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Evaluation of Failures of Tractors Working in Sugarcane Transportation

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ABSTRACT: This study was conducted in Elguneid Sugar Factory with the objective of the evaluation of the failures of tractors operating in sugarcane transportation. Results showed that there was no significant difference between seasons for the same type of tractors. There was significant difference between the different types of tractors in the frequencies of failures. The tires and gearbox were the major failures of tractors (A) while cranking and electrical failures were the major problem of tractors (B).

***Keywords**: Sugarcane; Tractor; Failure; Downtime; Repair and maintenance.*

INTRODUCTION

Modern machines in general, if properly operated and given the necessary field maintenance will operate for long periods and do a great deal of work before major repairs are required (FAO, 1973). Experience showed that even with good supervision, field maintenance is often neglected, and although competent operators may be available, accidents will happen and will damage equipment. Machine breakdowns can be very expensive, not only from the standpoint of the expenditure necessary for repair, but also because the disastrous effect on crop productivity and the fact that idle staff must still be paid.

Parson *et al*., (1981) stated that the importance of timeliness is well accepted concept when considering efficient machinery selection. Leading farmers generally recognize the importance of being in time. They understood the relationship between timeliness and machine reliability long before agronomists, engineers, and economists developed the coefficients and analytical tools now commonly used for machinery systems analysis. Harris and Bender (1973) defined timely operation as the "ability to perform an activity at such a time that quantity and quality of a product are optimized". The penalty of not carrying out an operation within the optimum time will be a reduction in yield, a loss of quality or both.

Time efficiency is defined as a percentage reporting the ratio of the time a machine is effectively operating to the total time the machine is committed to the operation. Timeliness is defined as the ability of the machine to perform a given operation at the specified time when the field and crop is at its suitable condition in quality and quantity. It is impossible to predict when some part of a machine will fail, but many breakdowns in the field can be avoided by scheduled inspection during operation. Watches for signs that will help avoid breakdowns. Losing three or four days of a busy season is not only expensive, but through putting the subsequent operation off schedule. FMO (1975) set these rules to reduce breakdowns:

1. Inspect and repair machines well ahead of the season.
2. Avoid rocks, holes and obstructions.
3. Do not overload the equipment.
4. Practice preventive maintenance.
5. Check out strange sounds, vibration or smells.
6. Make small repairs when needed.
7. Use periodic checkup to locate potential troubles.

Breakdowns are field stoppages due to sudden failure of a part. The expected repair time for breakdowns is not usually included in the calculation of predicted field efficiency, but such time losses do interfere with machine performance. The probability for the lost time due to breakdowns can be considerable. A probability number is the decimal ratio of the number of times a breakdown is observed

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to the total number of observations (Hunt, 1977). Green and Bournce (1981) stated that the concept of reliability becomes important when failures lead to some finite length associated with repairing, restoring or replacing the failed item. FAO (1990) summarized the factors on which reliability indices depend, as service, maintenance, operator skill, quality of spare parts, quality of supplies (fuel, oil, etc...)

For mechanical power technology, reliability indices in developing countries will rarely exceed 60%for engine powered machinery and 80% for implements. On the other hand, in developed countries, with sophisticated service networks and easy access to replacement parts and, therefore, reduced downtime, the indices may be 10-20% higher.

Green and Bourne (1981) stated that the reliability of machinery will be increased under the following conditions

1. The availability of good maintenance, service and repair facilities.
2. The presence of skilled workshop labor.
3. The presence of trained and attentive operators.
4. Services carried out regularly, and as recommended.
5. Machinery protection against damage.

Bohm (1995) found that the two most common causes of breakdown were overloading and poor maintenance, particularly the oil and filters. On the other hand Monge (1994) stated that about 25% of tractor breakdowns are attributed to effects in the cooling system.

Hunt (1971) stated that the breakdowns were considered to be unpredictable events which may be caused by one or more of the followings:

1. Accidents, such as striking hidden object, storms, fires, etc.
2. Improper service or maintenance, such as lack of lubrication.
3. Improper machine operation such as overloading, overturning and running too fast.
4. Improper set-up such as omission of parts, foreign objects, objects left in the machine and improper bolt-tightening torques.
5. Improper design such as underestimation of loads and service factors, and the deliberate under design to gain a price advantage.

Clyde *et al.*, (1979), in studying skidder downtime found that the weather factor has the greatest severity on unscheduled downtime. He found that there were 1.4 failures per machine weekly. He determined 38 classes of failure. He found that for both types of skidders under investigation the total downtime was 23%. For grapple type skidder it was 30.8% and 18.4 % for choker skidder. By neglecting the non-machine failure (labor, weather …etc) the downtime for all skidders was 16.5 % with 15% for the grapple machine and 17.2 % for choker skidders.

Frequent machinery unscheduled downtime was due to failures of hydraulic hoses and fittings. While engine repairs or replacement were the main causes for long time breaks

The objective of this paper is to determine the specific failures of transportation units that cause unscheduled downtime.

MATERIALS AND METHODS

Experimental sites

This study was conducted at Elguneid Sugar Factory. The fleet consists of 12 tractors (A) and 33 tractors (B). The tractors types were designated as tractor A and tractor B.

Data Collection

The type of failure and the time required for repair were registered for each implement on daily basis. The frequency of failure, total time lost and the range of repair time was determined. The mean and the standard deviation were obtained as well as the percent of downtime from the total downtime.

RESULTS AND DISCUSSION

First season

Table (1) shows the comparison of the incidence of breakdowns between the two types of tractors. It showed that there was a significant difference between these types of tractors in the frequencies of failures. Tractors (B) showed 0.38 more breakdowns per tractor per season as compared to tractors (A).

Table 1
Frequency of failures of the first season.

Tractor type	*Observed frequency of failures*	*Expected frequency of failures*
A	101	120
B	139	120
Total	240	240

Second season

The reported individual failures showed a total of 2891 failures. These were 32 different types of failures. The total time lost was 2655 hours.

Table 2
Frequency of failures of the second season

Tractor type	*Observed frequency*	*Expected frequency*
A	37	62
B	87	62
Total	124	124

From Table (2) it can also be shown that the tractors (B) have the highest frequency of failures per tractor per season (87). It is 2.35 times that of tractors (A).

Third season

Table (3) shows the comparison between the two types of tractors in the incidence of downtime in the third season. It can be shown that tractors (B) have significantly higher numbers of failures than tractors (A).

Table 3
Frequency of failures of the third season.

Tractor type	*Observed frequency*	*Expected frequency*
A	79	95
B	111	95
Total	190	190

Further analysis was made to show the difference in the frequency of failure for tractors (A) between the seasons. Applying chi-squire test showed that there was a significant difference between the two seasons. The second season showed the lowest frequency (37) which is about 0.4 of that of the first season Table (4).

Table 4
comparison between seasons for tractors (A)

Season	*Observed frequency*	*Expected frequency*
1	101	73.33
2	37	73.33
3	79	73.33
Total	217	217

Also analysis was made to show the difference in frequency between the seasons of tractors (B). Chi-squire test showed that there is a significant difference. Like the tractor (A), tractors (B) showed the lowest frequency in the second season 0.6 of that of the first season Table (5).

Table 5
Comparison between seasons for tractors (B)

Tractor type	*Observed frequency*	*Expected frequency*
1	139	112
2	87	112
3	111	112
Total	337	337

Table (6) shows the total frequencies of failure for the two types of tractors. The tractor (B) has 120 more failures than tractor (A).

Table 6
Total frequencies of failures

Tractor type	*Observed frequency*	*Expected frequency*
A	217	227
B	337	227
Total	554	554

Figure (1) shows the percentages of the tractor type to total downtime. It showed that downtime resulted from tractors (B) was almost double of that of tractors (A), with percentages of 68.32% and 31.68% respectively.

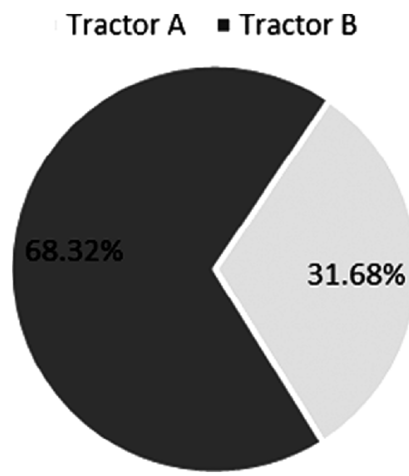

Figure 1: Contribution of tractor type to total downtime

Figure (2) shows the frequency of different classes of failures. Results showed that the main problem of tractors (B) lies in the transmission system. It showed the highest frequency of failure (74.5 failures per

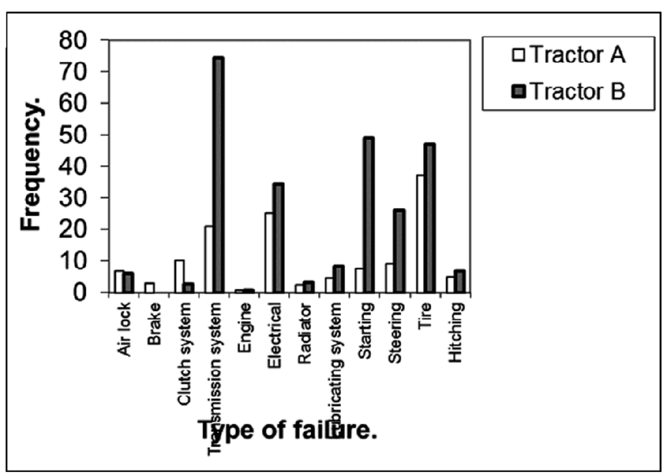

Figure 2: Frequency of failures for the tractors

tractor compared to 20.8 failures of tractors (A)), cranking (49.1 failure per tractor compared to 7.4 for tractor (A)) and tire puncture problems (46.9 failure per tractor compared to 37.3 of tractor (A)).

Table (7) showed that tractor (B) resulted in highest frequency of failure per unit tractor. Results showed about 258 incidence of tractors (B) failure as compared to 131 incidences for tractors (A). The tractor (B) enters the workshop about 1.4 times a day while the tractor (A) enters the workshop about 0.7 times a day. This fact reflects the burden upon the agricultural workshop. Also it necessitate that there should be a good and scheduled maintenance program for these tractors to minimize incidents of failure and to save time since any delay in sugarcane delivery to the factory will lead to harmful effects.

Table 7
Number of major failures per tractor per season

Failure	*A*	*B*
Air lock	6.6	5.9
Brake	3.0	0
Clutch system	10.1	2.5
Transmission system	20.8	74.5
Engine	0.7	0.8
Electrical	25.3	34.5
Radiator	2.2	3.2
Lubricating system	4.4	8.3
Starting	7.4	49.1
Steering	9.1	26.1
Tire	37.3	46.9
Hitching	4.7	6.7
Total	131.3	258.5

Figure (3) and (4) show the percentages and the total time lost of the various classes of failures to the total downtime. Results showed that transmission problems gave the highest percentage of lost time 27.6 % which equals to 120.5 hours per tractor, followed

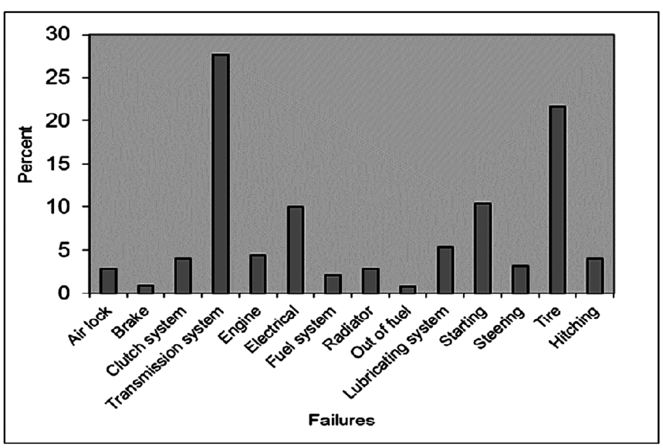

Figure 3: Percentage of major failure

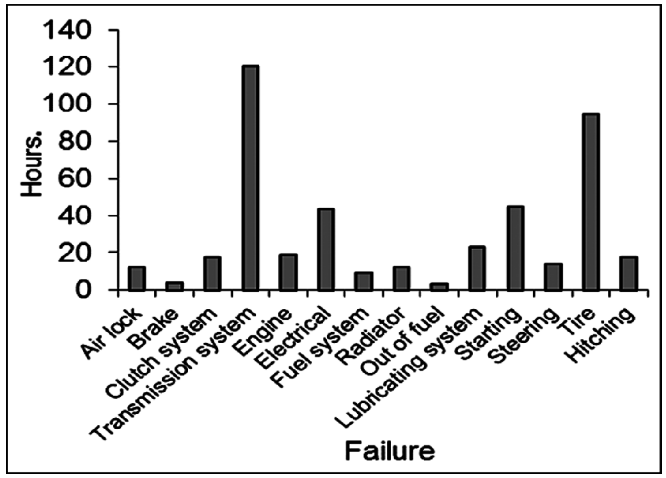

Figure 4: Total time lost per failure

by tire puncture which contributed to 21.7% (equivalent to 94.6 hours / tractor). The third problem was the cranking problems 10.3% (equivalent to 45 hours/tractor), followed by the electrical failures 10% (equivalent to 43.6 hours per tractor). It can be concluded that problems of transmission and tires may be attributed to harsh operating conditions of the tractors. This fact contradicts with Monge (1994) who found that 25% of tractor failures were attributed to cooling system failure. Cooling system failure (radiator) contributed to 2.1% only. Radiator punctures were noted to be a frequent cause of failure, as well as removal of radiator for "rodding" coolant passages to reduce the severity of overheating.

Exploration of failures

Failures were further analyzed with respect to total downtime and number of occurrences. It worth mentioning that during this research work it was observed that for the three seasons and in the two sites no day passed without failure or breakdown in all types of transportation units.

Engine

Engine failures accounted for 4.39% of the total downtime and the time lost for engine repair was 365.08 hours.

Transmission

The transmission failures occurred 74.5 times per tractor for the tractor (B) and 20.8 for tractor (A). The total time lost in transmission failures was found to be 3268.24 hours, with the tractors (B) contributed to about 87.6 of this time.

Radiator

Radiator problems accounted for 3.2% of the total downtime and took about 281.92 hours for repair.

Brakes

The brake failures were not a major problem in Elguneid Sugar Factory. Brake failures occurred only three times in tractor (A) and were never witnessed in the tractors (B). It took only 3.8 hours for repair.

Fuel system

The typical causes of failures were air and water in lines and leaking high pressure injector, fuel lines, fuel transfer pump and fuel tank. Probably most of these problems could have been avoided if more care had been given in handling of fuel and scheduling fuel filter changes. The fuel system failures occurred 376 times and took about 303.5 hours for repair.

Tires and wheels

Tire failures occurred 1994 time with mean of 44.3 hours per tractor. Major problems were tire repair, bolt tightening, steel wheel rim and hubs were the prime sources of wheel failures. The high incidence of tire failures is attributed to the harsh operating conditions.

Hydraulic hose and fittings

Main problems were hydraulic control and fittings, hydraulic valve, O' rings as well as hydraulic pumps and hose failures.

Steering system

The steering system occurred 195 times with total hours lost in repairing was 242.35 hours.

Lubricating system

The components frequently failed were the oil pump and oil seals for all types of transportation units. It took about 555.06 hours in Elguneid.

Air lock of fuel system

Air lock was occurred 273 times. This type of failure can be avoided by delivering good quality fuel, timely replacing fuel filters and adequate fuel supply.

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