**International Journal of Engineering and Information Systems (IJEAIS)**
**ISSN: 2643-640X**
**Vol. 8 Issue 5 May - 2024, Pages: 10-16**

# Smart Phone Application for Tractor Noise Levels Assessment at Different Tillage Operations

**Dandison M. Wali*1, Reuben N. Okparanma2, Silas O. Nkakini3**

1Department of Agricultural and Environmental Engineering, Rivers State University
Port Harcourt, Nigeria.
*Corresponding Author: dandison@ust.edu.ng
2Department of Agricultural and Environmental Engineering, Rivers State University
Port Harcourt, Nigeria.
reuben.okparanma@ust.edu.ng
3Department of Agricultural and Environmental Engineering, Rivers State University
Port Harcourt, Nigeria.
silas.nkakini@ust.edu.ng

***Abstract****: The high levels of noise from tractor during tillage operation in the farm has become an environmental concern because of the potential health impacts of the noise on personnel. This study assessed noise levels from tractor on land area of 160m x 38m (6080 $m^2$) divided into three blocks of 9 subplots marked 50m x 2m along with 1m between each plot. A space of 2m between each block and 1m at the sides of the outer blocks was also considered. The tractor was adjusted to forward speeds of 5, 7 and 9km/h, during ploughing, harrowing, and ridging operations. The results showed increase in noise levels of 71.30 dB(A), 79.00 dB(A), and 81.70 dB(A) at the various speeds. The study revealed noise levels at a setback distance of 5m, 10m, and 15m representing 71.30 dB, 70.9 dB, and 54.00 dB. The result showed impact of noise to personnel in the farm at setback distance of 5m and less harmful at 15m setback of NESREA recommendation of 2007 and WHO's permissible limit. The result shows statistically difference at 95% confidence level during ploughing, harrowing and ridging operations. The noise levels decrease as the setback distances increases with high coefficient of determination ($r^2$) ranged from 0.7673 to 0.9423 for ploughing, harrowing, and ridging operation. The study are useful reference and guideline that may assist policy makers, regulatory bodies, local council and even tractor operators to adopt appropriate measures to ensure health of personnel on the farm.*

**Keywords— Assessment of tractor; noise levels; tillage operation; smart phone**

## 1. INTRODUCTION

Noise problem caused by tractor on the field of transport can have significant effects on both human beings and the natural environment. [1] about 1.1 billion people (aged between 12 – 35 years) are in danger of deafness because of noise pollution. [2] revealed that the negative impacts of noise on human and aquatic life such as headache, sleeplessness, psychological disorders, lack of concentration, hearing loss, learning difficulties, stroke, and hypertension reduce the quality of life. One of the most prevalent and common issues with man-machine systems is noise. And so, tractor operators, mechanics, and other staff who operate in close proximity to a tractor in operation are affected by the noise, vibration, and harmful fume emissions that result from the mechanization of agricultural output. [3] sounds that are unwanted or unpleasant are referred to as noise, as a result of improvements in commercial, industrial, and social activities.

The study [4] characterized noise as an environmental pollutant that rises very quickly. Engine noise, intake fan exhaust, and mechanical noise produced by combustion, gears, cams, bearing, and pump, among other things, all contribute to tractor noise. Its noise spectra run from 200 to 2000 Hz, which is the complete audible spectrum. The severity of a noisy tractor may include annoyance of varied degrees, lack of focus, exhaustion, rhythm disturbance, and hearing damage. Transport noise, occupational noise, and neighborhood noise are the three main forms of noise. The occupational noise caused by diesel-powered tractor engines is the main topic of this study. A study conducted in Varanasi city of India [5], reported that traffic related noise pollution exceeds the permissible level by few folds and it may reach up to 15m from the source with exceedance of allowable level. With the persistence of noise in the environment both human and aquatic health are at risk of hearing loss. Apart from hearing problems, increasing noise levels induce cognitive impairment, high blood pressure with severe headache, constant strain on vocal cords, which leads to laryngitis, irritation, and decreased productivity at work [6, 7]. Judging by the noise problem requires joint state, local administrative and tractor operators to create a novel approach for noise pollution. Among all occupations, agricultural workers have one of the highest rates of hearing loss. This is a result of a number of loud farm equipment, including tractors, combines, grinders, choppers, grain dryers, and chainsaws [8]. The aim of the study is to conduct a smart assessment of tractor noise level during different tillage operations (ploughing, harrowing, and ridging) using a smart phone.

## 2. MATERIALS AND METHODS

### 2.1 Materials

The following instruments and equipment used for the experiment were disc plough, disc harrow, disc ridger, measuring tape, plastic ruler, steel tape, tractor Model Swaraj 978 FE, and smart android phone, Tecno Model KD7, Spark 5 Pro, version 10.

### 2.1.2 Area of Study

Figure1: shows the map of Rivers State University indicating University Research and Teaching Farm where the experiment was conducted. The site location lies on the latitude of 4° 49′ 27″ N and longitude of 7° 2′ 1″ E with an altitude of 274 mm above mean sea level; and average annual rainfall depth of 2310.9 mm. The experimental filed plot ambient temperature 26 $^0$C was related to Port Harcourt metropolis having a mean monthly relative humidity of 85 %, a daily minimum temperature of about 23 $^0$C and a mean daily maximum temperature of 32 $^0$C [9].

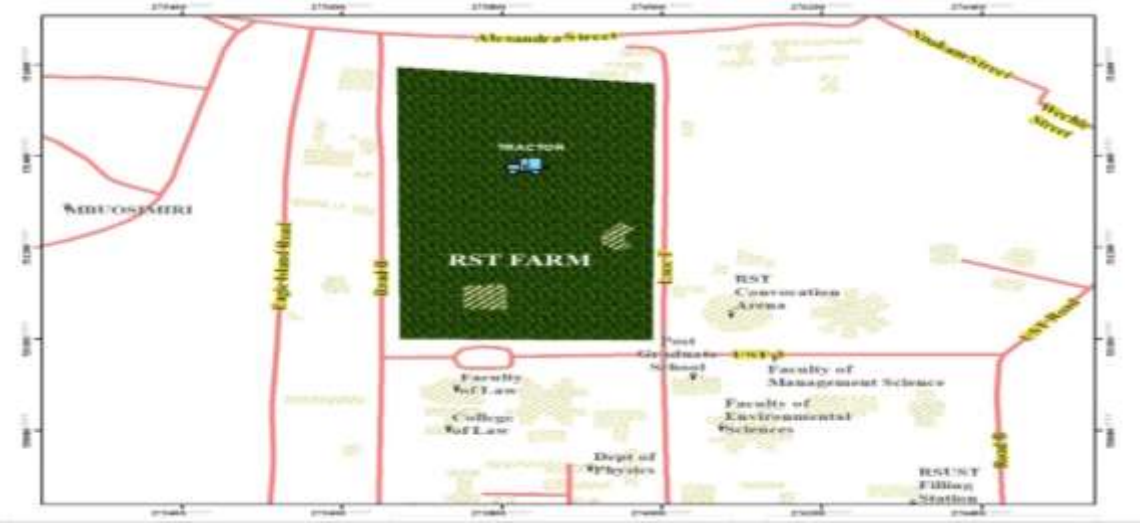


**Figure 1: Map of River State Indicating Rivers State University Research Farm**

### 2.1.3 Instrument and Equipment used for the Study

Table 1 and 2 shows the following equipment and specifications used for the research.

**Table 1: Tractor Specifications**

| Parameter | Description |
|---|---|
| Model | Swaraj 978 FE |
| Drive | 2 Wheel drive |
| Engine horse power | 72 hp |
| Lifting power | 2200 kg |
| Hitch | 3 point CAT III |
| Front tyres | 7.5 - 16 ,8 – ply |
| Rear tyres | 16.9 - 28,12 - ply |
| Width | 2030 mm |
| Weight | 3050 kg |
| Manufacturer | Swaraj, India. |

**Table 2: Implement Specifications**

| Parameter | Plough | Harrow | Ridge |
|---|---|---|---|
| Number of Disc | 3 | 14 | 4 |
| Working Depth (330) | 300 | 160 | 330 |
| Frame Width (mm) | 1180 | 1390 | 2525 |

| | | | |
|---|---|---|---|
| Width of Cut (mm) | 1120 | 1150 | 1320 |
| Disc Diameter (mm) | 660 | 600 | 660 |
| Manufacturer | Swaraj | Swaraj | Baldan Implementos Agricolas |

### 2.1.4 Data Source and Collection

The experimental land area of 160m x 32.5m (5200m$^2$) was used with Swaraj tractor (Model 978 FE) during tillage operation. Data for this study were acquired by direct observation of tractor engine by placing a smart phone (Techno Model KD7, spark 5 pro version 10), China at different setback distances. The noise map was developed from the data collected on the smart phone during different tillage operations and setback distances.

### 2.1.5 Experimental Procedures

A geographical positioning system (GPS) Garmin 76 CX was used to obtain geo-coordinates for Northings and Eastings of the sampling points. A smart phone device (Techno Model KD7, spark 5 pro version 10) was used to measure the sound level generated at different speeds and varying depths for ploughing, harrowing and ridging operations. The device conforms to the international electro technical commission IEC 61672-1: 2013. A calibration check was done on the sound level meter before and after use so as to avoid interference. The smart phone device was switched on and held at arm's length with the microphone pointed towards the smart sound source, which is 4cm away from the tractor and the readings taken. The experimental design adopted was the 3 X 3 factorial method shown in Table 3. The design consisted of 27 experimental treatments with three replicates. Randomization was achieved using draw lots approach on the experimental land area of 160m x 32.5m (5200 m$^2$), which was divided into three blocks of 9 subplots. Each subplot was marked 50m x 2.5m each along with the paths dimension of 1m between each plot to provide different treatment options with a space of 4m between block and 1m at the sides of the outer blocks.

$S_1d_1$: Speed of 5km/h at 5 m setback for ploughing, harrowing and ridging
$S_1d_2$: Speed of 5km/h at 10 m setback for ploughing, harrowing and ridging
$S_1d_3$: Speed of 5km/h at 15 m setback for ploughing, harrowing and ridging
$S_2d_1$: Speed of 7km/h at 5 m setback for ploughing, harrowing and ridging
$S_2d_1$: Speed of 7km/h at 10 m setback for ploughing, harrowing and ridging
$S_2d_2$: Speed of 7km/h at 15 m setback for ploughing, harrowing and ridging
$S_3d_1$: Speed of 9km/h at 5 m setback for ploughing, harrowing and ridging
$S_3d_2$: Speed of 9km/h with 10 m setback for ploughing, harrowing and ridging
$S_3d_3$: Speed of 9km/h with 15 m setback for ploughing, harrowing and ridging

**Table 3: Layout of the 3 X 3 Factorial Treatment Combinations of Three Speeds and Four depths**

| | Factorial Treatment Combinations | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Treatment** | **$S_1$** | | | **$S_2$** | | | **$S_3$** | | |
| $d_1$ | $S_1d_1$ | $S_1d_1$ | $S_1d_1$ | $S_2d_1$ | $S_2d_1$ | $S_2d_1$ | $S_3d_1$ | $S_3d_1$ | $S_2d_1$ |
| $d_2$ | $S_1d_2$ | $S_1d_2$ | $S_1d_2$ | $S_2d_2$ | $S_2d_2$ | $S_2d_2$ | $S_3d_2$ | $S_3d_2$ | $S_2d_2$ |
| $d_3$ | $S_1d_3$ | $S_1d_3$ | $S_1d_3$ | $S_2d_3$ | $S_2d_3$ | $S_2d_3$ | $S_3d_3$ | $S_3d_3$ | $S_2d_3$ |

**Note: 27 Treatments ($S_1d_1$, $S_2d_1$, $S_3d_1$, $S_1d_2$, $S_2d_2$, $S_2d_2$, $S_1d_3$, $S_2d_3$ and $S_3d_3$) Each Replicated Three Times**

### 2.1.6 Determination of Noise Level

Noise measurements was conducted at three different tractor forward speeds, and setbacks in the farm where tillage operations with aid of tractor were carried out. -.

The level of noise intensity was measured considering different situations and readings taken at the setbacks distances:

i. At three different forward speeds;
ii. At three different setbacks distances

Prior to the measurements, the tractor was at normal running speed. Measuring devices (noise meter and android phones) as shown in Plate 1 and 2 were held at arm's length of 5, 10, and 15m respectively away while the tractor was still in motion. The readings were taken at different tractor forward speeds with varying distances during the tillage operations.

**Plate 1: Smart Phone (Techno Model KD7, spark 5 pro version 10) Used for the Experiment**

**Plate 2: Discription ot plate 2 is missing**

### 2.1.7 Method of Data Analysis

A two factor Analysis of variance (ANOVA) was used to determine the significance of the difference in the mean values of each treatment. This was done based on the F-test. This difference was considered significant if $F_{computed} > F_{table}$ at 5% and 1% significance levels.

## 3. RESULTS AND DISCUSSIONS

### 3.1 Tractor's Noise Levels during Ploughing, Harrowing and Ridging Operations

The measured ambient noise on the experimental plot was 40 dBA. Fig 2 to 4 shows the different tillage operation which during ploughing the noise level of the tractor increased with speed between 5, 7, and 9 km/h respectively as displayed in Fig 3. The results showed increases in noise level due to changes in tractor forward speed of 71.30, 79.00, and 81.70 dBA corresponding to 5, 7, and 9Km/h. However, there was progressive decrease in noise level at setback distances of 5, 10, and 15m. The result of 5 m distance with 81.7 dBA implies that operators would be at the risk of hearing impairment if they exceed 8 hours per day safe limit of exposure during ploughing operation. Table 3 shows the decrease in noise level from the operator assistance at a setback distance of 5, 10, and 15m. The noise level ranged from 80.40 – 67.40 dBA at 5Km/h with rated speed of 5m to 15m distance. Similar trends were observed in 7 and 9Km/h with rated speed of 5 to 15m distance.

The results were higher the permissible limit of 70 Dba except for 7m distance with almost the same value [10, 11]. This study is closely to a report carried out [12] on 31 tested tractors for noise at ear elevation in the driver seat generated 85dBa. This implies that tractor operators are exposed to danger of hearing loss if exceeds the 8 hour/day safe limit for farm operations as stated by Occupational and Safety Health Administrators [11, 13]. Also, the operator assistance could be at the risk of auditory loss unless a setback distance of 20 m is maintained from the tractor. Statistically, there was no significant difference at 5 % confidence level. Fig 4 present ridging operation at tractor forward speed of 5, 7 and 9km/h. with different setback distance of 5, 10, and 15m. Noise level increases due to change in tractor forward speed. However, the noise level reduced as the operator assistance moved away from the tractor at a setback of 5, 10, and 15 m. This shows that the tractor forward speed has effect on noise level. The noise level ranged from 66.50- 83.30 dB which is less than NESREA and WHO permissible limit of 70 Dba at 15m setback distance. Operators continuous exposure could result hearing loss if 8 hour/day safe limit for tractor operators are not considered as stipulated by occupational and safety Health administrators (OSHA). ANOVA result showed that there was statistically significance at 5% confidence level.

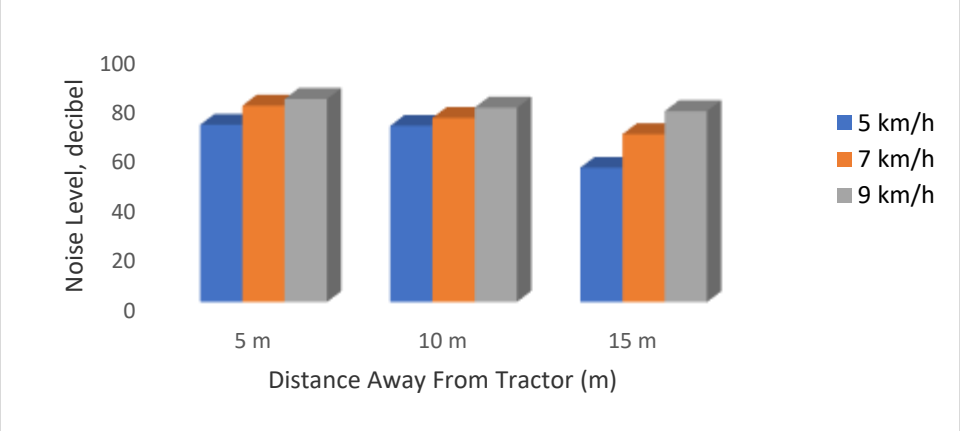


**Figure 2: Noise Levels at Different Operating Condition during Ploughing**

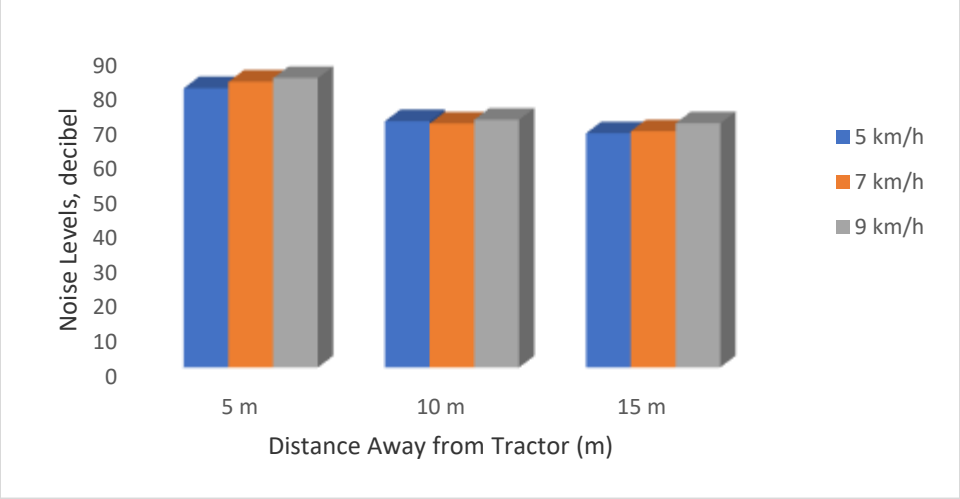


**Figure 3: Noise Levels at Different Operating Condition during Harrowing**

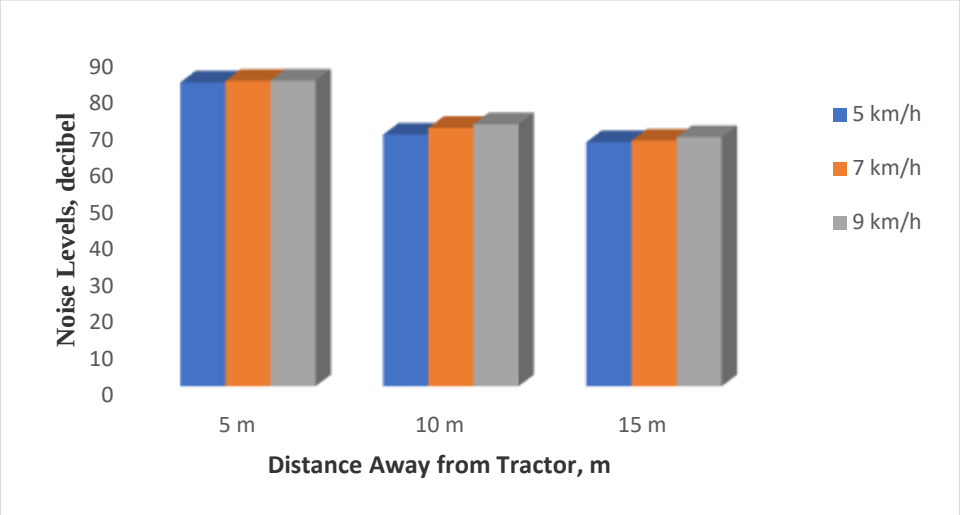


**Figure 4: Noise Levels at Different Operating Condition during Ridging**

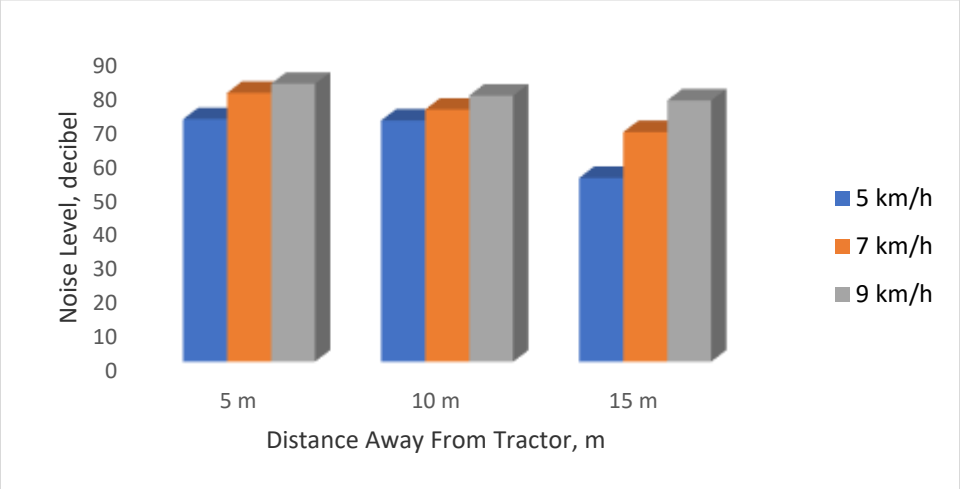


**Figure 1: Noise Levels at Different Operating Condition during Ploughing**

## 4.Conclusion

This study investigated the level of noise emitted by tractor during tillage operations on the experimental plot in Rivers State University Research and Teaching farm, Port Harcourt. From the results obtained, the following conclusion were drawn. The change in tractor forward speed that ranged from 5 to 9 km/h during tillage operations (ploughing, harrowing, and ridging) increased the noise level of the tractor. The ANOVA result for the assessment of noise levels during ploughing operation indicated that there were no significant different at 95% confidence levels but there was significant difference at 5% confidence levels as the tractor forward speeds increase from 5 to 9 km/h.

## 5. REFERENCES

[1] World Health Organization (WHO), (2021). Deafness and hearing loss. Retrieved from https://www.who.int/news-room/facts/detail/deafness-and-hearing-loss. (Accessed 14th April, 2024).

[2] Wokekoro, E. (2020). Public awareness of the impacts of noise pollution on human health. *World Journal of Research and Review*. *10*(6), 27–32.

[3] Celen, I. H., & Arin, S. (2003). Noise levels of agricultural tractors. Pakistan. *Journal of Biological. Sciences. 6*(19), 1706–1719.

[4] Anomohanran, O., Iwegbue, C. M. A., Oghenerhoro, I. O., & Egbai, I. J. C. (2008). Investigation of Environmental Noise Pollution Level of Abraka in Delta State, Nigeria. *Trends in Applied Sciences Research, 3*(4), 292-297.

[5] Shalini, K., & Kumar, B. (2018). Study of road traffic noise control sound pressure levels in Varanasi City India. *International Journal of Applied Engineering Research*, *13*(8), 6248–6252.

[6] Chowdhury, S. C., Razzaque, M. M., Helali, M. M., & Boden, H. (2010). *Assessment of noise pollution in Dhaka city.* In: 17th International Conference on Sound and Vibration (ICSVB). 2490 -2497.

[7] Masum, M. H., Pal, S. K., Akhie, A. A., Ruva, I. J., Akter, N., & Nath, S. (2021). Spatiotemporal monitoring and assessment of noise pollution in an urban setting. *Environmental Challenges.* 5,1–11.

[8] Baker, D.E. (2002). Noise: The invisible hazard. Department of Agricultural Engineering, University of Missouri-Columbia.

[9] Ogbonna, D. N., Ekweozor, I. K. E., Nrior, R., & Ezinwo, F. (2019). Evaluation of Organic Nutrients Supplements and Bioaugmenting Microorganisms on Crude Oil Polluted Soils. *Current Journal of Applied Science and Technology. 38*(6),1-19.

[10] National Environmental Standards and Regulations Enforcement Agency (NESREA), (2009). Federal Republic of Nigeria, Abuja, Regulations no. 35, Official Gazette. 67.

[11] Occupational Safety and Health Administration (OSHA), (1983). Occupational noise exposure: hearing conservation amendment. Federal register. *Occupational Safety and Health Administration (OSHA)* 48,9738–9783.

[12] Broeste, S. K., Hansen, D. A., Strand, R. L., & Stueland, D. T. (1989). Hearing loss among high school farm students. *American Journal of Public Health.79*(5), 619–622.

[13] Mijinyawa, Y., & Akinyemi, A. (2012). Assessment of the noise level generated during ploughing and harrowing operations in Ibadan Nigeria. *ARPN Journal of Agricultural and Biological Science. 7*(8), 650–653.