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Farm Machinery Breakdown Classification – Seed drills

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ABSTRACT

Work job orders for 196 seed drills collected by HADCO (Hail Agricultural Development Company), Saudi Arabia, were used in this study. The work job orders were classified in terms of the parts used and the cost of each item. Distribution of repair and maintenance as listed in the work-job orders was classified as repairs by 55% while 45% was found to be maintenance. Moreover, Classification of repair and maintenance for parts of seed drills was 66% for rapair jobs and 34% for manitinance jobs. Cost ratio term was developed, by dividing the repair or maintenance cost by the seed drill purchase price. The results indicate that the average cost ratio was affected by annual working area. Also repair and maintenance cost decreased as increasing the number of seed drills every year, and due to the increasing number of working area, the costs increased after about 430 ha/year.

Keywords. Repair costs; maintenance costs; breakdown; seed drill; machinery management.

Indexing terms/Keywords

Machinery; breakdown; seed drill;Saudi Arabia; *HADCO*.

Academic Discipline And Sub-Disciplines

Agricultural Engineering; Farm Machinery.

SUBJECT CLASSIFICATION

Farm machinery management

TYPE (METHOD/APPROACH)

Original research work

INTRODUCTION

The farm machinery is a major investment in farming system. Repair and maintenance is a major component of farm machinery operating costs. Seed drills are critical machines in farming, where the planting season, in most of the small grain areas; where it ranges from 3 to 5 weeks. So classifying the breakdowns studies will be helpful for farmers to prepare the spare parts and be ready to any breakdown of the seed drills in the field. And it is more important for industry, where defining parts with more breakdown, will help in improving the design and fabrication of those parts. Real field data are very important in such studies.

Costs of owning and operation of farm machinery represents 35-50% of the costs of agricultural production system when excluding the land [1]. Agricultural engineers researchers worked extensively on modeling and costing repair and maintenance of farm machines. Several studies were conducted in both developed and undeveloped countries [2-18]. Most studies depended on surveys to collect the necessary information due to the lack of accurate records with the users of farm machines.

Appraisal of repair and maintenance cost models for farm machinery is important to decide for replacement time and to decrease total costs [19-20]. The cost of repair and maintenance for tractors in developing countries represents 53% of annual operating costs, in comparison to 8% in advanced countries [21]. In other study on grain drills used in HADCO farm (Hail agricultural development company) iin Saudi Arabia, the annual cost decreases with increasing use up to 390 ha/year, then the costs starts to increase [22]. The use of grain drills in United States of America ranges between 14-225 ha/year [23] and this indicates a high usage of grain drills at HADCO farm.

The studies regarding classification of repair and maintenance for farm machineries are limited because they require an accurate detailed historical record of repair and maintenance. The previous studies on this regard are limited by what has been done by the authors. Suhaibani and Wahby [24] analyzed 1670 work job orders for 40 tractor. The analysis showed that 51% of job orders classified as repairs and 49% as maintenance. The mean total costs for repair was significantly higher than that of maintenance, and both repair and maintenance were related to tractor working life (age) and tractor power. Al-Suhaibani et al. [26] reported that c lassification of repair and maintenance in grain harvesters is very important for identifying the major causes of breakdowns. Howere, the results lead to some conclusions. First, of all work job orders received, about 72 % were for repairs and 28% for maintenance, repairs had the highest percentage of work orders, 72%, while the maintenance was 28%. Mean total costs were significantly higher than maintenance costs, and represented 83.8% of mean total costs. The most common repairs were pre-harvest followed by general and engine repairs. The most common maintenance was in the following order: engine, electrical, general, and pre-harvest maintenanceand pre-harvest repairs were usually executed every year before harvesting season. The pre-harvest repairs reduced costs of most of other repair or maintenance jobs in the machines during the harvesting season. Secondely, repair and maintence mean

total costs were directly related to both cutting width and harvester age (in years). Howere, repair and maintence mean total costs of the 8.22 m harvester was 60% of mean total costs and they were significantly higher than that of both 4.88 m which was 15%; and 3.69 m which was 25%.

The repair and maintenance costs are the most important parts of machine operating costs and they are dependent on the amount of usage and the age of the machine, So, it is clear that there is a need for further investigation of the seed drills repair and maintenance classification. Thus the objective of this paper is to identify the types of repair and maintenance event and to study the effect of the grain drill age (working life) and repair and maintenance costs percentages.

MATERIALS AND METHODS

Bakground of the data source

HADCO (Hail Agricultural Development Company), is one of many large agricultural companies in Saudi Arabia established to take a part in developing agriculture in different areas of the country. Hail area is located in the mid nortth part of Saudi Arabi, about 700 km north west of the capital Riyadh, mape of Saudi Arabia as (Fig.1). The company's farm area is about 300 km^2 , and it is contains more than 350 central pivots, as farming area (the area of each pivot is about 70 ha, 400m radius).The farm is served by huge fleet of farm machinery. There is a central workshop servicing the company's equipment, and a good management team for both the machinery and farming process. Hadco farm map, Fig. (2).

Repair and maintenance actual data were recorded in WJO (work job order). Each WJO included the following data: date of the job, machine type and serial number, power, working hours, type of work done, number of parts used, and total labor hours. Each WJO was forwarded to the financial department in the company to be completed by adding labor and parts costs, and overhead cost; before being stored in the computer. In this study, data from the actual repair and maintenance cost were collected from the company's computer.seed drill characteristics are presented in Table 1. For seed drills, the variables considered were the accumulated area divided by 100 and machine age (years). The average area for each machine was calculated by dividing the planted area over the number of machines used in that year.

Fig. 1. Map of Saudi Arabia.

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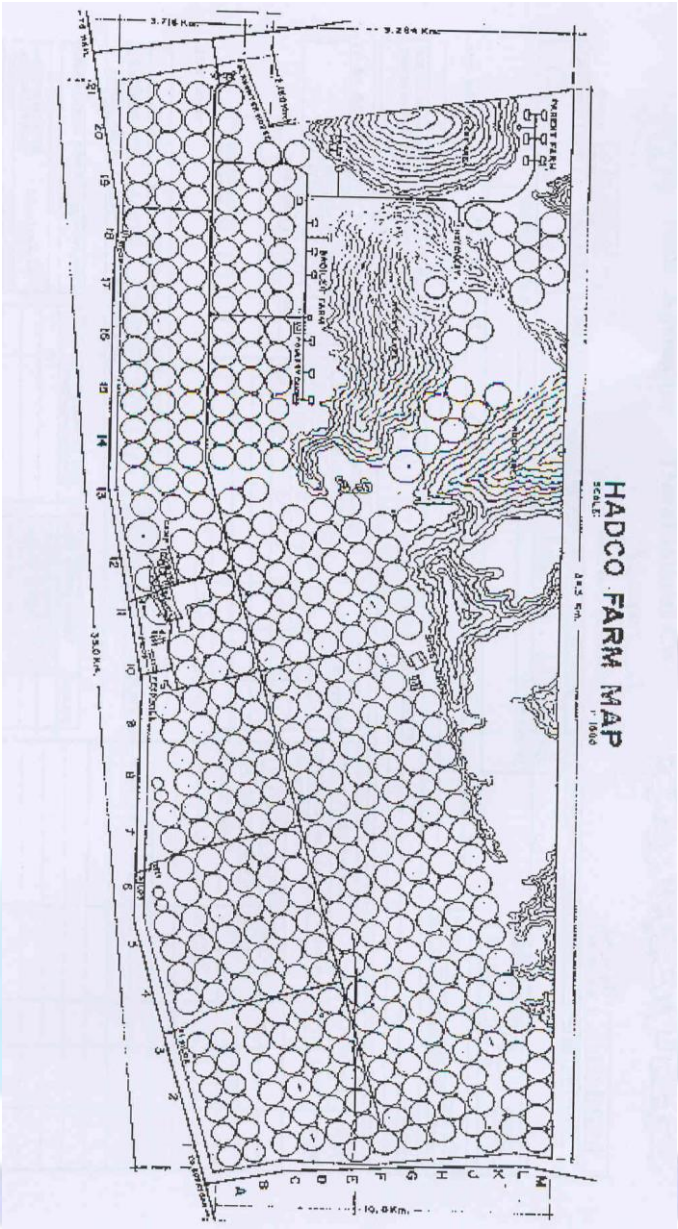

Fig. 2. HADCO farm map.

Table 1. Seed drill Characteristics.

No. of seed drills	Model	Width,m	Mean use, ha/year	Purchase date	Purchase price, US$
4	Nordsten/Combimatic	4.2	461	Nov. 82	12247
18	Nordsten/Combimatic	4.2	414	Dec. 83	15290
12	Nordsten/Combimatic	4.2	407	Nov. 84	13200
8	Nordsten/Combimatic	4.2	400	Dec. 85	11548

The data for 42 seed drills were obtained from HADCO. The data included detailed work-job orders for each seed drill for at least 5 to 10 years of machines operating life. 196 work-Jobs orders were analyzed to find the percentage of repair and maintenance costs for all seed drills through different machine ages, and working area per year and the type of repair and maintenance costs work-job. The percentage of repair and maintenance costs, both in terms of labor and parts, was also considered in the study. The costs will be expressed in terms of the ratio of cost to purchase price, as it is listed in Table 1. Classification of repair and maintenance will be based on work-job orders for each seed drill during the period of study and machine age. Further, the study will include the most common types of break down.

RESULTS and DISCUSSION

Repair and maintenance Costs

Fig. 3 shows the distribution of repair and maintenance as it was listed in the work-job orders (WJO). 55% of the WJO was classified as repairs, while 45% was found to be maintenance. While Fig. 4 shows the costs percentage between labor and parts costs as a percentage of purchase price. Parts costs for seed drills was the highest compared with all other costs, that may be due to the high working area per year for each machine which lead to more repair and maintenance needed every year. It was noticed that from Fig. 5, the repair costs was higher than that of maintenance, and the cost of parts were much higher than labor costs for both repair and maintenance. **It** was noticed that annual rapiar and mantinance costs of seed drills decreased as increasing annual area up to about 430 ha/year and then started to increase after that area. Fig. 6 shows the cost of labor and parts of seed drills repair. Table 2 lists the average values of working area (ha/yr) and machine age and the number of seed drills used every year.

Table 2. Relationships between machine age and working area.

Age, year	No. of machines	Working area, ha/year
5	5	399.9
6	16	403.2
7	19	416.6
8	26	421.9
9	21	421.1
10	16	422.8
11	4	470.4

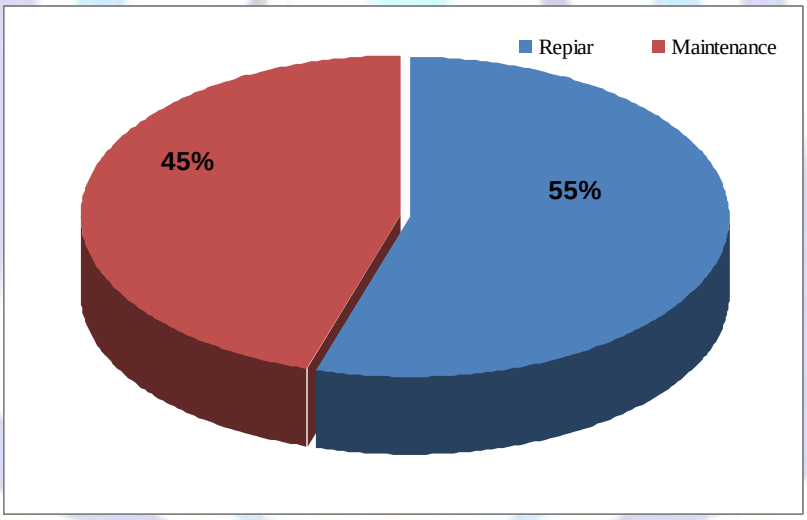

Fig. 3. The ratio between repair and maintenance work-job orders.

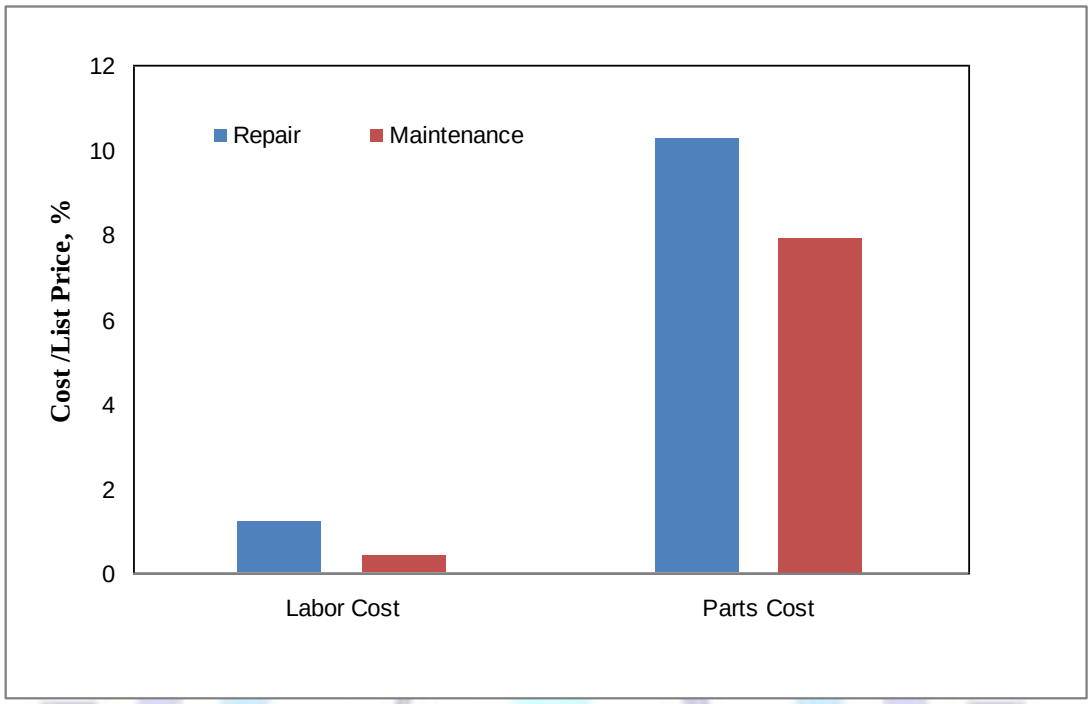

Fig. 4. The costs percentage between labor and parts costs as a percentage of purchase price.

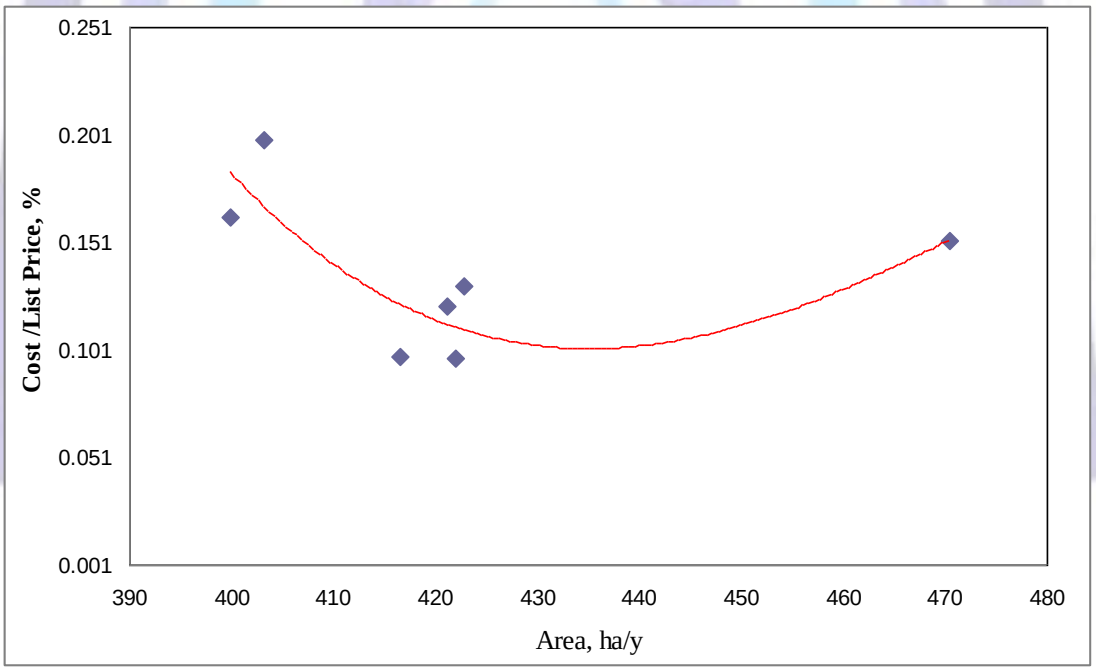

Fig. 5. The relationship between working area and cost ratio of seed drills.

Due to the different dates of purchase for seed drills, the number of machines used every year was not the same, as it was shown in Ttable 2. Also, the average cost ratio as it was affected by annual working area (Fig. 5) depended on the number of machines each year. The rapiar and manitence cost was decreased as increasing the number of seed drills every year, and due to the increasing number of working area, the costs increased after about 430 ha/year. Howevere, Fig. 6 shows the relationship between cost of labor and parts of seed drills repair, while in Fig. 7 shows the same cost but for maintenance. The repair costs took the same trend as in Fig.6, while the maintenance cost fluctuated depending on the period of maintenance for all machines, which changed from year to year and on the type and amount of machine maintenance.

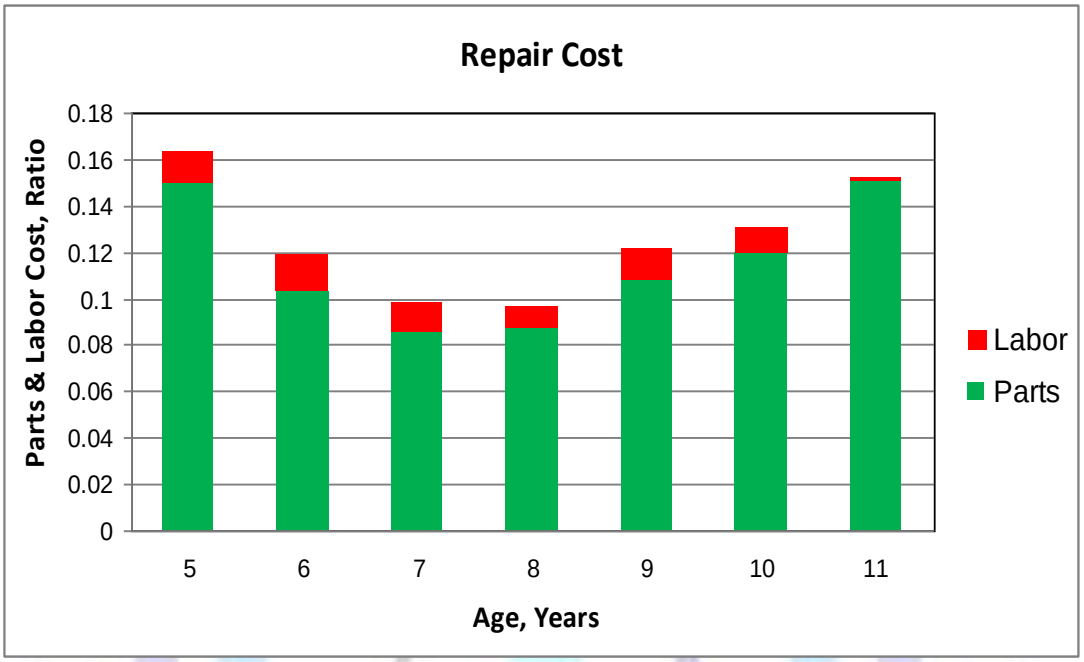

Fig. 6. Costs of labor and parts of seed drills repair.

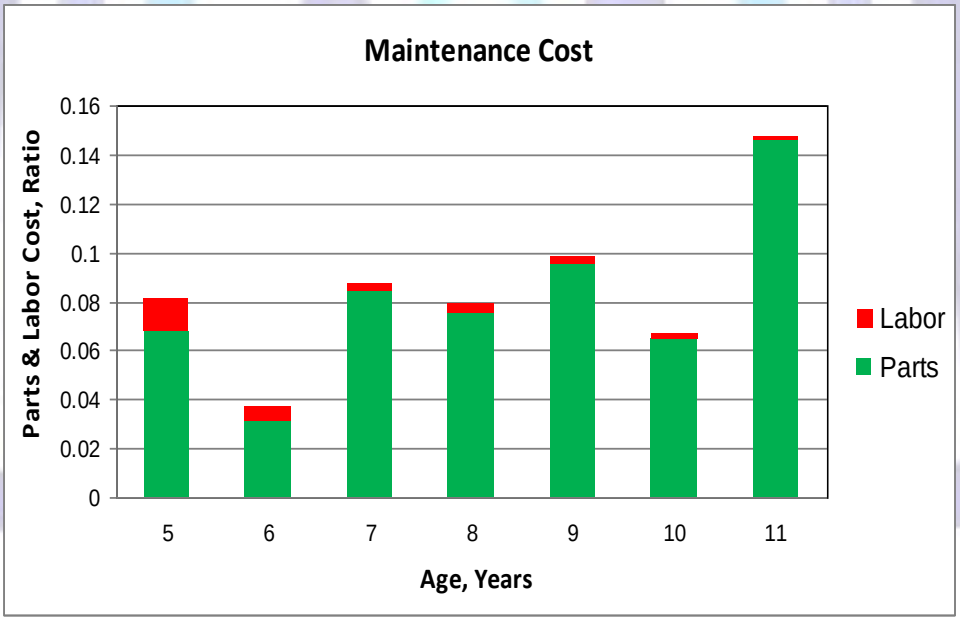

Fig. 7. Cost of labor and parts of seed drills maintenance.

Classification of repair and maintenance for parts of seed drils

The nature of field operations of seed drills is usually on tilled and unpaved soils, which results in reasonable vibration in the machine. The vibration was greatly affecting all parts of the seed drill, so that many small items either lost or become lose, and need repair or maintenance. The previous 196 work job orders were classified in terms of the parts used and the cost of each item. The ratio of this classification is shown in Fig. 8, where 66% of the parts were classified as repair, while the rest was classified as maintenance (34%). The frequency of each item is listed in Table 3. It was noticed that each work-job could include the same item more than once, depending on the need of the job. So that, the total number of all parts were add-up to 4106 items. The frequency distribution is shown in Table 3.

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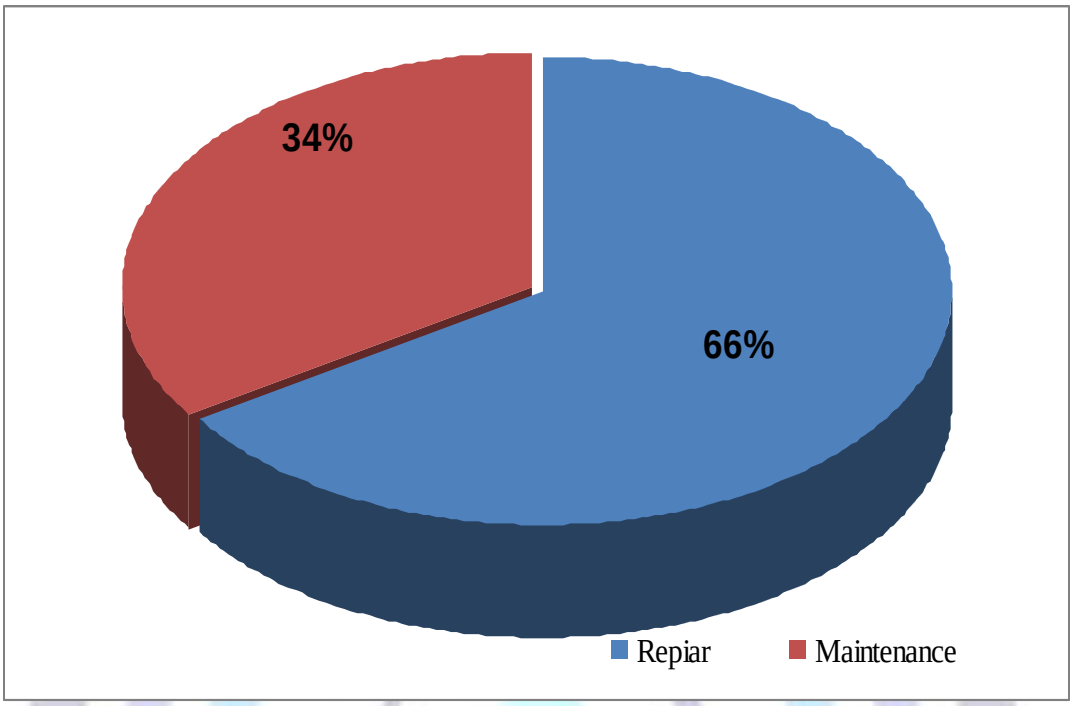

Fig. 8. The distribution of parts between repair and maintenance.

It was found that the most item replaced was sprocket and chain assembly, which amounted to 18 % and 18.5% for repair and maintenance, respectively. While the traction rod was the least part replaced for all seed drills over the period of the study. The others item in the list of Table 3 was mainly consist of small items such as: nuts, washers, bolts, retainers and such other items affected by movement vibration of seed drills. As it is shown inTable 3, these items had almost half of the total number of items for both repair and maintenance. Further study will be done on the type of each item and their related costs as it was affected by machine age and foe each machine.

Table 3: Classification and name of parts used for seed drills.

Repair		Part name	Maintenance	
Freqyancy	%		Frequancy	%
487	18.0	Sprocket and chain assembly	260	18.5
205	7.6	Coulter housing and point	150	10.7
170	6.3	Wheel and tires	85	6.1
165	6.1	Labor	84	5.9
95	3.5	Bearings	35	2.5
59	2.2	Seed tube and hose	24	1.7
45	1.7	Rocker shaft	34	2.4
44	1.6	Seed roller	35	2.5
42	1.6	Disc	19	1.4
40	1.5	Clutch spring assembly	24	1.7
25	0.9	Gear	10	0.7
14	0.5	Traction rod	2	0.1
1308	48.5	Others	645	45.8
2699	100	Total	1407	100

CONCLUSION

Classification of repair and maintenance in seed drills is very important for identifying the major causes of breakdowns. The results of this study lead to the following conclusions:

- Annual rapiar and mantinance costs of seed drills decreased as increasing annual area up to about 430 ha/year and then started to increase after that area Parts costs for seed drills was the highest compared with all other costs.
- The average cost ratio was affected by annual working area.
- Of all work job orders analysed, about 66% was repair jobs, while 34% was maintenance jobs.
- Classification of repair and maintenance for parts of seed dril was 66% for rapair jobs and 34% for manitinance jobs.

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Author' biography with Photo

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