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Research Article

Effects of some functional parameters on noise pollution of John Deere 3350 and New Holland 155 tractors

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ABSTRACT- In this study, noise pollution from the John Deere 3350 and New Holland 155 tractors was measured at three operator-related positions: 10 cm from the driver's ear and at distances of 7.5 and 20 m from the tractor centerline, as they traveled over asphalt and soil surfaces. Measurements were conducted under three engine speeds (1000, 1500, and 2000 rpm) and three gear settings (gears 1, 2, and 3), with three replications for each condition. Data were analyzed using a factorial test within a completely randomized design. Results indicated that noise levels increased with higher engine speeds and gear settings on both surfaces. The main factors had a statistically significant effect on noise emission levels in both tractors at the 1% probability level. For the John Deere 3350, noise levels at the driver's ear position exceeded the standard limit of 85 dB (A) at all gear and speed combinations on asphalt, except for 1st gear at 1000 rpm. The New Holland 155 exhibited lower noise levels at the driver's ear compared to the John Deere 3350, likely due to the presence of an enclosed cab.

INTRODUCTION

The safety of agricultural machinery operators is a critical concern for managers, particularly as technological advancements and increased mechanization in agriculture aim to boost productivity. However, these developments have introduced issues such as noise and vibration, which necessitate greater attention to machinery design (Liljedahl et al. 1996). Noise pollution can have indirect effects on human performance, including reduced efficiency and productivity, and a higher risk of accidents and errors due to the decreased concentration (Tetsuro et al. 2004). Major adverse health effects of noise exposure include temporary or permanent hearing loss, disturbances in the vestibular system, confusion, nausea, gait instability, reduced work capacity, and increased heart rate and blood pressure, which in turn elevate oxygen consumption and respiratory rate (Durgut and Celen 2004; Irwin and Graf, 1979). Dewangan et al. (2005) investigated the noise characteristics of four types of tractors and their impact on operator health. They reported that noise levels exceeded the standards recommended by ISO and OSHA, making them intolerable over an eight-hour workday and posing serious long-term health risks for farmers. In another study, Hassan-Beygi et al. (2007) employed an artificial neural network to predict the noise intensity of a 13-hp trailer, finding a minimal prediction error of only 2 dB. Aybek et al. (2010) observed that sound pressure levels decreased as the center frequency bands increased during various tractor operations. Their study also confirmed that tractors equipped with original (factory-installed) cabins significantly reduced noise levels compared to non-cab or retrofitted cab tractors. JunHong and Bing (2005) analyzed noise sources in front of diesel engines and concluded that noise intensity measurements are useful in identifying specific noise-generating components. Sehsah et al. (2010), in a study involving two tillers under different surface conditions (soil and asphalt), reported maximum noise levels at the driver's ear position of 98.2 dB on soil and 92 dB on asphalt—both exceeding the World Health Organization's (WHO) recommended limits. Additionally, noise levels were consistently higher at the driver's ear than at surrounding positions. Melemez and Tunay (2010) examined noise levels in 145 agricultural machines and found that user exposure ranged from 76 to 105 dB. The average noise level for non-cab tractors was 93 dB, while tractors with original cabins recorded 77 dB, below the danger threshold, highlighting the protective benefits of enclosed cabs. Behroozi Lar et al. (2011) evaluated noise exposure from Massey Ferguson 399 and Walter T170 tractors and found that, without a cabin, average noise levels at the driver's ear exceeded the permissible limit of 85 dB, with peak values reaching 94.4 dB and 92.7 dB,

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respectively. Lashgari and Maleki (2014) investigated the noise characteristics of the 3065 Sampo combine. Their results demonstrated a strong linear relationship between noise level and A-weighted sound pressure level (R^2 = 0.99), although no significant regression was found for unweighted sound pressure levels (R^2 = 0.66). They also reported that original cabins effectively reduced noise and sound pressure levels, with average values significantly higher at high engine speeds than at lower speeds.

In another study, Lashgari and Maleki (2015) evaluated the noise emissions of a garden tractor. Their findings showed that sound pressure level, type of operation, gear ratio, and engine speed significantly affected the emitted noise at the 1% probability level. Furthermore, sound pressure levels and hearing threshold limits were higher during operations on rural roads compared to tillage conditions. Ghaderi et al. (2019) investigated noise pollution from various fuel blends, biodiesel, bioethanol, and diesel, in an MF285 tractor. Noise levels were measured in different gears and at two positions: the operator and a bystander. The results provided insights into how alternative fuels affect noise emissions under varying operational conditions. Barač et al. (2024) applied machine learning techniques to predict in-cabin noise levels in a LANDINI POWERFARM 100 tractor based on speed, tire pressure, and surface type. Among several models tested, a monotone multilayer perceptron (MLP) neural network achieved the highest accuracy, while gradient boosting machines (GBM) performed best when combining all datasets. Although the models showed promising results, the authors emphasized the need for further testing to enhance predictive performance. Gomes et al. (2021) assessed noise levels from three agricultural tractors with different power ratings, both with and without implements. Measurements were taken at 40 positions around each tractor while operating at 540 RPM. Results showed that in all scenarios, noise levels exceeded regulatory thresholds, underscoring the necessity of hearing protection for both operators and nearby workers. Jahanbakhshi et al. (2020) examined noise emissions from two Massey-Ferguson tractors (models 285 and 399) by comparing standard exhaust systems with combined resistance exhaust systems. Following ISO 7216 and ISO 5131 standards, noise levels were measured under various engine speeds, gear settings, and microphone placements. A total of 72 tests were conducted and analyzed using a factorial design. The combined resistance exhaust system significantly reduced noise levels and extended permissible exposure times, offering a more effective approach for noise mitigation. Moraes et al. (2023) investigated the noise impacts of air-assisted spray bars, finding that they significantly increased noise levels near the source, especially at high engine speeds. While operator cabins helped reduce in-cabin exposure, external workers remained at risk, emphasizing the importance of personal hearing protection. Özkul and Sümer (2022) evaluated noise exposure during olive harvesting and its implications for worker health. Recorded noise levels ranged from 66 to 88 dB (A), with higher exposure associated with handheld and tractor-mounted equipment. The study concluded that prolonged exposure could adversely affect both health and work efficiency, highlighting the urgent need for protective strategies.

A study conducted in Pakistan revealed that tractor noise exposure varied depending on the type of implement used, with seed drills producing the lowest noise levels (81.9 dB (A)) and disk harrows the highest (86.9 dB (A)) (Yamin et al., 2021). Elevated noise levels were associated with psychological effects such as stress and anxiety, negatively impacting operator well-being. The study recommended the use of protective measures, including soundproof cabins, earplugs, and maintaining a safe distance of at least 48 meters from the noise source. In another investigation, Zahariev and Atanasov (2024) compared noise levels from three second-hand tractors differing in engine power and year of manufacture. The study identified areas around the tractors where noise levels exceeded 80 dB (A) and emphasized the importance of personal protective equipment (PPE) to safeguard workers' health. Their findings support more effective noise pollution monitoring and the development of protective strategies to maintain worker productivity and safety.

In the present research, noise pollution resulting from operational variables was examined in John Deere 3350 and New Holland TM155 tractors. Noise levels were measured both at the operator's location and in the surrounding area, allowing for a comparative analysis of emissions from both models. The data were evaluated against international standards for occupational health and user comfort, and permissible exposure durations were calculated. Based on the findings, recommendations were provided to optimize the key factors contributing to noise emissions in agricultural tractors.

MATERIALS AND METHODS

In this study, noise data from John Deere and New Holland tractors were measured and recorded under real-world operating conditions while the tractors moved on both soil and asphalt road surfaces. To maintain scientific rigor while avoiding excessive test complexity, simple yet precise measuring instruments and tools were employed. To enhance the validity of the collected data and the recorded sound signals, careful attention was given to the selection of test locations, the range of operating conditions, the variables studied, and the measurement equipment. These steps were taken prior to data collection to ensure the accuracy and reliability of the results.

Necessary equipment

In this study, two tractor models were used: the John Deere JD3350 (109 hp, without cabin) and the New Holland TM155 (153 hp, with cabin). A digital anemometer (model AM-4206, with a resolution of 0.1 m/s for wind speed and 0.1 °C for ambient temperature) was used to monitor environmental conditions during testing. Noise levels were measured using a sound level meter (model SL-4013, made in Taiwan), which has an accuracy of 0.1 dB, operates within a frequency range of 31.5 to 8000 Hz, and covers a measurement range of 30 to 130 dB. To record noise signals emitted from the tractors, data were collected from the sound sensor and stored in a data logger, then transferred to a computer via an RS232 cable. The sound level meter used in this study complied with IEC 61672 and IEC 1010 standards for precision measurement equipment. Data acquisition and visualization were managed using Lutron 801 software, specifically developed for accurate data recording from various Lutron instrumentation models (Fig. 1).

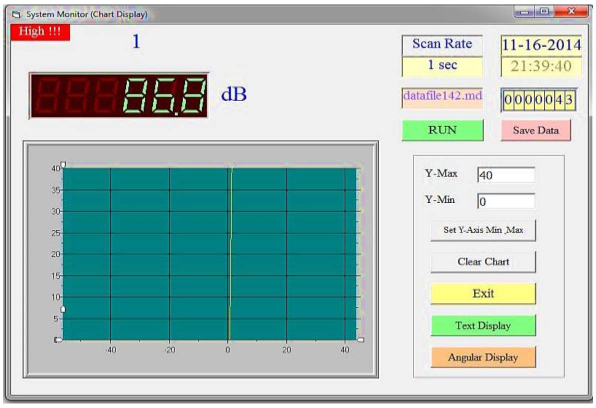

Fig. 1. View of the Lutron 801 software.

In this study, to measure noise at the operator's position, the microphone was placed 10 cm from the driver's ear. To comply with standard procedures and minimize microphone vibration during testing, a helmet equipped with a stable clip was used to securely position the microphone. The microphone was fixed tightly within the clip to prevent movement, and the driver maintained a forward-facing posture throughout the test runs, in accordance with ISO 5131 (1996). For measurements at the surrounding positions, the microphone was mounted at a height of 1.2 meters above the ground and placed at distances of 7.5 meters and 20 meters from the centerline of the tractor's path (Fig. 2). The test site and conditions were selected following the guidelines of the International Organization for Standardization (ISO 5131, 1996; ISO 7216, 1992). Accordingly, the measurement area was flat, open, and free from large reflective surfaces such as buildings and trees. During testing, wind speed did not exceed 5 m/s (18 km/h), and measurements were not conducted under adverse weather conditions such as rain, snow, or lightning. Additionally, the background noise level was ensured to be at least 10 dB lower than the measured tractor noise. All tests were conducted under stable and calm atmospheric conditions. The dimensions of the test area are illustrated in Fig. 3. In this figure, the segment from point A to B represents the 30-meter path used for tractor passage. Points C and D indicate the microphone positions at distances of 7.5 and 20 meters, respectively, from the centerline of the tractor, simulating the location of nearby individuals.

At least three measurements were taken at each microphone position and under each experimental condition. Noise levels were recorded using A-weighted frequency weighting (dB (A)) and the slow time response setting (S), in accordance with ISO 5131 (1996). Measurements were initiated after 10 seconds of steady tractor operation to ensure data stability. Any noise peaks that clearly deviated from the typical noise profile were excluded from the analysis, as prescribed by the standard.

Fig. 2. How to measure the noise of the tractor in the surroundings positions.

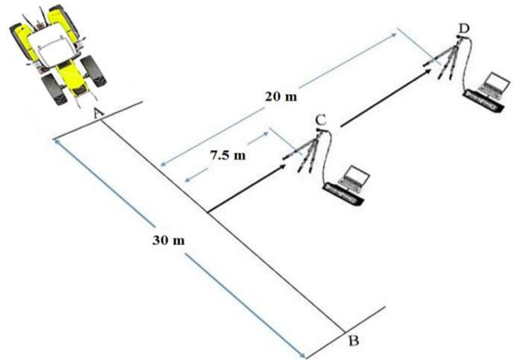

Fig. 3. Schematic of dimensions of measuring area of the noises emitted from tractors.

Measuring amount of permissible hours

For noise evaluation, A-weighted sound intensity levels (dB (A)) were used, as this weighting reflects the sensitivity of the human ear to different frequencies. According to occupational health standards, the permissible exposure limit is 85 dB (A) for an 8-hour workday (Table 1). As recommended by the European Commission, noise assessments should be based on A-weighted levels to ensure accurate evaluation of health risks.

Table 1. Proposed hours of exposure to the noise pollution (Chan., 1998)

Noise level dB (A)	85	88	91	94	97
Proposed hours	8.0	4.0	2.0	1.0	0.5

The values of these times were calculated using Eq. (1) (Chan, 1998).

$$T(hr) = \frac{8}{2^{\left(\frac{L-85}{3}\right)}} \quad \text{Eq. (1)}$$

where T is the permissible hours and L is the measured noise level.

Tests tables

The different levels of the measured variables are reported in Table 2. In this research, the total of tests performed with three replicates for each tractor reached 162.

Table 2. Different levels of measured variables for each tractor

Variables	Variables levels		
Engine speed (rpm)	1000	1500	2000
Gear ratio	Gear 1	Gear 2	Gear 3
Operation state	Movement in the asphalt road	Movement in the soil road	-
Microphone position	Driver's ear position	7.5 m distance	20 m distance

Data analysis

Noise pollution data for the John Deere and New Holland tractors were collected across 162 tests in the time domain, considering variations in operational variables. Statistical analysis was conducted using SAS 9.1 software to evaluate the main effects and interactions among the variables. Mean comparisons were performed using Duncan's multiple range test based on the average Sound Pressure Level (SPL) values. Subsequently, the results were visualized through charts generated using Microsoft Excel 2013.

RESULTS AND DISCUSSION

Analysis of the variance of noise data in the time domain

The results of the analysis of variance (ANOVA) for the main factors, engine speed, gear ratio, microphone distance, and road type, and their interaction effects on the noise levels of the John Deere and New Holland tractors are presented in Table 3 and Table 4. The analysis revealed that the main factors (engine speed, gear ratio, microphone distance, and road type), as well as the interaction effects of engine speed with gear ratio and engine speed with microphone distance, were significant at the 1% probability level for the John Deere tractor. This indicates, with 99% confidence, that there are significant differences among the means. However, the interaction effects of the other factors were not found to be significant.

Table 3. The results of the variance analysis of the means of the main factors levels and their interaction effects on the noise level of John Deere tractor

Source of changes	Degrees of freedom	Mean squares	Sum of squares
Engine speed	2	465.88**	931.76
Gear ratio	2	79.25**	158.51
Microphone distance	2	2051.04**	4102.08
Road type	1	75.01**	75.01
Engine speed × Gear ratio	4	0.90**	3.60
Engine speed × Microphone distance	4	3.31**	13.24
Engine speed × Road type	2	0.08ns	0.17
Gear ratio × Microphone distance	4	0.09ns	0.38
Gear ratio × Road type	2	0.15ns	0.30
Microphone distance × Road type	2	0.42ns	0.84
Engine speed × Gear ratio × Microphone distance × Road type	28	0.12ns	3.46
Error	108	0.17	19.27
Total	161	-	5308.65

** shows significance at the probability level of 1%. ns shows non-significant.

Table 4. The results of the variance analysis of the means of the main factors levels and their interaction effects on the noise level of New Holland tractor

Source of changes	Degrees of freedom	Mean squares	Sum of squares
Engine speed	2	444.76**	889.52
Gear ratio	2	88.58**	177.17
Microphone distance	2	1342.55**	2685.11
Road type	1	44.55**	44.55
Engine speed × Gear ratio	4	1.09**	4.39
Engine speed × Microphone distance	4	2.68**	10.73
Engine speed × Road type	2	0.15ns	0.30
Gear ratio × Microphone distance	4	0.03ns	0.12
Gear ratio × Road type	2	0.10ns	0.20
Microphone distance × Road type	2	0.07ns	0.14
Engine speed × Gear ratio × Microphone distance × Road type	28	0.06ns	1.80
Error	108	0.12	13.01
Total	161	-	3827.11

** shows significance at the probability level of 1%. ns shows non-significant.

In the case of the New Holland tractor, the results showed that the main factors (engine speed, gear ratio, microphone distance, and road type), as well as the interaction effects of engine speed with gear ratio and engine speed with microphone distance, were significant at the 1% probability level. This indicates, with 99% confidence, that there are significant differences between the means. However, the interaction effects of the other treatments were not found to be significant.

The investigation of noise pollution in the driver's ear position

It should be noted that the mean values from three repetitions were used for the presentation of the figures and the interpretation of the results. The mean noise levels at the driver's ear position across various gears and engine speeds during operation on soil and asphalt roads are shown in Fig. 4 and Fig. 5. As indicated in Fig. 4, the mean noise level at the driver's ear for the John Deere tractor, in gear 1 with a 1000 rpm engine speed while operating on an asphalt road, was 85 dB, which is at the standard permissible limit. However, for all other engine speeds and gears, and on both soil and asphalt roads, the mean noise level exceeded the standard permissible limit. Therefore, to ensure the user can work the maximum allowable 8-hour shift per day, the use of ear protection and the design and construction of a driver's cabin are crucial engineering measures for noise reduction.

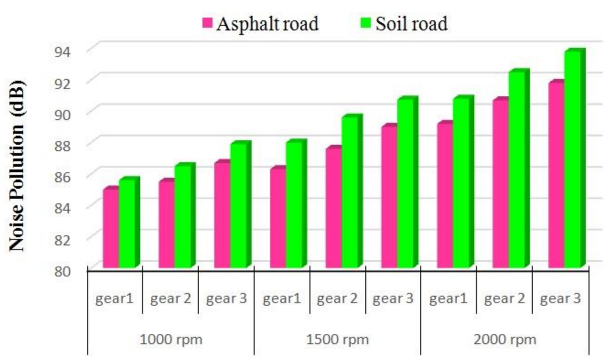

Fig. 4. Changes in sound pressure levels at the position of the driver's ear in different gears and engine speeds of John Deere tractor.

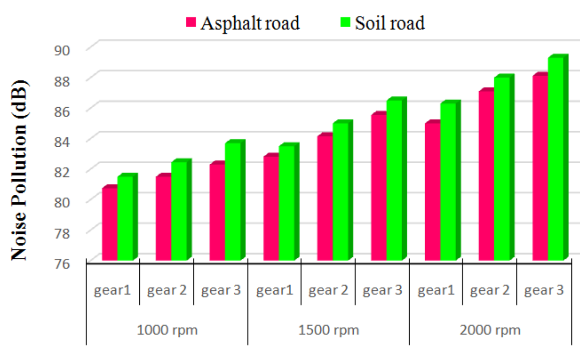

Fig. 5. Changes in sound pressure levels at the position of the driver's ear in different gears and engine speeds of New Holland tractor.

Fig. 5 illustrates that the mean noise level at the user's ear position for the New Holland tractor during operation on the asphalt road was 85.55 dB at 1500 rpm in gear 3, 87.1 dB at 2000 rpm in gear 2, and 88.12 dB at 2000 rpm in gear 3. Similarly, on the soil road, the mean noise level at the user's ear position was 86.5 dB at 1500 rpm in gear 3, 86.3 dB at 2000 rpm in gear 1, 88 dB at 2000 rpm in gear 2, and 89.3 dB at 2000 rpm in gear 3, all of which exceeded the standard permissible limit of 85 dB (A). Therefore, the use of ear protection and the design and construction of a driver's cabin are strongly recommended. At other engine speeds and gear configurations, the sound pressure levels were below the standard permissible limit. The results from Fig. 4 and Fig. 5 indicate that as the engine speed increased from 1000 to 2000 rpm, the mean sound pressure level in both the John Deere and New Holland tractors also increased. This trend can be attributed to the higher frequency of combustion strokes and piston blows per unit of time, as well as the power transmission system's dynamics. Additionally, the results show that shifting from gear 1 to gear 3 at all engine speeds led to an increase in the mean sound pressure level, which may be due to the effects of speed and road surface characteristics. These findings align with previous studies by Behroozi Lar (2011) and Jahanbakhshi (2017). For example, Bacria and Herişanu (2009) investigated diesel engine noise in agricultural machinery and observed that higher engine speeds were linked to increased combustion frequency and mechanical vibrations, which resulted in higher noise emissions. Similarly, Erdiwansyah et al. (2019) studied the impact of various engine operating conditions on noise emissions and found that operational parameters, including engine speed, significantly influenced noise levels. These results are consistent with the findings of this study.

The changes in noise pollution due to the different microphone distances

The mean values of changes in the sound pressure level at different distances of the microphone in gear ratios and various speeds of the tractor engine during the movement on soil and asphalt roads are reported in Fig. 6 and Fig. 7.

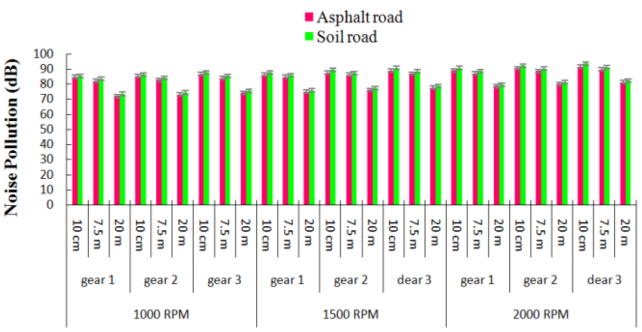

Fig. 6. The changes in sound pressure level at different distances of the microphone in the gear ratio and different speed of the John Deere tractor engine.

As shown in Fig. 6, at all engine speeds and gear configurations, the mean noise level of the John Deere tractor decreases with increasing distance of the microphone from the noise source. This reduction is observed during operation on both soil and asphalt roads and can be attributed to the damping effects of sound (noise) waves in the air.

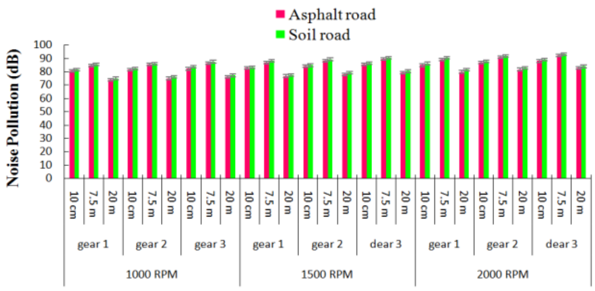

Fig. 7. Changes in sound pressure level at different distances of the microphone in the gear ratio and different speed of the New Holland tractor engine.

As shown in Fig. 7, at all engine speeds and gear configurations, the mean noise level of the New Holland tractor decreases as the microphone distance from the surroundings position increases from 7.5 to 20 m. This reduction is attributed to the damping effects of sound (noise) waves in the air. On the other hand, the reason for the prolonged permissible exposure time to New Holland tractor's noise pollution at the driver's ear position, compared to the surroundings position (7.5 m), is the driver's cabin. This result is consistent with the findings of Behroozi Lar et al. (2011) and Jahanbakhshi et al. (2016). The noise production source in the tractor causes fluctuations in air particles, which transmit these fluctuations to one another, leading to noise emission. As the air particle fluctuations are transmitted, energy loss occurs. When the microphone is positioned at the driver's ear, the transmission path is shorter, resulting in less energy loss compared to the surroundings position (at 7.5 and 20 m distances). Therefore, the noise level at the driver's ear position is consistently higher than at the surroundings position. Similar findings were reported by Crocker and Ivanov (1993) and Crocker (1998). The reduction in measured noise with increasing distance is a well-known phenomenon that follows the inverse square law. Huang et al. (2022) also demonstrated in open-field measurements that sound pressure levels decrease with increasing distance from the noise source, which supports the findings of lower levels recorded at 7.5 and 20 m distances in this study.

Exposure time to noise pollution of tractors

The sound pressure levels of the John Deere tractor at different gears and engine speeds, along with the permissible exposure hours to the tractor's noise during movement on soil and asphalt roads, are presented in Table 5 and Table 6, calculated using Eq. (1).

As shown, in gear 1 with a 1000 rpm engine speed during the movement of the John Deere tractor on the asphalt road, the driver is allowed to operate for up to 8 hours according to the standard. However, in other gears and engine speeds, the permissible work hours for the driver are less than 8 hours (the standard limit is 85 dB (A)), due to the proximity to the noise source (the tractor). Therefore, based on the results, the use of hearing protection for the drivers of the John Deere tractor is absolutely necessary. The sound pressure level at the surroundings position (7.5 m distance) reveals that in gear 3 at 1000 rpm on the soil road, and in gears 2 and 3 at 1500 rpm, as well as in all gears at 2000 rpm on both soil and asphalt roads, the noise levels are below the standard permissible limit for 8-hour exposure. Consequently, individuals exposed to noise pollution from the John Deere tractor at 7.5 m should also use hearing protection. Furthermore, no time limit is needed for individuals at the surroundings position (20 m distance), as the sound pressure level is sufficiently low. Regarding the New Holland tractor, the permissible exposure time in the driver's ear position shows that in gear 3 with a 1500 rpm engine speed on the soil road, and in all gears with a 2000 rpm engine speed on both soil and asphalt roads, the exposure time is less than 8 hours. However, for other gears and speeds, the driver can operate the tractor for more than 8 hours. At the surroundings position (7.5 m distance), the permissible exposure time on the asphalt road at gear 1 with 1000 rpm is 8.77 hours. In all other gear and engine speed combinations, the permissible exposure time is less than 8 hours, making hearing protection necessary for people exposed to the New Holland tractor's noise at 7.5 m. The increased permissible exposure time in the driver's ear position for the New Holland tractor, compared to the surroundings position (7.5 m distance), is attributed to the tractor's cabin. The presence of the cabin in the New Holland tractor helps reduce the transmission of noise to the interior, which aligns with findings from Han et al. (2022), who investigated noise reduction techniques in agricultural tractor cabins. Their research confirmed that well-designed cabins significantly reduce the noise reaching the operator, supporting the results observed in this study.

There is also no time limit for those who are exposed to noise pollution of New Holland due to the low sound pressure level in the surroundings position (20 m distance). Given that working environments with a lot of noise are effective on the mind's performance, focus, accuracy, and response time, these effects ultimately lead to lower performance and productivity of peoples. Therefore, the working environment of the drivers of tractors must be in a position to have the least effect induced by factors such as the noise so that they can handle many tasks in driving and controlling the tractor.

Table 5. Sound pressure level exposure to the noise pollution of John Deere tractor

Engine speed	Road type	Gear statue	SPL(D) (dB (A))	SPL(O1) (dB (A))	SPL(O2) (dB (A))
1000 rpm	Asphalt road	1	85.00	82.20	72.19
		2	85.50	82.89	73.20
		3	86.70	84.00	74.40
	Soil road	1	85.60	83.70	73.60
		2	86.50	84.40	74.50
		3	87.90	85.65	75.69
1500 rpm	Asphalt road	1	86.30	84.99	75.00
		2	87.60	86.30	76.29
		3	89.00	87.10	77.74
	Soil road	1	88.00	86.00	76.00
		2	89.60	87.51	77.52
		3	90.74	88.59	78.79
2000 rpm	Asphalt road	1	89.19	87.30	78.90
		2	90.69	88.79	80.20
		3	91.80	89.99	81.35
	Soil road	1	90.79	88.73	79.80
		2	92.49	90.38	81.40
		3	93.79	91.19	82.49

SPL **:**Sound pressure level; D **:**Driver position; O1 **:**Surroundings position- 7.5 m distance; O2 **:**Surroundings position- 20 m distance.

Table 6. Permissible time of exposure to the noise pollution of John Deere tractor

Engine speed	Road type	Gear statue	Permissible time (hour)		
			D	**O1**	**O2**
1000 rpm	Asphalt road	1	8.00	15.27	154.34
		2	7.12	13.02	122.21
		3	5.40	10.07	92.62
	Soil road	1	6.96	10.80	111.43
		2	5.65	9.18	90.50
		3	4.09	6.88	68.75
1500 rpm	Asphalt road	1	5.92	8.01	80.63
		2	3.38	5.92	59.85
		3	3.17	4.92	42.81
	Soil road	1	4.00	6.34	64.00
		2	2.76	4.47	45.04
		3	2.12	3.49	33.59
2000 rpm	Asphalt road	1	3.03	4.70	32.74
		2	2.14	3.33	24.25
		3	1.66	2.52	18.59
	Soil road	1	2.09	3.37	26.59
		2	1.41	2.30	18.37
		3	1.05	1.91	14.28

SPL **:**Sound pressure level; D **:**Driver position; O1 **:**Surroundings position- 7.5 m distance; O2 **:**Surroundings position- 20 m distance.

As demonstrated by Bilski (2013) and other researchers, the presence of a cabin has a significant effect on noise reduction (Aybek et al., 2010; Bilski, 2013). However, it is important to note that a large number of tractors currently in use worldwide do not have cabins, such as many John Deere tractors, which are often used without them. For such tractors, the use of a cabin or hearing protection devices becomes absolutely essential. Hearing protection tools are designed to reduce the noise level reaching the ear, thereby safeguarding the operator’s hearing. The occupational health risks associated with high noise exposure in agricultural settings have been well documented in several studies. The agreement between the findings of this research and those of Erdiwansyah et al. (2019) further emphasizes the importance of adhering to noise exposure guidelines. Additionally, both engineering and administrative controls are critical to protecting operator health and ensuring a safe working environment.

CONCLUSIONS

This research investigated the effect of engine speed and gear ratio on the noise pollution of John Deere 3350 and New Holland 155 tractors. The results revealed that at the operator's ear position, the sound level of the John Deere tractor exceeded the standard limit of 85 dB (A) in all gears and engine speeds. Therefore, it is essential for the tractor operator to wear ear protectors in order to ensure they can work for the maximum recommended 8 hours per day while maintaining their health and safety. As the microphone distance from the operator's ears increases, the noise level decreases, which is attributed to the damping effect of the surrounding environment. The analysis showed that the main factors, engine speed, gear ratio, microphone distance, and road type, had a significant effect on the emitted noise level at the 1% probability level. Furthermore, the sound pressure level increased as the engine speed and gear ratio heightened. The New Holland tractor demonstrated a positive effect on noise reduction compared to the John Deere tractor, likely due to the presence of the operator's cabin.

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CRediT AUTHORSHIP CONTRIBUTION STATEMENT

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DECLARATION OF COMPETING INTEREST

The authors declare no conflicts of interest.

ETHICAL STATEMENT

In this research, the principles of research ethics have been followed.

DATA AVAILABILITY

The data of this article in the Master's thesis can be accessed at the following address.
https://elmnet.ir/doc/11170975-21601

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REFERENCES

Aybek, A., Kamer H. A., & Arslan, S (2010). Personal noise exposures of operators of agricultural tractors. Applied Ergonomics, 41(2), 274-281.

Bacria, V., & Herişanu, N. (2009). Considerations upon the noise generated by some diesel engines used in agriculture consideraţii asupra zgomotului generat de unele, Research Journal of Agricultural Science, 41(2), 325-330.

Barač, Ž., Radočaj, D., Plaščak, I., Jurišić, M., & Marković, M. (2024). Prediction of noise levels according to some exploitation parameters of an agricultural tractor: A machine learning approach. AgriEngineering, 6(2), 995-1007. https://doi.org/10.3390/agriengineering6020057

Behroozi Lar, M., Pour, Z. K., Payandeh, M., & Bagheri, J. (2011) Noise level of two types of tractor and health effect on drivers. Journal of American Science, 7(5), 382-387.

Bilski, B. (2013). Exposure to audible and infrasonic noise by moderm agricultural tractors operators. Applied Ergonomics, 44(2), 210-214.

Crocker, M. J. (1998). Handbook of acoustics. vol 1. New York: John Wiley & Sons.

Crocker, M. J., Ivanov, I. N. (1993). Noise and vibration control in vehicles. St.Petersburg: Interpublish Ltd.

Dewangan, K. N., Kumar, G. P, & Tewari, V. K. (2005). Noise characteristics of tractors and health effect on farmers. Applied Acoustics, 66(9), 1049-1062.

Durgut, M. R., & Celen, I. H. (2004). Noise levels of various agricultural machineries. Pakistan Journal of Biological Sciences, 7(6), 895-901.

Erdiwansyah, Sani, M. S. M., Mamat, R., Zikri, J. M., Razak, N. F. D., & Munawir. (2019). Experimental investigation of vibrations and noise characterization for spark ignition engine. Journal of Physics: Conference Series, 1262(1), 012014. https://doi.org/10.1088/1742-6596/1262/1/012014

Ghaderi, M., Javadikia, H., Naderloo, L., Mostafaei, M., & Rabbani, H. (2019). An analysis of noise pollution emitted by moving MF285 Tractor using different mixtures of biodiesel, bioethanol and diesel through artificial intelligence. Journal of Low Frequency Noise, Vibration and Active Control, 38(2), 270-281.

Gomes, A. P. A., Ferraz, G. A. S., Marin, D. B., Da Silva, F. B., Dos Santos, L. M., & Ferraz, P. F. P. (2021). Noise levels emitted by agricultural tractors with and without implements activation. Nativa, 9(4), 413-418. https:doi.org/10.31413/nativa.v9i4.12493

Hassan-Beygi, S. R., Ghobadian, B., Kianmehr, M. H, Chayjan, R. A. (2007) Prediction of a power tiller sound pressure levels in octave frequency bands using artificial neural networks. International Journal of Agriculture & Biology, 3(9), 494-496.

Han, H. W., Im, W. H., Choi, H. J., Cho, S. J., Lee, S. D., & Park, Y. J. (2022). Effect of sound insulation on noise reduction in an agricultural tractor cab. Scientific Reports, 12(1), 1-15. https://doi.org/10.1038/s41598-022-26408-3

Huang, S., Lu, C., Li, H., He, J., Wang, Q., Gao, Z., Panpan, Y., & Li, Y. (2022). The attenuation mechanism and regular of the acoustic wave on propagation path in farmland soil. Computers and Electronics in Agriculture, 199, 107138. https://doi.org/10.1016/J.COMPAG.2022.107138

Irwin, J. D., Graf, E. R. (1979). Industrial Noise and Vibration Control. London: Prentice-Hall, Inc.

ISO 5131. (2015). Acoustics-Tractors and machinery for agriculture and forestry-measurement of noise at the operator's position-survey method. Retrieved from: https://www.iso.org/standard/66227.html

ISO 7216 (2015) Acoustics - Agricultural and forestry wheeled tractors and self-propelled machines - Measurement of noise emitted when in motion. Retrieved from: https://www.iso.org/standard/66228.html

Jahanbakhshi, A., Ghamari, B., & Heidarbeigi, K. (2016). Effect of engine rotation speed and gear ratio on the acoustic emission of John Deere 1055I combine harvester. Agricultural Engineering International: CIGR Journal, 18(3),106-112.

Jahanbakhshi, A., Ghamari, B., & Heidarbeigi, K. (2017). Assessing acoustic emission in 1055I John Deere combine harvester using statistical and artificial intelligence methods. International Journal of Vehicle Noise and Vibration, 13(2),105-117.

Jahanbakhshi, A., Yousefi, M., Karami-Boozhani, S., Heidarbeigi, K., & Abbaspour-Gilandeh, Y. (2020). The effect of combined resistance muffler on noise pollution and the allowable driver exposure in Massey-Ferguson tractors (MF 285 and MF 299). Journal of the Saudi Society of Agricultural Sciences, 19(6), 409-414. https://doi.org/10.1016/j.jssas.2020.06.002

JunHong, Z., & Bing, H. (2005). Analysis of engine front noise using sound intensity techniques. Mechanical Systems and Signal Processing, 19(1), 213-221.

Lashgari, M., & Maleki, A. (2014). Sound quantity and quality of sampo 3065 combine harvester. Iran Agricultural Research, 33(1), 73-86.

Lashgari, M., & Maleki, A. (2015). Psychoacoustic evaluation of a garden tractor noise. Agricultural Engineering International: CIGR Journal, 17(3), 231-241.

Liljedahl, J. B., Turnquist, P. K., Amith, D.W., & Holki, M. (1996). Tractors and their powers units. American Society of Agricultural Engineers (ASAE).

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.

Moraes, S. R., Dias V. de, O., Cornélio, J. P. L., & Hitz, M. E. (2023). Noise in Agricultural Machinery: Modernization and Workers' Health Brezil: Seven. https://doi.org/10.56238/interdiinovationscrese-077

Chan, H. S. (1998). Criteria for a recommended standard, occupational noise exposure, revised criteria. Washington D.C., USA: National Institute for Occupational Safety and Health, Department of Health and Human Services. https://doi.org/10.26616/NIOSHPUB2025104

ÖZKUL, S., & SÜMER, S. K. (2022). Noise exposure in olive harvest mechanization. Kahramanmaraş Sütçü İmam Üniversitesi Tarım ve Doğa Dergisi, 25(2), 348-356. https://doi.org/10.18016/ksutarimdoga.vi.770711

Sehsah, E. E., Abass Helmy, M., & Sorour, H. M. (2010). Noise test of two manufactured power tillers during transport on different local road conditions. International Journal of Agricultural and Biological Engineering, 3(4), 19-27.

Tetsuro S, Takeo F, Shizuma Y, Syuji H (2004) Effects of acoustical noise on annoyance, performance and fatigue during mental memory task. Applied Acoustics 65, 913-921

Yamin, M., Yousaf, Z., Bhatti, K. M., Ibrahim, M., Akbar, F. N., Shamshiri, R. R., M. adid., & Tauni, R. A. (2021). Noise exposure and its impact on psychological health of agricultural tractor operators. *Noise Control Engineering Journal*, *69*(6), 500-506. https://doi.org/10.3397/1/376947