

Tractor Noise Levels Impact on Operator Safety

Egela, M. E. and A. R. Hamed

Agricultural Engineering Research Institute (AEnRI), ARC, P. O. Box 256, Giza, Egypt



ABSTRACT

Acoustic noise is one of the most persistent pitfalls of the operators of construction, mining and agricultural machineries, predominantly hearing loss or weak hearing. Also noise include decreased productivity, increased heart rate, and increased blood pressure, startle reaction, and other cardiovascular and psychophysiological system changes (Mansoor, et al. 2011, 2012). The aim of this reaserch was to investigate the impact of noise levels emitted from the agricultural tractors under field operations on the operator safety. Three types of tractors used in this study were Nasr, Belarus and Universal/UTB (Romani). They are without cabin and represent about 76% of the total number of tractors used in Egypt (Economic affair sector, 2012). The noise emitted from them was monitored and evaluated under plowing and land leveling operations as a heavy duty operation field. The data was collected at different engine speed and gears as recommended by the operator for each operation. Measurements of noise levels were taken with the use of Cirrus CR 110A doseBadge and RC 110A reader unit. The noise level measurements were performed in accordance with the Egyptian environmental law (EEL) number 4/1994 modified issue in 2012. Results show that the sound pressure level (SPL) in operator ear and the noise dose % from all tractors under all cases were more than EEL allowable 90 dBA criterion level for 8 hour of operation. The obtained results indicated that the noise levels with "A" frequency weighting (L_{Aeq} dB) for all tractors loaded with chisel plow were the highest measured values. The noise levels emitted from the Nasr tractor were the highest and ranged from 102 to 107 dBA, for Belarus tractor were ranged from 99 to 105 dBA and for UTB tractor were ranged from 96 to 104 dBA. The daily noise exposure levels ($L_{ex(8)}$ dB) from Nasr, Belarus and UTB tractors were 105, 102 and 100 dBA and the corresponding noise dose % as function of equivalent-continuous sound pressure level were 800%, 560% and 400% respectively. The results showed that there was highly significant difference in the systolic blood pressure (SBP) before and after work shift. Similar results were found for the diastolic blood pressure (DBP). For the classification of blood pressure among the operators before and after work shift, majority of the operators was under stage one hypertension (64.5 %), followed by pre-hypertension (28.4 %) and stage two hypertension (7.1%). This study showed that there was association between noise exposure and blood pressure among the operators. It is recommended that; the tractors operators must use one of hear protecting tool to increase working hours, arrange work schedules to let operators exchange work activities so that no one person is exposed to the noise for more than permissible hours in one day and proved tractors with a cabin for the tractors types under this study.

Keywords: noise dose, safe exposure time, Egyptian environmental law, blood pressure.

INTRODUCTION

Noise in agriculture is another relevant risk factor to be taken into account in evaluating health and safety of workers. In fact, one of the major sources of discomfort for workers operating a tractor is the noise that occurs during work (Karamounsantas *et al.*, 2009, Jaliliantabar *et al.*, 2010, Bilski *et al.*, 2013 and Vallone and Catania, 2014). Moreover, excessive noise is a global occupational health hazard with considerable social and physiological impacts, including noise-induced hearing loss (Deborah *et al.*, 2005). Excessive noise level effect during the working process is the cause of hearing loss in 16% of all cases. Besides, excessive noise level can increase workers' injury risk at the sake of decreasing the possibility of acoustic hazard assessment (Radonjic *et al.*, 2012, Cvetanovic *et al.*, 2014 and WHO 2015). European Parliament was enacted on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (noise). It stipulates an average upper limit of noise exposure of a worker during an eight-hour shift of work at 85 dBA (European Commission, 2003 and International Labor Organization, 2004).

Miyakita *et al.* (2004) mentioned that agricultural mechanization in Japan has progressed dramatically. These technological developments have resulted in an increase in exposure to sources of noise that are not only annoying, but damaging to hearing. Melemez and Tunay (2010) mentioned that the average noise level that the operators were exposed during the operations was above the hazard limit; for tractors without cabins on which the loading equipment is mounted, it was 93.5

dBa and with a noise level of 77.7 dBA, it was below the warning limit for tractors with original cabins.

Noise levels of 51 tractors used in India the sound levels for some tractor models exceeded 100 dBA and all were greater than 90 dBA. None of the tractors in the study had cabins and most were reportedly in use beyond their expected economic life (Kumar *et al.*, 2005). The wheeled agricultural tractor is one of the most prominent sources of noise in agriculture. The noise generated by the old-generation of agricultural tractors significantly exceeded noise exposure limits and may cause high risk of noise-induced hearing loss (Adamczyk, 2005, Bilski, 2013). The field data results show that the noise lower exposure action value LEX, 8h of 80 dBA is expected to be exceeded for the tractors manufactured before 1991 (Ričardas *et al.*, 2015).

Noise levels of 155 tractors of 36 farms were studied, three quarters of the tractors were without cabins had noise levels in excess of 90 dBA. It is recommended that using hearing protection when working time on a tractor with a cabins approaches 3 to 4 hours and when working time on a tractor without a cab approaches 1.5 to 2 hours (Holt *et al.*, 1993). Hamam *et al.*, (2007) measured the noise levels in surrounding workplace area (at driver seat, front side, left side, right side and rear side) for three tractors, Landini (65.6 kW), Nasr (48.5 kW) and Daedong (26 kW). These tractors were running on concrete, asphalt and crop field. It is founded that using a hearing protection aids for reducing noise levels especially for those workers accompanying the attached equipment for the tractors under study.

Aybek *et al.*, (2010) mentioned that the human ear is not uniformly sensitive to all noise frequencies. Therefore, the “A” weighting scale was devised to correspond with the ear’s sensitivity. They concluded that depending on the cabin types used, the operators could usually work from 4 to 6 h a day without suffering from noise induced inconveniences while from 2 to 3 h is permissible for plowing and forage harvesting on tractors without cabins. According to Stansfeld and Crombie (2011) founded that there was an association between environmental noise exposure and hypertension and ischemic heart disease. Carter *et al.*, (2002) and Haralabidis *et al.*, (2008) reported that an acute noise exposure has been shown to induce physiological responses such as increased blood pressure and heart rate. Nadiyah *et al.*, (2016) reported that the noise level at prime mover was between 74.5 dB to 88.9 dB which is above the action level of 85dB. Results showed that stress was the commonest health affect claimed by the workers (76.47%) followed by communication disorder (68.63%), emotional disorder (64.71%) and exhaustion (62.75%). Recent international hypertension guidelines have also created categories below the hypertensive range to indicate a continuum of risk with higher blood pressures in the normal range (Chobanian *et al.*, 2003 and Mancina *et al.*, 2007).

The objectives of this study were to: (a) evaluate the sound pressure levels emitted from the agricultural tractors and noise doses under actual field operations, (b) compare the emitted noise with the Egyptian and international criterion levels for safe exposure time, (c) determine the impact of the noise on the operator safety and working ability and (d) investigate the association between noise exposure with blood pressure among the operators.

MATERIALS AND METHODS

The study was conducted in the Rice Mechanization Center, Meet Eldeeba, Kafr El-Sheikh, AENRI, ARC, during the Autumn of 2014, while preparing the field after rice and corn crops. Three types of tractor without cabin a, Nasr with 48.5 kW, Belarus with 59.7 kW and Universal/ UTB with 61.9 kW were used. Those three tractors are the most common tractors which represent about 76% of the total number of tractors used in Egypt (Economic affair sector, 2012). The noise measurements were made during operating under full load of primary plowing and land leveling. The tractors were operated in the field at the gears and

engine speed recommended for the particular field operation. The engine speed was ranged between 2200-2500 rpm. Attention was paid to ensure that no other noise making machine was working in the surrounding area during the measurements. Figure 1 shows the percentage of tractors distribution in Egypt.

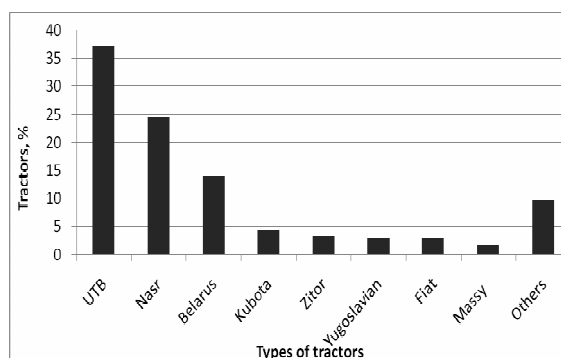


Fig. 1. Distribution percentage of tractors in Egypt by the year 2012 (Economic affair sector, 2012).

A portable personal noise Cirrus device doseBadge Reader was used in this study to measure the sound pressure level (SPL) to which the operators were exposed when working under actual operating conditions with loading tractors. The Cirrus device consists of doseBadge CR: 110A and the reader unit RC. The doseBadge and reader unit allow the user to define the configurations to be loaded into the reader unit according the standards of the EEL. Calibration was performed before and after each measurement. Measurements are downloaded from the doseBadge to a reader unit via an infra-red link (Cirrus, 2013).

The dosimeter stores the noise level information and carries out an averaging process, where noise usually varies in duration and intensity and where the person changes locations. Wearing dosimeters over a complete work shift gives the average noise exposure or noise dose for that person. This is usually expressed as a percentage of the maximum permitted exposure. If a person has received a noise dose of 100% over a work shift, this means that the average noise exposure is at the maximum permitted level. The stored data were presented by a personal computer at the end of experiment for analyzing the treatments. Figure 2 shows the Reader units RC 110A and doseBadge CR: 110A. DoseBadge was fixed on the operator shoulder.



Fig. 2. Reader units RC 110A and doseBadge CR:110A positioned on the operator shoulder.

The equivalent-continuous sound level (L_{Aeq}) was calculated (Cirrus, 2013) as:

$$L_{Aeq} = 10 \text{ Log}_{10} \left(\frac{1}{T} \int_{T_1}^{T_2} \frac{P^2(t)}{P_0^2} dt \right) \text{ dB}$$

Where:

L_{Aeq} = equivalent-continuous sound pressure level, dB
 $P(t)$ = instantaneous, frequency weighted, sound pressure, Pa

P_0 = reference sound pressure, 20 μ Pa

T = measurement period or run time ($T = T_2 - T_1$)

T_1 = start time to measure noise, s

T_2 = end time to measure noise, s

The noise instrument should used for 2 hours to get the accumulative L_{Aeq} for the 8 h / day (Cirrus, 2013).

Table 1 shows the noise dose % and daily permissible exposure times to noise according the EEL limits.

Table 1. Noise dose percentage and daily permissible exposure times to noise

Noise Level, dBA	90	95	100	105	110	115	EEL
Permissible exposure Time, hr/day	8	4	2	1	0.5	0.25	4/2012

According to the EEL the criterion level is set to 90 dBA and the exchange rate for sound exposure (noise) level is 5 dBA. This study introduces the dose concept to understand the noise level impacts on the tractor operators. The noise dose is represents the accumulated noise has exceeded the criterion level. The noise dose is expressed as a percentage (%) (Cirrus, 2013). For the measured sound exposure level of an 8-hour working per day. The 100% noise dose is equivalent to a level of 90 dBA over 8 hours work ($L_{ex(8)}$ dBA). If the noise level reached 95 dBA and a person is exposed to a constant or equivalent sound exposure

Table 2. Classification of blood pressure.

Blood pressure category	Systolic (upper) mmHg	Diastolic (lower) mmHg
Low blood pressure (hypotension)	Less than 90	Less than 60
Normal	90 to 120	60 to 80
Prehypertension	120 - 139	80 - 89
High blood pressure (hypertension stage 1)	140 - 159	90 - 99
High blood pressure (hypertension stage 2C)	160 or higher	100 or higher
High blood pressure crisis (seek emergency care)	180 or higher	110 or higher

A completely randomized design of field layout was taken. The subjects were taken as replications. The treatments (tillage and land leveling bu Nasr, Belarus and UTB) were randomized in orders to minimize the effects of variation of different agricultural tractors due to different agricultural operations, the experiments were conducted in the open field. The data were processed for frequencies procedure and Analysis of variance using statistical package for social science (SPSS version 20 software) and a probability value of $p \leq 0.05$ was considered to show a statistical significant difference among mean values (Snedecor and Cochran, 1989).

RESULTS

This study was carried out to evaluate the sound pressure levels and noise doses according to EEL criterion levels emitted from the agricultural tractors under actual field operations, compare the emitted noise with ISO criterion levels for safe exposure time,

level of 95 dBA for eight hours, it is resulting in a 200% noise dose, and then the allowed exposure time per a day must be 4 hours. Permissible exposure time and dose % are varies according to the standards used. The measured values of the noise levels were compared with the limits of the ISO 9612: 2009 criterion levels.

A total of 14 experience tractors operators were used under this study. They were randomly selected among the available operators. A measurement of systolic blood pressure (SBP) and diastolic blood pressure (DBP) were taken using automatic electronic blood pressure meter UA-651. The cuff which was attached to the operators' wrist or upper arm was connected to an electronic monitor. Figure 3 shows the device used and the measurement process.



Fig. 3. Pressure meter UA-651 and measurements for the operator.

The measurements were carried out before and after each work shift to clarify the effect of noise on the operator. Table 2 shows the classification of blood pressure according to the World Health Organization (WHO, 2003).

determine the impact of the noise on the operator safety and working ability and investigate the association between noise exposure with blood pressure among the operators.

Sound pressure levels for the three tractors under tillage operation

Results in Figure 4 showed that the sound pressure levels (SPL) with "A" frequency weighting L_{Aeq} dBA for the tractors loaded with the chisel plow. The SPL for Nasr tractor was ranged from 102.3 to 107.5 dBA. Resulting on the permissible exposure time is in between 0.5 to 1 hour/day, to ensure the operators work in safe operating conditions. The SPL for Belarus tractor was ranged from 99.4 to 105.2 dBA. The permissible exposure time is 1 hour/day . The SPL for UTB tractor was ranged from 96.2 to 104.2 dBA. The permissible exposure time is 2 hours/day. The SPLs for all cases were more than the EEL allowable 90 dBA criterion level for eight hour of operation.

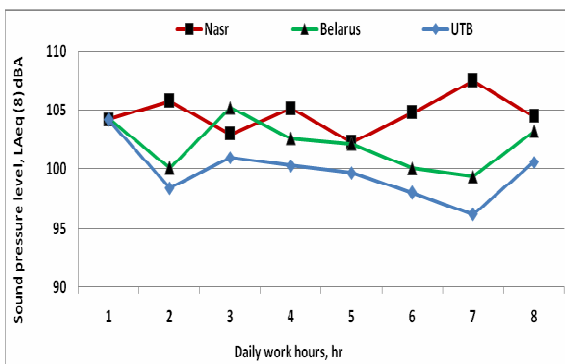


Fig. 4. Sound pressure level for Nasr, Belarus and UTB tractors loaded with chisel plow.

Sound pressure levels for the three tractors under land leveling operation

Results in Fig. 5 shows that the SPL with “A” frequency weighting L_{Aeq} dBA for the tractors loaded with hydraulic land leveler. The SPL for Nasr tractor was ranged from 97.6 to 104.9 dBA. Permissible exposure time is in between 1 to 2 hours/day for the operators to ensure operating in safe conditions. The SPL for Belarus tractor was ranged from 96.6 to 102.6 dBA. Permissible exposure time is in between 1 to 2 hours/day. The SPL for UTB tractor was ranged from 94.7 to 99.3 dBA. Permissible exposure time is in between 2 to 4 hours/day. The SPLs for all cases were more than the EEL allowable 90 dBA criterion level for eight hour of operation.

Noise doses under tillage and land leveling operations

Fig. 6 shows the daily personal noise exposure levels ($L_{ex(8)}$ dB) from the three tractors loaded with chisel plow. The $L_{ex(8)}$ dB were for Nasr 104.7, Belarus 102.1 and UTB 99.8 dBA and the corresponding noise doses % from L_{Aeq} were for Nasr 478%, Belarus 421% and UTB 317% respectively. This means that, the Nasr, Belarus and UTB tractor operators have exposure to auditory load stress of 4.8, 4.2 and 3.2 times of the ordinary one under the limits for the EEL. The $L_{ex(8)}$ dB from the three tractors loaded with hydraulic land leveler were for Nasr 101.3, Belarus 99.5 and UTB 96.8 dBA and the corresponding noise doses % were for Nasr 403%, Belarus 305% and UTB 246%

respectively. This means that, the Nasr, Belarus and UTB tractor operators have exposure to auditory load stress about 4, 3 and 2.5 times of the ordinary one under the limits for the EEL. As shown in Fig. (6).

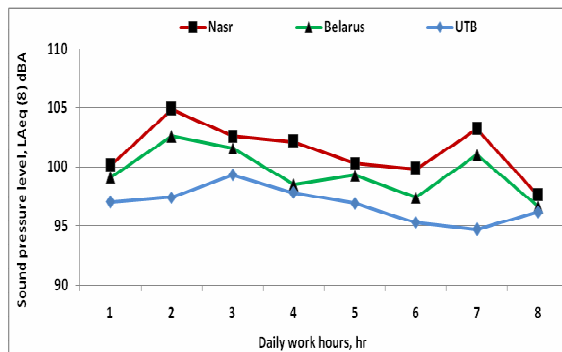


Fig. 5. Sound pressure level for Nasr, Belarus and UTB tractors loaded with hydraulic land leveler.

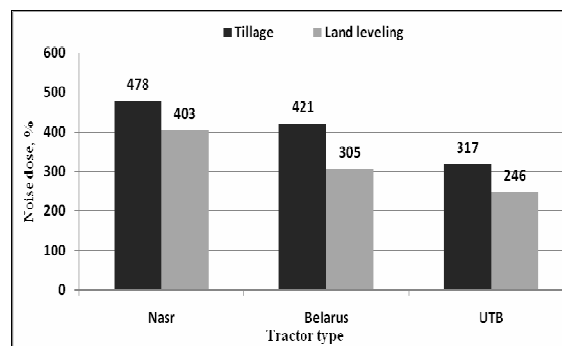


Fig. 6. Noise dose for Nasr, Belarus and UTB tractors under tillage and land leveling operations.

Comparison of noise parameters under the EEL (2012) and ISO (2009)

Table 3 presents comparison between the noise levels according the EEL and the ISO criterion levels. Also the daily permissible exposure times to noise and the noise doses according the criterion limits.

Table 3. Comparison of noise parameters under the EEL and ISO

Noise level, dBA	90	95	100	105	110	115	
Permissible exposure time, hr/day	8	4	2	1	0.5	0.25	EEL 4/2012
Noise dose, %	100	200	400	800	1600	3200	
Noise level, dBA	85	88	91	94	97	100	
Permissible exposure time, hr/day	8	4	2	1	0.5	0.25	ISO 9612: 2009
Noise dose, %	100	200	400	800	1600	3200	
Noise level difference dBA	5	10	15	20	25	30	
Permissible exposure time, hr/day	2.5	< 1	0.25	-	-	-	judge the EEL noise levels by the ISO std.
Noise dose, %	266	833	3200	-	-	-	

Referring to the parameters under the EEL and ISO criterion levels for noise levels, exchange rate and noise dose can be observed that criterion noise levels under the EEL and the ISO are 90 and 85 dB respectively. The exchange rates are 5 dB under the EEL and 3 dB under the ISO. Evaluation of the EEL limits by ISO limits founded that the difference in

criterion level is 5dB; this allow working for 2.5 hr/day and increase in noise dose by 2.7 times. At the level 95 dB allow working for less than one hour per day and increase in noise dose by 8.3 time. Under these criterion levels of the EEL the Egyptian tractor operators are exposed to serious risks.

Statistical analysis of ANOVA for treatments conducted

Table 4 presents the results of the statistical analysis of ANOVA for treatments conducted of three types of tractors and two field operations. Data analysis showed that there was highly significant difference (f =

13.82) on the mean of equivalent continuous SPL with “A” frequency weighting (L_{Aeq} (dB)) were between 103.30 and 105.99 for Nasr tractor under primary tillage to different types of tractors and the field operations. This is considerably excess of the noise level proposed by the EEL.

Table 4. Analysis of variance for the effect of three types of tractors and two field operations on equivalent continuous sound pressure levels on operators.

Tractor under field operation	Mean	Std. D.	C. V.	Std. Er.	95% Confidence Interval for Mean		F	Sig.
					Lower Bound	Upper Bound		
Nasr primary tillage	104.65	± 1.60	1.54	0.569	103.30	105.99	13.82	0
Nasr land leveling	101.32	± 2.30	2.28	0.815	99.39	103.25		
Belarus primary tillage	102.12	± 2.11	2.07	0.746	100.36	103.88		
Belarus land leveling	99.51	± 2.08	2.09	0.735	97.77	101.25		
UTB primary tillage	99.80	± 2.38	2.39	0.843	97.80	101.79		
UTB land leveling	96.82	± 1.44	1.49	0.511	95.61	98.03		

Association between noise exposure and blood pressure

Fig. (7) shows that the tractor operator's SBP and DBP are increased due to exposure to noise exceed the criterion level. For Nasr, Belarus and UTB tractors operators, the SBP values were 138, 127 and 113 mmHg before work shift and 162, 151 and 140 (mmHg) after the work shift respectively. The operator's DBP of Nasr, Belarus and UTB tractors were 85, 78 and 77mmH before the work shift and 99, 97 and 92 mmHg after the work shift respectively. This indicates that, the operators have exposure to hazard levels of noise resulting in high levels of both the SBP and the DBP. As a result, the operators must work less than 8 hour/day, in general, to ensure operating in safe conditions corresponding to that, the operators productivity will be less. According the classification of blood pressure (WHO, 2003) as showed in Table 3. The operators SBP before and after work shift were classified. The majority of the operators SBP after work shift were stage one hypertension (64.5 %) followed by pre-hypertension (28.4 %), and stage two hypertension (7.1%) and before work shift was pre-hypertension (57.4 %), followed by normal (42.6 %). The operators DBP after work shift were stage one hypertension (85.8 %), followed by pre-hypertension (14.2 %) and before work shift were normal (78.7 %) followed by pre-hypertension (21.3 %). It concluded that there was

association between noise exposure and blood pressure among the operators.

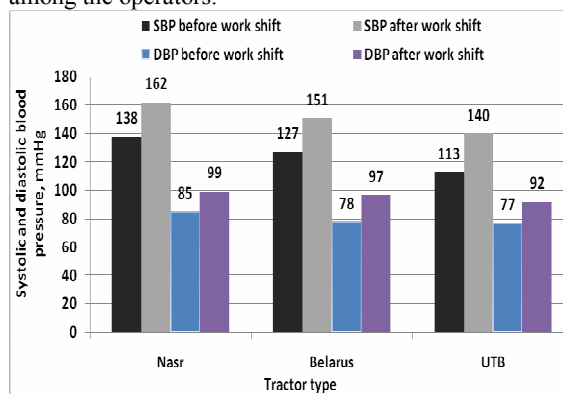


Fig. 7. Comparison of the systolic and diastolic blood pressure for the tractors operators before and after work shift

Statistical analysis of ANOVA for the operator's SBP and DBP

Table 5 presents the statistical analysis of ANOVA for the operator's SBP and DBP measured before and after work shifts as affected by noise. The results showed that there was highly significant difference in the SBP before and after work shift (f=23.17). Similar results were found for the DBP (f =140.55).

Table 5. Effects of noise level on operator's systolic and diastolic blood pressure.

Blood pressure status	Mean	Std. D.	C. V.	Std. Er.	95% Confidence Interval for Mean		F	Sig.
					Lower Bound	Upper Bound		
SBP before work shift	123.35	± 9.89	8.02	2.64	117.64	129.07	23.17	0
SBP after work shift	143.50	± 12.13	8.45	3.24	136.49	150.50		
DSBP before work shift	77.85	± 3.52	4.53	0.942	75.82	79.89	140.55	0
DSBP after work shift	94.14	± 3.73	3.97	0.999	91.98	96.30		

DISCUSSION

The noise emitted from the three tractors under the work conditions was exceeds the criterion level for the EEL which is 90 dBA. It may be concluded that drivers should work with lowest engine speed and the lowest gear but; this is contradictory because tractors in this case, would not produce enough power to do the job. The alternatives are either stay on driving for less than 8 hours

according to the EEL permissible working time as shown in Table 1, or the driver wears some kind of ear protection. Sound levels that cause hearing loss begin at about 85 dB(A). Hearing loss occurs more quickly with louder noise. OSHA standards consider sound measured at 85 decibels or higher as damaging to the eardrum and therefore a risk to hearing (Anonymous, 2004). Therefore the noise criterion level and noise exchange rate for the

EEL are preferably change to be decreased from 90 to 85 and from 5 to 3 respectively, to obtain more safely working environment for Egyptian tractor operators.

CONCLUSION

The obtained results concluded that:-

- 1-The equivalent continuous SPL with L_{Aeq} dB for Nasr, Belarus and UTB under primary tillage were ranged from 102.3 to 107.5, 99.4 to 105.2 and 96.2 to 104.2 dBA respectively at 8 h.
- 2-The daily personal noise exposure level, $L_{ex(8)}$ dB for Nasr, Belarus and UTB was 104.7, 102.1, 99.8 dBA respectively. The corresponding noise dose % were 478%, 421% and 317% at 8 h.
- 3-The maximum noise levels and noise dose were obtained from Nasr tractor followed by Belarus tractor and UTB tractor under primary tillage. It is excess of the noise level proposed by the EEL, and causes a high risk on the operator hearing.
- 4-There was highly significant difference on the mean of equivalent continuous sound pressure levels with "A" frequency weighting (L_{Aeq} (dB)) for the noise level after work shift on operator's systolic and diastolic blood pressure.
- 5-The majority of the operators SBP before work shift was pre-hypertension (57.4 %), followed by normal (42.6 %) and after work shift were stage one hypertension (64.5 %) followed by pre-hypertension (28.4 %), and stage two hypertension (7.1%).
- 6-The study showed that there was association between noise exposure and blood pressure among the operators.

RECOMMENDATION

- 1- Use of personal protective tools like earmuffs or ear plugs to reduce the noise level impact.
- 2- Arrange work schedules to let operators exchange work activities so that no one person is exposed to the noise for more than permissible hours in one day
- 3- Those three types of tractors (Nasr, Belarus and UTB) should be equipped with cabin, to increase the operator's safety and their work productivity.
- 4- Future imported tractors for the same categories especially must be equipped with factory made cabin.
- 5- Perform farther studies to analyze and determine the main source of this noise in order to decrease its levels while field working and to increase the operator's safety and work productivity.
- 6- The criterion level and change rate for the EEL it is recommended to be decreased from 90 to 85 and from 5 to 3 respectively, to obtain more safely working environment for Egyptian tractor operator.

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تأثير مستويات ضوضاء الجرارات على سلامة المشغل محسن إبراهيم عجيلة وأحمد رجب حامد

معهد بحوث الهندسة الزراعية ، مركز البحوث الزراعية ، صندوق بريد ٢٥٦ ، الجيزة ، مصر .

الضوضاء الصوتية هي واحدة من عوامل الخطر الأكثر شيوعا على مشغلي البناء والتعدين والآلات الزراعية ، ويعتبر الضجيج الناتج عن فقدان السمع هو واحد من الأمراض المهنية الشائعة ، آثار التعرض للضوضاء تسبب مشاكل كبيرة ولا تقتصر فقط على فقدان السمع ، بل هناك آثار أخرى للضوضاء تشمل انخفاض الإنتاجية ، وزيادة معدل ضربات القلب ، وزيادة ضغط الدم ، ورد فعل منفر من مكان العمل ، وغيرها من التغيرات في الجهاز الدوري والحالة النفسية للمشغلين (منصور وآخرون ٢٠١١ ، ٢٠١٢) . تهدف هذه الدراسة الى بحث تأثير مستويات الضوضاء المنبعثة من الجرارات الزراعية تحت ظروف التشغيل الفعلي على سلامة المشغلين . استخدم في هذه الدراسة ثلاثة أنواع من الجرارات هي النصر ، البيلاروس والروماني ، وهم بدون كابينة ويمثلون حوالي ٧٦٪ من إجمالي عدد الجرارات المستخدمة في مصر (قطاع الشؤون الاقتصادية ، ٢٠١٢) ، تم تقييم الضوضاء المنبعثة من الجرارات تحت ظروف عمليتي الحرث و التسوية والتان تمثلا لأصعب العمليات الزراعية. وتم أخذ البيانات عند سرعات محرك مختلفة ووضعية تروس كما هو موصى به من قبل المشغل لكل عملية ، تم أخذ قياسات لمستويات الضوضاء باستخدام جهاز Cirrus CR 110A dosebadge and RC 110A ، حيث تم وضع مستويات وحدود الجهاز وفقا للقانون البيئي المصري (EEL) رقم ٤ لسنة ١٩٩٤ المعدلة في عام ٢٠١٢. أظهرت النتائج أن مستوى ضغط الصوت (SPL) وجرعة الضوضاء على سمع المشغل من كل الجرارات تحت ظروف التشغيل المختلفة أعلى من المسموح بها طبقا لـ (EEL) وهي ٩٠ ديسيبل كمستوى قياسي للتشغيل لمدة ٨ ساعات يوميا ، وبينت النتائج المتحصل عليها ان مستويات الضوضاء عند مستوى ضغط الصوت المستمر المكافئ ($L_{Aeq}dB$) لكل الجرارات عند الحرث بالمحراث الحفار كانت اعلى قيم مقاسة . ووجد ان مستويات الضوضاء المنبعثة من الجرارات النصر كانت الاعلى وتقع من ١٠٢ إلى ١٠٧ ديسيبل ، وللجرار البيلاروس كانت من ٩٩ إلى ١٠٥ ديسيبل ، وللجرار الروماني كانت من ٩٦ إلى ١٠٤ ديسيبل على الترتيب . ووجد ان مستويات التعرض للضوضاء اليومية ($L_{ex}(8)$) من الجرارات النصر ، البيلاروس والروماني كانت ١٠٥ ، ١٠٢ و ١٠٠ ديسيبل ، وبلغت جرعة الضوضاء كدالة من مستوى ضغط الصوت المستمر المكافئ L_{Aeq} للجرارات الثلاثة ٨٠٠ % ، ٥٦٠ % و ٤٠٠ % على الترتيب . وأظهرت النتائج أن للضوضاء تأثير معنوي على ضغط الدم الانقباضي وكذلك ضغط الدم الانبساطي قبل وبعد فترة العمل . ومن خلال تصنيف ضغط الدم للمشغلين قبل وبعد فترة العمل وجد ان غالبية المشغلين تقع تحت حالة ارتفاع ضغط الدم في مرحلة الحدة من الدرجة الاولى بنسبة (٦٤.٥٪) تليها ارتفاع ضغط الدم قبل مرحلة الحدة بنسبة (٢٨.٤٪) ثم حالة ارتفاع ضغط الدم في مرحلة الحدة من الدرجة الثانية بنسبة (٧.١٪) وقد أظهرت هذه الدراسة وجود تأثير معنوي عند التعرض للضجيج على ضغط الدم . وتوصى هذه الدراسة باستخدام احدى وسائل حماية السمع بالنسبة للمشغلين لهذه النوعية من الجرارات وللعمل على زيادة انتاجية المشغل ، كذلك ضرورة تنظيم ساعات العمل والا تزيد عن الحدود التي تسبب الضوضاء ، تصنيع كابينة لهذه الجرارات محل الدراسة .