CONSTRUCTION OF "WAMTLISH" PROGRAM TO INTEGRATE MACHINES FOR WHEAT PRODUCTION

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ABSTRACT

The present research aimed to select the suitable integrated machines for wheat production depending on the field area and available time for each operation. A Visual Basic program "WAMTLISH" is used to calculate the information from the wheat operating systems. This program is divided into three main subroutines to be worked on the main wheat production processes including; manure spreaders, tillage, leveling, irrigation, seeding, and harvesting to select machine number and specifications that recognized to give obtain the minimum operating time and cost. The program has been tested in a case study where machines width, field area and field shapes. The research established that the increases in machine width by 60 % for square and rectangle field shape the operating time decreased by 65.60 and 59.92% and the operating cost decreased by 66.48 and 60.99% respectively. The program is easy to give quake and fit information about the numbers and operating width for all needed wheat production machines. For example, the numbers of required machines to plant 25 feddan per two days (16 h) are three chisel plows for first and two for second tillage, two levelers, one seeder, two manure spreader and two combine harvester with operating width of 1.25m; 1.25m; 2.5m; 1.5m; 2.4 and 1.5 and with 3.6 km/h; 4.5 km/h 4.0km/h; 5.0km/h; 5.0km/h and 7.0km/h respectively. Furthermore, the total operating costs is 2881.1 L.E. The program can be applied at service stations to determine the best automation system at the lowest cost and in the available time for the farmer.

INTRODUCTION

Agricultural mechanization is a key input to agricultural production where it embraces the use of tools, implements, and machines for agricultural development. In Egypt, the use of mechanization in agriculture has significantly increased. The integrated management of mechanized farms using manure distribution, plowing, leveling, irrigation,

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seeding and harvesting machines basically achieved to select the suitable machine for field to realize highest production with low costs. **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 crop.

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.

Hunt (2002) indicated that most management decisions for farm machinery involve an accurate knowledge of costs, and maintaining an accurate record of costs is an indispensable part of the machinery manager’s job. But such records are not being used to their maximum extent unless these records are also used to aid in decision- making processes that are the core of good machinery management. Therefore, the logical solution for this issue is to ensure such as these organizations with different facilities which are vital to facilitate a decision-making process for different field machinery. Certainly, one of the most efficient facilitations is that of implementing a computer-based information system for agribusiness management **(Batte, 2005)**.

Making replacement decisions for agricultural machinery needs both a reliable computerized information system of machinery cost data and a systematic approach to determine the optimum time of replacement. Such requirements, nonetheless, which are paramount for decision-making, are not applicable to different fleets of field machinery in the Agricultural Mechanization Stations, and consequently the machinery manager faces the risk of a machine failing at a crucial time.

Therefore, the overall objective is to present a user-friendly computer program called “WATLSMIH”. This name is relative to the employment steps for wheat crop production. Also, this program will aid the managers of agricultural mechanization making the decisions of replacement and use the farm machineries depending on field area and the available time of each operation for different wheat mechanization systems.

METHODOLGY

On the base of Visual basic and Minitab programs the "WAMTLISH" program is designed to calculate and draw the critical specified information for wheat production. The wheat production operations such as soil bed preparation, planting, irrigation and harvesting machines need to be a good combination of equipment that are commensurate with the farm size and equipment operators. So, the steps to compute the program of wheat production, the overall field capacity, operating time and costs for all operation are identified. The steps of main program as input and output items were documented as follows:

1): The input data divided into two main partitions the first are information from the field area, available time (T), field dimensions (Fdd). The second is that, the information from the user (engineer) as machine working speed (S, m/s), working width (w), number of turning (n), field width (Fw), turnings on treatment of headland (k) and time of adjustments, control, tending of machine, etc (T).

2): The "WAMTLISH" program was prepared to calculate and draw the output for operating time and cost (Os) for all operations under study.

3): The output data suggesting the optimum integrated mechanization system information as machine type, operating cost and total operating time.

The soil texture in Dakahlia Governorate mostly is clay loam. This texture and the soil mechanical analysis are Silt of 47.50%; Clay of 27.25%; Fine sand of 21.85%; Coarse sand of 3.4% and $CaCo_2$ of 2.95% at depth of 15 cm.

The specifications of implements in experiments were:

1) Chisel plows working width of 150- 200- 250 cm in two rows, forward speed of 3.6 – 4.5 km/h and 3 hitch points
2) Hydraulic leveler with operating width of 2.5–3.0–3.5 m and forward speed of 4 km/h.
3) Seeder working width of 2.40 - 2.75– 3.15 m; planting rows spacing of 15cm and forward speed of 5 km/h.
4) Irrigation pump with 420 – 575 - 640 - 800 rpm to give flow rate of 609; 485; 435; 321L/min respectively at differential pressure of 50 psi.
5) Combine harvester with drum diameter of 0.61 m threshing drum length of 1.02 m and forward speed of 1.0 – 3.0 – 5.0 – 7.0 km/h and engine power of 103-117kW and grain tank volume of 6.0 kg/s paddy.

RESULTS AND DISCUSSION

Overview of wheat production areas

Wheat is extensively grown in all the most of Egypt Governorates. Dakahlia is one of the famous Governorates in planting wheat owing to wheat area represents about 300,025 feddan produced about 6.07 million ton with average rate of 20.23 ardab/feddan. At the last six years, the cultivated wheat area identified as shown in figure (1). From figure, it can be clear the wheat area decreased from 336 517 feddan in 2006 to 300 025 feddan in 2011. The figure (2) illustrates the total yield of wheat crop at the same period of years. The total wheat yield also decreased from 7.24 million ton in 2006 to 6.07 million ton in 2011 (**Central Agency for Public Mobilization and Statistics**

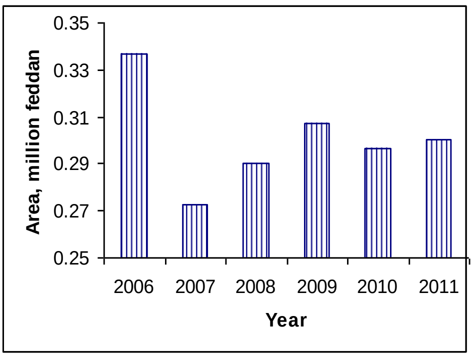

Figure 1: The cultivated wheat area.

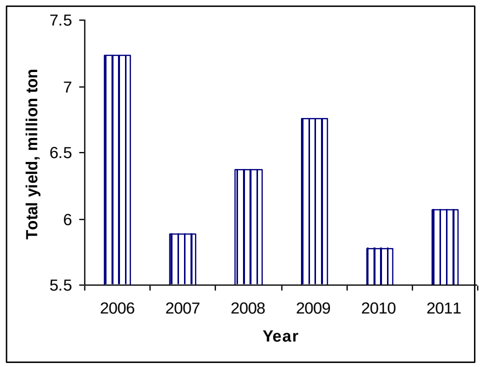

Figure 2: The total yield of wheat crop.

2012). The collected data, for the field size (area per feddan) function for the number of fields in Dakahlia Governorate, are shown in figure (3). From the figure, it can be seen that, the highest field numbers occurred at field size > 1 feddan and the lowest was found at the field size <50 feddan. Also, the figure exemplify that the field area less than 5 feddan is about 90.92 % from the total fields number. Regarding to the collected data for the number of wheat production machines such as plows levelers, manure spreaders, seeders, irrigation pumps and combine harvesting, are shown in figure (4). The figures clear that, the maximum number of machines was found for tillage operation, so the main importance mechanized operations are tillage and irrigation followed by harvesting. Consequently, the other operations have a slightly importance to allow the enough machines as levelers, manure spreaders and seeders because of these operations usually were done manually.

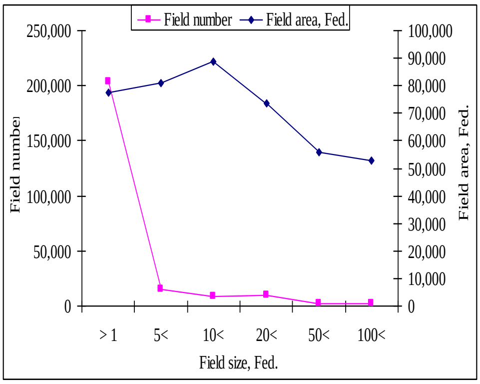

Figure 3: The field size via numb of fields and fields area

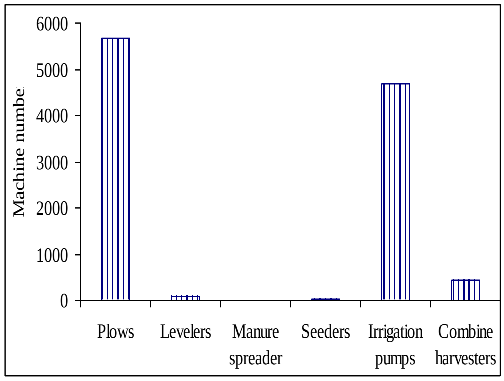

Figure 4: Some machine number Dakahlia Governorate

Program Application

Manure machine in the "WAMTLISH" program

The second group of output data was illustrated as an interdependent relationship related to three main parameters "field area, operating time and cost" during manure spreader. Figures (5-A; 6-A and 7-A) illustrated the relationship among the rectangle field area, operating time and operating machine cost for manure spreader (M) and figures (5-B; 6-B and 7-B) show the effect of operating manure width on above relation. All figures in paper were drawing with data out deviated between “CI” and “PI” guides with non-liner regression according to Minitab program. For example, at field area of 25 feddan; speed of 5 km/h, machine width of 1.5 m then overall spreader field capacity, operating time, operating cost (Os, LE) and number of spreader machines as 1.783 fed/h, 14.014h, 588.599 LE and 1.0 respectively. On the other side, increasing the machine operation width tend to rapidly increases OCM and slowly decreases each of operating time and costs.

Tillage operation in the "WATLMSIH" program

Regarding to “WAMTLISH” program and by substituting data on the window for tillage operations at the optimum plowing speed of 3.6 km/h for the first tillage (T1) and of 4.5 km/h for the second tillage (T2) under field area and width variables, the output data for (T1) at 25 feddan were 1.284 fed/h, 19.45 h and 1284.332 LE for OCT, operating time and costs respectively as shown in figures (8-A; 9-A and 10-A). On the other side, increasing the machine operation width tend to rapidly increases OCT1 and slowly decreases each of operating time and costs as shown in figures (8-B; 9-B and 10-B).

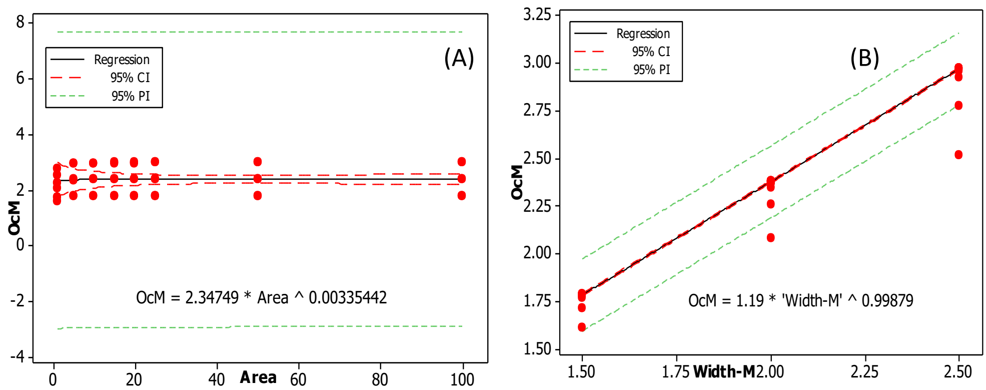

Figure 5:The fitted line plot of overall manure (OCM) vs field area and width

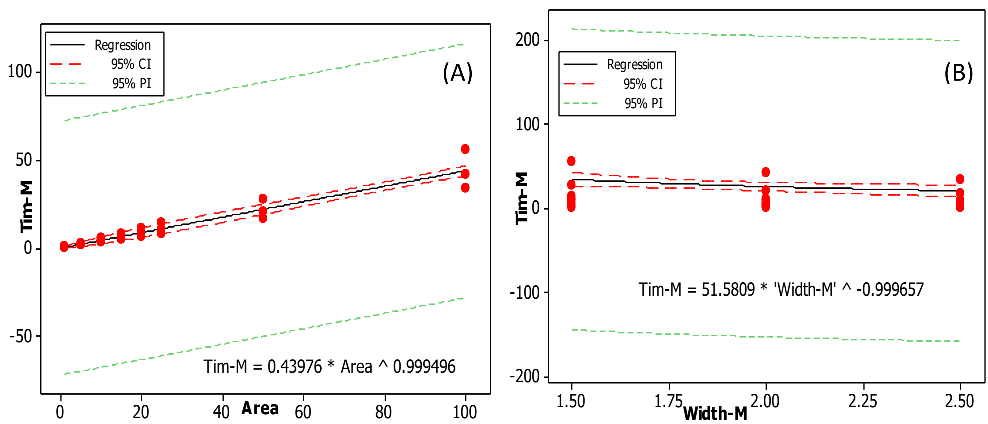

Figure 6: The fitted line plot of manure operating vs field area and width

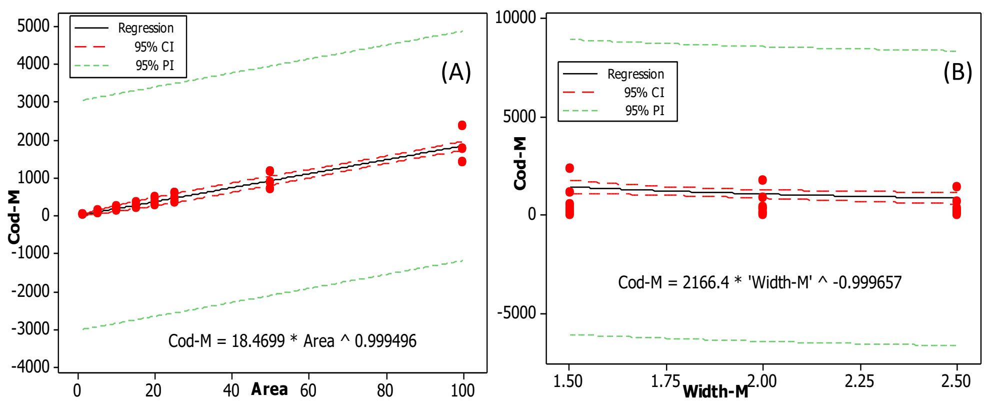

Figure 7: The fitted line plot of the manure cost vs field area and width

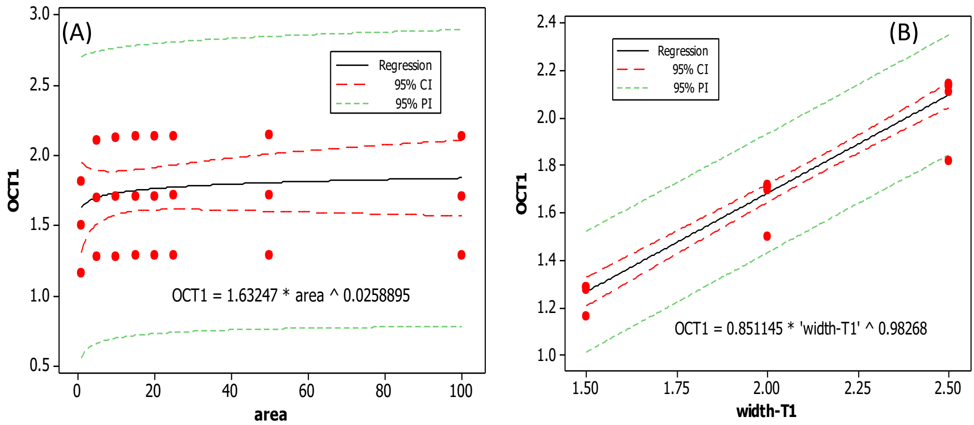

Figure 8: The fitted line plot of the overall tillage field efficiency (OCT1) vs field area and tillage width at first tillage

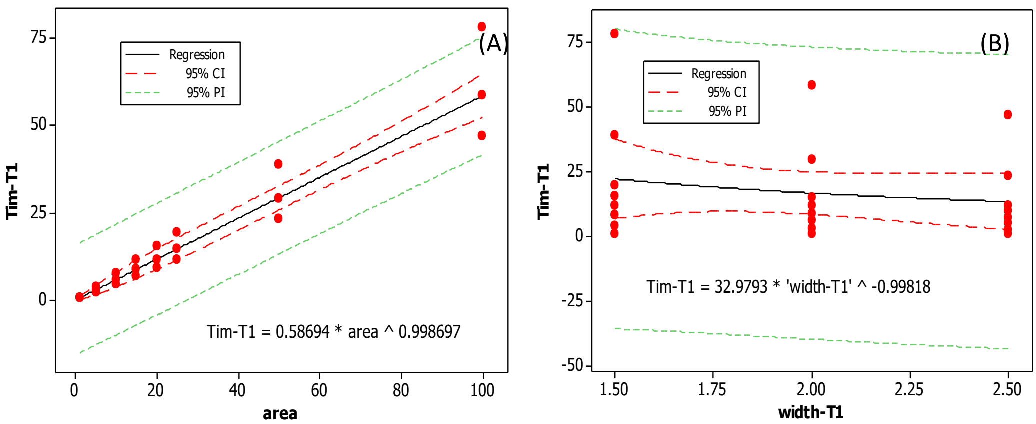

Figure 9: The fitted line plot of the overall time (T1) vs field area and tillage width at first tillage

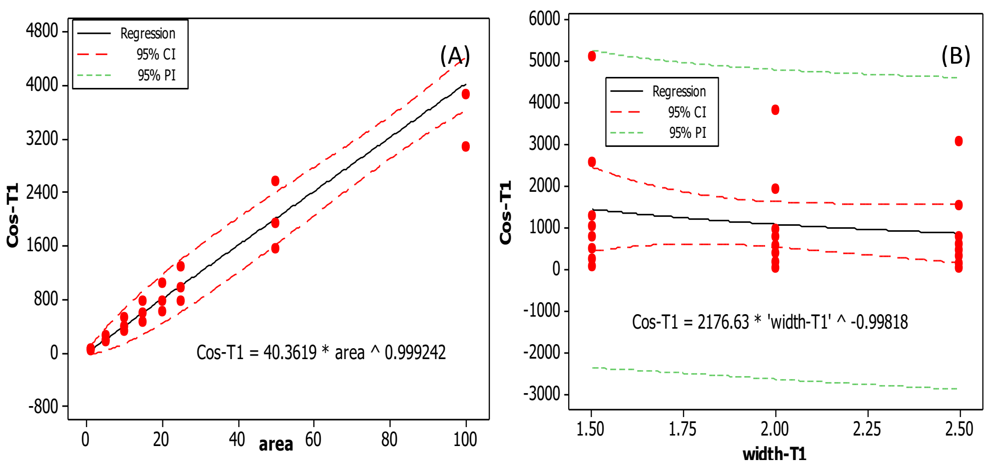

Figure 10: The fitted line plot of cost-T1 vs field area and tillage width at first tillage

But for second tillage (T2), the output dada were 1.604 fed/h, 15.58 h and 1028.57 LE for overall field capacity, operating time and operating costs respectively as shown in figures (11-A; 12-A and 13-A). Also, the same trend was found as study the relationship between data output and tillage width.

For example at increases the operating tillage width from 1.5 to 2.5 the overall field capacity increased by 1.73 time while operating time deceased by the same ratio (1.73 time) and operating costs decreased by 1.72 time per one feddan. On the other side, increasing the machine operation width tend to rapidly increases OCT2 and slowly decreases each of operating time and costs as shown in figures (11-B; 12-B and 13-B).

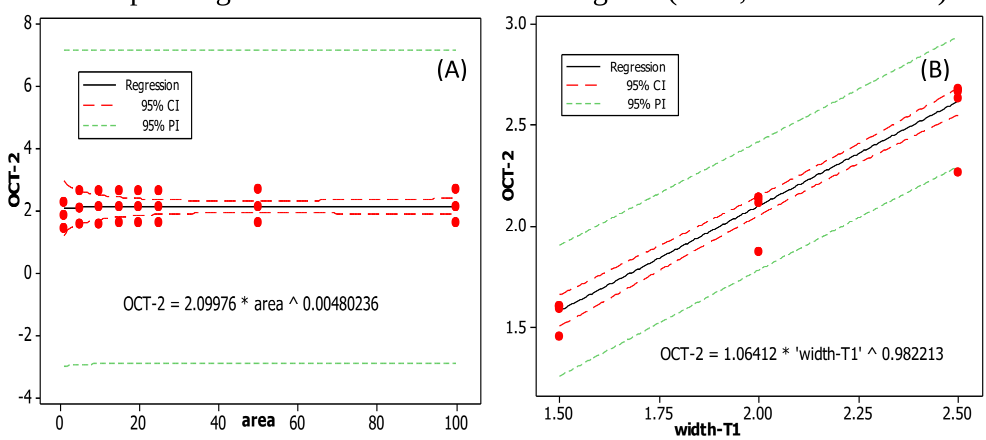

Figure 11: The fitted line plot of the overall tillage field efficiency (OCT2) vs field area and tillage width at second tillage

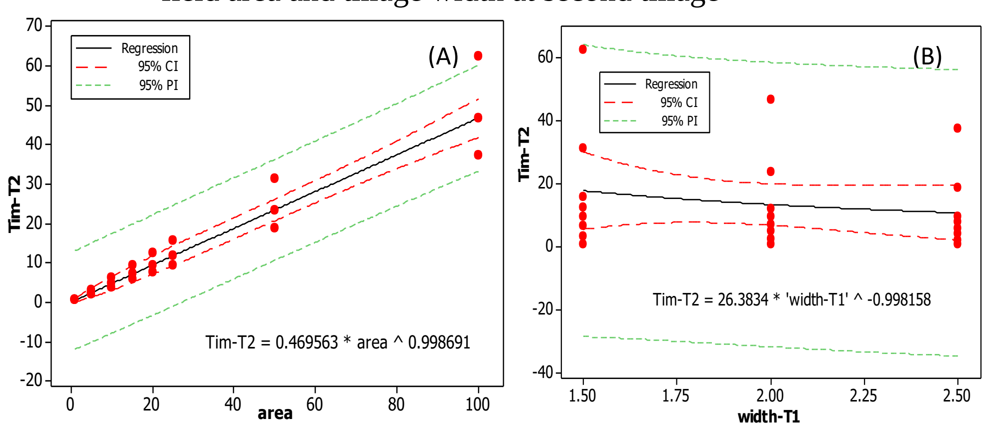

Figure 12: The fitted line plot of the overall time (T2) vs field area and tillage width at second tillage

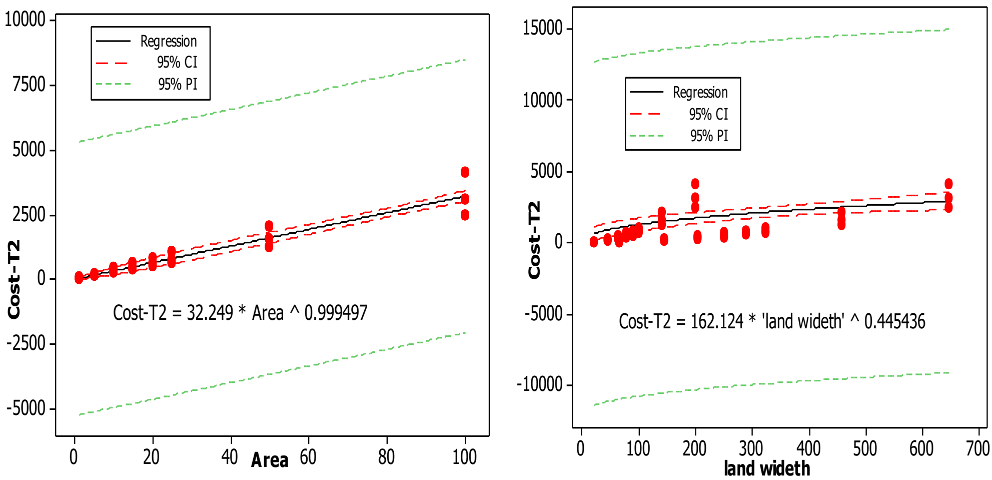

Figure 13: The fitted line plot of Cost-T2 vs field area and tillage width at second tillage

Leveler in the "WAMTLISH" program

The operation condition during leveler operated were leveler speed of 4.0 km/h, machine width of 2.5m and field length of 324.03m. The result of program under this condition recorded the 2.376 fed/h, 10.517h, 504.859 LE and 2 unit for overall field capacity (OCL), operating time (Ot) and operating cost (Os) and unite number respectively at 25 feddan as area under operating shown in figure (14-A; 15-A and 16-A). Also, at increases the leveler width the Oc-L direct increases and each of Time-L and C-L slowly decreases. On the other side, increasing the machine operation width tend to rapidly increases OCT1 and slowly decreases each of operating time and costs as shown in figures (14-B; 15-B and 16-B) and regarding to "WATLMSIH" program. During increasing the operation width for leveler the operating time reduced to half and the cost slowly increased. For example, the operating time decreased from 4.224 to 2.125 h by increasing the operation leveler width twice it mean the duplicating the number of used machines per operation.

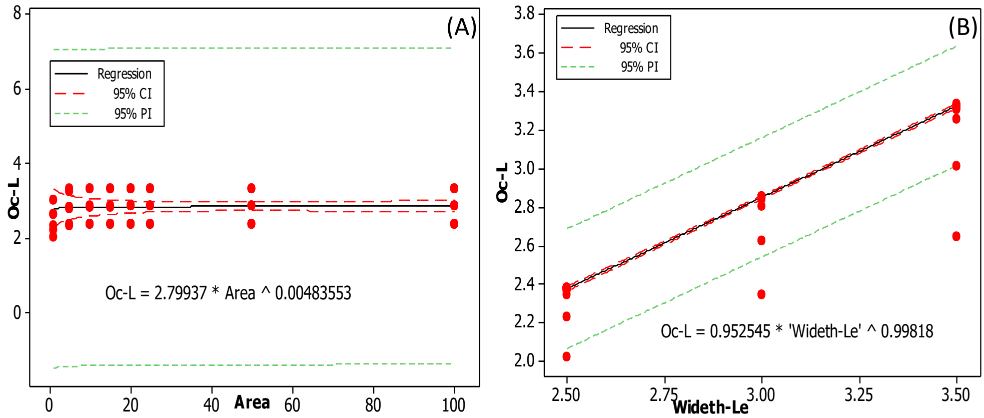

Figure 14: The fitted line plot of the overall leveler machine (OCL) vs field area and leveler width

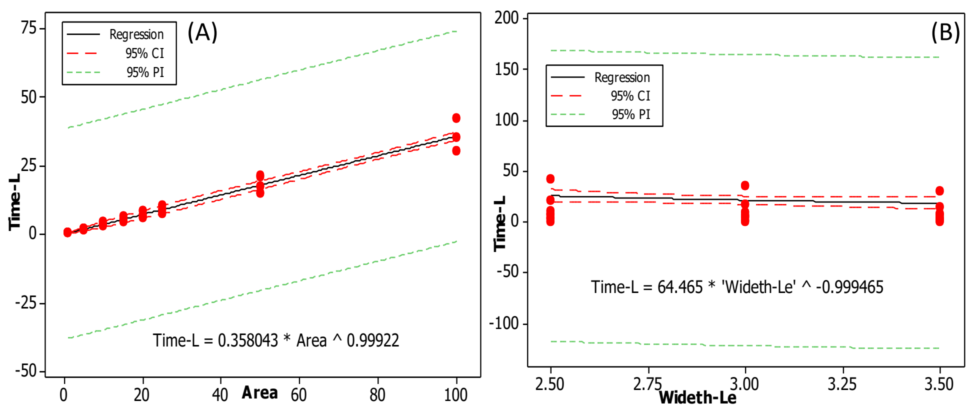

Figure 15: The fitted line plot of the time-L vs field area and leveler width

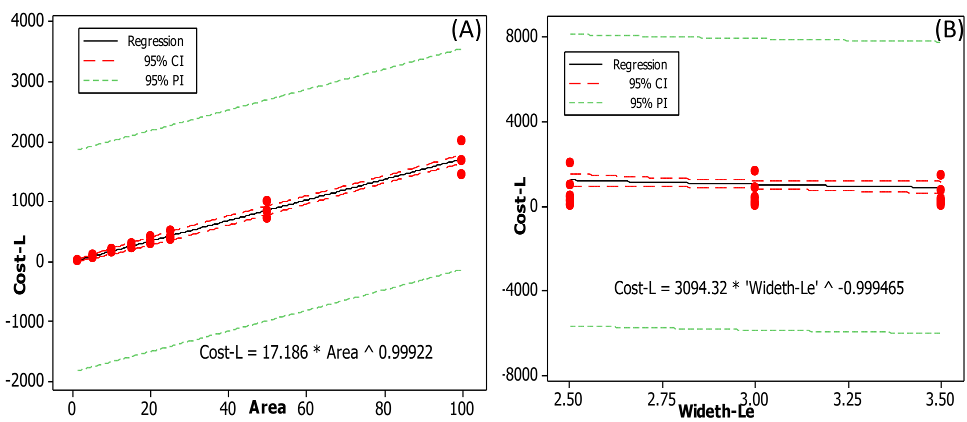

Figure 16: The fitted line plot of the leveler cost vs field area and leveler width

Irrigation operations in the "WAMTLISH" program

By substituting in program as 25 feddan field area and pump discharge of 321 and average yield of 22 kg the (OCI = 3.715 fed/h, Tim-Irri =100.928h, Cost-Irri=1816.70, and Qn=1687.7 m^3/fed. Regarding to figures (17-A; 18-A and 19-A) the OCIrri is directly increases with increases the field area and operating time and cost are slowly increases with increases Tim-irri and Cos-Irri during irrigation the wheat field. Also, data in figures (17-B; 18-B and 19-B) indicated that by increasing Qirri tend to rapidly increases OCIrri and slowly decreases each of operating time and costs.

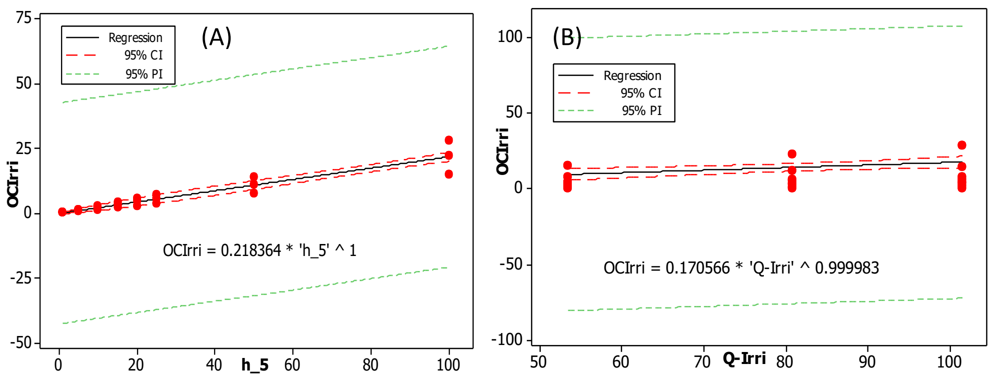

Figure 17: The fitted line plot of the overall irrigation vs field area and pump discharge

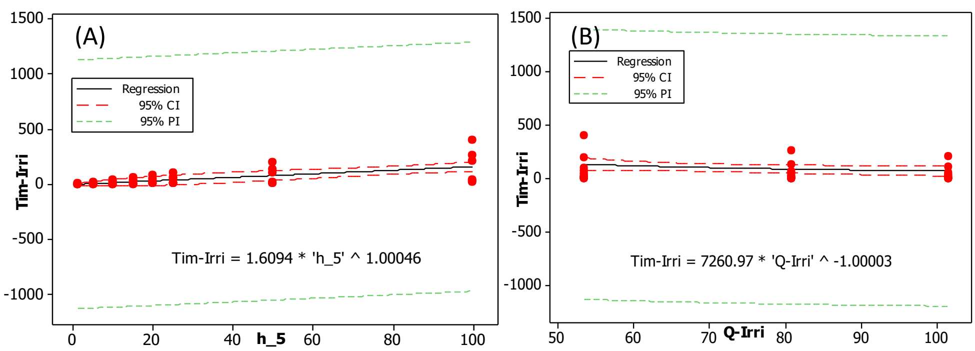

Figure 18: The fitted line plot of operating time of irrigation vs field area and pump discharge

Seeder machine the "WAMTLISH" program

The obtained data for seeding machine using the program are OC-S = 2.852 fed/h, Time-S=8.764 h and Cost-S = 262.930 LE, per planting 25 feddan. Generally, from figures (20-A; 21-A and 22-A) and (20-B; 21-B and 22-B) it is clear that, increasing operation width the operating time reduced to half and cost slowly increased. For example, operating time decreased from and 5.267 to 1.770 h by increasing the number of used seeder machines twice at field area of 10 feddan.

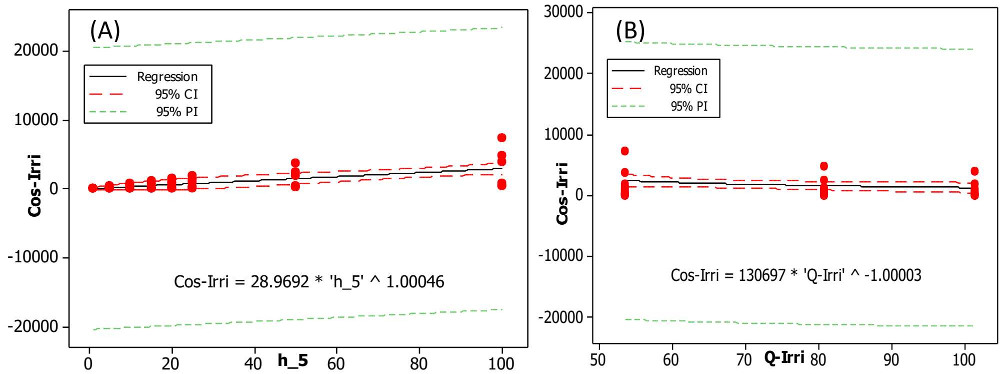

Figure 19: The fitted line plot of the irrigation cost vs field area and pump discharge

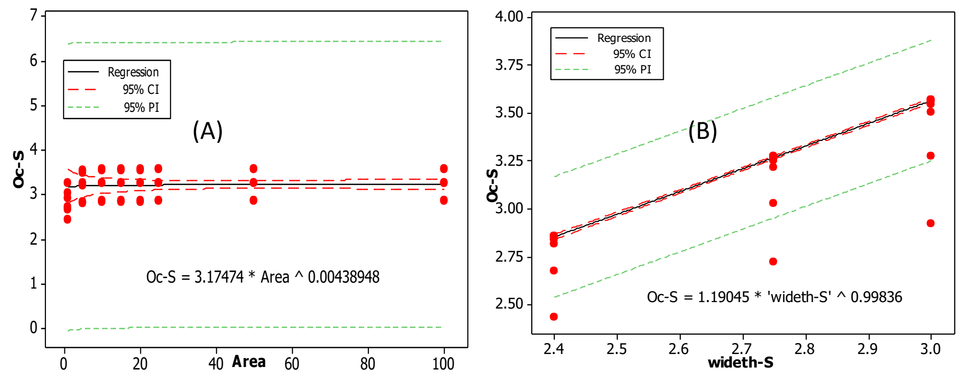

Figure 20: The fitted line plot of the overall seeding machine (OC-S) vs field area and width

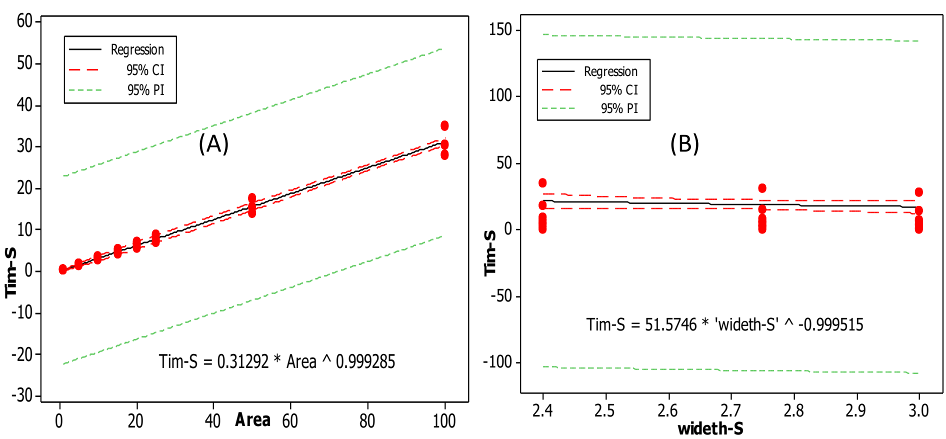

Figure 21: The fitted line plot of the time of seeding machine vs field area and width

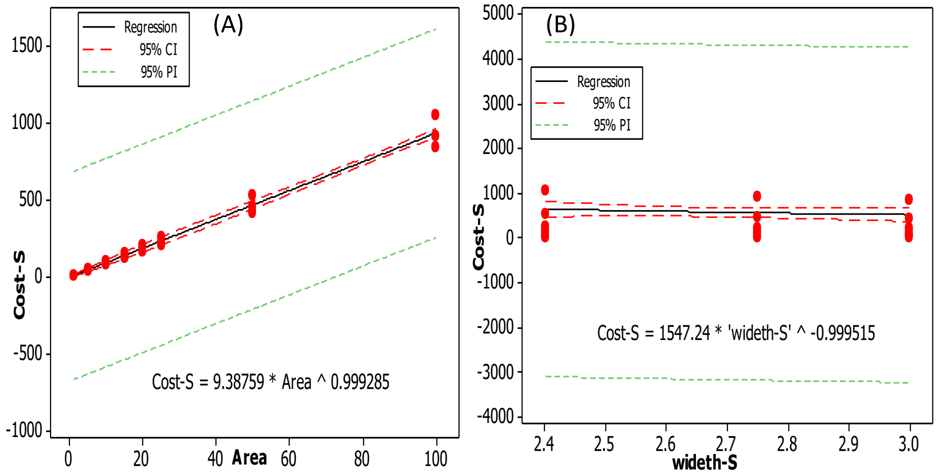

Figure 22: The fitted line plot of the seeding machine cost vs field area and machine width

Regarding to "WAMTLISH" program, the total operating times for each of (T1, T2, L and S) 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 single machine increased from 21.79 to 217.06 h and from 1140.58 to 11269.20 LE at increasing field area from 10 to 100 feddans. These results mean that by duplicating the number of used machines per operation (S) total operating time and total operating costs decreased by 6.2 and 2.2 % for 10 and 100 feddan respectively.

Harvesting operations in the "WAMTLISH" program

The overall harvesting field capacity (OCH, fed/h), operating time (OtH), operating cost (OsH, LE) and number of harvesting machines (Mn) was found as OCH = 2.444 fed/h, OtH = 10.204 h, OsH = 2449.08LE, and Mn = 2 respectively at substitute in "WAMTLISH" program with harvesting machine of 7km/h; cutting width of 1.5 m; cutting bar of 0.9m field area of 25 feddan.

Regarding to figures (23-A; 24-A and 25-A) the OCH is directly increases with increases the field area. But operating time and cost are slowly increases with increases Tim-Ha and Cos-Ha during wheat harvesting. Meanwhile, data in figures (23-B; 24-B and 25-B) indicated that increasing harvesting width tend to rapidly increases OCH and slowly decreases each of operating time and harvesting costs.

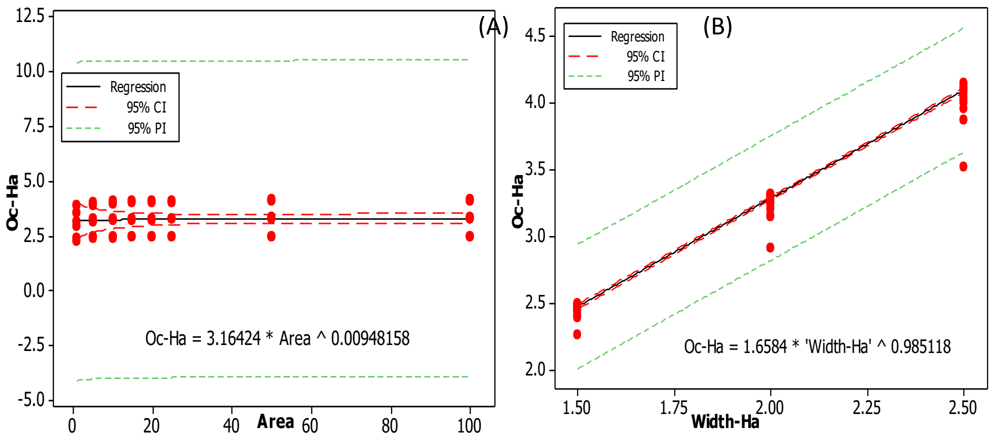

Figure 23: The fitted line plot of the overall harvesting vs field area and width.

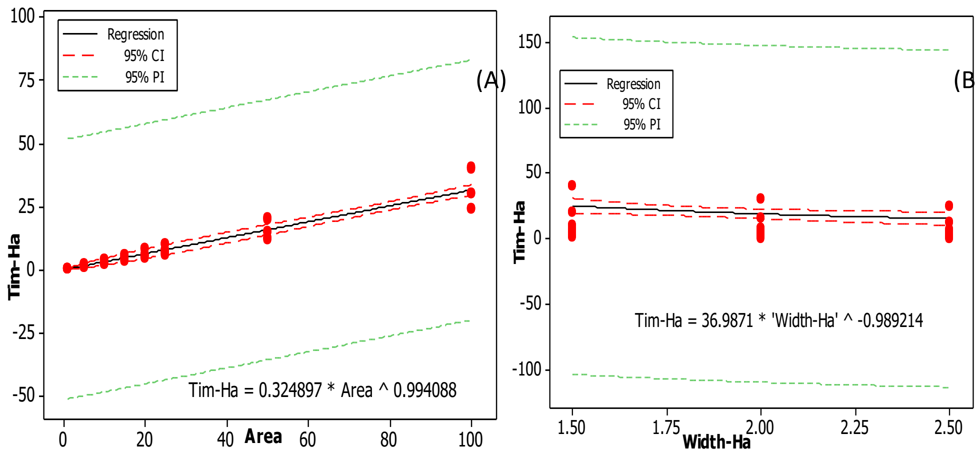

Figure 24: The fitted line plot of operating time of harvesting vs field area and width.

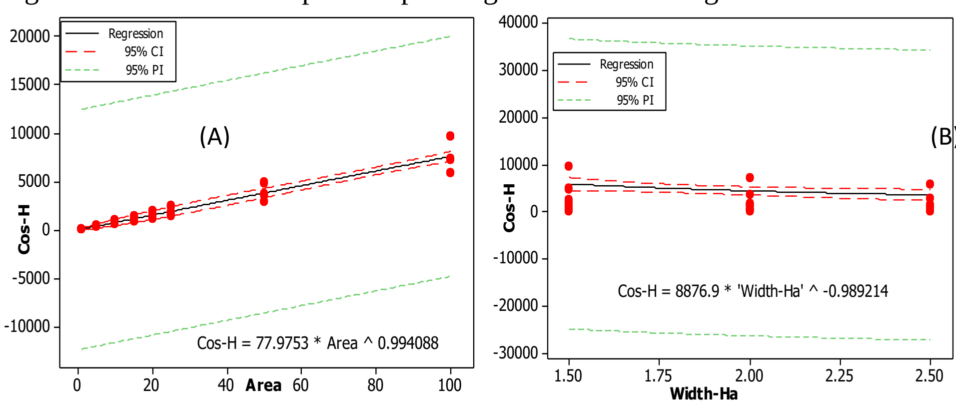

Figure 25: The fitted line plot of the harvesting cost vs field area and width.

CONCLUSION

The constructed program “WAMTLISH” has many advantages; simplicity to use from Agric. Service Stations, stability to change the both of inputs values, reliability for many different mechanized operations. Also, The program can be applied at service stations to determine the best automation system at the lowest cost and in the available time for the farmer. For example, the numbers of required machines for fulfilling 25 feddan per two days (16 h) are three chisel plows for first and two for second tillage, two levelers, one seeder, two manure spreader and two combine harvester with operating width of 1.25m; 1.25m; 2.5m; 1.5m; 2.4 and 1.5 and 3.6 km/h; 4.5 km/h 5.0 and 7.0km/h respectively. Furthermore, the total operating costs is 2881.1 L.E. The program can be applied at service stations to determine the best automation system at the lowest cost and in the available time for the farmer.

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الملخص العربى

بناء برنامج للميكنة المتكاملة لإنتاج القمح

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يهدف هذا البحث إلى تحديد نظام متكاملة يناسب إنتاج محصول القمح معتمداً على مساحة الحقل والوقت المتاح لكل عملية زراعية. حيث تم بناء برنامج "WAMTLISH" على لغة البيزك المرئى "Visual Basic" لحساب المعلومات من نظم التشغيل لإنتاج القمح.

١- أستاذ تكنولوجيا القوى والآلات - قسم الهندسة الزراعية – كلية الزراعة – جامعة المنصورة.
٢- مهندسة بكلية الزراعة – جامعة المنصورة.

وينقسم هذا البرنامج إلى ثلاثة أجزاء فرعية تعمل على العمليات الرئيسية لإنتاج القمح والتى تشتمل على؛ توزيع السماد العضوي، الحرث والتسوية والري والتسطير، والحصاد لإختيار أنسب عدد ومواصفات الآلات للحصول على أقل وقت تشغيل وأقل تكاليف. وقد تم اختبار البرنامج كدراسة حالة عند متغيرات عرض الآلات، مساحة وشكل الحقل. وقد خلص البحث إلى أن الزيادة في عرض الآلات بنسبة ٦٠ ٪، إنخفض وقت التشغيل بنسبة ٦٥,٦٠ و ٥٩,٩٢ ٪ لكل من الحقل المربع والمستطيل على التوالى، وكذلك تكلفة التشغيل انخفضت بنسبة ٦٦,٤٨ ٪ و ٦٠,٩٩ عند نفس أشكال الحقل السابقة على التوالى. علاوة على ذلك، فإن الزيادة في العرض الآلة بنسبة ٦٠ ٪ أدى إلى انخفاض وقت التشغيل بنسبة ٦٥,٥٦ و ٥٤,٢٥ ٪ لكل من الحقل المربع والمستطيل على التوالى، وكذلك انخفضت تكلفة التشغيل بنسبة ٦٩,٣٨، ٥٧,٩٥ عند نفس أشكال الحقل السابقة. وعلية يوصى البحث بإمكانية تطبيق البرنامج في محطات الخدمة لتحديد أفضل نظام آلى متكامل بأقل تكلفة وفي الوقت المتاح للمزارعين .