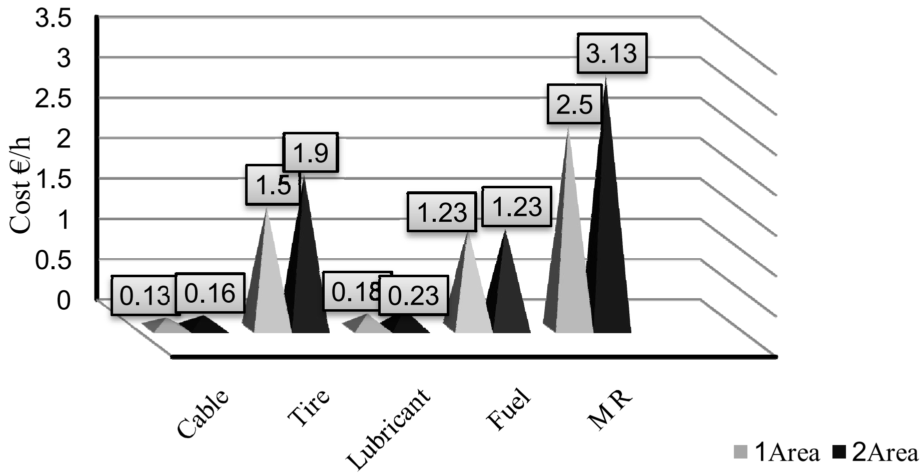


Fig 4. Compare of operating costs in two area

- Labor costs

Labor costs include direct and indirect payments to those worked in skidding which includes the cost of fee, food, clothing, insurance, taxes, transportation and any other costs that is paid by the employer to the worker during the year. The sum of these costs as annual labor costs is divided by the number of useful work hours per year, and the labor costs is achieved [6]. Labor costs are not related to the rate of planned work, even if the skidder stop working it must be paid. Given that the area 2 is located in 80 km and area 1 is located in 20 kilometers from machinery yard, so the cost of transportation in the area is twofold.

Table 7. Calculate of labor costs

	Logging equip costs (€)	Transport costs (€)	Total
Area 1	12.22	0.50	12.74
Area 2	15.20	1	16.2

By adding the hourly skidding cost and labor cost and dividing it to the amount of skidder production, the skidding cost is obtained per volume unit (cubic meters). The figure shows that for every cubic meter of extracted logs how much fee will be imposed on the contractor.

Table 7. Calculate of hourly logging cost

Area	Total Logging costs	Hourly Production	Hourly Logging costs
1	12.74+14.1=26.84 €/h	6.50 m^3/h	$\frac{26.84}{6.5}$ = 4.12 €/m^3
2	15.35+16.2= 31.55€/h	9.52 m^3/h	$\frac{31.55}{9.55}$ = 3.30 €/m^3

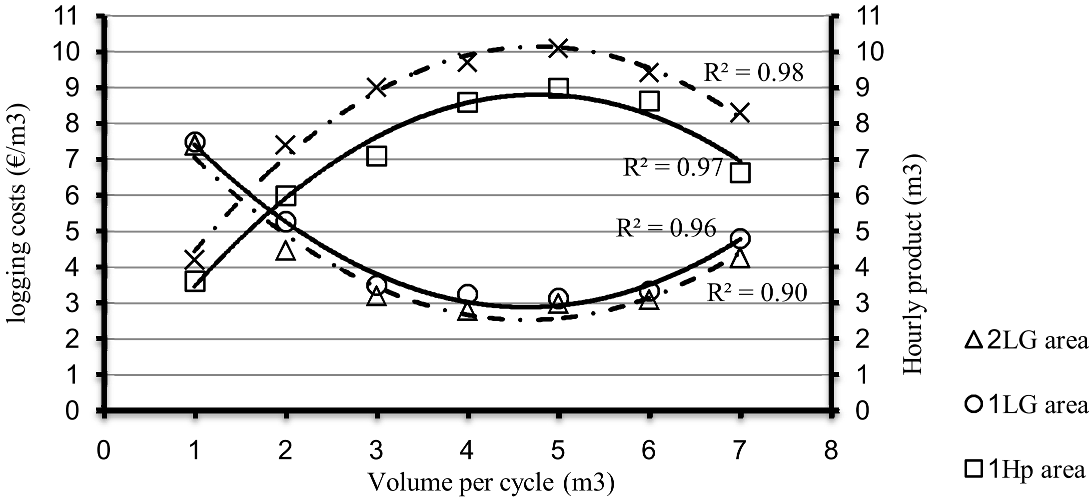


Fig 5. Effect of loadig volume on logging costs and hourly product

Figure 5 shows the effect of load volume in each cycle on the hourly production and skidding cost.

Table 8. Anova model

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	31.476[a]	7	4.49	150.52	.000
Intercept	248.47	1	248.47	8317.46	.000
Volume	31.00	6	5.16	172.95	.000
Area	0.47	1	0.47	15.91	.007
Error	0.17	6	0.03		
Total	280.13	14			
Corrected Total	31.65	13			

In Skidding costs lowest cost for Area 1 can be achieved with 5m3 load volume and for Area 2 with 4 cubic meters load volume.

For skidding cost comparison per load volume in each cycle between the two study areas, average comparison technique (ANOVA) was used.

Results showed that the mean difference between the cost of skidding for different load volumes is significant (p-value < 0.05). But in a test of two areas comparison according to the results of the test (p-value > 0.05), difference between the skidding costs of two areas is not significant.

DISCUSSION AND CONCLUSIONS

The current mechanized logging techniques also need to be improved by adopting the reduced impact logging (RIL) techniques, so as to promote regeneration of desired commercial timber species and as a consequence, sustainability of the forests [19]. Knowing the production and cost of skidding system play a key role in the management planning and reduced impact logging in the forests of northern Iran [20]. The results showed that skidder 450C performance on two forest regions with various log qualities and volumes is different. Due to the fixed physical characteristics of two areas and similar skidder conditions and drivers abilities, the most important performance difference is the amount and number of extracted logs per cycle. The main logs on area 1 are hornbeam and Parrotica persica species. The logs of these species, especially Parrotica persica species are often rough and full of side branches [6]. Thus, the time required to collect and provide logs and skidding time increases. The average number of logs on area 1 in each cycle is 41% more than the area 2. Area 2 which was located at a higher altitude, the most logs were beech that have more diameter and high quality. This led the average volume per cycle to be 46% higher. In Area 1 the average number of loads and volume in each cycle is lesser, thus the skidder performance in

Area 2 was higher. The smaller the log or tree, the rate of production in the unit of time will be lower and consequently the operation cost in production unit will be higher. Conversely, the larger the log hourly production, operating costs will be lower.

In forest regions similar to Area 1 with lower density and inappropriate log quality it is necessary to have lopping operation and extra branches have to be cut to reduce skidding time.

According to Figure 5, increase of load volume in each cycle always does not contribute to the increase of performance but the trend continues until the pace of machine does not reduce. Increase of load volume from the point of curve maximum decreases the hourly production due to the skidder deceleration. Knowing that the skidder performance in habitat different conditions is different, can be impressive in decisions, programming and log extract scheduling.

A cost analysis showed that the cost of skidding in two forest regions with a variety of different habitat characteristics is different. Factors of maintenance and repair costs, fuel and tire for area 1 are 46%, 22. 7% and 27.7%, and for Area 2 are 32%, 18% and 28.6%, respectively. The repair costs with direct relationship to workdays are changed in relation to hourly production performance and useful workdays because of difference in the number of days between two areas. Maintenance and repair costs, oil, tires and cables increase in Area 2 due to the less useful hours of work. The more the useful work hours the machine has, total cost increases but the cost per hour decreases. Labor costs are a function of salary, payment and distance from the center.

Area 2 is farther (80kilometeres distance) and the work environment is harder due to its location in higher altitude, thus payment and transportation of area 2 is more than area 1. The total cost per hour work of skidder in Area 2 is more than Area 1. But the cost per unit of production that is log extract per meter in every hour was more in Area 1. Figure 7 compares the cost of system and skidding between two-areas.

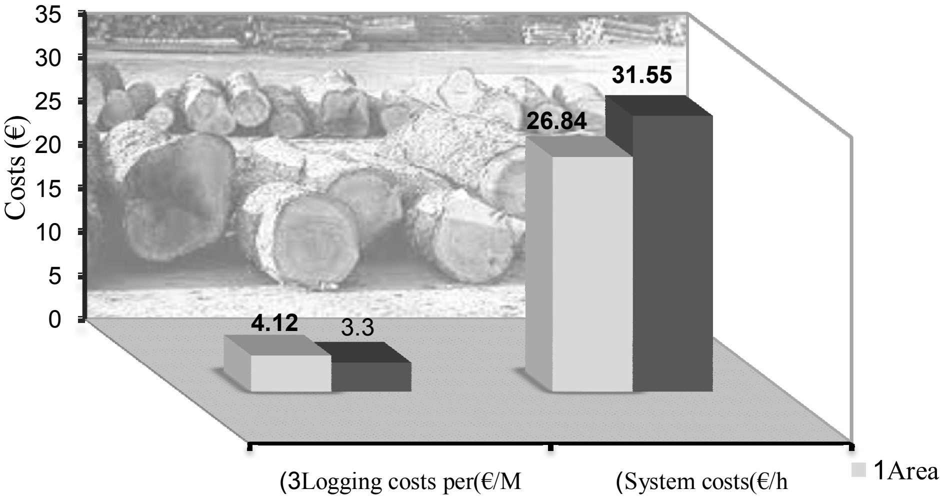


Fig 6. Compare of Logging and system costs in tow area

The main reason for hourly production in Area 2 was the higher skidder performance in the area. In fact, the hourly production performance of skidder in area 2 causes lower cost per production unit. Other factors such as job safety cost, road construction and environmental costs can be taken into account [18]. With regard to the 50 years harvesting of wood in Iran, the amount of harvest from the forest has declined due to government policies, therefore contractors income has reduced. It is necessary to have more research on harvesting cost in order to reach a more economical harvesting with the results.

REFERENCES

1. Rizvandi, V. Jourgholami, M. (2012). Production and cost comparison of conventional and directional tree felling. Iranian Journal of Forest 4(1): 1-11.
2. Bilek, E M. (2009). Machine cost analysis using the traditional machine-rate method and charge out. Proceedings of 2009 COFE: Environmentally Sound Forest Operations 32nd Annual Meeting of the Council on Forest Engineering. USA, June 15-18, 2009: 12p.
3. Davis, C. Kellogg, l. (2005). Measuring machine productivity with the multiDat data logger: A demonstration on three forest machines. Annual COFE proceedings, Fortuna, CA, 10p.
4. Parsakhoo, I. Hoseeini, S A. Lotfalian, M and Jalilvand, c. (2009).Efficiency and cost analysis of forestry machinery usage in Hyrcanian forests of Iran. World Applied Sciences Journal 6 (2): 227-233.

5. Mousavi, R. Nikooy, M. Nezhad, A. E. Ershadfar, M. (2012).Evaluation of full tree skidding by HSM-904 skidder in patch cutting of aspen plantation in Northern Iran. Journal of forest Science 58 (2): 79–87.
6. Lotfalian, M. (2011). Wood Transportation. Aeeizh Press. Iran-Tehran. 342p
7. Pir Bavaghar, M. Sobhani, H. Feghhi,J. Darvishsefat, A. Marvi-Mohadjer, M R. (2007). Investigation on production rate and cost of Timberjack 450C in tow skidding directions in combined harvesting system. Iranian journal of forest and poplar Research 15 (4): 374-385.
8. Naghdi, R. Nikooy.M. Bagheri, I and J, Javadpour.Efficiency comparison of Timber Jack 450C skidder in planned and unplanned logging system (Case study: second district of Nave-Asalem). (2008). Iranian journal of forest and poplar Research 16 (4): 649-659.
9. Abdul Rahim A.S.a, Mohd shahwahid H.O.b. Zariyawati, M.A. (2009).Comparison analysis of logging cost between conventional and reduce impact logging practices. Int Journal of Economics and Management 3(2): 354 – 366.
10. Väätäinen, K. Asikainen, A. Sikanen, L. and Ala-Fossi, A. (2009). The cost effect of forest machine relocations on logging costs in Finland. Journal of Forestry Studies 45: 135-141.
11. Jourgholami. M. Majnounian, B. (2011). Evaluating and comparison of two skidding methods using wheeled cable skidder.Iranian Journal of Forest 3(3): 189-200.
12. Çalışkan, E. (2012). Productivity and cost analysis of manual felling and skidding in Oriental spruce (Picea orientalis L.) forests. Ann. For. Res. 55(2): 297-308.
13. Marvi Mohadjer, M R. (2011). Silviculture. University of Tehran publications. Iran. 386p.
14. Sarikhani, N. (1991). Forest Utilization. University of Tehran publications. Iran.776p.
15. Holzelitner, F. Stampfer, K. Visser, R. (2011). Utilization of rates and cost factors in timber harvesting based on long-term machine data.Croatian journal of forest engineering. 32(2): 501-508.
16. FAO. (1992). Cost control in forest harvesting and road construction. Food and Agriculture Organization of the United Nations Rome, Forestry Paper, 99: 101-189.
17. Lotfalian, M. Moafi, M. Sotoude Foumani, B. Akbari, R A. (2011). Time study and skidding capacity of the wheeled skidder timberjack 450C. Journal of Soil Science and Environmental Management 2(7): 120-124.
18. Akay, A. Session, J. (2004). Identifying the factors influencing the cost of mechanized harvesting equipment. KSU. Journal of 65 Science and Engineering 7(2): 65-72.
19. Seng, H. Ratnam, W. Mohamad Noor, S. Clyde, M. (2004). The effects of the timing and method of logging on forest structure in Peninsular Malaysia.203: 209-228.
20. Sobhany H. (1991). Harvesting system evaluation in the Caspian Sea. Journal of Forest Engineering, 2: 21–24.
21. Mc Donald, T P. Fulton, J P. (2005). Automated time study of skidders using global positioning system data. Computers and Electronics in Agriculture 48 (2005): 19–37.

How to cite this article

Mohammad Hejazian, Majid Lotfalian, S. Ataollah. Hosseini, Asghar Fallah. Analysis and Evaluation of Ground skidding Costs of two Stands with Respect to Production per Hour and Log quality.Bull. Env. Pharmacol. Life Sci., Vol 2 (11) October 2013: 69-77