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ANALYTICAL STUDY FOR AGRICULTURAL EQUIPMENT MAINTENANCE & REPAIR SERVICING IN NEW LANDS

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ABSTRACT

the main objectives of this research were to develop database and interface computer program help in the determination of the common agricultural equipment failures in new lands. The questionnaire sheet was designed and reviewed to collect the type of data required for surveying the common technical failures of the agricultural equipment. Database program (using Excel 97) was developed to organize the collected data. An interface computer program was developed using Excel 97 to facilitate calculations. Results showed that the new lands suffer from absence of specialized serving centers-shortage in spare parts- weakness of labor skillful and labor training centers.

INTRODUCTION

Egypt is living now an agricultural revolution in each of the agricultural sectors, specially, in the land reclamation sector. Egyptian government has been applied the modern techniques in agricultural production in the new lands such as the modern irrigation systems and the advanced agricultural equipment etc. Since the types of agricultural equipment play a very important role in the performance of the agricultural operations, the task of utilizing them economically should take great care. Agricultural equipment maintenance & repair is the big deal for the agricultural mechanization sector. Agricultural equipment owners and agricultural equipment for rent offers (specially in new lands) are suffering from the big shortage in management skills; the big shortage in mechanization information channels; the big shortage in maintenance & repair facilities such as workshops, spare parts and instruments; and the big shortage in skilful workers. So, the maintenance & repair system has to have skilful workers, besides, it could provides spare parts even with high price. This system has to be well equipped to perform the required maintenance & repair operations with it's maintenance & repair facilities .The main objectives of this research were to develop database and interface computer programs help in the determination of the common agricultural equipment failures in new lands. ***Younis (1989)*** mentioned that the objectives of maintenance are: reduce the rate of wear, reduce the failures probability of machines, guarantee of accepted level of quality, reduce of time losses, economy of the total costs, avoid accident and sudden hurt. He mentioned that the maintenance includes, tighten the parts and connection, grease, check clearances and control of operating, repair of the failures which are small and replacing the parts which unreliable for work.

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He also mentioned that there are some factors affect the efficiency of maintenance such as technical labor, training program and obstacles of administerial and operational.
He divided the maintenance to: Preventive maintenance, corrective maintenance, periodical maintenance and perfect maintenance. ***Dummer and winton (1990)*** mentioned that the main objective of maintenance manual is to provide all the information required to carry out each maintenance task without reference to the base workshop, design authority or any other source of information, it may therefore include the following: specification of system performance and functions – theory of operation and usage limitations – method of operations – range of operating condition – supply requirements – corrective and preventing maintenance routines – permitted modifications – description of spares and alternatives. ***El Anie (1990)*** mentioned that the maintenance are serviceable activity not less of important than the production which are main activity because the maintenance result increase of the efficiency of tractor and increase the rate of performance. ***Megahed (1990)*** divided the maintenance according to size of failure as follows: field maintenance, maintenance at level of small workshops, maintenance at service stations and repair & maintenance in big service stations. ***El-Banna (1988)*** stated that repair frequently required due to routine wear, operator neglect, accidental breakage and routine overhaul. ***El-Shafi (1992)*** stated that the maintenance schemes can be divided into three main categories: run-to breakdown maintenance, which is historically the first maintenance strategy employed. He added that a machine is repaired only after a failure has occurred. This is very expensive maintenance management scheme, since it requires: big spare parts inventory, long machine down period, high overtime labor costs and low production availability. He also indicated that preventive maintenance, in which basic maintenance operations are performed on a periodic time basis, the advantage of this maintenance strategy is that it is a planned strategy and is based on previous experience and the mean-time between failure statistics for the machine. ***Megahed (1995)*** mentioned that there are insignificant difference between the averages of annual breakdowns for different spare parts such as: radiator, oil pump of engine, oil filter, gear box, hydraulic device, fuel filter, belts, storage battery, front & rear tires, and clutch in the tractors of some marks (Universal "Romanian", Nasr and Belarus) working in different governorates.

MATERIAL AND METHODS

This study was carried out through 2002-2003 at Ganoub-El-Tahrir zone with the objective to develop database and interface computer program help in the determination of common agricultural equipment failures.

1. Data collection

The questionnaire sheet was designed and reviewed to collect the type of data required for surveying the common technical failures of agricultural

equipment. The questionnaires were distributed on about 150 beneficiaries (equipment owners, equipment contractors and equipment operators).

2.Data organization

Database program (using Excel 97) was developed to organize the collected data. Database program for tractors and machines are shown in figures (1) and (2). As shown in figure (1), the database program for tractors failures includes the following fields: tractor model – mechanical power (hp) – failure type –tractor idle period (h/year) – annual operating hours (h/year) and operating hour rental cost (LE/h) . As shown in figure (2), the database program for machines failures includes the following fields: machine name – mechanical power (hp) in case of self propelled machine –failure type – machine idle period (h/year) – annual operating hours (h/year) and operating hour rental cost (LE/h).

3. Occurred failure percentage (*OFP*)

The occurred failure percentage (*OFP*) for the total investigated equipment was determined using equation (1)

$$OFP = \frac{FEN}{TEN} \times 100 \qquad (1)$$

Where:

OFP	=	Occurred failure percentage	, %;
FEN	=	Failure equipment number	
TEN	=	Total equipment number	

4. Occurred failure rate (*OFR*)

The occurred failure rate for each equipment was determined using equation (2)

$$OFR = \frac{OFN}{AOH} \qquad (2)$$

Where:

OFR	=	Occurred failure rate	, time/h;
OFN	=	Occurred failure number	, time/year;
AOH	=	Annual operating hour	,h/year.

5. Average idle period lost cost (*AIPC*)

The average idle period lost cost due to the idle period based upon the average idle period and the average operating hour rental cost(27 LE/h) for tractors. The (*AIPC*) was determined using equation (3)

$$AILC = AIP \times ARC \times OFN \qquad (3)$$

Where:

AILC	=	Average idle lost cost	, LE/year;
AIP	=	Average idle period	, h/time;
ARC	=	Average operating hours rental cost	,LE/h;
OFN	=	Occurred failure number = $OFR \times AOH$	, time/year.

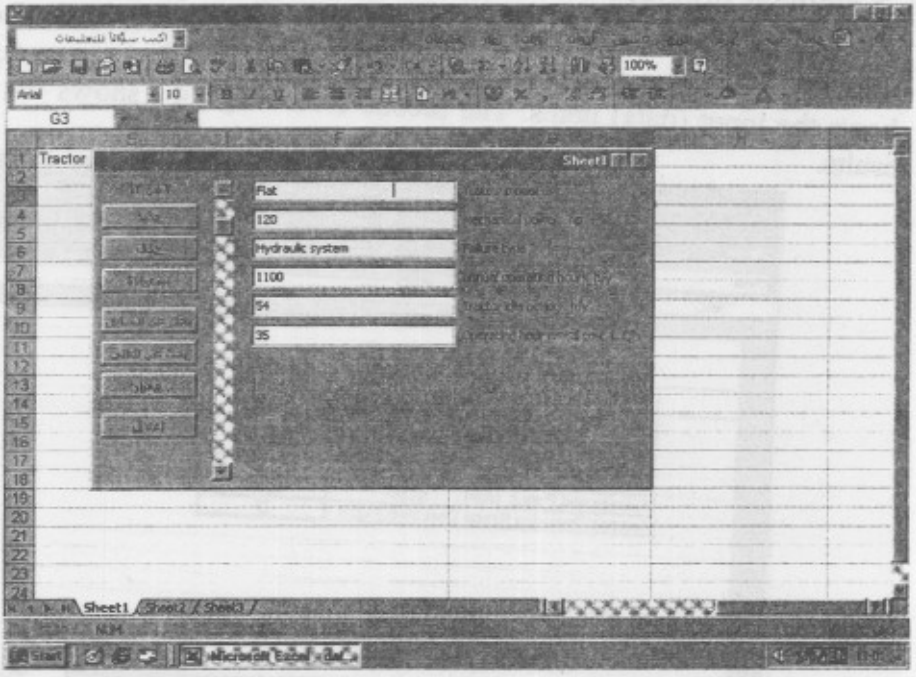

Fig. (1): Tractor database screen.

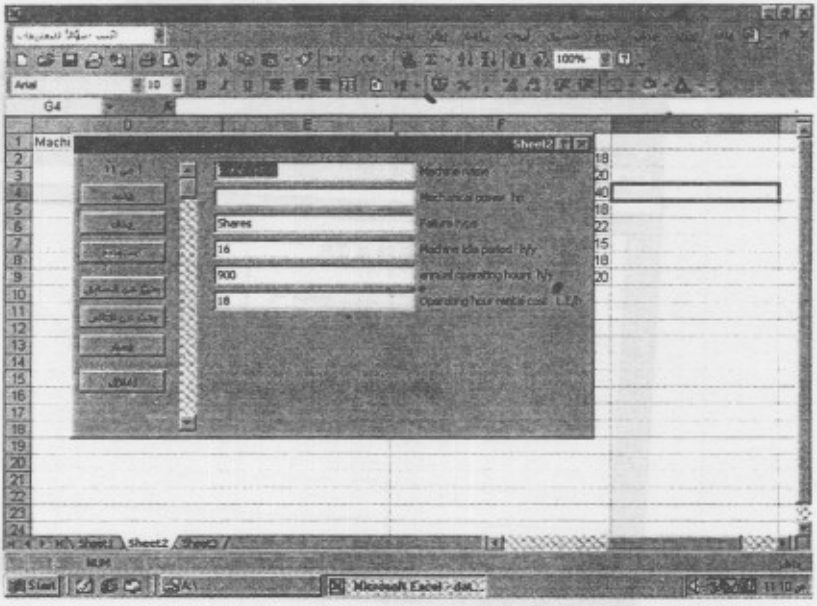

Fig. (2): Machine database screen.

6. Computer program

An interface computer program was developed using Excel 97 to facilitate calculations. This program consists of two screens .The first screen fig.(3) shows the input (data) items. The second screen fig.(4) shows the output results.

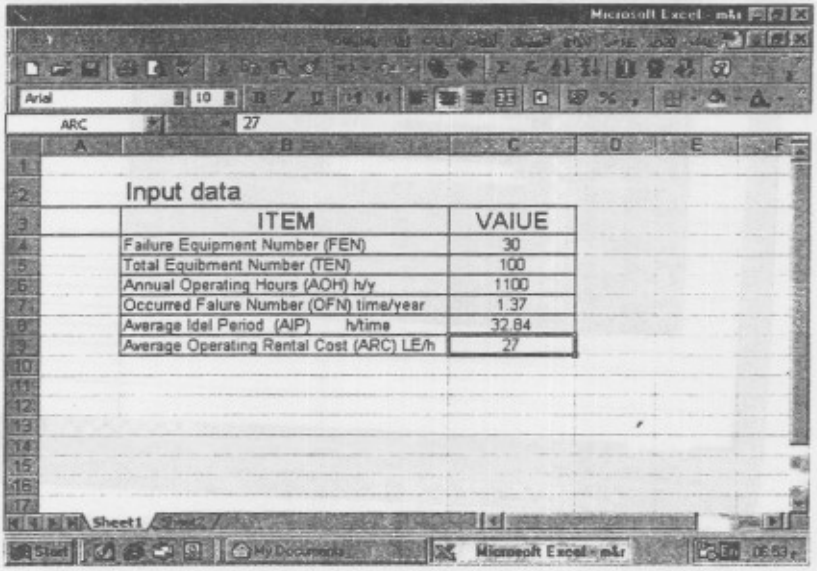

Fig. (3): Input data screen.

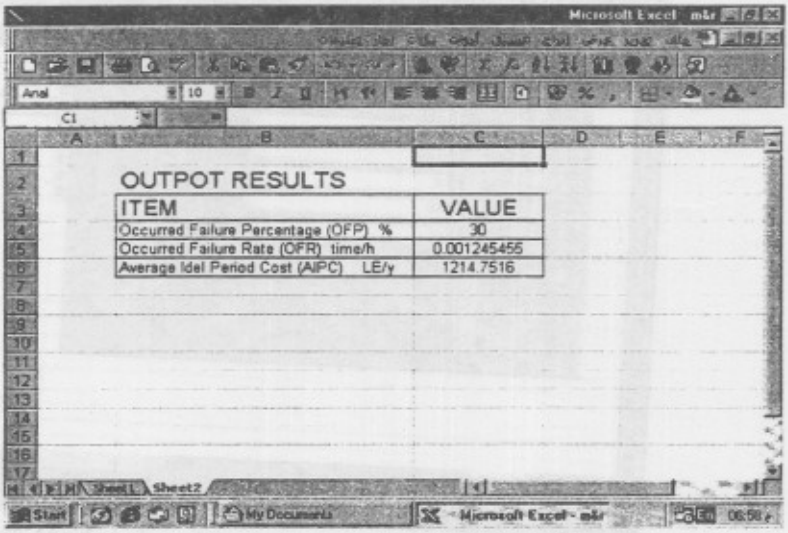

Fig. (4): Output results screen.

RESULTS AND DISCUSSION

Analysis and calculations of the collected data were illustrated in tables (1and 2). Table (1) shows the tractors common failures in new lands (research area). While table (2) shows the agricultural machines common failures in the same research area. Results of this research work were discussed in four items as following:

Table (1): Tractor common failures in new lands.

Failure type	Occurred failure, %	Occurred failure rate, Time/h	Average idle period, h/year	Average idle lost cost, L.E/year
Hydraulic cylinder	30	$1.2 * 10^{-3}$	45	1215
Fuel filter	27	$2.5 * 10^{-3}$	20	540
Air filter	25	$3.3 * 10^{-3}$	20	540
Injection pump	22	$1.6 * 10^{-3}$	35	945
Oil filter	22	$2.5 * 10^{-3}$	20	540
Oil pump	20	$0.6 * 10^{-3}$	25	540
Fuel pump	18	$2.1 * 10^{-3}$	23	621
V-belt	15	$3.3 * 10^{-3}$	18	486
Water pump	10	$0.1 * 10^{-3}$	20	540
Radiator	9	$1.6 * 10^{-3}$	16	432

Table (2): Machines common failures in new lands.

Machine	Failure type	Occurred failure, %	Occurred failure rate, Time/h	Average idle period, h/year	Average idle lost cost, L.E/year
Single knife ower	Cutter bar	40	$3.3 * 10^{-3}$	22	420
Corn picker	Belts, chains	35	$0.5 * 10^{-3}$	10	400
Planter	Belts, chains	30	$0.5 * 10^{-3}$	10	200
Threshing achine	Belts	30	$6.2 * 10^{-3}$	10	150
Rotary plow	Shares	27	$3.3 * 10^{-3}$	16	320
Rotary cultivator	Shares	25	$2.8 * 10^{-3}$	20	400
Seeder	Feeding system	25	$3.3 * 10^{-3}$	14	252
Moldboard plow	Beans, shares	20	$3.3 * 10^{-3}$	20	400
Chisel plow	Beans, shares	20	$3.3 * 10^{-3}$	16	288
Potato digger	Chains, belt	18	$4.4 * 10^{-3}$	10	250
Combine	Belts	15	$6.6 * 10^{-3}$	20	2400

1. Occurred failure percentage (*OFP*):

Figure (5) shows that the common occurred failure percentage values of the examined tractors were 30, 27, 25, 22, 22, 20, 18, 15, 10 and 9% for hydraulic cylinder, fuel filter, air filter, injection pump, oil filter, oil pump,

fuel pump, v-belt, water pump and radiator. The biggest occurred failure percentage value, 30 %, was for hydraulic cylinder, this high value refers to absence of maintenance & repair centers and shortage in laborer skills for operating and maintenance & repair. The second biggest occurred failure percentage value, 27%, was for fuel filter due to the bad fuel station and the bad storage of spare parts. The third biggest occurred failure percentage value, 25%, was for air filter due to dusty condition (prevailing condition) in new lands area.

Results also showed that the occurred failure percentage values from 22 % up to 9 % were in the same range comparing with the occurred failure percentage for Nile valley and delta old lands.

As shown in fig. (7) the common occurred failure percentage values of the examined agricultural machines were 40, 35, 30, 30, 27, 25, 25, 20, 20, 18 and 15 % for single knife mower, corn picker, planter, threshing machine, rotary plow, rotary cultivator, seeder, moldboard plow, chisel plow, potato digger and combines respectively. The highest occurred failure percentage values of 40, 35, 30, 30, 27, 25 and 25 % for single knife mower, corn picker, planter, threshing machine, rotary plow, rotary cultivator and seeder were due to the shortage in operating, maintenance and repair instructions, laborer skills, bad storage and desert land properties. Results also showed that the occurred failure percentage values of 20, 20, 18 and 15 % for moldboard plow, chisel plow, potato digger and combines were the same trend comparing with occurred failure percentage for the agricultural machines in Nile Delta and Valley (old lands) areas.

2. Occurred failure rate (*OFR*)

Occurred failure rate (time/h) that the failure is occurred once each a certain number of operating hours, so, the highest occurred rate value equivalent to the lowest value of operating hours per time. Table (1) shows that the occurred failure rate values were 0.0033, 0.0033, 0.0025, 0.0075, 0.021, 0.0016, 0.0016, 0.0012, 0.001 and 0.0006 time/h for air filter, V-belt, fuel filter, oil filter, fuel pump, radiator, injection pump, hydraulic cylinder, water pump and oil pump respectively.

From figure (5) its clear that the highest occurred failure rate values were 0.0033 and 0.0025 for air filter, V-belt and fuel filter, oil filter respectively. These highest values were due to absence of maintenance & repair centers and shortage in laborer skills for operating and maintenance, absence of maintenance & repair centers and shortage in laborer skills for operating and maintenance & repair e & repair as mentioned before. OFR values from 0.0021 to 0.0006 take the same trend comparing with OFR values in Nile Delta and valley. Table(2) shows that the occurred failure rate values were 0.0066, 0.0062, 0.0005, 0.0005, 0.0044, 0.0033, 0.0033, 0.0033, 0.0033, 0.0033 and 0.0028 time/h for combines, threshing machine, corn picker, planter, potato digger, seeder, chisel plow, moldboard plow, rotary plow, single knife mower and rotary cultivator respectively. As shown in figure (7), the highest OFR values were 0.0066 and 0.0062 time/h for combines and threshing machines, respectively due to absence of maintenance &

repair centers and shortage in laborer skills for operating and maintenance & repair as mentioned before. All OFR values start from 0.005 to 0.0028 time/h take the same range comparing with Nile Delta area.

3. Average idle period (*AIP*):

The average idle period *AIP* (h/year) was determined according to idle period hours per occurred failure time multiplied in number of occurred failure times per year. As shown in table (1), the average idle period *(AIP)* values were 45, 20, 20, 35, 20, 25, 23, 18, 20 and 16 h/year for hydraulic cylinder, fuel filter, air filter, injection pump, oil filter, oil pump, fuel pump, V-belt, water pump and radiator, respectively. Figure (6) shows the biggest average idle period values were 45 and 35 h/year for hydraulic cylinder and injection pump due to absence of specialized maintenance and repair centers besides shortage in skillful labor in the studied area. Generally, all average idle period values were more than the average idle period values comparing with Nile Delta lands due to absence of maintenance & repair centers and spare parts bad storages.

Table 2 shows that the agricultural machines average idle period AIP values were 21, 10, 10, 10 16, 20, 14, 20, 16, 10 and 20 for single knife mower, corn picker, planter, threshing machine, rotary plow, rotary cultivator, seeder, moldboard plow, chisel plow, potato digger and combines, respectively. Figure (8) shows that the biggest average idle period values were 22, 20 and 16 h/year for single knife mower, combines, moldboard plow, rotary plow and chisel plow, respectively due to weakness of spare parts stores and absence of specialized serving centers. All average idle period values take the same trend comparing with Nile Delta land.

4. Average idle lost cost (*AILC*):

Maintenance and repair costs are considered the most important item of the machinery operating cost. Maintenance and repair costs are varying from area to another according to maintenance and repair infrastructure. Analyzing of the collected data showed that maintenance and repair costs values are high in the studied area than their values in Nile Delta lands due to absence of maintenance and repair infrastructure. This study discussed the predicted average lost costs due to machinery idle period. Results show that the idle lost costs increasing with the increase of idle period. As shown in table (1) and figure (6) that the average idle lost cost values were 1215 and 945 LE/year for hydraulic cylinder (average idle period 45 h/year and average operating rental cost 20 LE/h) and injection pump (average idle period 45 h/year), respectively. Also, figure (8) shows that the average idle lost costs value, 420 LE/year, for single knife mower (average idle period 22 h/year) was bigger than values 400, 288 and 320 LE/year for moldboard plow (average idle period 20 h/year), chisel plow (average idle period 16 h/year) and rotary plow (average idle period 16 h/year), respectively.

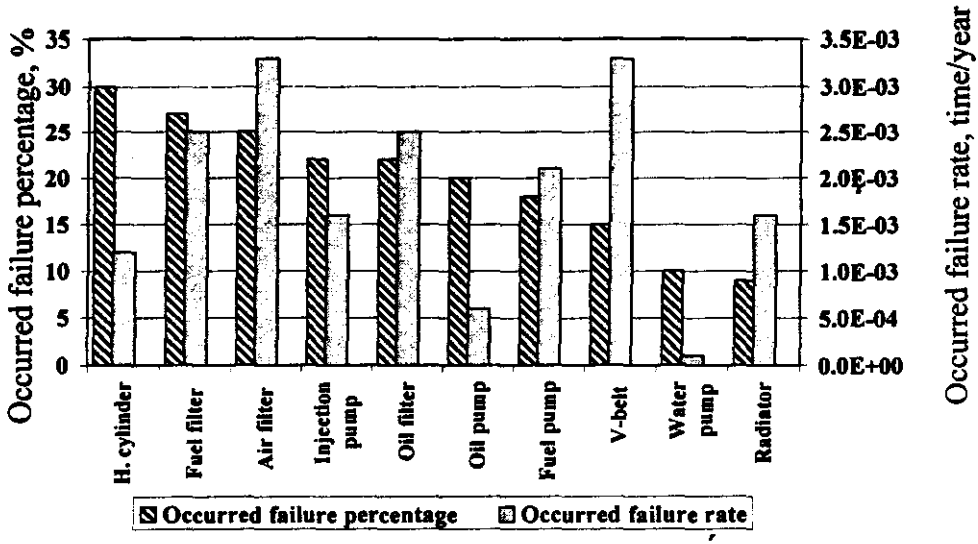

Fig. (5): Tractors occurred failure percentage and rates.

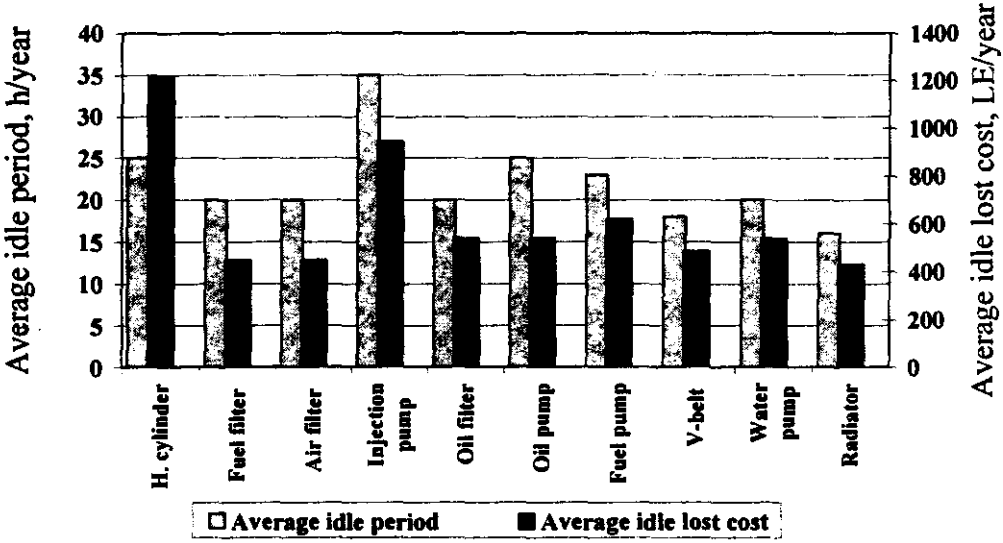

Fig. (6): **Idle period of tractors and lost cost.**

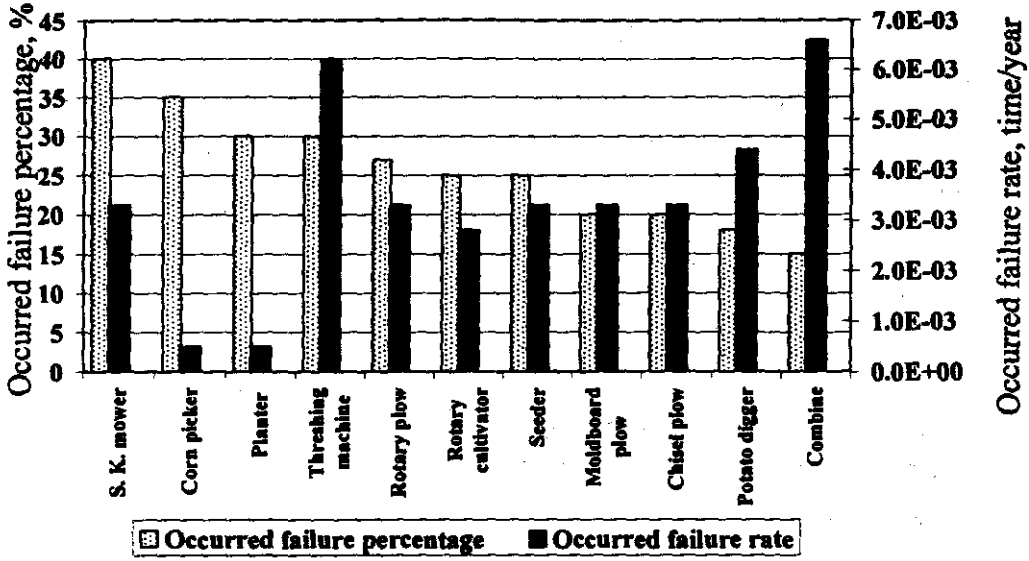

Fig. (7): Machines occurred failure percentage and rates.

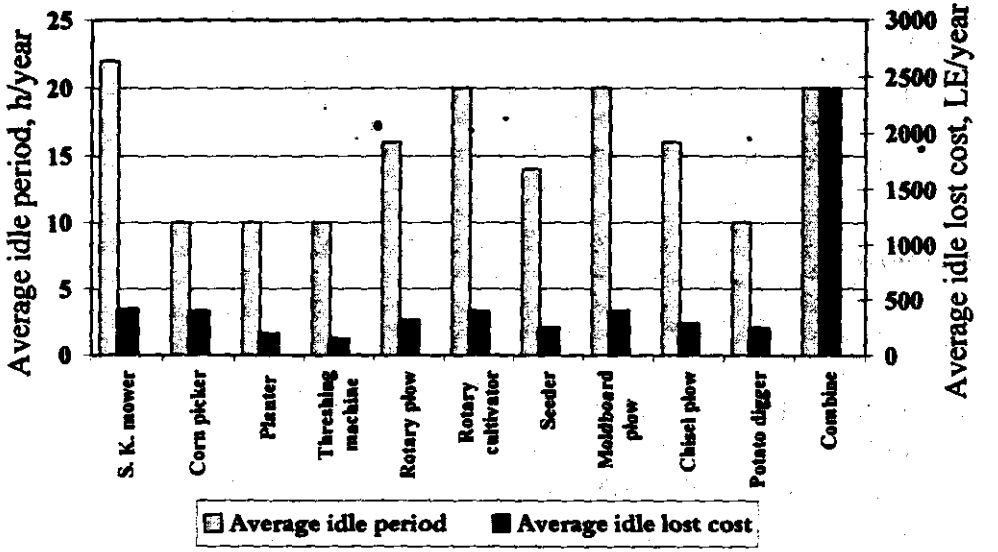

Fig. (8): Idle period of machines and lost cost.

CONCLUSION

From the present study, the following conclusions could be made:

1. The common tractor components occurred failures percentage values were 30, 27, 25, 22, 22, 20, 18, 15, 10 and 9 % for hydraulic cylinder, fuel filter, air filter, injection pump, oil filter, oil pump, fuel pump, V-belt, water pump and radiator respectively.
2. The common agricultural machines occurred failures percentage values were 40, 35, 30, 30, 27, 25, 25, 20, 20, 18 and 15 % for single knife mower, corn picker, planter, threshing machine, rotary plow, rotary cultivator, seeder, moldboard plow, chisel plow, potato digger and combines respectively.
3. The highest occurred failures rate values were 0.0033 and 0.0025 time/h for air filter and V-belt respectively and 0.0066 and 0.0062 time/h for combine and threshing machine respectively.
4. The highest average idle period values were 45 and 35 h/year for hydraulic cylinder and injection pump respectively and 22, 20 and 16 h/year for single knife mower, combines and moldboard plow respectively.
5. The idle lost cost values increasing with the increase of idle period.
6. New lands are suffering from absence of specialized serving centers-shortage in spare parts- weakness of labor skillful labor training.

RECOMMENDATIONS

1. It is to important to construct maintenance and repair specialized centers in the study area.
2. This study proposed maintenance and repair management schematic system (fig.9) in order to increasing maintenance and repair management procedures efficiency.

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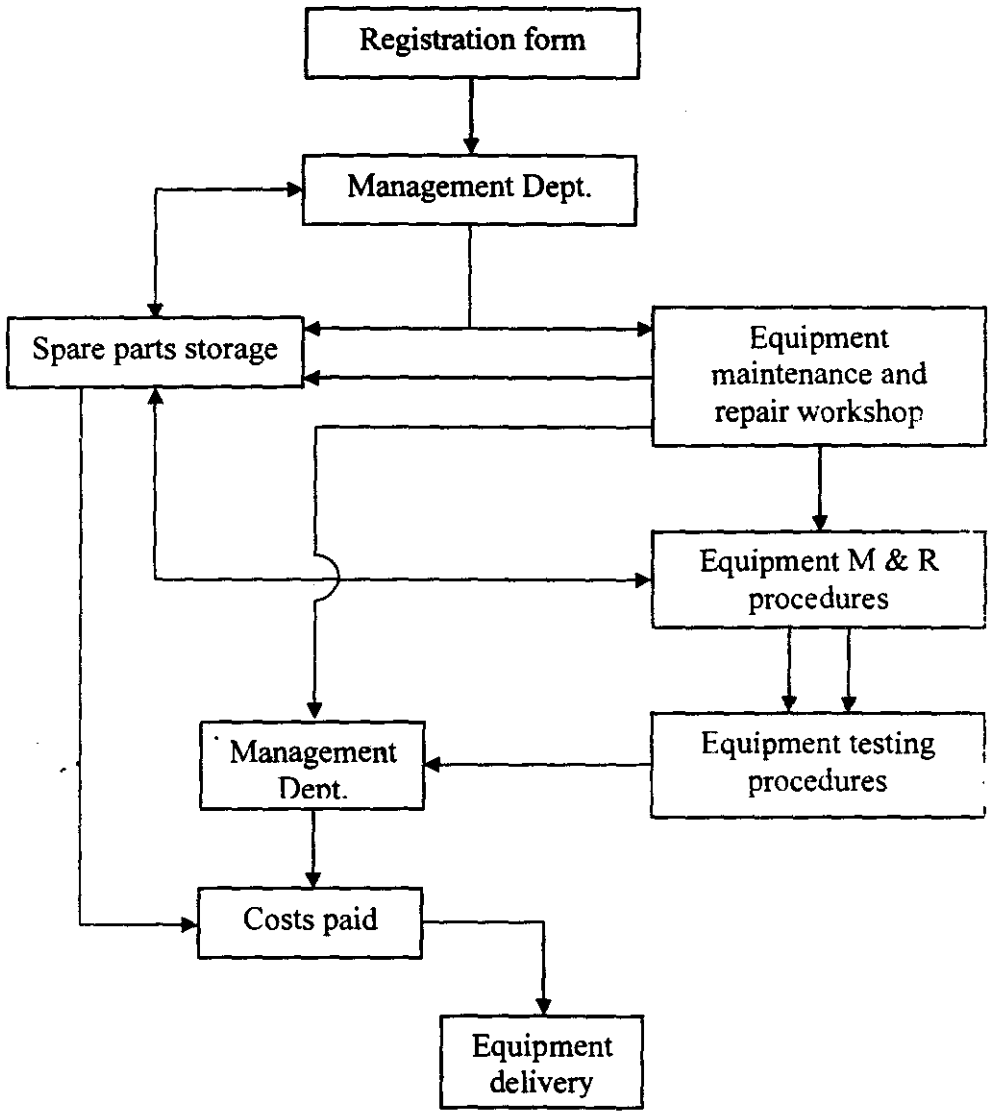

Fig. (9): The proposed maintenance and repair management schematic system.

الملخص العربى

دراسة تحليلية لخدمات الصيانة و الأصلاح للمعدات الزراعية في الأراضي الجديدة

محمد نجيب رستم*

أجريت هذه الدراسة في أحدى مناطق الأستصلاح الجديدة خلال الفترة ٢٠٠٢ – ٢٠٠٣ بهدف التعرف على نظم تقديم خدمات الصيانة و الإصلاح للمعدات الزراعية بالإضافة إلى تحديد الأعطال المتكررة و معدلات تكرارها و كيفية التغلب عليها. و قد تم عمل قاعدة بيانات بإستخدام برنامج Excel-97 لتحليل البيانات التي تم تجميعها باستخدام استمارات الأستبيان. و كذلك تم عمل برنامج كمبيوتر Excel-97 لتسهيل العمليات الحسابية.

وقد أوضحت النتائج ان النسبة المئوية لاعطال الجرارات المنتشرة في منطقة الدراسة كانت ٣٠ ، ٢٧ ، ٢٥ ، ٢٢ ، ٢٢ ، ٢٠ ، ١٨ ، ١٥ ، ١٠ و ٩% لكل من الجهاز الهيدروليكي ، مرشح الوقود ، مرشح الهواء ، طلمبة الحقن ، مرشح الزيت ، طلمبة الزيت ، طلمبة الوقود ، سير حرف V ، طلمبة المياه وجهاز التبريد علي الترتيب . وان النسبة المئوية لاعطال الآلات الزراعية المنتشرة في منطقة الدراسة كانت ٤٠ ، ٣٥ ، ٣٠ ، ٣٠ ، ٢٧ ، ٢٥ ، ٢٥ ، ٢٤ ، ٢٠ ، ١٨ و١٥% لكل من المحشة الترددية المفردة ، ماكينة لقط الذرة، آلة الزراعة علي خطوط ، ماكينة الدراس ، المحراث الدوراني ، العزاقة الدورانية ، السطارة ، المحراث القلاب المطرحي ، المحراث الحفار ، آلة حصاد البطاطس وآلة الحصاد الجامعة (الكومباين) .

وقد أوضحت النتائج أيضا أن اعلي معدلات للاعطال كانت لكل من مرشح الهواء ، سير حرف V ، آلة الحصاد الجامعة (الكومباين) و ماكينة الدراس .

و قد أظهرت الدراسة عدم وجود مراكز متخصصة لتقديم خدمات الصيانة و الأصلاح و التدريب في منطقة الدراسة بالإضافة إلى ضعف مهارات الكوادر الفنية و غياب و سوء تخزين قطع الغيار و قد أوصت الدراسة بضرورة إنشاء مراكز متخصصة للصيانة و الإصلاح في منطقة البحث كما اقترحت الدراسة مخطط لإدارة مراكز تقديم الخدمة و الصيانة لرفع كفاءة تقديم خدمات الصيانة و الأصلاح لمثل هذه المناطق.

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