# Environmental Impact Of Tillage Operations And Tractor Speed On Hydrogen Sulphide(H2s) Gas Emission

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## ABSTRACT

The use of tractors for mechanized farming system cannot be overemphasized as it is the 'brainbox' for any field operation carried out in farming. This research work investigates the hydrogen sulphide ($H_2S$) gas emissions into ecosystem during land preparation in a mechanized farming system, considering the series of tillage operations (primary and secondary) at various speed of operations. A field operation study was conducted and the amount of $H_2S$ gas emissions were measured during the three major tillage operations (Plough, Harrow and Ridge preparations) at tractor hand throttle speeds of 15, 20 and 24 km/h respectively. The results obtained in the study revealed that for all tillage operations (1st ploughing, 2nd ploughing, harrowing and ridging), hydrogen sulphide ($H_2S$) emission is highest at tractor speed of 20km/hr and for all the tillage operations, hydrogen sulphide emission is lowest at low speed. 2nd plough emits the lowest hydrogen sulphide while ridging emits the highest hydrogen sulphide at any speed. During 2nd plough, hydrogen sulphide emission rate is always at its lowest point irrespective of the tractor speed and as speed increases, hydrogen sulphide emission rate increases in the order of 2nd ploughing, harrowing and ploughing the emission of $H_2S$ gas into the environment during farmland preparations using tractor is determined by the type of tillage operations(first ploughing, second ploughing, harrowing and ridging) employed at varying tractor speeds operation (15km/h, 20km/h and 24km/h ). It can be deduced from the result that tillage operations are also one of the primary sources of direct $H_2S$ emission into the atmosphere.

Keywords: Emission; Farmland; Tillage; Operation; Tractor speed

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## 1. INTRODUCTION

Faleye (2012) defined agricultural mechanization as the application of mechanical technology and increased power to agriculture, largely as a means to enhance the productivity of human labour and often to achieve results well beyond the capacity of human labour with optimum yield at minimal cost. This includes the use of tractors of various types as well as animal-powered and human-powered implements and tools. Crop production requires a number of tillage operations like seed bed preparation, seeding, fertilizing, spraying, dusting of chemicals, irrigation, harvesting and processing. In order to develop the land for production of food, there should be land preparation which involves clearing of the land of all bushes and trees to make it ready for use of equipment and other operations for the purpose of management of previous crop residue (Wolkowski, 2011).

Tractor plays an important role during land preparation such as land clearing and land reforming. The degrees of land clearing depend on the end use to which the land is to be put. After land is cleared, the land forming operations begins. This involves the establishment of the correct grades (or slopes) to meet water movement (irrigation and drainage) requirements. The grade is determined by soil type; rainfall and cropping pattern, and is done in such a way as to prevent soil erosion. The first operation in land forming is tillage. Sahay (2010) defined tillage as the mechanical manipulation of soil to provide favourable condition for crop production. Tillage operation is divided into primary tillage and Secondary tillage. The processes involved in the primary and secondary tillage include first plough, second plough, harrowing and ridging. These operations were carried out with the use of tractors.

Energy expanded from fossil fuels(combustion), releases carbon compounds and sulphur compounds into the atmosphere. Sulphur compounds such as hydrogen sulphide present in the air contributes to the "Greenhouse Effect" and related global warming. Hydrogen sulfide ($H_2S$) is a very toxic gas at high concentrations. Because it occurs in nature as by-product of decomposition, it is found in natural gas, crude petroleum, volcanic gas and hot springs and is produced by numerous industrial activities, it is regarded as both an environmental and industrial pollutant. It is colorless, is heavier than air, and has a characteristic odor of rotten eggs at low concentrations; however, at higher concentrations the olfactory response is lost. Because $H_2S$ can affect many different tissues and organs, it has been termed a broad spectrum toxicant. At high concentrations, $H_2S$ blocks the oxidation process of tissue cells, reduces the oxygen-carrying capacity of blood, and depresses the central nervous system. (Roth, 2004).

## 2. MATERIALS AND METHODS

The study was conducted in Lagos State University of Science and Technology, Ikorodu, West central state of Nigeria under the western vegetation in sandy-loamy soil. The study area falls within the geographical location 16$^{o}$37’0” North, 3$^{o}$37’0” east of the western part of Nigeria.
The equipment and materials used for the study include: measuring tape, New Holland tractor (old and new), Massey Fergusson tractor (old and new), 14.4 hectares of land, 2 Hand held gas collector (multiRAE Pro), Disc plough, disc harrow and Ridger. Tractor below the age of ten years are referred to as NEW and above ten years are referred to as OLD. The major tillage operations were conducted first plough; second plough; harrowing and ridging at 13days, 5days,and 3 days time intervals respectively . The $H_2S$ gas emission were monitored before, during and after the tillage operation.

Before the first plough, the $H_2S$ in the environment was measured. During the first plough, the four tractors were allowed to run at various speed of 15km/hr. 20km/hr and 24km/hr. The $H_2S$ emission was monitored after 1-3 days. After 13 days, the second plough was carried out using the four tractors at the operating speed of 15km/hr, 20km/hr and 24km/hr. The depth of the operation also varied. After the fifth day, the harrowing operation was carried out using the four tractors at various operating speed of 15km/hr, 20km/hr and 24km/hr. Finally, after the third day, the ridging operation was carried out with the four tractors at the operation speed of 15km/hr, 20km/hr and 24km/h

## 3. RESULT AND DISCUSSION

### Results

TABLE 1: Hydrogen sulphide, ($H_2S$) emission levels (ppm) before tillage operations

| 1st Ploughing Operation | 2nd Ploughing Operation | Harrowing | Ridging |
|---|---|---|---|
| 0.12 ± 0.03 | 0.09 ± 0.02 | 0.02±0.01 | 0.02±0.01 |

TABLE 2: Hydrogen sulphide, ($H_2S$) emission levels (ppm) after tillage operations.

| Day | 1st Ploughing Operation | 2nd Ploughing Operation | Harrowing | Ridging |
|---|---|---|---|---|
| 1st | 0.11 ± 0.01$^b$ | 0.12 ± 0.00$^b$ | 0.10 ± 0.02$^b$ | 0.13 ± 0.02$^c$ |
| 2nd | 0.02 ± 0.01$^a$ | 0.02 ± 0.00$^a$ | 0.03 ± 0.02$^a$ | 0.06 ± 0.01$^b$ |
| 3rd | 0.01 ± 0.00$^a$ | 0.02 ± 0.01$^a$ | 0.01 ± 0.00$^a$ | 0.02 ± 0.01$^a$ |

Superscripts with the same letters down the column are not significantly ($p < 0.05$) different (DMRT).

TABLE 3: INTERACTION OF TILLAGE OPERATIONS AND SPEED

| | Speed of 15km/hr | Speed of 20km/hr. | Speed of 24km/hr. |
|---|---|---|---|
| 1st plough | 0.7625 | 0.9875 | 0.8375 |
| 2nd plough | 0.6125 | 0.8 | 0.6775 |
| Harrowing | 0.7 | 0.9075 | 0.77 |
| Ridging | 0.8125 | 1.055 | 0.8975 |

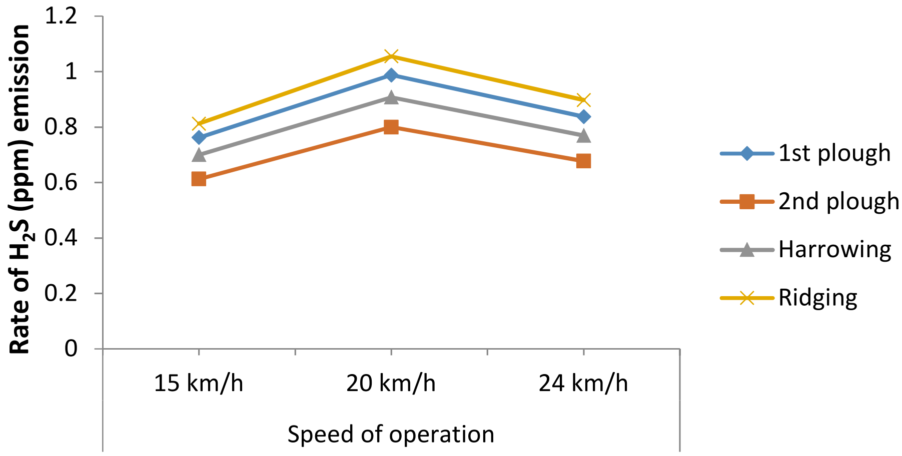


Figure 1: Effect of tillage and speed of operation on hydrogen gas emission

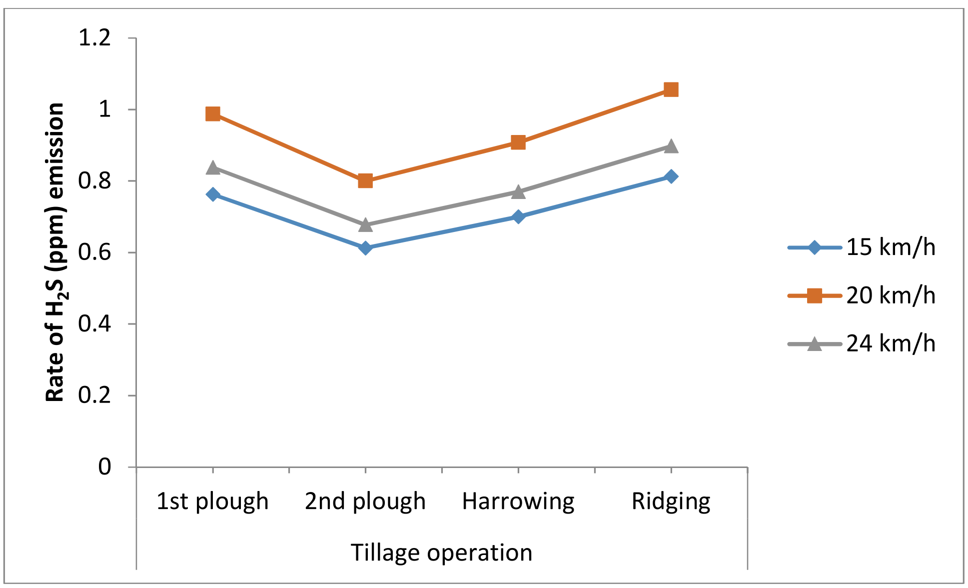


Figure 2: Effect of tillage and speed of operation on hydrogen sulphide gas emission

## 4. DISCUSSION

### Hydrogen sulphide ($H_2S$)

The level of $H_2S$ was determined to 0.12 ± 0.03 ppm before the 1st ploughing activity (Table 1). It was shown after the 1st ploughing activity that $H_2S$ levels reduced significantly ($p < 0.05$) from 0.11 ± 0.01 ppm on day 1 to 0.01 ± 0.01 ppm on day 3 (Table 2). However, $H_2S$ concentrations were higher than the threshold (0.01 ppm) (EC, 2016; EPA, 2016) except on the 3rd day after the 1st ploughing for 1 hr sampling period. Level of $H_2S$ was detected to be 0.09 ± 0.02 ppm before the 2nd ploughing activity (Table 1).

After the 2nd ploughing activities, $H_2S$ level was determined to reduce from 0.12 ± 0.00 ppm on the 1st day to 0.02 ± 0.01 ppm on 3rd day significantly ($p < 0.05$) (Table 2). Concentration of $H_2S$ was higher than the threshold (0.01 ppm) (EC, 2016; EPA, 2016) all the sampling points during the 2nd ploughing for 1 hr sampling period. Concentration of $H_2S$ was found at 0.02 ± 0.01 ppm before harrowing the soil (Ta. There was an indication that $H_2S$ concentration reduced significantly ($p > 0.05$) from 0.10 ± 0.02 ppm on day 1 to 0.01 ± 0.00 ppm on day 3 after the soil harrowing operation. The determined concentrations of $H_2S$ exceeded the standard (0.01 ppm) (EC, 2016; EPA, 2016) in all the sampling points during the harrowing operation for 1 hr sampling period. Before the ridging operation, level of $H_2S$ was detected at 0.02 ± 0.01 ppm. There was high significant ($p > 0.05$) reduction in the $H_2S$ concentrations from day 1 at 0.13 ± 0.02 ppm to day 3 at 0.02 ± 0.01 ppm after the soil ridging operation.

During 2nd plough, hydrogen sulphide emission rate is always at its lowest point irrespective of the tractor speed. Figure 1, as speed increases, hydrogen sulphide emission rate increases in the order of 2nd ploughing, harrowing and ploughing as shown in figure 2. $H_2S$ values were higher for ridging operations at speed of 15km/hr. Figure 2, the least value however was recorded at for second ploughing at speed of 15km/hr5km/hr with a value of 0.61.fom figure 2, it can be observed that higher values were recorded for ridging operation. With ridging operation at speed of 20km/hr having the highest value for all tillage operations of 1.06. From figure 1, it can be deduced that there is no significant difference in $H_2S$ emission for the following combinations of farm operations and tractor speed; for any tillage operation (1st ploughing, 2nd ploughing, harrowing and ridging), hydrogen sulphide ($H_2S$) emission is highest at tractor speed of 20km/hr.

For all tillage operations, hydrogen sulphide emission is lowest at low speed of 15kn/hr, 2nd plough emits the lowest hydrogen sulphide while ridging emits the highest hydrogen sulphide at all the speed of operation. From Table 14, it was observed there is no significant difference in first plough at 15km/hr second plough at 20km/hr and harrowing at 24km/hr; first plough at 24km/hr second plough at 20km/hr and ridging at 15km/hr; second plough at 20km/hr harrowing at 24km/hr and ridging at 15km/hr; second plough at 24km/hr and harrowing at 15km/hr; harrowing at 20km/hr and ridging at 24km/hr. There is significant difference in the following combinations of tillage operation and speed; first plough at 20km/hr second plough at 15km/hr and ridging at 20km/hr.

## 5. CONCLUSION

All the four tillage operations i.e. 1st plough, 2nd plough, harrowing and ridging have very high hydrogen sulphide emission at low speed of 15km/hr. All the tillage operations have $H_2S$ emission decreasing as the tractor speed increases. This is an indication that operating tractor at a low speed is harzardous to the operator as $H_2S$ gas released is dangerous to human health. It also contributes to green house gas emissions that cause climate change.

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