

Research Article

# Assessment of Maintenance Activities and Strategies for Tractor and Operator Care in Gurage Zone, Wolkite Town, Ethiopia

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## Abstract

Data was collected from 53 tractor operators and stakeholders from the Wolkite. Many types of tractors were used and the common brands were Sonalika, Indo-farm, John Deer, Massey, Fergusson, and New Holland. Of these tractors, about 30.18%, 20.75%, and 18.86% were used for plowing, harrowing, transporting, threshing, planting, and spraying activities by Sonalika, Indo-farm, and John deer respectively. Regarding training to operate the machine, about 71.69% replied yes and about 28.31% replied don't have the training to maintain the machine, but they develop their skills through different experiences. But for their maintenance activities, they replied as 22.64% for daily, 92.45% for weekly, and 100% for monthly. In the case of checking the fluid level of the tractors about 9.43% within 3 hours, 20.75% within 6 hours, and 84.9% within 10 hours with oil level, about 3.77% within 3 hours, 11.32% within 6 hours and 98.11 within 10 hours for checking the water level and lastly about 15.09% within 3 hours, 71.69% within 6 hours and 94.33% within 10 hours to check the level of fuels. Moreover the washing of the tractors after the operation was 1.88% washed their tractors after operation; about 5.66% didn't wash their tractors, and about 92.46 washed without schedule. For lubricating different rotating parts of the tractors, about 56% of the respondents lubricate their tractor parts and about 92.45% of the respondents clean the battery cables and terminals frequently. About 3.77% and 16.98% use shelter for their tractors and record-keeping experience during their work.

## Keywords

Checking, Maintenance, Operations, Training, Tractors, Washing

## 1. Introduction

The use of farm machinery constitutes one of the important capital inputs in agricultural production. For operating the agricultural machinery, they need high input costs. Proper agricultural machinery management therefore requires keeping them in good working condition, having them repaired or reconditioned at when due, selecting suitable types and sizes, keeping cost records, and controlling it [6].

For the farming activity, there is the main source of farm power such as human, animal, and mechanical, which almost replaces the other sources for heavy and time-consuming operations. Since agricultural tractors are used to carry out static and dynamic operations under different farm conditions, they are subject to many failures and breakdowns caused by direct and indirect loads. Tractor breakdowns were mainly

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**Received:** 27 February 2024; **Accepted:** 13 March 2024; **Published:** 6 August 2024



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due to age, wear and tear accidents, material and design errors, irregular maintenance, and incorrect use and repair of damages. For this, the components and parts of agriculture machinery must be inspected as per the manufacturer manual and specifications schedule. However, many failures are due to bad maintenance, wrong use, incorrect service, and wrong repair activities. Bello recommended that the machines depreciate and decrease their function immediately after they are manufactured [4]. So it is of great importance to avoid stoppage and breakdowns of the parts and components of tractors and other farm machinery. The consequences for stoppage and breakdowns are different for different implements and machines for different operation types.

Agricultural tractors operate in a poor and unpleasant environment and must be adequately maintained to effectively perform their desired functions. As a result, the maintenance and repair program has become inescapable. The serviceability and reliability of any machine in performing its desired function depends on how much the maintenance practices that are observed in operating such a machine. Maintenance is needed to ensure that the components carry on the purposes for which they were designed. The basic objectives of the maintenance activity are to deploy the minimum resources required to make sure that components perform their intended purposes properly, to ensure system reliability, and to recover from breakdowns [12].

Emert et al. reported that poorer and irregular maintenance reduces tractor reliability, increases fuel consumption, decreases engine power, reduces engine life span, and increases exhaust emissions and environmental pollution [7]. So proper maintenance carried out at the right time saves the farmer the cost of replacement of the parts and repair and reduces the incidence of unexpected breakdowns and downtime [15].

The background of Ethiopian agriculture mostly depended on a pair of ox which was operated for 5 hours of daily activities. Now in some parts of the country, some mechanical power is used in agricultural working systems to perform different work. The current government of the country gives high attention to performing agricultural works by agricultural work. The government removes the importing tax for agricultural machinery importers and gives a high chance for small-scale farmers to buy different list costs. However, most farmers have no educational level and need support from different stakeholders on how to use, drive, maintain, store, and other activities. So no research was conducted to show this gap during using machinery. Moreover in Ethiopia, machinery repair and maintenance and fuel and lubricant consumption are not given enough attention, and most operators operate through the local experience without appropriate driver education and licenses. This study was therefore aimed at examining the expertise of tractor operators with tractor operation and maintenance and assessing their attitudes towards recommended maintenance practices plus the habit of using personnel protective equipment.

## 2. Materials and Methods

### 2.1. Description of the Study Area

The survey data was collected and conducted at Wolkite and Gubrie districts in the Gurage Zone, Southern Nations, Nationalities, and People's Region's capital Hawassa is approximately 155 km /97 miles away from Wolkite (as the crow flies). The distance from Wolkite to Ethiopia's capital Addis Ababa (Addis Ababa) is approximately 134 km/83 miles. The Wolkite land has flat and rising and falling topography which is suitable for mechanization and most cereal crops such as teff, wheat, and barley were grown in the area. The soil type mostly in the Gurage zone was verti-soil and some parts were silt and silt sand.

### 2.2. Data Collections

A written questionnaire was prepared based on maintenance and personnel protective equipment using ideas collected from operators, machinists, and owners of the tractors which were important data for this study. The data was collected from a total of 53 persons comprising 28 tractor operators, 10 owners of tractors, and 15 machinists at the maintenance center in Wolkite and Gubrie towns. The questionnaire was prepared by personnel information like level of education, knowledge about tractors, training for maintenance and tractor holding practice, use of PPE, type of tractors used in the area and their function, maintenance type and practices such as lubrications, greasing, and timely inspection.

### 2.3. Data Analysis

The data collected were summarized and analyzed using the Statistical Package for Social Scientists (SPSS) version 23 and results are displayed using descriptive charts and frequency tables.

## 3. Results and Discussions

### 3.1. Personnel Information

Under this subtitle, personnel data was collected to determine their qualification of education, marital status, awareness about how to use personnel protective equipment, and lastly their age matters.

#### 3.1.1. Level of Education

The response from personnel information about their educational status indicates a high percentage of grades 8-10. The second mark in the table indicates that most of them were diploma-level. This indicates they can't read the manufacturer's manual to adjust and maintain the tractor, and easily understand tractor conditions like vibrations, the sound of the

engine, and its conditions. Aikins and Kyere, and Adjei et al. recommended that the majority of these operators have no formal education, which implies they cannot read and understand the operators' manual which impairs their effectiveness in undertaking the recommended operation and maintenance practices putting themselves and the tractor at risk [1, 2].

**Table 1.** Educational level of the operators, owner of the tractor, and machinists.

Educational level	Frequency	Percentage (%)
Un-educated	8	15.04
from grade 1- grade 8	5	9.43
From grade 9-grade 10	16	30.18
From grade 11- grade 12	5	9.43
Diploma level	13	24.6
Degree level	6	11.32
Total	53	100

### 3.1.2. Ages

**Table 2.** Age of the operators, owners, and machinists.

Age ranges (years)	Frequency	Percentage (%)
Below 20	3	5.67
Between 21-30	12	22.64
Between 31-40	27	50.94
Between 41-50	9	16.98
Above 51	2	3.77
Total	53	100

More than 50.94 % of the age was between 31 and 40 years, which indicate they were young and active to understand and familiar with their machines.

Age matters for machine operators to minimize the accidents and the ability to focus on the activity of maintenance of the machine, and he/she can care about the machine, persons, and the environment. Table 2 indicates the age range of the respondents of the questionnaires. Most of them were between the ages of 31-40.

### 3.1.3. Marital Status

Figure 1 shows the marital status of the respondents which indicates more percentage of respondents was found to be married.



**Figure 1.** Marital status.

### 3.1.4. Tractors' Safety Usage and Functioning of Personnel Protective Equipment

Tractors have contributed immensely to farm productivity. Over the years, manufacturers have added many safety features such as seat belts, ROPS, and PTO guards, and PPE for operators. Although today's tractors are safer than previous models, they are still involved in farm accidents. A well-trained operator, aware of the potential hazards will help minimize this risk [10].

Lehtola and Brown recommend that all employees who operate agricultural tractors be informed of safer operating practices when first assigned to operate a tractor and at least annually thereafter [13]. Checking ROPS whether the tractor had securely fastened the seat belt, optimum operating speed, watching obstacles, and operating the tractor smoothly, avoiding jerky turns, starts, or stops.

According to the U.S. Department of Labor, tractor accidents accounted for 40 percent of farm fatalities in 2017. Tractor overturns were the leading cause of death for these farmers and farm workers, according to the Centers for Disease Control and Prevention. According to the National Agriculture Safety Database, the use of ROPS and a seat belt is estimated to be 99 percent effective in preventing death or serious injury in the event of tractor rollovers.

From this point of view, they responded to the type of machine with different equipment and to the habit of PPE. Table 3 indicates that about PPE and the type of tractors with safety equipment. From this, about 67.92% of the tractor drivers, maintenance and owners don't use PPE and they don't worry about it.

**Table 3.** Personnel protective equipment.

Frequency	Percentage (%)	Using of PPE
6	11.32	Always
11	20.75	Some times
36	67.92	Not using PPE
Total = 53	100.00	

### 3.2. Tractor Available in the Area and Their Practical Functions

From the response, most of the tractors available in the area were Sonalika brand type of tractors which accounts for about 30.18%, this is due to the tractors are environmentally suitable

and easy to manage and others were available at a small level.

The above-listed tractor was used for different purposes in the town. One tractor performs more than one operation due to the willingness of servants in the town and rural areas. The following Table 4 indicates the responses from interviewers and they put the arrows.

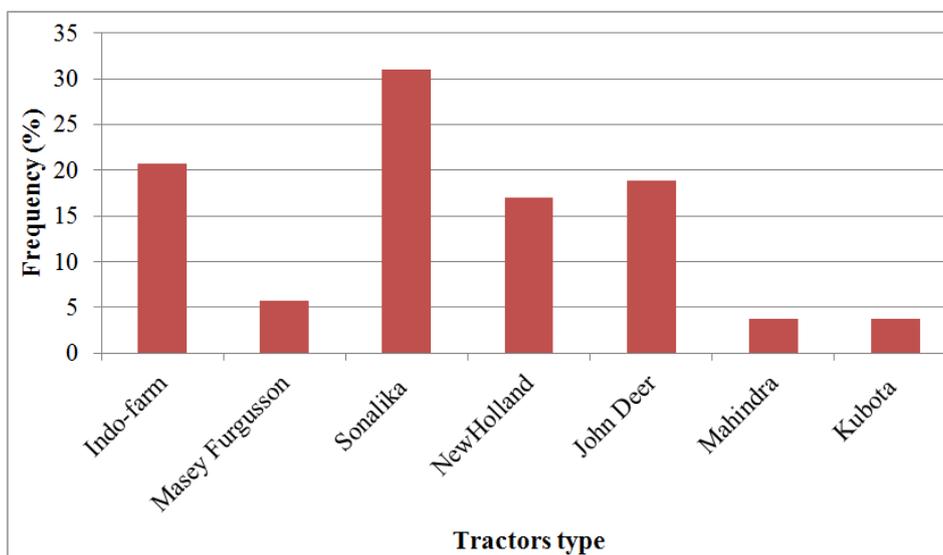


Figure 2. Tractor types available in the area.

Table 4. Function of tractors in the area.

Tractor type	Activities						Frequency (%)
	Ploughing	Harrowing	Planting	Transporting	Threshing	Spraying	
Indo-farm	√	√	√		√	√	20.75
Massey-Ferguson	√	√	√		√	√	5.66
Sonalika	√	√	√	√	√	√	30.18
New-Holland	√	√	√				16.98
John-deer	√	√	√				18.86
Mahindra				√	√		3.77
Kubota				√	√		3.77

### 3.3. Training Activities

Training of the direct stakeholders of the machine is a crucial activity to minimize accidents, down timing, breakage of spare parts, and prolong the life span of machines. Developing his/her knowledge and providing different types of training

regarding their working environment are unreasonable activities. Here the respondents give their training activity and responses per different types.

From the data collected, the following figure shows about 71.69% of the respondents were trained in tractor operations from different driving centers with licenses.

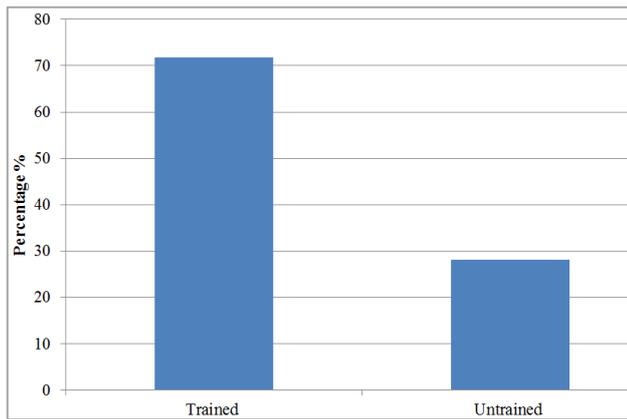


Figure 3. Training for tractor operation.

Figure 4 shows the percentage of training regarding maintenance training delivered to different operators and machinists in the town. It shows that about 60.38% of the respondents were not trained on the issue of the maintenance of different agricultural machinery in the town.

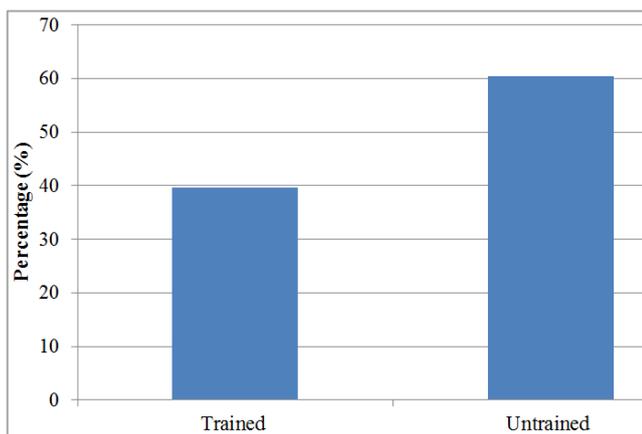


Figure 4. Training on maintenance.

### 3.4. Maintenance Activity

Maintenance is generally recognized as the single largest controllable cost factor in any production assembly and up until now represents a challenge leading the management to reevaluate their maintenance strategies. Maintenance can be defined as the practice of keeping the form or shape of equipment, machine systems, or objects in their original status as much as possible. Note that maintenance is not repairing a machine after it breaks or when it stops working [9]. Moreover, maintenance is the regular care needed by the machine to work well, safely, and long. It is by no means concerned with repairing a machine after breakdown, and is intended to protect the machine so that it doesn't break or wear too quickly [8]. It is a means of achieving the optimum value for the equipment to perform its desired and designed functions. Regular maintenance is one of the prerequisites for a

long-lived and reliable engine performance. Maintenance of agricultural machinery has a critical role in successful agricultural production and minimizing the downtime of machines. Its goals were ensuring the safety of operations and increasing the life span of machines and related equipment for more operations. Moreover, it is one major activity in the agriculture operations. Thus, the increased competition in agricultural production demands maintenance improvement, aiming at the reduction of maintenance expenditures while keeping the safety of operations. By considering this important function of the maintenance idea, the respondents respond to the following type of maintenance activity with their specific machine maintenance activity. Figure 5 indicates the frequency of the maintenance type.

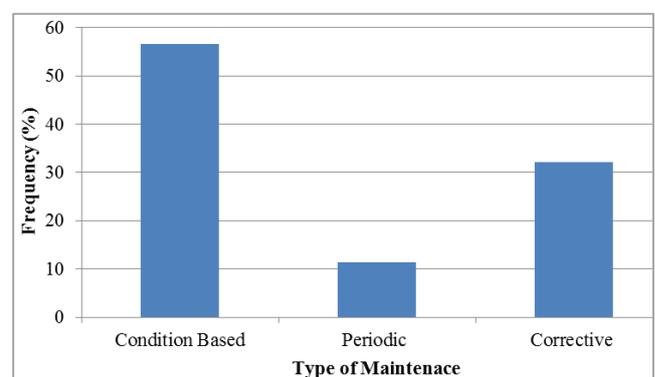


Figure 5. Types of maintenance actively performed in the area.

From the graph above, they mostly used condition-based type of maintenance practices rather than corrective and periodic types. They try to maintain their machine through the condition of the machine and try adjusting as per it.

#### 3.4.1. Routine Maintenance

Routine maintenance is the simplest form of planned maintenance but very essential. As a name, it is carried out at regular intervals. It involves periodic checks of relevant areas. The frequency of such checks ranges between hourly, daily, weekly, and monthly or as recommended by the manufacturers. Routine maintenance reduces fuel bills and extends equipment life. Readings obtained from such checks could be collated in a maintenance record over a longer period to give a behavior history of the equipment. Examples are washing and cleaning, filing of the distributor cap, change of oil, topping of battery, electrolyte, lubrication, inspection, and minor adjustments of pressure, flow, tightness, etc. [3].

Operators are responsible for daily preoperational checks of their tractors. This preoperational check needs to include at least the following activities, check oil, fuel, and other fluid levels, check for any oil, fuel, or fluid leaks, check tire condition and inflation levels, make sure that the platforms and steps are clean and free of debris and tools, check to see that lights, brakes and steering mechanism are working properly

and make sure that all gauges are giving proper readings and that the engine transmission and hydraulic system aren't making any unusual sounds [13].

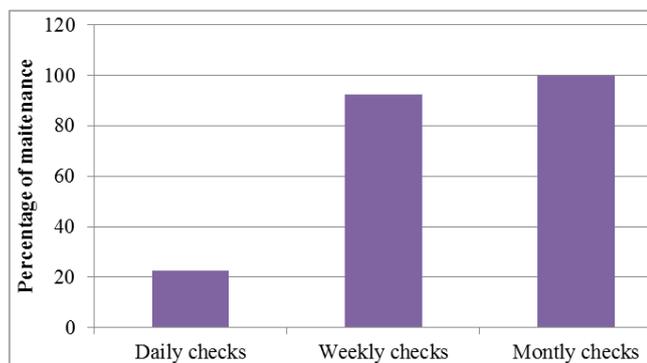


Figure 6. Routine maintenance activities in the town.

### 3.4.2. Checking of Fluid Level Before and After Operation

The fluid level of the farm machine and other related machines was the critical activity that needs daily inspection and filling in the recommended level was no type of question. So, here the operators and stakeholders are asked to fill their activities for checking the level of fluid for the tractors and machines.

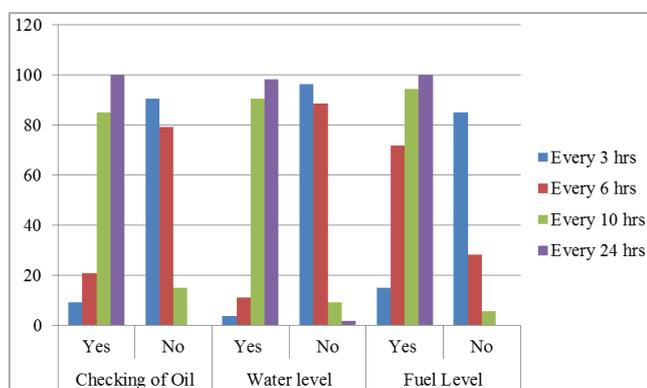


Figure 7. Checking of fluid level in the machine.

Figure 7 expresses the checking the oil level, water level, and fuel level of the machine for each daily checking with different time intervals. For checking the oil level of different time segments, most of them said no and a smaller number of respondents said yes. For water level, the opera-

tors check with 10 hours correctly and some of them don't check with 3 and 6 hours of time intervals. Finally, for fuel level, they were adapted to check the level of fuel within 6 and 10 hours of the time segments and less attention within 3 hours.

### 3.4.3. Washing of Tractor Work

Regular cleaning or washing of the tractor is essential because it will enable the tractor to last longer. Leaving soil and plant materials in the machine will decay on tractor parts, cause corrosion, and minimize the strength of machine parts. So washing agricultural machinery is one of the maintenance activities that must be performed daily or after 72 hours of operations. Moreover, oily steps and dirty safety decals on the tractor expose the operator to danger [11].

In the study area, the respondents say that they don't wash their tractors daily or weekly. Even they have no idea how to wash their tractors because of the working conditions and area of the tractors. No one performs the daily washing activity of the machine after operation. Only about 1.88% of the machine user was washing their tractor weekly and every two weeks after operation. Most of them wash their tractors with unscheduled activity accounting for about 92.46%.

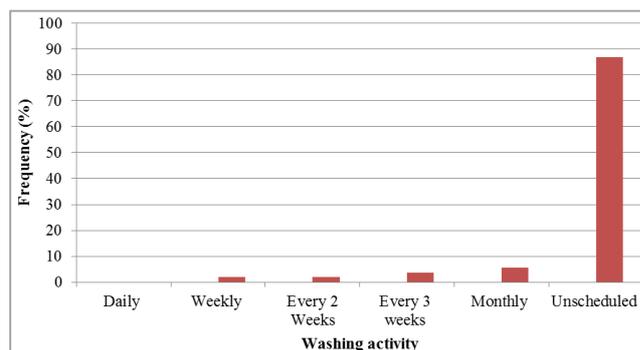


Figure 8. Washing activity of the tractors.

### 3.4.4. Lubrication and Greasing

Oil reduces wear, cuts friction, absorbs shocks, cushions, loads, seals between the cylinder wall and piston rings, cools, prevents bearing corrosion, provides rust protection, and neutralizes and cleans working surfaces. Lubricating the moving parts of the engine protects it from friction, wear, and excessive heating [3]. About 56% of the respondents grease and lubricate different parts of the tractor parts. The rest 44% of respondents don't grease or lubricate the tractors and moving parts of the tractor.

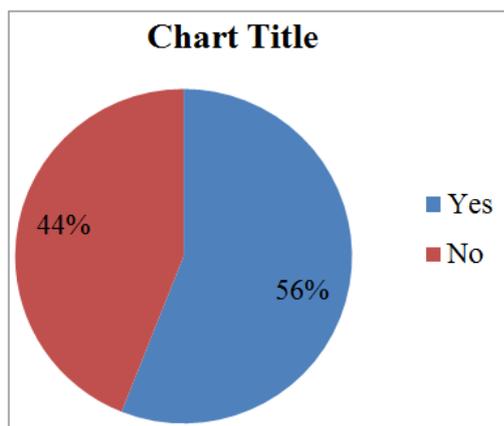


Figure 9. Lubrication and greasing of the tractors.

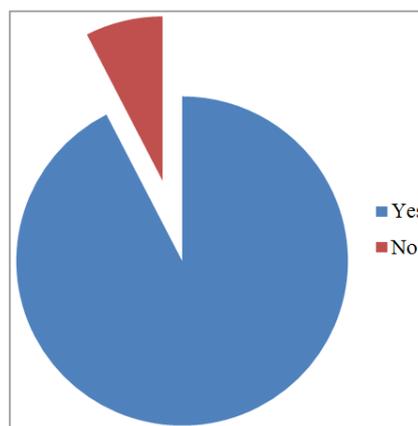


Figure 11. Cleaning of battery cables and terminals.

### 3.5. Shelter or Housing of Tractors

Tractors and most of the agricultural machinery were constructed from metallic and corrosion materials, and different spare parts of the machinery were assembled and disassembled the part and will be exposed to theft. Aikins and Kyere recommended that leaving the tractor in the open space will expose it to harsh environmental conditions such as wind and rain which will lead to rusting [2]. Provision of shelter for the tractor will therefore protect it from theft and environmental conditions which will result in longer life and improved appearance. Of the respondents, only 3.77% were using the shed for their tractors, and about 75.47% of the respondents did not use housing or a shed for their tractors.

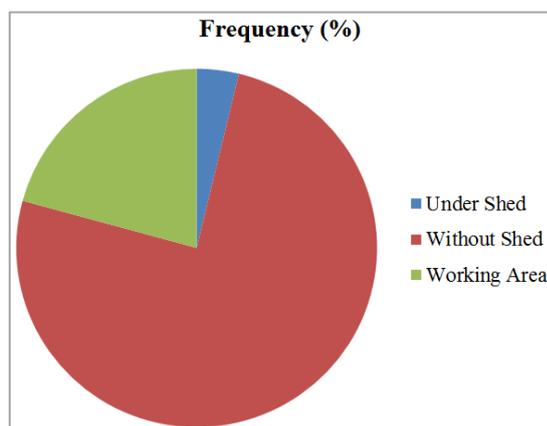


Figure 10. Use of shelter or house for tractors.

### 3.7. Record-Keeping Practice

Record keeping enables an operator to know which parts of the tractor were last serviced and which parts need servicing. It is upon this evidence that decisions are made for future actions [5, 14]. Most of them were not practiced for the case of the recording of the machine operating activity and the materials needed for the critical works. About only 16.98% of the respondents were keeping records of activity on the machine before or after operation which needs maintenance. Some others replied sometimes they keep a record of activity so as not to forget what is needed for his or her machine maintenance. They were about 11.32%. About 71.7% of the respondents don't keep a record of activity for the machine.

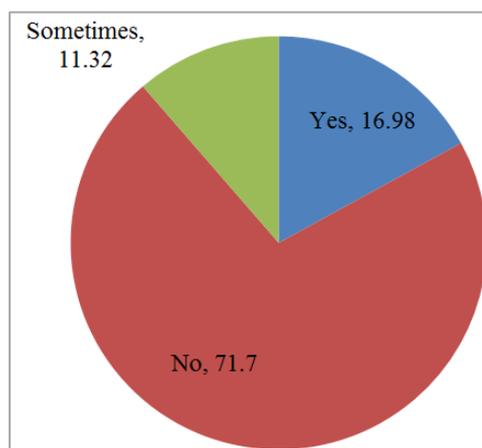


Figure 12. Record keeping of the operators.

### 3.6. Cleaning of Battery Cables

From the nature of tractors' working conditions, it has a chance of dirtying battery terminals and cables due to working environments. The operators are advised to clean the tractor's battery cables and terminals daily if possible. From respondents, about 92.45% clean the battery terminals and cables after working and the rest don't perform.

## 4. Conclusions

Most people have negative ideologies regarding to the maintenance and operation of tractors compared to other machines and vehicles. Because they think the tractors were constructed for agriculture, so no need to care for tractors. From this point of view, the operators and maintenance per-

form their work through training or without training. In the study areas, such problems were recorded as limitations regarding training, daily checking, maintenance requirements, washing of the tractors after or before operation, lubricating, shelter or house allocation for tractors, and adjustment of the different parts of the tractors. In general, tractors have the same engine systems with different machines; they need equal maintenance and care which we apply for different machines and vehicles. About 71.69% have a license to drive tractors. Even during the operations of the tractors, only 67.92% use personnel protective equipment. These results show how much the working environment was hazardous and serious and the operator attitudes toward using protective equipment were less.

Another important issue was shelter and record keeping from tractor operators and machinists were less. It implies that about 3.77% of the respondents use a shelter or houses for their tractors and others don't simply park in the working areas or around their residential areas which expose their tractors to wind sun, and other climatic factors such as corrosion, rust, or breakage. Moreover, only 16.98% of the respondents use recording books to schedule, remind, and repair different parts of tractors. This leads to an unscheduled working system and forgetting some important work that needs for maintenance and care. So, the tractor as a machine must be in good areas with a recommended type of shade.

## Abbreviations

PPE	Personnel Protective Equipments
PTO	Power Take off
ROPS	Rollover Protection Structures

## Author Contributions

Yemane Woldeyesus Ambo is the sole author. The author read and approved the final manuscript.

## Conflicts of Interest

The authors declare no conflicts of interest.

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