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Implementation Web Decision Support Model for Predicting Performance of Field Machinery Operation (DWDSS)

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Abstract— Farm machinery planning, design and operation are complicated undertaking due to time and cost constraint and due to prevalence of complicated interacting and overlapping field operations involving capacity constraints and cooperating units. The classical DSS models that applied in the past to machinery planning and policy analysis as well as to performance assessment and simulation of machinery demand, and supplies are criticized by limitations in programming and the difficulty in manipulation and storing the bulky data usually encountered in machinery records. In contrast by application of a web-based decision support system (DWDSS) the user can enjoy the facility to store the data in the server. (DWDSS), is a user-friendly interactive program which permits the user to interact by entering the required input records. The model estimates machinery performance of various farm machines. It consists of one model, which helps the farm manager to take the correct optimum selection of his agricultural machinery. DWDSS predicts field efficiency, field capacity, draft power required to operate machines and PTO power. The DWDSS was successfully validated statistically in comparison to the published data from the ASAE (2009). The comparison indicated that there were no significant differences (probability = 0.05) between them in the calculations that were executed. The DWDSS model was applied to real case conditions in Wad Salma and Rahad irrigated schemes in the central clay plains under similar treatments. The DWDSS results of field efficiency, theoretical field capacity, working rate and draw bar power was found fairly identical to the actual Wad Salma and Rahad data. The results indicated that, generally, the actual field efficiencies of the studied machines were found to be lower by 7% than ASAE published data and t-test comparison between Wad Salma and Rahad schemes in working rate of the three tillage implement, indicated no significant difference between the two means at probability level =0.05. In general, the results indicated that the DWDSS could be applied to any real-life case successfully and with confidence. This is reached by helping the decision maker in planning and operation of a farm fleet by deciding size of farm power.

Keywords— Web-Based Decision Support, mathematical simulation models.

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I. INTRODUCTION

This Size selection of machinery must necessarily base on predicted performance and expected cost. In field machinery selection, the most pertinent variable is size or capacity of the machinery. Forward speed and power found to affect field capacity and effectiveness of operation [1].

Machinery selection is a vital element in planning implementation, and operation of agricultural services used for large-scale mechanized schemes or for small holders. Matching the tractor–implement size was reported to be a difficult task [2]Effective mechanization at the field level can only be achieved through the proper selection of machinery, together with proper machinery field management. Studies by [3]indicated that the developed countries, that use intensive mechanization technology, possess 26% of the useable agricultural areas worldwide and more than 73% of the world agricultural tractors; whereas, the Arab countries that possess about 3% of the total agricultural areas have less than 1% of the total number of tractors. In fact, such less-developed countries are frequently facing acute problems with regard to financing agricultural production operations. This situation necessitates making the correct decisions, especially when high sums of money are to be directed for buying new machines and equipment to expand existing agricultural areas or to replace old machines and equipment The effective field capacity is the actual rate of performance of land or crop processed in a given time, and it can be expressed in area / time or material / time. It was found that the effective field capacity was affected by implement size, [4]reported that heavy disc harrow showed the higher effective field capacity than light disc harrow

[5]reported that the lost time was the most important factor that affects the field capacity and Efficiency of a machine. It may be lost as a result of adjusting or lubricating the machine, break downs clogging turning at the ends, adding seed's fertilizer or operator personal time [6]. The factors affecting field efficiency were reported by [1]as theoretical capacity of the machine, machine and severability, field shape, field patterns, field size, yield), soil and crop condition and system limitation Implement type and soil physical conditions were important factors affecting the field capacity and efficiency of tillage implement, when soil conditions are poor for machine operations, forward speed will generally be reduced [7]found that chisel plow recorded higher values of power requirement, theoretical field capacity and effective field capacity in loose clay soil as compared to disk plow, and moldboard plow[2] Developed computer software to select and

Evaluate alternative machinery complements and estimated their costs. he performance of a machine often depends on the skill of the operator or on weather and soil conditions[8].

However, variances among machines can be estimated through field trials, research reports, and personal experience. Peterson et al. [9]establish that field efficiency decreased with increasing implement width when field operations were behaved between patios .therefore, selection of width implement can be estimated as the follows equation.

$$W = \frac{FC * CF}{SE} \quad (1)$$

Where,

FC = field capacity, ha/h.

CF = correction factor.

E = field efficiency.

W= width, m.

S= speed, km/hr

Randal et al. [10]noted that field efficiency decreased with increasing planter width. Field size had the little impact on field efficiency. Steichen and Powell [10]displayed a farm's ability index for fields and concluded that field efficiency was a function of implement and terraces design. Field efficiency includes the effect of the time lost in the field and downfall to make use of the full width of the machinery [11]. It is not constant for a specific machine, but varies with the size and shape of the field, pattern of the field operation, crop yield, and moisture. [12] Presented a graphical technique for predicting drawbar pull, drawbar power, transportable speed, and transportable reduction of 2WD tractors under various soil conditions[13]coded a selection algorithm on PC-computer using fundamental Language.

The algorithm chooses the optimum sizes of farm machinery and tractor power by considering farm sizes, cropping pattern, soil environment and weather variability. The factors impressive field efficiency were recorded by Donnell [1], as theoretical

capacity of the machine, machinery maneuverability, field shape, field patterns, field size, yield soil and crop condition and system limitation.Culpin[14]mentioned equation of theoretical field capacity as equation

$$TFC = \frac{S * W}{C} \quad (2)$$

Where,

TFC = theoretical field capacity, ha/h.

S = speed, km/hr.

W = implement width, m.

C = constant = 10

The effective capacity can be computation on Area base or material base as follow equation

$$C_a = SW * \frac{E_f}{10} \quad (3)$$

Where,

C_a= area capacity, ha/h.

S = speed, km/h.

W = working width, m.

E_(f)= field efficiency

$$C_m = \frac{SWY * E_f}{10} \quad (4)$$

Where,

C_m = material capacity, t/h,

S = field speed, km/h,

W = i working width, m

E_f= field efficiency

Y =yield unit of the field, t/ha.

Implement type and soil physical conditions are important factors affecting the field capacity and efficiency of tillage tool implement, when soil conditions are poor for machinery operations, forward speed will normally be reduced .[15] Reported that chisel plow recorded higher values of power requirement, theoretical field capacity and effective field capacity as compared to disk plow, and moldboard plow.

The optimum capacity of a machine can be assessed from equation asfollow

$$M_{CO} = \sqrt{\frac{100FA}{C_{OP} * K_p}[W_c + T_{OC} + \frac{T_c * A * W}{pwd}\ ]} \quad (5)$$

Where,

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M_{CO} = machine optimum capacity, ha/h (acre)

FA = area, ha

C_{OP}= ownership cost percentage, percent

K_p = unit price dollars/ha·h

W_c =Workers cost, dollars/ha (dollars/acre =

T_{OC} =tractor ownership cost, dollars/ha

T_c = timeliness coefficient from ASAE;

A = area, ha

Pwd=probability of a working day

The model was designed to minimize farm total cost. The physical method was described by the America Society of Agricultural Engineers in their standard yearbook of. The approach matched the tractor and implement width via consideration of soil conditions, soil attractive force, and engine power and speed .The main objective of this study was to develop (MOPWT) web-based system to predict theoretical field capacity, effective field capacity and field efficiency of a field operation for implement with different effective widths and different operating speeds, the (MOPWT) is a user–friendly interactive program. It estimates machinery performance of different agricultural machines to determine the properties of the operating parameters when using or choosing farm machinery to help the managers of the farm or scheme to take the correct optimum decisions in managing agricultural field machinery.

II. Development of System Designs and Documentation

A. Overview

The DWDSS is a DSS formulated to assist designers and managers in the process of design planning, and improvements of machinery fleet in multi-farm fields. It includes a database, simulation modules, user-friendly interfaces and cost analysis modules. The developed system can be described as content management system (CMS) (Fig. 2.0). It is composed of various subsystems or modules with different files with different formats for database, input, output layouts, individual -machine interfaces, detailed design, processing logic, and external interfaces.

The application of DWDSS is based on client-server architecture. It comprises a Web module and a simulation engine. The Web module controls the simulation engine, creates the user interface, importing and showing numerical and graphical data. The architecture of DSS Web Server and client are schematized in (Fig. 1.0).

Basically the system have been developed using the Dynamic Web Content PHP, MySQL, JavaScript, CSS, and HTML5. All the computation is performed on the server side through the set of functions and stored procedures to achieve higher system flexibility, and to minimize client system requirements. The SQLServer is applied for database management, which allows a simultaneous connection of several users. The server is established by four component modules, each one responsible for a task (1) Communication – the interface with the Web applications using TCP/IP like transport way; (2) Logic – the control of execution and respective data flow; (3) Simulation the computation of simulation models; and (4) Data abstraction – the isolation and optimization data model and data modifications

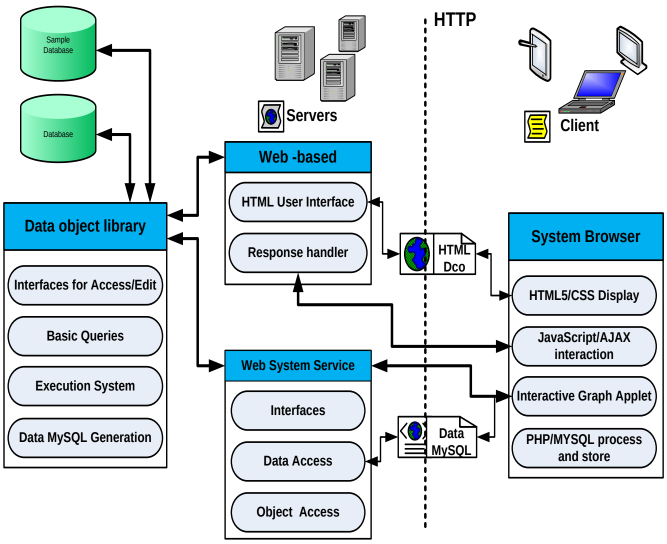

Fig. 1.Conceptual structure of DSS Web Server and client.

B. System Technique and Style:

The system management and operation of agricultural machinery DWDSS is a button menu driven composing of sub-modules and interactive in nature. The general flow diagram of the system structure is illustrated in the (Fig. 2.0). The system is composed of an introductory interface and a main menu (Fig. 1.0). It derives through sub-modules distributed over the tables. The main menu controls the details of all program operations. Spreadsheets are either visible lists or hidden processing parameters have been built by the tool during the input. Visible input forms received input data from users, subjected them to conversions and directs them to hide processing data where all the processes are done through case specific transformation functions, based on information previously provided by the users. For example, when an operation is allocated from the field cultivation the user can choose from a main menu the program specialist for the operation from the list created by the system because the list includes machineries that have been inserted by the user (in the “machineries” data set).

C. Individual Machine Interface

This section provides the detailed design of the system and subsystem inputs and outputs relative to the user/operator. Any additional information may be added to this section and may be organized according to whatever structure best presents the operator input and output designs. Depending on the particular nature of the project, it may be appropriate to repeat these sections at both the subsystem and design module levels. Additional information may be added to the subsections if the suggested lists are inadequate to describe the project inputs and outputs (Fig. 2.0).

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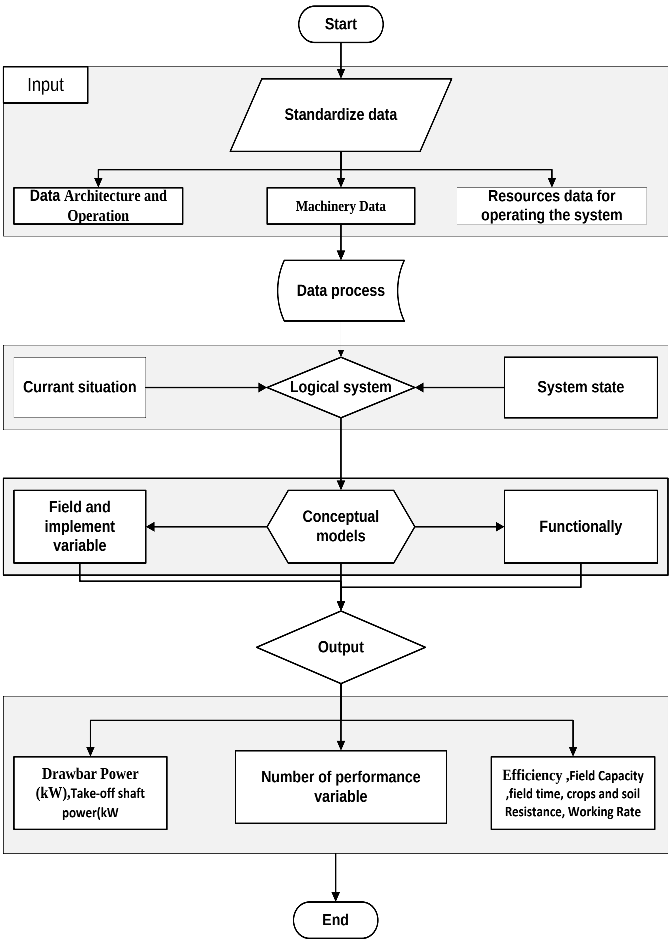

Fig. 2. General flow diagram data base components in relation with respective data sources and uses in the design process.

D. System Architecture and Operation

1. *System Data*
The data needed to run the system is two folds: user direct input data (with help by selecting from lookup tables) and resources data build in the system but can be modified by the user. These two types of data can be corrected or edited during data input process. The user direct input data is referred to as standardized data set.

2. *The user direct input Data Set*
This section is a description of the input data sets for the project used by the operator for providing information to the system. The main data set is the standardized data which includes data sets concerning: user profile, system control, project field information, Crops and crops rotation (season). (Fig. 2.0). shows and describes: the high-level data flows and the initial data sets including the general information for the system under study, the definition of the machinery that will be operated, the fields included in the production system, and the allocation of crop rotation to field areas. The tool allows users to insert input data through lists in system or input by user in more than one form depending on either personal preferences or the type of available data. For example, in the case of Spraying of the pesticide must enter process data (e.g. farm number, crop, area, name pesticide, dosage, implement and tractor). Based the data that have been previously provided by the user, the system provide the layout of all input data screens and also graphical user interfaces. This section contains edit criteria for the data elements, including specific values, range of values, and mandatory/optional alphanumeric values. It also addresses data entry controls to prevent edit bypassing.
The standardized Data Set is built in data set and refers to: User profile, System Control data, Project Field information data, and Crops and crops rotation (season) data.

3. *User profile:*
Using the Web-based system interface, users may set up a profile that includes name, phone number, email address, and other PII (Personally-identifiable information). In addition, users may set up a password for continued access to their PII. Access any of their own provided personal information, of their social security number, and change profile information, including changing contact information. Based on the country selected, the system applies the appropriate databases listed by the country code, such as country-specific coefficients (e. g. Crop, machines, pesticide, and currency per country). The user can choose to remain anonymous or share information with other users.

E. System Control data set

The control data set consists of: title, name of the project, irrigation method, numerical parameters of interest rates and fuel prices and the selected parameters of the preferred currency, which creates the standardized data set, and the name of the program template to use to create the table. Table number is used in both as a title of the table and to name any resulting files used with other variables in the control data set of document and track the table production process.

1. *Tractors parameters data*
In this data set, the parameters of the available tractors for the operation are to be uploaded to the system. Every tractor should be identified by its serial number and reference is to be made for its purchase cost actual and annual use. This information is to be used in in driving the coefficients for the calculation of the fixed and variable costs of the tractor. The tractor type (2-wheel drive, 4- wheel drive, chain drive) and its power and time of use also need to be identified. Other coefficients for the calculation fixed

and variable cost includes those related to repair and maintenance factor for each tractor, insurance cost, settled cost.

2. *Machinery specifications data*

The system provides the users the option to select the type of machines to be used in the system and enter the machine required input data in similar way as done previously for tractor. The machinery types listed in the system data set are connected with a database that provides all the correct coefficients needed for the calculation of fixed and variable costs and the data related to operational performance. The system allocates each machine to specific number of task and gives a task number for each. For each machine when allocated for specific task the system identify: the field efficiency (%), and the operating width. Once machine inputs (purchasing cost, hourly use, and repair and maintenance factor, needed power, operating time and travelling speed) are defined the system generates outputs typical to those assigned for the tractor.

F. *The System data base*

A database is an organized collection of data. The data are typically organized to model aspects of reality in a way that supports processes requiring information. Special storage procedure is required for data base organization.

1. *Stored databases*

Formally, database in the system provide the interface between the users and the database and supporting data structures. Databases are created to operate large quantities of information by inputting, storing, retrieving and managing that information. Databases are set up so that one set of software programs provides all users with access to all the data. The system provided a number of lists to support users when inserting the input data on programs.

2. *System Database Storage Procedure*

There are different ways of listing all databases within the SQL Server. The first method is the use of the sp-databases system stored procedure. The sp-databases lists databases that either reside in the SQL Server Database Engine or are accessible through a database gateway. Another way of getting a list of all databases within the SQL Server is with the sp-helpdb system stored procedure. The Sp-helpdb system stored procedure reports information about a specified database or all databases. If no database name is passed to the Sp_helpdb system stored procedure, it will display information about all databases on the server running SQL Server. Yet, the third way of getting a list of data bases within the SQL Server is by querying the sys.databases system view. Regardless of which method to use, all of these methods will return not just as user databases but as system databases as well (such as the master, model, msdb and tempdb databases). If the SQL Server instance has Reporting Services installed, the Report Server and Report Server Temp DB databases will also be included in the list

III. System Processes

The processes executed by the developed via evaluation of the technical field performance of machines. The function of part of the process is to compute the fleet size of power units and machinery required to complete the field operations during the specific period of time. The procedure to Predicts the technical performance of field machinery by determining machine productivity (theoretical field capacity, effective field efficiency and working rate) and soil-crop-machine parameters (soil resistance, draw bar or propulsion power, power at take-off shaft and unit power). Consequently, the model determined the minimum field capacity of tillage implements required to complete the operation in a reasonably short time. He also determines the minimum width of implement required attaining this goal, and the size and number of tractors required to perform the operation, the standard values of machinery technical parameters, which were adapted from ASAE (2009.)Data, are used as view look-up tables, to aid the user in the correct utilization of the program.

IV. Study Areas

A. *Study site*

The study was conducted within the area of the irrigated central clay plains of Sudan, which includes: Rahad Scheme and Wad Salman Scheme. Rahad Scheme is one of the largest and most important irrigated schemes in Sudan. The scheme is located in the State of Gedarif (45% of the total area) and Wad Salma (55% of the total area), on the eastern bank of Rahad River at about 276 km from Khartoum Wad Salman project is located on the east bank of the Blue Nile about 60 km south of Sinnar and the actually cultivated area on average for the last seasons are about 10000 ha. The project extends from the Blue Nile to Dinder River and from the Suki- Gedarif railway line to the Rahad Supply Canal plus a small area on the southern side of the Rahad Supply Canal

B. *Data Collection:*

The required input data for this study was categorized as primary and secondary source data. Primary data was collected using formal and personal contacts with individual agricultural engineers, from Rahad and Wad Salman agricultural schemes, in particular agricultural engineering organization. The secondary data was collected from bulletins, operation manuals and specifications sheets of machinery and tractors, agricultural operations scheduling program and internal periodical routine reports. The data given was for the season 2009-2010, 2010-2011, and 2011-2012 and 2012-2013. Other secondary data was collected from the most relevant published national and international data and periodicals. The main source data were the ASAE yearbook (2009) Hunt (1983), Witney (1988), Agricultural Bank of Sudan Reports (HQ), and information bulletins from many agricultural machinery dealers in Sudan and worldwide. These data were referred to when it is used in the texts.

V. STATISTICAL ANALYSIS

The Randomized Complete Block Design (RCBD), Duncan's Multiple Range Test (DMRT) for mean parting and Independent Paired t-test using MSTATC statistical package, was followed for the statistical analysis of variance for the data of DWDSS output parameters.

VI. RESULTS

A. DWDSS Model Verification

The verification of any software program is concerned with establishing whether the program is a correct or comprehensive representation of reality (Cheng et al., 1992). The verification aims to determine facts about the system under consideration in order to explain its structure and operation. However, to test a program validity it is continuously preferable to employ arithmetical tools for comparison and punishment. Frequently, verification is complete with an established target such as published programs or models or acknowledged field or research data.

B. Comparison of DWDSS with Published Data

The data of Disk Harrow published by ASAE (2009) was used as input to the DWDSS model. The results obtained included efficiency, theoretical field capacity, field, working rate, soil and crop resistance, unit draw bar power, and take-off power as presented in Table (1).

As set in Table (1), the percentage deviation between DWDSS and ASAE real data are in the range of 0 to 5.4%. The root means square error (RMSE) rate was calculated by the following equation:

$$RMSE = \sqrt{1/n \sum_{i=1}^{n=6} ((WBDSSdata) - (ASAEdata))^2} \quad (1)$$

The effects showed that there was a very low RMSE (0.1866) (Table 1). Rendering to Ventura et al (1999) the found discrepancy indicates a high constancy between the two data. Paired t-test comparison, as shown in Table (2), indicates no significant difference between the two models (probability = 0.05). This is due to the acceptance of the same theoretical basis for estimating the parameters under request in the model, and ASAE published data.

TABLE I. COMPARISON BETWEEN DWDSS DATA AND REAL ASAE DATA

PARAMETERS	**Theoretical field capacity (ha/h).**	**Field efficiency (%).**	**Working (ha/h).**	**Resistance (kN).**	**Drawbar (kW/m).**	**Take-off shaft power (kW).**	**RMSE**
DWDSS Data	4.2	81	1.172	17.3	11.4	71.9	0.1866
ASAE Data	4.2	80	1.172	18.1	12.03	75.8	
Deviation (%)	0	0	0	5.4	5.3	5.4	

TABLE II. T-TEST FOR THE MEAN VARIANCE OF THE ESTIMATION INDICATORS FOR DWDSS AND ASAE DATA.

Statistical Parameters	**Value**
Probability of T	5
Standard deviation of the difference	0.6355
Effective degrees of freedom	0.4038
Variance of the difference between the means	0.1998
T-tabulated	2.571
T-calculated	-1.4766
F-calculated	1.0459

C. DWDSS Validation:

Validation of a DWDSS model refers to the study of model use or its suitability for satisfying the purpose for which it is constructed [16]In this context, the main purposes of building the DWDSS model were to assess the technical performance of field machinery, in particular, land preparation to minimizing agricultural machinery management risks. The input data for used were taken from White Nile, wad Salam and Rahad Schemes records. Three types of machines, namely: the Offset Disk Harrow (24), Standard Disk Plow, and Tandem Disk Harrow, were compared under the firm soil conditions with the recommended forward speed for each machine.

Table (3) shows the output of the technical parameters studied. Analysis of difference for the technical parameters studied when comparing ASAE, wad Salma and Rahad data, by using (RCBD) Randomized Complete Block Design and Duncan's Multiple Range Test (DMRT) for mean separation (Table 3), exposed that: There were differences in field efficiency (%). Though, those differences were not significant, and were due to the larger forward speeds used in the wad Salma and Rahad schemes as compared to that recommended in ASAE Standards. The differences in the theoretical field capacity (ha/h) were not significant, and were also due to the dissimilar forward speeds used In spite of the differences in the working rate (ha/h), due to the fact that it is a job of field efficiency, those differences were not significant.

ASAE data gave the maximum working rate. The differences in soil and crop resistance (KN) were non-significant. But, the Offset Disk Harrow recorded the highest level of resistance since its unit draft was higher than recommended in ASAE Standards. In spite of differences in forward speeds, there were no significant differences in unit Drawbar Power (kW/m).

TABLE III. OUTPUT OF THE STUDIED TECHNICAL PARAMETERS PERFORMANCE VARIABLE.

Machine Type	**Site**	**Technical Parameters**						
		Efficiency (%).	**Field Capacity (ha/h).**	**Working Rate (ha/h).**	**Resistance (kN).**	**Drawbar (kW).**	**Drawbar (kW/m).**	**Take-off shaft(kw)**
Standard Disk Plow	wad Salma	75.1	0.99	0.43	11.9	23.1	16.3	34.6
	Rahad	77	0.95	0.49	12.3	22.2	15.2	33.3
	ASAE	80	0.9	0.53	12.2	20.4	13.6	30.6
Offset Disk Harrow	wad Salma	79	3.4	1.2	20.6	45.8	10.9	68.7
	Rahad	78.4	3.2	1.2	20.7	43.1	10.3	64.7
	ASAE	85	2.94	1.38	20.2	39.4	9.4	59.1
Disk Harrow	wad Salma	77.7	4	1.1	13.2	34.7	8.3	52
	Rahad	78.3	3.4	1.1	12.5	27.8	6.6	41.8
	ASAE	80	2.2	1.17	12.3	34.1	8.1	51.1
Parameter	Mean	78.94	2.66	0.96	15.1	32.29	10.97	48.43
C.V	(%)	1.8	11	52	2.3	8.6	7.9	8.6

D. DWDSS Model Application

As previously indicated, this study was applied for the case of the central clay plains where the major irrigated schemes of Wad Salma and Rahad are situated in the two schemes is managed mainly for summer crops. It beginnings during the dry summer period by employing Disk Plows or Heavy-Duty Disk Harrows or using primary tillage implements (Disk Plows) followed by a secondary tillage operation with light Disk Harrows. In the Rahad scheme disking was in large part used as the primary tillage operation. .

To study the applicability of DWDSS both wad Salma and Rahad input collected data were employed in the program to generate evaluation performance indicators for the use of three types of land preparation machines namely: Standard Disk Plow, Offset Disk Harrow (24") and Tandem Disk Harrow under firm soil conditions and using the recommended forward speed for each machine.

E. DWDSS Model Performance in Wad Salma Scheme

Input data required for DWDSS were taken from collected primary and secondary sources in the wad Salma scheme as mentioned before The output of the values of the technical parameters studied in the wad Salma Scheme for the Standard Disk Plow 'as the example for land preparation implements' are as presented in Table (4 From Table (4) the DWDSS calculated field efficiency, theoretical field capacity, working rate and draw bar power results was justly identical to the actual wad Salma data. The percentage deviation range was between 8.8 and 11.0%. Never-the-less, theoretical field capacity and draw bar power predicted by DWDSS were found to be higher, and this may indicate that the forward speed used was high resulting in greater theoretical field capacity and draw bar power.

TABLE IV. DWDSS OUTPUT VALUES OF THE TECHNICAL PARAMETERS IN THE WAD SALMA SCHEME

Technical Parameters	DWDSS	wad Salma	Deviation (%)
Field Efficiency (%)	75.1	69	8.8
Theoretical Field Capacity (ha/h)	0.99	1.1	10
Working Rate (ha/h)	0.43	0.4	7.5
Drawbar Power (kW)	23.1	26	11

F. DWDSS Model Performance in Rahad Scheme

Input data required for DWDSS were taken from the collected primary and secondary basis in the Rahad scheme as mentioned previously. The output values of the technical parameters studied are as presented in Table (5).From Table (5), DWDSS field efficiency, theoretical field capacity, working rate and draw bar power results were fairly matching to the actual Rahad data. The percentage deviation range was between 5.3 and 10.4%. Never-the-less, theoretical field capacity and draw bar power predicted by DWDSS were higher for the similar reason as indicated in the case of the Wad Salma scheme.

TABLE V. DWDSS OUTPUT VALUES OF THE TECHNICAL PARAMETERS VARIABLE IN THE RAHAD SCHEME.

Technical Parameters	DWDSS	Rahad	Deviation (%)
Field Efficiency (%)	77	72	7.2
Theoretical Field Capacity (ha/h)	0.95	1	5.3
Working Rate (ha/h)	0.49	0.46	6.5
Drawbar Power (kW)	22.2	24.5	10.4

G. Comparison of DWDSS Output for in the Wad Salma and Rahad Scheme in operation rate

The output of the comparison between Wad Salma and Rahad schemes in working rate of the three mentioned tillage implements are as shown in Table (6), Fig. (1). as given in Table (6) and Fig. (1), the working rate of Offset Disk Harrow in Wad Salma and Rahad scheme was greater than for the other implements, and greater for the Tandem Disk Harrow than the for the Standard Disk Plow. Commonly, Rahad scheme was greater by 12.2% in working rate of the Standard Disk Plow when compared with Wad Salma scheme. T-test comparison between Wad Salma and Rahad schemes in working rate of the three tillage implement, indicated no significant variance between the two means (Table 7).

TABLE VI. COMPARISON BETWEEN WAD SALMA AND RAHAD SCHEMES IN OPERATION RATE

Implement Type	Working Rate		Percentage of Variation (%)
	(Wad Salma)	(Rahad)	
Standard Disk Plow	0.43	0.49	12.2
Offset Disk Harrow	1.25	1.15	10
Tandem Disk Harrow	1.076	1.068	0.74

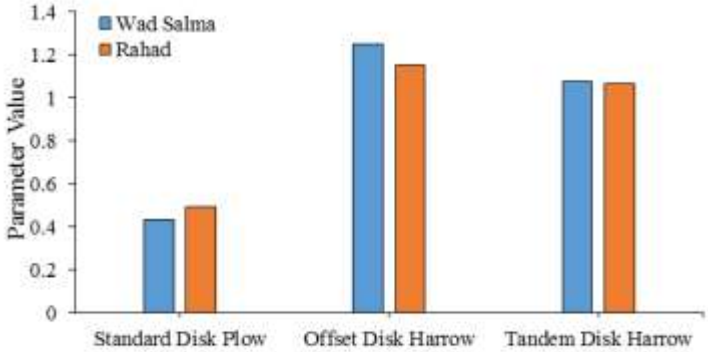

Fig. (1): Comparison between Wad Salma and Rahad Schemes in Operation rate

TABLE VII. OUTPUT OF PAIRED T-TEST COMPARISON BETWEEN WAD SALMA AND RAHAD SCHEMES IN OPERATION RATE.

Statistical Parameters	Value
Probability of t	0.7629
Standard deviation of the difference	0.0464
Effective degrees of freedom	2
Variance of the difference between the means	0.0021
T-tabulated	4.303
t-calculated	0.3451
F-calculated	1.4425

In all-purpose, Table (6), Table (7) and Fig. (1) Indicated that the DWDSS could be functional to any real-life case successfully and with confidence.

VII. CONCLUSION

A web-based decision support system (DWDSS) model friendly, self-guidance, reactive, menu driven and composed of sub modules with capabilities to Estimation of machinery fleet size and power demand was developed and proves. The developed system predicted the field performance parameters of implement with different width operated at different speeds. Found to be higher, and this may indicate that the forward speed used was high resulting in greater theoretical field capacity and draw bar power according to the results obtained from this research, the web tool can be used support decisions at different planning levels besides testing various input surrogates, and by employing sensitivity analysis. The tool can support decisions on the strategic level (e.g., number and adjust dimensioning of machines, machine capacity, crop chooses, and labour requirements).

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