Original Article
Eur J Forest Eng 2018, 4(1): 13-17
© Copyright 2018 by Forest Engineering and Technologies Platform on-line at www.http://dergipark.gov.tr/ejfe

Analysis of Noise Level Influencing Farm Tractor Operators during Forest Harvesting Operation

İnanç Taş[1*], Halit Büyüksakallı[2], Abdullah E. Akay[1]

[1]Bursa Technical University, Faculty of Forestry, 16310 Yıldırım, Bursa, Turkey.
[2]Muğla Sıtkı Koçman University, Köyceğiz Vocational School, 48000 Muğla, Turkey

Abstract

In Turkey, forest harvesting activities are generally performed by forest villagers or small-size contractors managed by forest villagers. Highly mechanized harvesting equipment are not very common since they are not affordable by forest villagers or contractors. Farm tractors are mostly used in forest harvesting operations because of relatively low hourly equipment cost. In fact, farm tractors have been used in many stages of forest operations including skidding, forwarding, cable yarding, and loading. However, working environment of farm tractors is subject to intensive noise disturbance during forest harvesting activities. Thus, tractor operators often expose excessive noise effect which can result in hearing impairment or permanent hearing loss. In this study, the average and peak noise levels generated by a Türk Fiat 450 model farm tractor during forest harvesting operation were measured. The average and peak noise levels were measured as 84.52 dBA and 105.02 dBA, respectively. To minimize the potential hazard of noise exposed by operator, daily working hours and resting times should be determined based on noise level and the pieces that affect the level of the noise should be maintained and isolated properly.

Keywords: Forest harvesting, farm tractor, noise level, worker health and safety

1. Introduction

As technology advances in recent decades, forestry operations have become more and more mechanized in many countries with strong forestry industry. Mechanized forest harvesting methods have important advantages of high productivity, labor efficiency, and worker safety over traditional harvesting methods (Akay and Sessions, 2004). On the other hand, mechanized harvesting equipment are very expensive and their operating costs are highly correlated with the fuel price. In Turkey, mechanized equipment are not very common in forest harvesting activities which are generally conducted by forest villagers or contractor companies with limited budget.

When the mechanized harvesting machines are not favorable due to high capital investment and energy consumption, farm tractors with low initial costs and operating costs have been used in forestry operations (Akay, 2005). Since the performance of the regular farm tractors are limited due to terrain conditions and the size of the forest operation, farm tractors should be modified and empowered with additional equipment to be used efficiently and economically in mechanized harvesting operations (Türk and Gümüş, 2010). The necessary attachments and advanced features of modified farm tractors may include pulling and skidding winch, loading grapple, protective operator cabin or roll bars, higher ground clearance, and advanced hydraulic capacity (Öztürk and Akay, 2007).

In Turkey, forest villagers and contractor companies commonly use modified farm tractors equipped with appropriate forestry attachments in many stages of forest operations including skidding logs from stump to landings, transporting logs in tractor-trailer, cable logging tower, and loading and unloading logging trucks. Farm tractors can be also equipped with harvesting head to fell and buck trees (Carbaugh and Hensle, 2006). However, operating farm tractor during forest operations potentially results in harmful effects (i.e. noise, vibration, gases, dust, etc.) on operators. Especially high level of noise is one of the most important effects on the human health (Doygun and Gurun, 2008). Besides, the operators who expose to high level noise most of the working hours are also under great health risk.

Noise is identified as unwanted sound with adverse effects on auditory and non-auditory mechanisms (Mirbod et al., 1992). The noise level of the machines generally depends on structural feature of the

*Corresponding author: Tel: +90-224-3003430 E-mail: inanc.tas@btu.edu.tr
Received 24 May 2018; Accepted 08 June 2018
This work is licensed under a Creative Commons Attribution-NonCommercial 4.0 International License

equipment, location of the noise source, noise reflecting surfaces, operation technique, roughness of the work, and maintenance of the machine (Serin and Akay, 2010). In forestry machinery, main noise sources are the engine, exhaust system, cooling fans, transmission, and hydraulic components. Due to high noise level and long exposure time, the physiologic (i.e. hearing impairment, high blood pressure, heart diseases, and breathing problems) and psychological (i.e. uneasiness and nervousness) health problems can be observed on the workers (Durgut and Celen, 2004; Serin and Akay, 2008). Besides, these health problems may adversely affect labor productivity and motivation during forest harvesting operations.

The studies conducted on examining the effects of noise level on human health reported that the workers, who are exposed to average noise level of 85 dBA for 8 hours, experience significant hearing impairment problems from a lifetime of exposure (Lutman, 2000). The noise level of 80 dBA and less may not result in significant problems on human health and its effect can be prevented by using personal hearing protections such as earplugs or earmuffs (Güvercin and Aybek, 2003).

According to the International Labor Organization (ILO), the warning limit is set to 85 dBA and hazard limit is set to 90 dBA and above (Melemez and Tunay, 2010). When the workers are exposed to noise level of 80 dBA and less may not result in significant health problems and its effect can be prevented by using personal hearing protections; however, the noise level of 85 dBA for 8 hours might cause serious hearing loss problems. Previous studies reported that the workers exposed to noise level of 85-115 dBA may suffer physiologic and psychological health problems while the noise level of 115 dBA or higher results in permanent hearing loss problems (Serin and Akay, 2010). In order to protect the hearing of workers, daily working hours should be determined based on maximum permissible exposure level of noise (Table 1) (Güvercin and Aybek, 2003).

Table 1. The maximum daily exposure times of the workers for various noise levels

Noise Levels (dBA)	Daily Exposure Times (hours)
90	4
95	2
100	1
105	0.500
110	0.250
115	0.125

In Turkey, there is an increasing interest in using farm tractors during forestry operations where the terrain conditions and the size of the forest operation are not limiting factors. Farm tractors utilized in forest operation may result in physiologic and psychological health problems on the operators. However, there are not many studies investigating the level of noise exposed by the farm tractor operator during forest harvesting activities. In this study, it was aimed to analyze the noise level influencing a farm tractor operator during forest harvesting operation. The farm tractor skidding operation took place in a black pine stand located in Mediterranean city of Muğla in Turkey.

2. Material and Methods

2.1. Study Area

The study was conducted in Karaçam Forest Enterprise Chief of Köyceğiz Forest Enterprise Directorate located in the border of Muğla Forestry Regional Directorate (Figure 1). The average elevation and ground slope was 475 m and 30%, respectively.

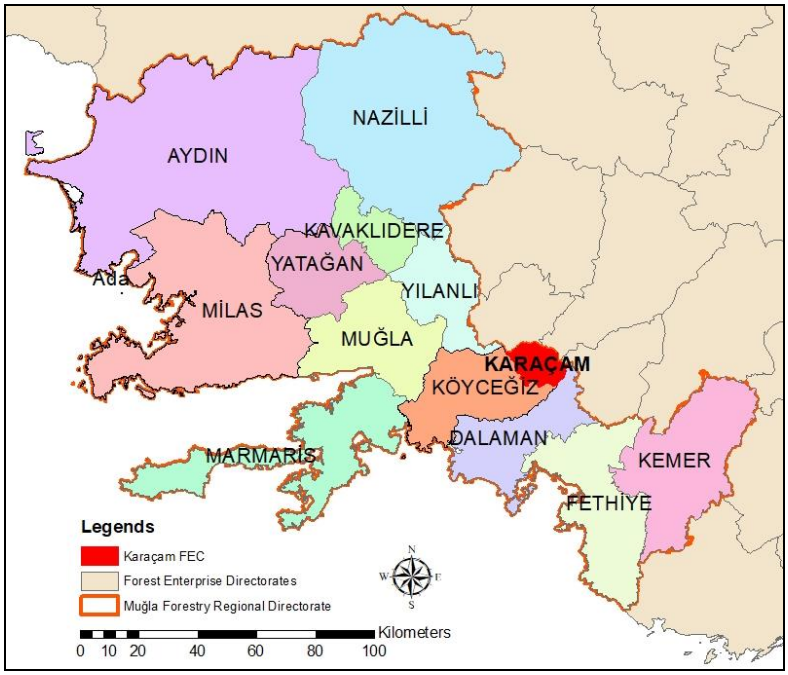

Figure 1. Study area

Dominant tree species in the area was black pine (*Pinus nigra*). The peak noise levels generated by a Türk Fiat 450 model farm tractor during forest harvesting operation were measured (Table 2). During the operation, farm tractor moved from landing to stump, logs were attached to the tractor, and tractor skidded logs uphill to the landing area for unloading them on the ground (Figure 2).

Table 2. Technical specifications of the farm tractor

Properties	Values
Frame	4x2 2WD/4x4 4WD optional
Axle width	198 cm
Front Tire	6.00-19
Rear Tire	12.4-28
Weight	2100 to 2400 kg
Length	322 cm
Fuel	Diesel
Gears	8 forward and 2 reverse

Figure 2. Farm tractor (Türk Fiat 450) skidding logs uphill from stump to landing

2.2. Noise Level Analysis

The level of noise generated by the farm tractor was measured from the cabin to investigate the average and peak noise levels that operator were exposed during skidding operation. Extech EN300 model environmental meter device was used to measure the noise levels for 30 minutes long with 1 second intervals. The device was calibrated based on 110 dB(A) generated by the farm tractor prior to the measurements. When measuring the noise level in the operator cabin, the sound meter was placed in a location which was as close to the ears of the operator as possible. At the time of the data measurements, there was not any other noise sources that may interfere with the noise of farm tractor. The noise level measurements were recorded and then basic statistical analysis was performed by using SPSS 16 program.

3. Results and Discussion

The average and peak noise levels generated by a Türk Fiat 450 model farm tractor during forest harvesting operation were measured. The general statistics for the average and peak noise levels measured during uphill skidding operation were listed in Table 3. The average and peak noise levels were measured as 84.52 dBA and 105.02 dBA, respectively. However, the minimum noise level measured during skidding operation was 73.64 dBA., The distribution of the total of 1800 data collected during noise level analysis were indicated in Figure 3.

Table 3. Summary of noise level data

Noise Level Data	Values
Peak Noise Level (dBA)	105.20
Average Noise Level (dBA)	84.52
Minimum (dBA)	73.64
Measurement Time (minutes)	30

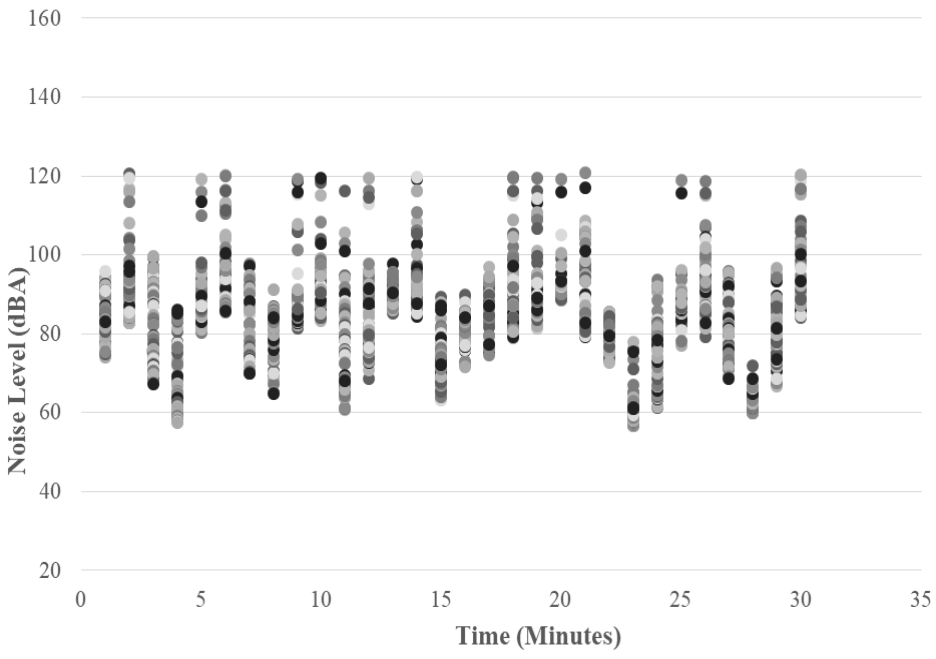

Figure 3. Noise level data measured during skidding operation

The mean value of the average noise levels in logging operation was very close to the warning limit of 85 dBA, which may cause significant hearing loss problems from a lifetime of exposure (Lutman, 2000). The minimum noise level measurement indicated that there were many noise levels less than 80 dBA during tractor skidding. It was stated that the negative effects of up to 80 dBA noise level on operators can be prevented by simple precautions such as earplugs or earmuffs.

The peak noise level measured during the skidding operation was 105.20 dBA, which was over the hazard limit of 90 dBA. Durgut and Celen (2004) reported that he noise level measured during agricultural activities were between 85 dBA and 117 dBA. During timber loading and stocking operations, the average noise level exposed by a tractor operator was measured as 93.5 dBA (Melemez and Tunay, 2010).

When the noise level exceeds the hazard limit, exposure time should be reduced to protect hearing of exposed workers (Lutman, 2000). Otherwise, it may results in permanent hearing loss problems, if exposure time exceeds 1/2 hours per day (Güvercin and Aybek, 2003). To protect operators from excessive noise level, appropriate tractor cabins should be installed for noise insulation. Previous studies indicated that tractor cabins can reduce noise level exposure to operator by 2-10 dBA (Tezer and Sabancı, 2005).

If the operators are subject to long-term noise exposure, other physiological effects such as high blood pressure, heart diseases, and respiration might be experienced (Durgut and Celen, 2004). Besides, excessive noise level may cause psychological health problems on the operators (Serin and Akay, 2008). These health problems affect the operator performance which then leads to reduction in the productivity of the tractor skidding operation and overall operation costs.

4. Conclusions

The average and peak noise levels generated by a farm tractor were analyzed during an uphill skidding operation. The results indicated that the mean value of the average noise level was 84.52 dBA which was very close to the warning limit of 85 dBA. On the other hand, the value of peak noise level was 105.20 dBA which was over the hazard limit of 90 dBA. Based on the interviews conducted with the tractor operator, it was revealed that he suffers from occupational hearing loss problems.

The operator also experiences psychological problems such as uneasiness and nervousness when he exposed to high level of noise for long working hours. The urgent precautions should be implemented to minimize the level of noise at in the noise source. The pieces that cause vibration and therefore generates excessive noise should be replaced or regularly maintained. The engine hood should be isolated to minimize the effect of the engine which is one of the main sources of noise level. Besides, safety measures should be taken to protect the operators from excessive noise exposure. The appropriate resting times should be arranged for the operators and their daily working hours should be also scheduled according to noise level. It is very important to use necessary personal protective equipment in the field to reduce the noise exposure level and the risk of hearing loss.

References

Akay, A.E., Sessions, J., 2004. Identifying the factors influencing the cost of mechanized harvesting equipment. *Journal of Science and Engineering, Kahramanmaras Sutcu Imam University*, 7(2): 65-72.

Akay, A.E., 2005. Using farm tractors in small-scale forest harvesting operations, *Journal of Applied Sciences Research.* 1 (2): 196-199.

Carbaugh, E., Hensley, A., 2005. Farm tractor harvesting systems. College of Natural Resources, Virginia Polytechnic Institute and State University, Blacksburg, VA. 7p.

Doygun, H., Gurun D.K., 2008. Analyzing and mapping spatial and temporal dynamics of urban traffic noise pollution: A case study in Kahramanmaraş, Turkey. *Environmental Monitoring and Assessment.* 142:65-72.

Durgut, M.R., Celen, H., 2004. Noise levels of agricultural machineries. *Pakistan Journal of Biological Sciences.* (7): 895-901.

Güvercin, Ö., Aybek, A., 2003. Noise Problem in Stone Pulverizing and Sieving Plants. *KSU Journal of Science and Engineering*. 6(2): 101-107.

Lutman, M.E. 2000. What is the risk of noise-induced hearing loss at 80, 853 90 dB(A) and above? *Occup. Med.* 50(4): 274-275

Melemez, K., Tunay, M., 2010. The investigation of the ergonomic aspects of the noise caused by agricultural tractors used in Turkish forestry. *African Journal of Agricultural Research,* 5(4): 243-249.

Mirbod, S.M., Inaba, R., Yoshida, H., Nagata, C., Komura, Y., Iwata, H., 1992. Noise exposure level while operating electronic arcade games as a leisure time activity, *Industrial Health*, 30: 65-76.

Öztürk T., Akay A.E., 2007. Modifying farm tractors for forest harvesting operations. International Symposium Bottlenecks, Solutions, and Priorities in the Context of Functions of Forest Resources. 17-19 October. İstanbul, Turkey.

Serin, H., Akay, A.E., 2008. The analyses of noise level during tree bucking operation. XIV. National Congress of Ergonomics. 30 October-1 November. Trabzon, Turkey. pp: 412-416

Serin, H., Akay, A.E., 2010. Noise level analysis of a bulldozer used in constructing a forest road in Mediterranean Region of Turkey, *African Journal of Agricultural Research*. 5(19): 2624-2628.

Tezer, E., Sabancı, A., 2005. Agricultural Mechanization I, Ç.Ü. Faculty of Agriculture, Publication No: 44, Class Book Pub. No: A-7, Adana.

Türk, Y., Gümüş, S. 2010. Log skidding with farm tractor. The 43rd International Symposium on Forestry Mechanization (FORMEC 2010), 11-14 July, Padova, Italy.