

Noise Levels Evaluation of Agricultural Tractors

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ABSTRACT

Agricultural mechanization is of extreme importance to high current agricultural demand. The increased production needs associated with the decrease in available area growth imply in the improvement and mechanization of techniques, being necessary to analyze all variables of the mechanization. As an example, exposure of workers to noise produced by agricultural tractors, which can be harmful to your health, to be occur a productive growth without affecting the minimum conditions imposed by Brazilian law. Excessive noise is a factor that affects the operators. Using a noise meter was measured Noise emission of two tractors, and using the Surfer software were generated maps for spatial analysis. The tractors were studied: Massey Ferguson: MF 4292 (the engine power of 110 hp at 2,200 rpm, manufactured in the year 2011), MF 292 TURBO (engine power of 105 hp at 2,200 rpm, manufactured in 1989). Therewith, we can evaluate the spatial influence of propagation of noise emitted by tractor. The results indicate the need the use of hearing protection equipment for workers staying for a specific period of time near an agricultural tractor in operation as specified in Norm NR-15.

Keywords: agricultural tractors, ergonomics, noise, geo statistics, level.

INTRODUCTION

Agricultural mechanization is important for agriculture, facilitating soil preparation activities, fertilizing, pulverization and harvesting that were once made by animal traction. This exchange increased productivity and final product quality (Cunha, 2009).

However, several factors influenced the performance of operators, such as sunlight, vibration, dust, pesticides, insects, engine heat and noise exposure (Fernandes, 2003).

According Menezes and Paulino (2004), exposure to noise can result in an immediate hearing loss, severe and permanent, and temporary hearing loss caused by moderate exposures, which are recoverable, and permanent hearing loss, considered unrecoverable.

The Brazilian Association of Technical Norms (ABNT) lays down the noise levels for acoustic comfort, and to the noise level of 85 dB is allowed 8 hours of exposure (Brazil, 2014).

Silveira et al., (2008) analyzed the noise level on a tractor with 8 years of use and concluded that the noise level was 96.7 dB and the operator should only be exposed without using ear protection to a period of 1 h 15 min without causing harmful effects. Yanagi Junior et al. (2012) evaluating the spatial variability of the noise of an agricultural tractor in different directions, concluded that noise

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levels were above 85 dB near the operator, and the maps generated by geostatistics can be used to define areas with different noise levels around the tractor.

Santos Filho et al. (2004), Dewangan et al. (2005) and Cunha & Theodore (2006) evaluated the noise caused by agricultural machinery and concluded that some operations were uncomfortable for the operator, even using ear protectors. Rodrigues et al. (2009) evaluated the effectiveness of protectors, and concluded that the protector must be adequate for each worker, for it to be effective.

The use of Personal Protective Equipment (PPE), training and awareness of employees are significant factors for the prevention of accidents (AMBROSI and MAGGI, 2013). Being the use of PPE required in relation to noise exposure.

The evaluations were based on the method described in NBR-9999 (ABNT, 1987). By this measure, the position and timing of noise level measurement the test room temperature between -5 and 30°C and the wind speed less than 5.0 m s^{-1} .

OBJECTIVE

This study aimed to evaluate the spatial variation of the noise level emitted by two agricultural tractors with different years of manufacturing and its influence in the comfort of the operator and other workers engaged in nearby activities.

MATERIALS AND METHODS

The work has been realized at Faculty of Animal Sciences and Food Engineering (FZEA) from University of São Paulo, located at Pirassununga city. The campus geographic location is $21^{\circ}59'$ South latitude and $47^{\circ}26'$ West longitude and 2083,33 feet altitude. The sampling grid were generated for square space of 40 meters continuous side contained in a cartesian plane with the tractor centrally positioned, in (0,0) x and y coordinates and every 8 meters were drawn straight perpendicular to the axes that defined the plan. The crossing of the lines determinate the data collection points, totaling 36 points. The distances and the positioning were determined using a Garmin – etrex Legend HCxGPS device. To measure noise, Icel DL 4020 decibelimeter were used.

The Figure 1 shows the data analysis area. The measurement were realized in each point of data collection using the decibelimeter always pointing the microphone toward the operator's ear, according to the Norm NBR-9999 (ABNT,1997), as shown in Figure 2.

The decibel meter scale used were decibels (dB), with the instrument adjusted to measure the machine noise with quick answer. Two tractors were used for testing, with different power and fabrication years. They are Massey Ferguson: MF 4292 (engine power of 110 cv at 2200 rpm manufactured in the year 2011, 907 hours worked) and MF 292 Turbo (engine power of 105 cv at 2200 rpm, manufactured in the year 1989, 7834,5 hours worked), the first younger and the second older. During the test, the tractors were in rotation as 540 rpm in PTO (Power Take-Off), the standard actual work rotation and used in most studies found in the literature.

After the data collection in both tractors, the results were put in the Surfer software, used to manipulate the data and generate a map of noise spatial distribution emitted by the tractors.



Fig1. Area used to collect the data.



Fig2. Method used to collect data

RESULTS AND DISCUSSION

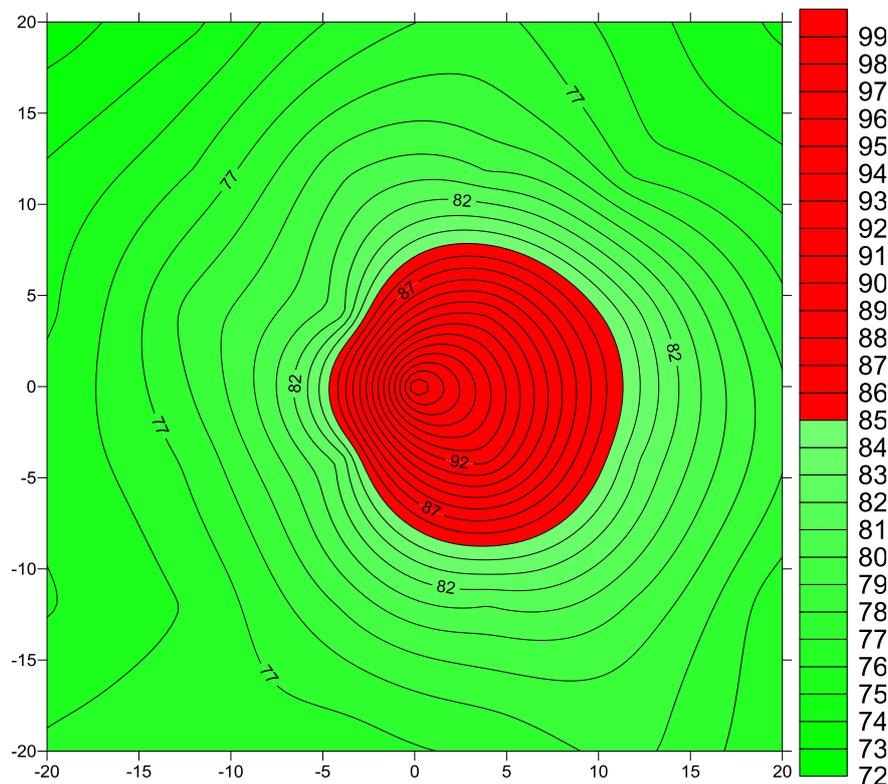
The data were interpolated with Kriging method, with 40 meters range, using the Surfer software.

The Kriging method estimates the value in not sampled positions, through neighbors' values. This method uses generalized linear regression to minimize the prediction errors (DEUTSCH e JOURNEL, 1998). The Kriging technique has been widely used in the generation of maps (YAMAMOTO, 2010).

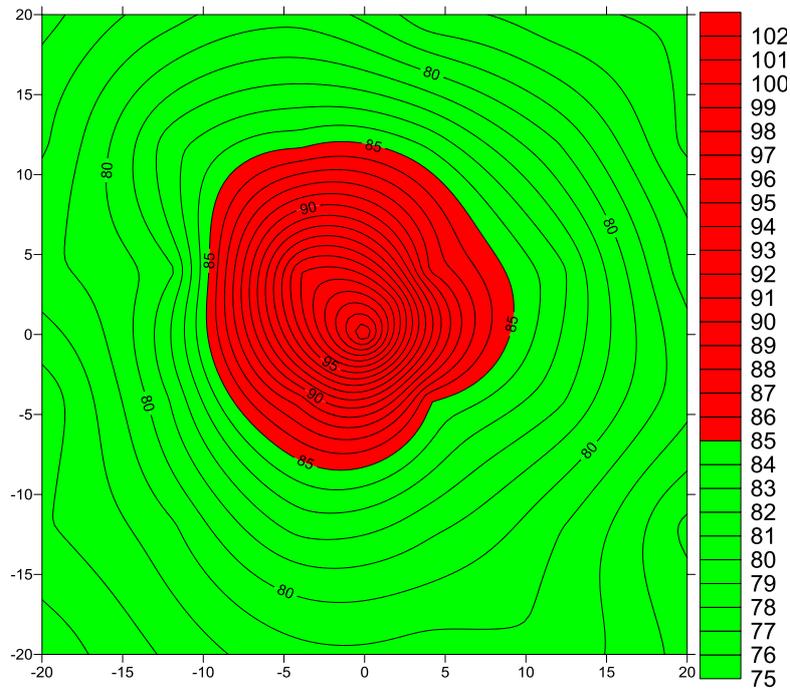
Surfer is software produced by Golden Software. It works on creating and visualization of 3D contours, terrain modeling, landscape view, surface analysis, gridding, titration and much more (Golden Software, 2014).

The measured data can be visualized at graphic 1 and graphic 2. The graphic 1 refers to the measurement in the tractor Massey Ferguson 4292 and the graphic 2 refers to the measurement in the tractor Massey Ferguson 292.

Based on the graphic 1 and 2, you can perceive the spatial dissipation of noise from tractors, inferring numerical values to noise in relation to spatial position too.



Graphic1. Model the noise interpolation map - MF 4292.



Graphic2. Model the noise interpolation map - MF 292.

Due to differences in the manufacturing model and other reasons, like the engine power, year of manufacture and particular components, is not plausible to compare both models. However, an analysis about spatial dissipation of noise can be done.

The MF 4292 has a smaller spatial field noise above permitted by law, in a working day of eight hours (85 dB), than the MF 292. However, MF 4292 in a range of two meters from the tractor, people is exposed more than 85 dB. Next to the exhaust and the engine, the measured noise level was 100.2 dB.

In the case of MF 292, the situation is further complicated, because in longer distances from the tractor, the use of PPE is needed. Next to the exhaust and the engine, the measured noise level was 102.5 dB and with a tractor clearance radius of four meters the noise level is greater than 85 dB.

This study can be number how far from the tractor using hearing protection is required, because in agriculture, mainly in household or small producers, the PPE is just used by the tractor operator. According to the norm NR-15, exposure to above the allowed vibration is considered average degree of unhealthiness (SOEIRO, 2011).

The use of hearing protection equipment for both the machine operator and the employees, exposed to excessive noise (above the permitted in law) in them working hours is required (Couto, 2011).

CONCLUSION

We can conclude that study the spread of noise is important because we know all the distance reached by above values permitted by Norm NR 15 and it is essential the use of equipment in the event of exposure to loud noises. The spatial variability of noise had a greater level in the older model than in the younger, being harmful in four meters tractor proximity distances. Thus, according to NR-15, it is necessary to use hearing protection on a journey of eight hours work, at 540 RPM PTO (Power Take-Off) for both the tractor operator and for people to stay closed to the tractor.

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