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# UTILIZATION THE SIMPLE PROGRAM IN INTEGRATED MANAGEMENT OF MECHANIZED WHEAT PRODUCTION

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## ABSTRACT

The present research aimed to select the suitable integrated machines for wheat production which can be used depending on the field area and the available time of each operation. The Visual basic program is used to belt a simple program "W.A.T.L.P.S.I.H." and to calculate the critical specified information from the wheat operating systems. This program is divided into three main subroutines for the main wheat production processes; tillage, leveling, seeding, manure spreaders, irrigation, and harvesting to select the machine number and specifications that recognized to obtain the minimum operating time and total cost. The program tested as a case study at the variables of machine width and duplicated, field area and field shapes. The research concluded that the increase in machine width by 60 %, the operating time decreased by 65.60 and 59.92% respectively at square and rectangle field shape, also the operating cost decreased by 66.48 and 60.99% at the corresponding field shape. Furthermore, the increase in machine width by 60 % the operating time decreased by 65.56 and 54.25% respectively at square and rectangular field shapes, also the operating cost decreased by 69.38 and 57.95% at the corresponding field shapes. The software program can be applied at service stations mechanism to determine the best automation system at the lowest cost and in the time available for the farmer.

## INTRODUCTION

The integrated management of mechanized farms basically achieved to select the suitable machine for field and crop specifications with low costs. Many programs can be used to select the suitable farm machinery (Rotz et al., 2007) but the program can be matching the machinery as integrate mechanization to reduce time and cost is infrequent (Siemens et al. (1990)). Al-Hamed and Al-Janobi (2001) explained that the computer models and simulation programs, for predicting the implements, help to evaluate various farm machinery systems. Proper selection of implement for a particular farm situation can be determined form the performance parameters obtained by these models and simulation programs. As field machines contribute a major portion of the total cost of crop production systems, proper selection and matching of farm machinery is essential to reduce significantly the cost of operating and farm machinery used. Abd El-Mageed et al. (1987) developed a mathematical model to predict the optimum width of tillage and seeding implements in a three years crop rotation. A series of mechanized operations were advised to prepare the seedbed of each crop in the rotation including rice crop. Gee-Clough et al. (1978) modeled the tractor-plowing performance using empirical relationships based on experimental data obtained from 14 different fields with sandy clay loam, clay loam, and sandy loam soils. Primordial and Sepaskhah (2006) used a very simple model to simulate rice yield under different water and nitrogen application rates. Ismail et al. (2009)

indicated that the field efficiency is the ratio of effective field capacity to theoretical field capacity, expressed as percent. It includes the effects of time lost in the field and of failure to utilize the full width of the machine. Thus, it is impossible for the machine to work effectively all the time. When a field operation is performed there is normally an optimal time for this operation with respect to the value of the crop. If the operation is performed earlier or later, the value of the crop may decrease due to changes in quantity and/or quality (ASAE, 2006). During calculating the machine capacity, the actual time spent carrying out the operation as well as the time spent on non-productive activities such as turning and adjustment need to be considered (Soerensen, 2003). Increasing machine capacity was discussed by Srivastava et al. (2006) as one way to decrease timeliness costs, as larger machines with greater capacity can accomplish more timely work. In addition, optimal work organization and machinery utilization are important in achieving cost reductions (Soerensen, 2003). Boehm and Burton (1997) indicated that the ownership costs per unit area vary inversely with the amount of annual used of a machine. Therefore, a certain minimum amount of work must be available to justify purchase of a machine and, the more work available. Willimam (2001) cleared that the goal of the good machinery manager should be to have a system that is flexible enough to adapt to a range of weather and crop conditions during minimizing the long-run costs and production risks.

The present research aimed to matching the suitable integrated machines that can be used depending on field area and the available time of each operation for wheat mechanization system.

**METHODOLGY**

The Visual basic program is used to belt a simple program and to calculate the critical specified information from the wheat operating systems. The steps of the studied procedure can be divided into:

1-Determination of operating time that affecting mechanized operations during wheat production for tillage “first and second”, leveling, seeding, fertilizing, irrigation and harvesting systems.

2-Design of program that matching the integrated management by estimating the operations of wheat production with knowing the estimated field area and available time.

The case study in Dakahlia governorate fields were done by collecting the information about the field size, number of fields, machine available and machine specifications. From these information the field and machine variables under studies are illustrated in Tables (1 and 2).

**Table 1: The field size and number in Dakahlia governorate (Central agency for public mobilization and statistics 2012)**

| Calcification of field area, Feddan | Field area, Feddan | Number of tenure |
|---|---|---|
| < 1 | 77,546 | 203,605 |
| 1< | 71,013 | 48,293 |
| 2< | 67,687 | 33,533 |
| 3< | 56,244 | 27,941 |
| 4< | 41,276 | 13,901 |
| 5< | 81,122 | 15,345 |
| 10< | 88,961 | 8,563 |
| 20< | 73,717 | 9,509 |
| 50< | 55,738 | 2,053 |
| 100< | 52,629 | 1,729 |

**Table 2: The operational machine variables under study**

| Machines | Item | Characteristics |
|---|---|---|
| Chisel plow | Number of shanks<br>Working width<br>Forward speed | 5 and 9 shanks<br>150 - 250 cm<br>3.6 km/h for 1st tillage and 4.5 km/h for 2nd tillage |
| Hydraulic leveler | Operating width<br>Forward speed | 2.5 – 3.5 m<br>4 km/h |
| Seeder | Working width<br>Forward speed | 2.40 - 3.15 m<br>5 km/h |
| Manure spreader | Operating width<br>Capacity<br>Forward speed | 1.50 – 2.50 m<br>3.0 – 4.0 $m^3$<br>5 km/h |
| Irrigation pump | Discharge | 321 - 609 $m^3$/min |
| Combine harvester | Operating width<br>Forward speed | 1.50 – 2.50 m<br>7.0 km/h |

The flow chart of the integrated machine system for wheat production and it's main operations are illustrated in Fig. (1). This program divided into three main subroutine (Fig., 2); the first is to select the implements and the machines of the soil bed preparation (tillage, leveling and seeding). The second step; select the wheat machines service (manure spreaders machine, irrigation pumps and harvesting). The third step; conform the obtained results of the two previous steps to integrate the appropriate machines and to select the machine number and specifications that recognized to obtain the minimum operating time and total cost (Figs. 3 and 4).

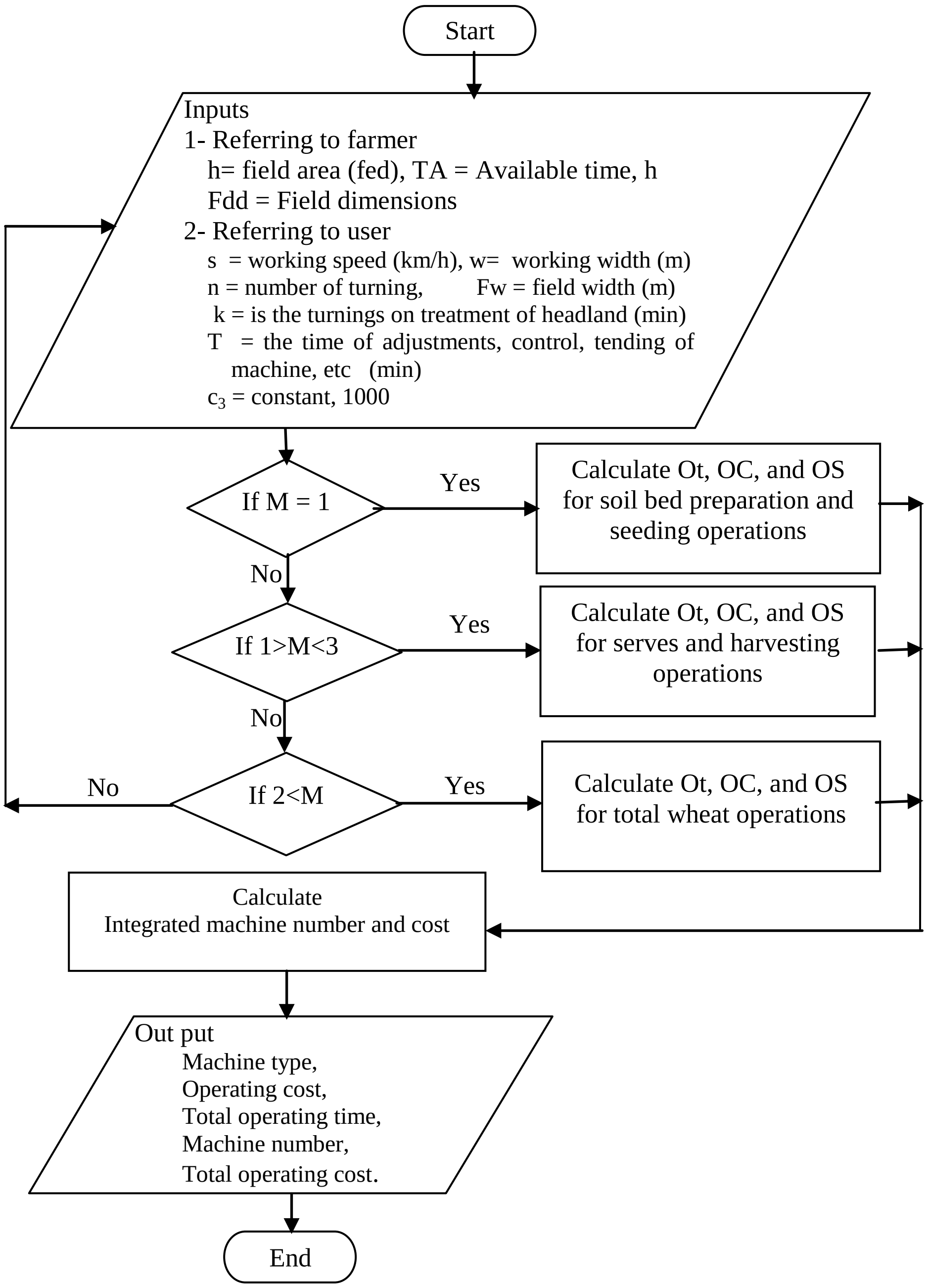



**Fig. 1: The main flow chart describes the program steps to integrated machine.**


Fig. 2: The window of main form of the program.

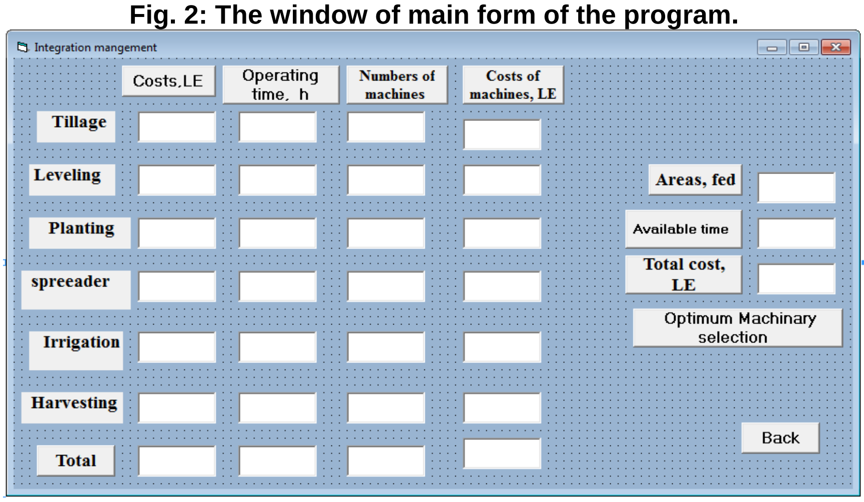



Fig. 3: The window of integration management.

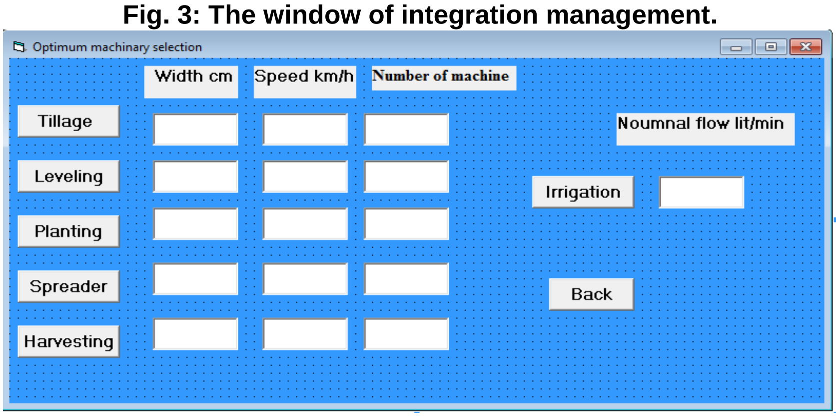



Fig. 4: The window of optimum machinery selection.

Where: s = working speed (km/h), w = working width (m), n = number of turning, Fw = field width (m), k = is the turnings on treatment of headland (min), T = the time of adjustments, control, tending of machine, etc (min)". These information used to calculate the operating time (Ot) and cost (OS) for all operations under study using the following equation:

$$Ot = \frac{1}{OC} \quad (1)$$

Where: OC is overall field capacity and equal;

$$OC = \frac{60}{\frac{h \times 252}{s \times w} + \left[ \frac{(Fw)^2}{2(2n-1)c_3 \times s \times w} + k + T\ h \right] \left[ \frac{1}{h} \right]}$$

(Ismail et al., 2010)

The cost of operation "LE" is calculated from the following equation:-

Cost of operation = $OS = operating\ \text{time} \times \text{cost in hour}$ (2)

While, the machine number is calculated from the following equation:

Number of machines = $\frac{operating\ \text{time}\ (h)}{dally\ \text{work}\ (h)}$ (3)

## RESULTS AND DISCUSSION

The computer program "W.A.T.L.P.S.I.H." was designed and tested through some collecting data about the different machines and the field areas for wheat crop production operations. The data results drawn as a combine of figures to show and compare how to select the suitable available time for each operation and the corresponding operation cost for different variables such as the field area, field shape, machine width and number.

The program output data was illustrated as combine nomogram related to three main parameters "field area, operating time and cost". Figure (5-A) illustrated the relationship among the field area, operating time and operating machine cost for first tillage (T1), second tillage (T2), leveling (L) and seeder (S) processes at widths of 1.5; 1.5; 2.5 and 2.4 m respectively for the square field shape during using one machine per each process. Also, Figure (5-B) demonstrated the same above relationship but at widths of 3.0; 3.0; 5.0 and 4.8m for the T1; T2; L and S respectively. It is mean use of pair machines per each process.

Generally, from Figures (5-A and 5-B) it is clear that, during increasing the operation width or using two machine for each type the operating time reduced to half and the cost slowly increased. For example, the operating time decreased from 7.805 to 3.916, 6.244 to 3.133, 4.224 to 2.125 and 5.267 to 1.770 h by duplicating the number of used machines per each operation (T1, T2, L and S) at field area of 10 feddans. Also, the total operating times recorded 10.94 and 108.56 h during increasing the field area from 10 to 100 feddans and the corresponding operating cost recorded 1139.88 and 11266.66 LE. Meanwhile, the total operating time and cost using the single machine by increasing field area of 10 to 100 feddans increased from 21.79 to 217.06 h and from 1140.58 to 11269.20 LE. These results mean that by duplicating the number of used machines per each operation (T1, T2, L and S) the total operating time decreased by 49.78 and 49.99 % at 10 and 100 feddans respectively and the total operating costs decreased by 0.062 and 0.022 % at 10 and 100 feddans respectively.

Figure (6-A) illustrated the relationship among the field area, operating time and operating machine cost for (T1), (T2), (L) and (S) processes at widths of 2.5; 2.5; 3.5 and 3.15 m respectively for the square field shape during using one machine per each process. Also, Figure (6-B) demonstrated the same above relationship but with using pair machines per each process. Figure (6) dominates the same above trend per each treatment.

At compare the data illustrated in Fig. (5-A) with data in fig. (6-A) it is easy to observe that by increasing the machine width from 1.5; 1.5; 2.5 and 2.4 m to 2.5; 2.5; 3.5 and 3.15 m for operation T1, T2, L and S respectively the total rate of operating time decreased by 0.6; 0.6; 0.72 and 0.8 times at square field shape.

Figure (7-A) presented the relationship between the field areas and each of operating time and cost for (T1), (T2), (L) and (S) processes at width of 1.5; 1.5; 2.5 and 2.4 m respectively for the rectangular field shape during using one machine per each process. Also Fig. (7-B) indicated the same above variables but using pair machines per each process. As the field area increased from 10 to 100 feddans the total operating times (T1, T2, L and S) were 10.88 and 108.51 h and the corresponding operating costs were 1234.05 and 12307.95 LE during using pair machines per each process.

Meanwhile, during using one machine per each process the accumulative operating time and cost are 21.73 and 217.02 h and 1232.25 and 123.700 LE. And the same conditions These results mean that, using pair machines per each process, the total operating time decreased by 49.92 and 50.00 % at 10 and 100 feddans respectively and the total operating costs decreased by 0.146 and 0.008 % at 10 and 100 feddans respectively

Figure (8-A) illustrated the relationship among the field area, operating time and operating machine cost for (T1), (T2), (L) and (S) process at width of 2.5; 2.5; 3.5 and 3.15 m respectively for the rectangular field shape during using one machine per each process. Also, Figure (8-B) demonstrated the same above relationship but with using pair machines per each processes. Figure (8) dominates the same above trend per each treatment.

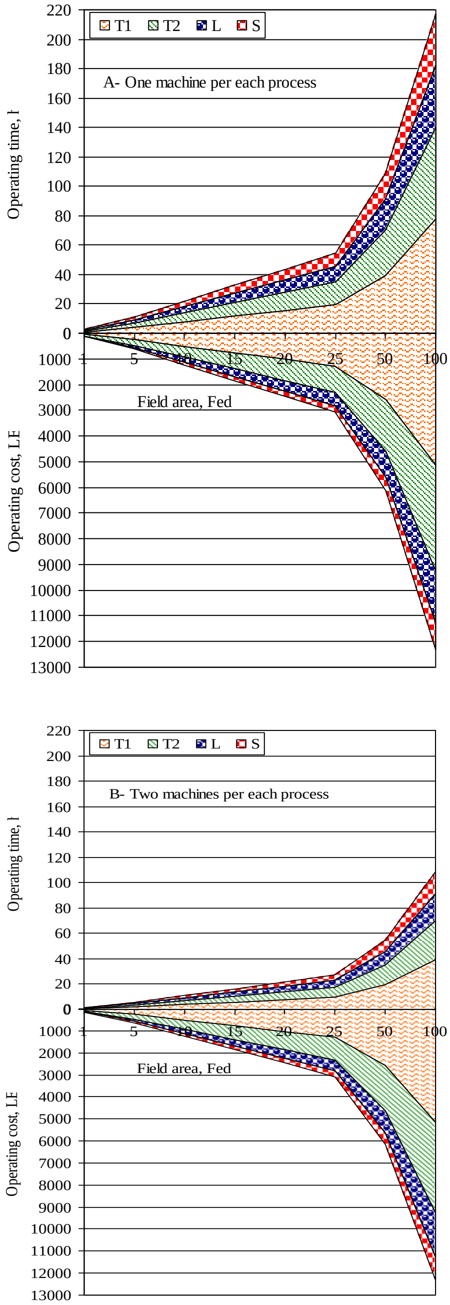
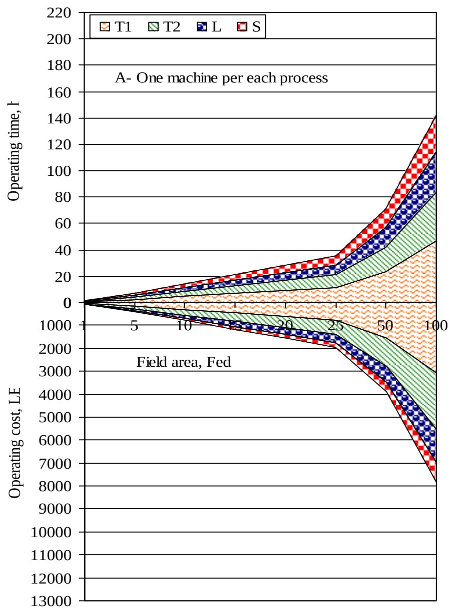



**Fig. 5: The accumulative curve for operating time and cost via square field area at (T1), (T2), (L) and (S) processes at widths of 1.5; 1.5; 2.5 and 2.4 m respectively**



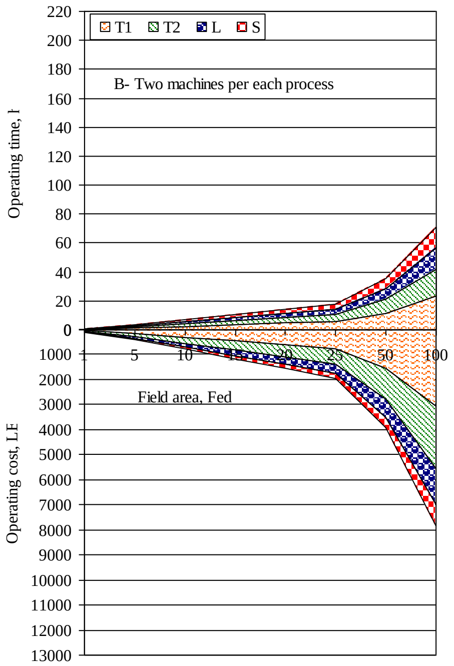
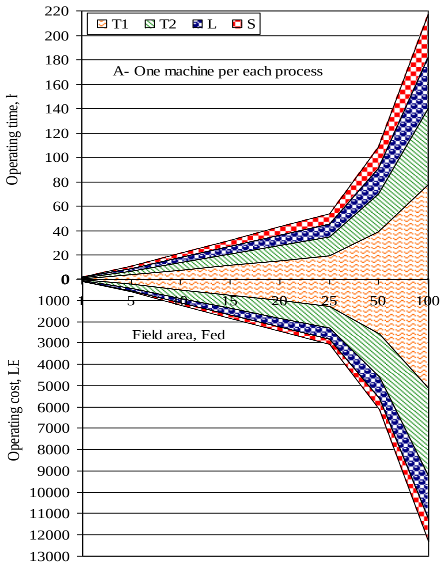




**Fig 6: The accumulative curve for operating time and cost via square field area at (T1), (T2), (L) and (S) processes widths of 2.5; 2.5; 3.5 and 3.15 m respectively.**



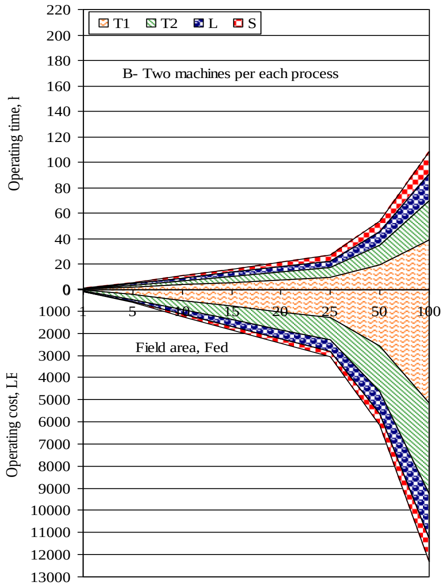




**Fig 7: The accumulative curve for operating time and cost via rectangular field area at (T1), (T2), (L) and (S) process width of 1.5; 1.5; 2.5 and 2.4 m respectively.**

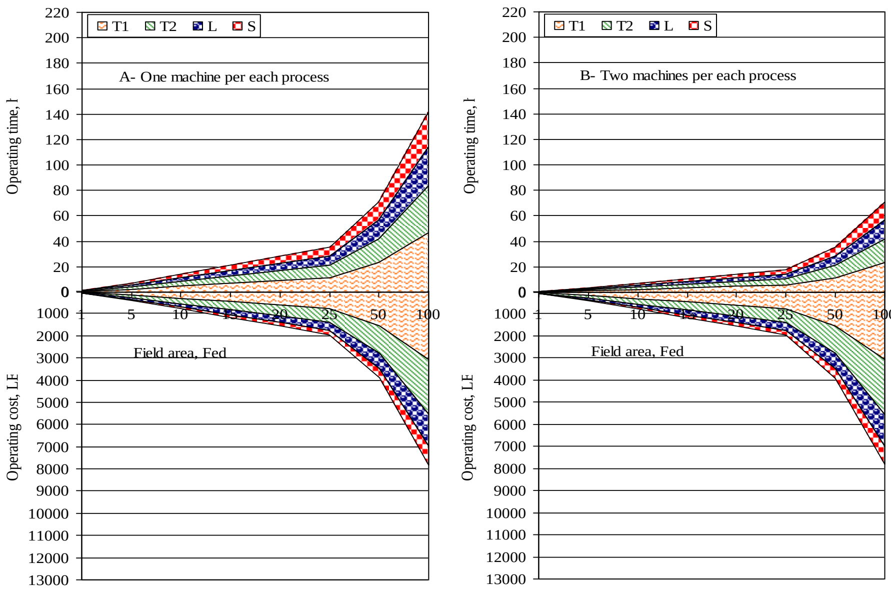



**Fig 8: The accumulative curve for operating time and cost via rectangular field area at (T1), (T2), (L) and (S) process widths of 2.5; 2.5; 3.5 and 3.15 m respectively.**

The second group of output data was illustrated as combine relationship related to three main parameters "field area, operating time and cost" during manure spreader, irrigation and harvesting wheat crop. Figure (9-A) illustrated the relationship among the square field area, operating time and operating machine cost for irrigation (I), manure spreader (M) and harvesting (H) at discharge of 321 $m^3$/min; and widths of 1.5 and 1.5 m respectively for the square field shape during using one machine per each process. Also, Figure (9-B) demonstrated the same above relationship but with using pair machines for irrigation (I), manure spreader (M) and harvesting processes.

The accumulate operating time and cost, at increasing the square shape area from 10 to 100 feddans, were 50.12 and 500.08 h and 1953.83 and 19318.49 LE respectively during (I); (M) and (H) of 321 $m^3$/min; 1.5 and 1.5 m respectively (Figure - 9-A). Meanwhile, increasing the field area from 10 to100 feddans, accumulate operating times were 25.14 and 250.25 h and the corresponding operating costs were 1986.41 and 19420.01 LE at the above conditions (9-B). Also, Figure (10-A) dominated the accumulative curve for operating time and cost via square field area for irrigation (I), manure spreader (M) and harvesting (H) at discharge of 609 $m^3$/min and widths of 2.5 and 2.5 m respectively during using pair machine per each process. Comparing the data illustrated in Figs (9-A) with data in (10-A) it is easy to observe that increasing the machine width from 1.5 to 2.5m for operation M and H the total rate of operating time decreased by 0.72 and 0.8 times at square field shape.

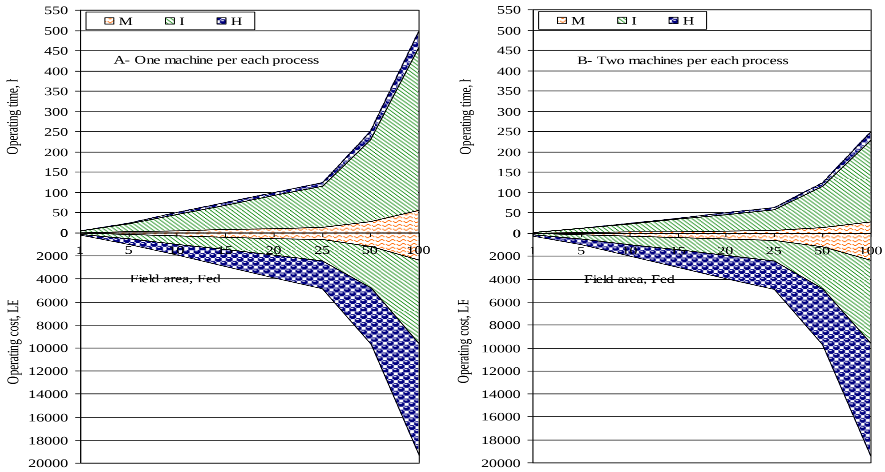



**Fig. 9: The accumulate curve for operating time and cost via square field area at (I); (M) and (H) process of 321 m$^3$/min discharge and 1.5 and 1.5 m width respectively.**

Figure (11-A) illustrated the relationship among the rectangular field area, operating time and operating machine cost for irrigation (I), manure spreader (M) and harvesting (H) at 321 discharge of m$^3$/min and widths of 1.5 and 1.5 m respectively for the rectangular field shape during using one machine per each process. Also, Figure (11-B) demonstrated the same above relationship but with using pair machines for irrigation (I), manure spreader (M) and harvesting processes.

The accumulate operating time and cost, at increasing the rectangular shape area from 10 to 100 feddans using one machine was 50.03 and 499.80 h and 1933.04 and 19254.15 LE respectively during (I); (M) and (H) of 321 m$^3$/min; 1.5 and 1.5 m respectively (figure -11-A). Meanwhile, increasing the field area from 10 to100 feddan, accumulate operating time was 25.04 and 249.98 h and the corresponding operating cost was 1944.89 and 19291.34 LE at the above conditions (11-B).

Also, Figure (12-A) dominated the accumulative curve for operating time and cost via square field area for irrigation (I), manure spreader (M) and harvesting (H) at discharge of 609 m$^3$/min; 2.5 and 2.5 m widths respectively during using pair of machine per each process are 132.58 and 135.33 h and 1124.21 and 11075.49 LE respectively at 10 to 100 feddan. Meanwhile, using one machine, by increasing the field area from 10 to100 feddans, accumulate operating times were 27.09 and 270.52 h and the corresponding operating costs were 1111.53 and 11037.61 LE at the above conditions (12-B).

Comparing the data illustrated in Figs (11-A) with data in (12-A) it is easy to observe that increasing the machine width from 1.5 to 2.5m for operation M and H the total rate of operating time decreased by 0.72 and 0.8 times at square field shape.

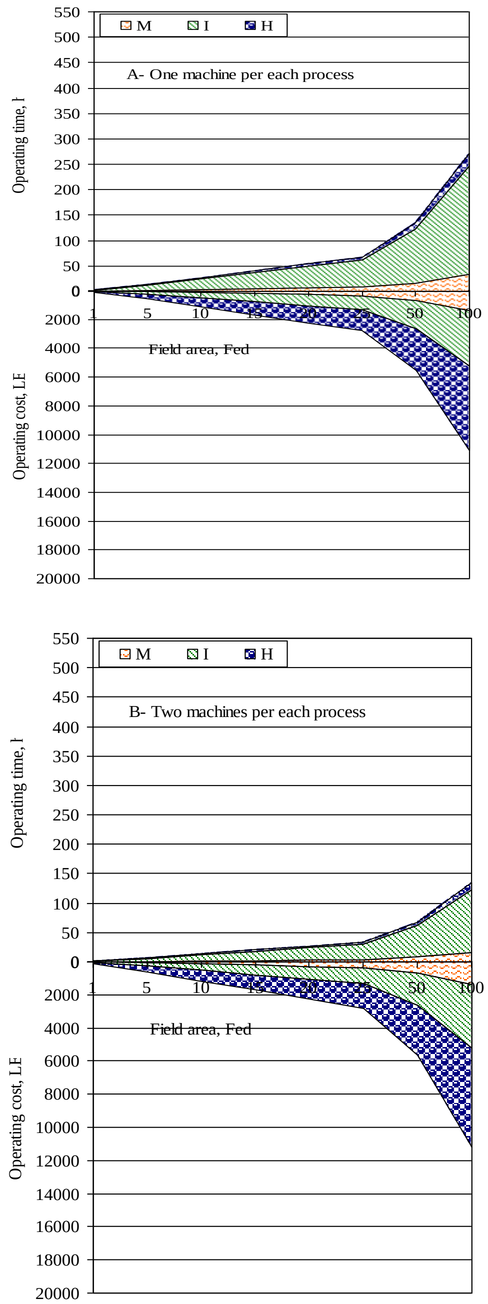
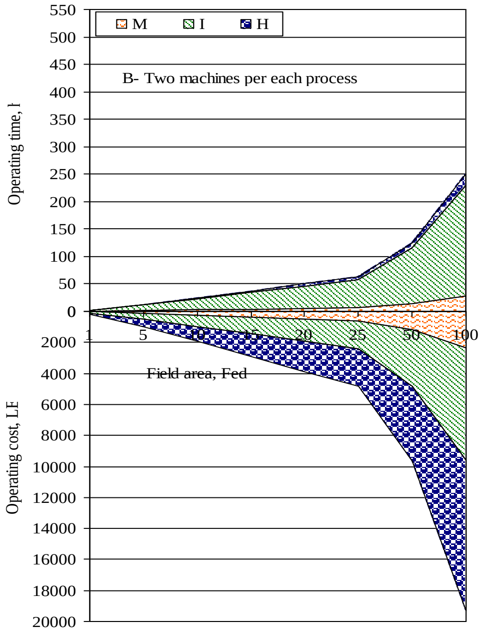



**Fig. 10: The accumulative curve for operating time and cost via square field area at (I); (M) and (H) process of 609 $m^3$/min discharge and2.5 and 2.5 m widths respectively.**



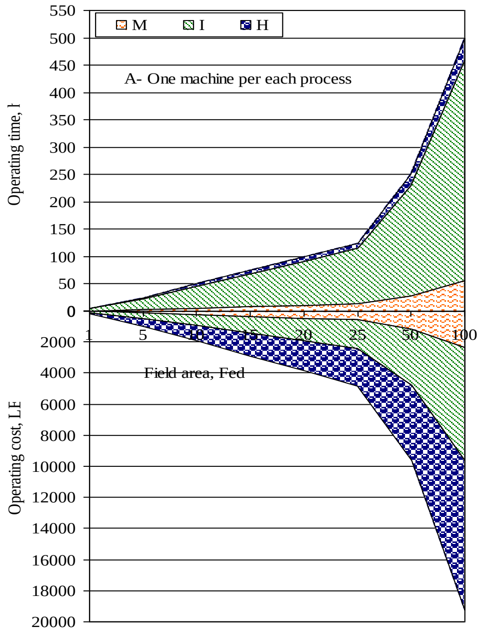




**Fig. 11: The accumulative curve for operating time and cost via rectangular field area and first machine widths at different maintenance machines operations.**

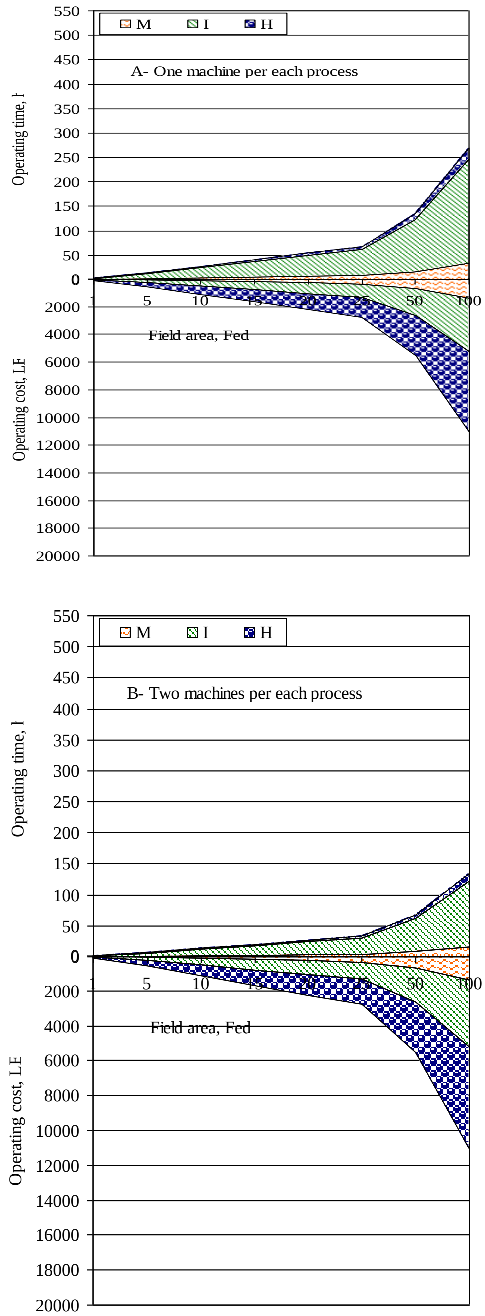



**Fig. 12: The accumulative curve for operating time and cost via rectangle field area and third machine widths at different maintenance machines operations.**

## CONCLUSION

The research concluded that the matching integrated system, which decreases operating time and cost for wheat mechanization using the “W.A.T.L.P.S.I.H.” program to be used for selecting the suitable machine width and number. The integrated system show that the increase in machine width by 60 %, the operating time decreased by 65.60 and 59.92% respectively at square and rectangular field shapes, also the operating cost decreased by 66.48 and 60.99% at the corresponding field shapes. Therefore, the increase in machine width by 60 %, the operating time decreased by 65.56 and 54.25% respectively at square and rectangular field shapes, also the operating cost decreased by 69.38 and 57.95% at the corresponding field shapes. The software program can be applied at service stations mechanism to determine the best automation system at the lowest cost and in the time available for the farmer

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## إستخدام برنامج بسيط في الإدارة المتكاملة لميكنة انتاج القمح

**هشام ناجى عبد المجيد ، محمد ماهر محمد إبراهيم و ولاء طلعت إسماعيل**
**قسم الهندسة الزراعية – كلية الزراعة – جامعة المنصورة**

يهدف البحث إلى إختيار نظام متكامل يعتمد على مساحة الحقل والوقت المتاح لكل عملية زراعية لإنتاج القمح. وقد تم إستخدام برنامج البيزك المرئى (Visual Basic) لتصميم برنامج بسيط يتم من خلاله إدخال بيانات عن عمليات إنتاج القمح. والبرنامج المصمم يتكون من ثلاث برامج ثانوية تشتمل على العمليات الأساسية لإنتاج القمح وهى عمليات الحرث، التسوية، الزراعة، التسميد العضوى، الرى والحصاد. ويتم من خلال حسابات البرنامج إختيار أنسب عدد ومواصفات للآلات الزراعية يمكن إستخدامها للحصول على الخدمة المطلوبة فى أقل وقت وبأقل تكاليف. وقد تم إختبار البرنامج تحت متغيرات تشتمل على عرض الآلات (ثلاث عروض تشغيل)، وعدد الآلات (آلة واحدة – آلتين)، ومساحة الحقل (ثمان مساحات)، شكل الحقل (مربع - مستطيل). ونتج من خلال إختبار البرنامج الفرعى الخاص بإختبار آلات إعداد التربة والزراعة ( T1, T2, L and S) أن زيادة عرض تشغيل الآلة بحوالى ٦٠% أدى إلى إنخفاض زمن إتمام العمليات الزراعية بنسبة ٦٥.٦٠، ٥٩.٩٢ % لكل من الأرض المربعة والمستطيلة على التوالى. فى حين إنخفضت تكاليف التشغيل بنسبة ٦٦.٤٨، ٦٠.٩٩% لكل من الأرض المربعة والمستطيلة على التوالى. وعند إختبار البرنامج الفرعى الخاص بإختبار آلات خدمة المحصول النامى والحصاد ((M, I and H) أن زيادة عرض تشغيل الآلة بحوالى ٦٠% أدى إلى إنخفاض زمن إتمام العمليات الزراعية بنسبة ٦٥.٥٦، ٥٤.٢٥% لكل من الأرض المربعة والمستطيلة على التوالى. فى حين إنخفضت تكاليف التشغيل بنسبة ٦٩.٣٨، ٥٧.٩٥% لكل من الأرض المربعة والمستطيلة على التوالى. وعليه فإنه يمكن تطبيق إستخدام البرنامج المصمم فى محطات الخدمة الآلية لتحديد أفضل نظام ميكنة بأقل تكاليف وفى الوقت المتاح للمزارع.

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