



شبكة المعلومات الجامعية
التوثيق الإلكتروني والميكروفيلم

بسم الله الرحمن الرحيم



MONA MAGHRABY



شبكة المعلومات الجامعية
التوثيق الإلكتروني والميكروفيلم



شبكة المعلومات الجامعية التوثيق الإلكتروني والميكروفيلم



MONA MAGHRABY



شبكة المعلومات الجامعية
التوثيق الإلكتروني والميكروفيلم

جامعة عين شمس

التوثيق الإلكتروني والميكروفيلم

قسم

نقسم بالله العظيم أن المادة التي تم توثيقها وتسجيلها
علي هذه الأقراص المدمجة قد أعدت دون أية تغيرات



يجب أن

تحفظ هذه الأقراص المدمجة بعيدا عن الغبار



MONA MAGHRABY

EXPERT SYSTEM FOR MANAGING SPRINKLER IRRIGATED NEW RECLAIMED LAND

By

OSAMA MUBARAK MOHAMED MOSTAFA

B.Sc., Agric. Sc. (Agricultural Mechanization), Fac. of Agric., Ain Shams Univ., 2007
M.Sc., Agric. Sc. (Irrigation & Drainage Eng.), Fac. of Agric., Ain Shams Univ., 2012

**A Thesis Submitted in Partial Fulfillment
Of
The Requirements for the Degree of**

**DOCTOR OF PHILOSOPHY
in
Agricultural Sciences
(On-Farm Irrigation and Drainage Engineering)**

**Department of Agricultural Engineering
Faculty of Agriculture
Ain Shams University**

2020

Approval Sheet

**EXPERT SYSTEM FOR MANAGING SPRINKLER
IRRIGATED NEW RECLAIMED LAND**

By

OSAMA MUBARAK MOHAMED MOSTAFA

B.Sc., Agric. Sc. (Agricultural Mechanization), Fac. of Agric., Ain Shams Univ., 2007

M.Sc., Agric. Sc. (Irrigation & Drainage Eng.), Fac. of Agric., Ain Shams Univ., 2012

This thesis for Ph. D. has been approved by:

Dr. Asaad AbdElKader Derbala

Professor of Agricultural Engineering, Faculty of Agriculture, Tanta
University

Dr. Yasser Ezzat Arafa

Professor of Agricultural Engineering, Faculty of Agriculture, Ain
Shams University

Dr. Abdel-Ghany Mohamed El-Gindy

Professor Emeritus of Agricultural Engineering, Faculty of
Agriculture, Ain Shams University

Date of Examination: 30 / 11 / 2019

EXPERT SYSTEM FOR MANAGING SPRINKLER IRRIGATED NEW RECLAIMED LAND

By

OSAMA MUBARAK MOHAMED MOSTAFA

B.Sc., Agric. Sc. (Agricultural Mechanization), Ain Shams Univ., 2007

M.Sc., Agric. Sc. (Irrigation and Drainage Engineering), Ain Shams Univ., 2012

Under supervision of:

Dr. Abdel-Ghany Mohamed El-Gindy

Prof. Emeritus of Agricultural Engineering, Agricultural Engineering
Department, Faculty of Agriculture, Ain Shams University (Principal
supervisor)

Dr. Hazem Sayed Mehawed

Head Researches of Agric. Eng., Irrigation and Drainage Engineering.
Dept., Agricultural Engineering Research Institute, ARC, Egypt

ABSTRACT

Osama Mubarak Mohamed Mostafa, Expert Systems for Managing Sprinkler Irrigated New Reclaimed Land . Unpublished Doctor of philosophy Dissertation. University of Ain Shams, Faculty of Agriculture, Department of Agricultural Engineering, 2019.

Accurate estimation of actual crop evapotranspiration (ET_a) as a parameter of irrigation scheduling is very critical for efficient use of limited irrigation water resources.

The aims of this investigation were to build an expert system for selection and design of center pivot system irrigation under different field conditions, study the effect of coefficient of uniformity (CU) and distribution uniformity for center pivot irrigation system, study the effect of the precise estimation of daily actual crop evapotranspiration (ET_a) on maximizing yield and improved water use efficiency.

A rule-based program named CPISM-ES (Center Pivot Irrigation System Management- Expert System) was coded and compiled using python-3.7.2 language. The program was verified using ready-to-use software programs (cropwat-8 and climwat 2) for estimating the daily reference evapotranspiration and a spreadsheet named the (FAO56Ax8.xls) introduced by FAO-56 for estimating the irrigation water management parameters. It also was validated by carrying out a field experiment at site :-El Salhyia and Wadi El-Natrun (11.2 m above sea level, 30,35°N,30,26°E) (55 m above sea level, 30.9°N, 29.7°E), was obtained from several different sources. The irrigation expert system aims to provide the farmers by the irrigation expertise to determine the exact water needed at exact time according to the crop requirements and the environmental factors which effect factors. The experiment included the following factors: a) obtaining climatic data from a weather station b) estimation crop evapotranspiration) coefficient of uniformity (CU) and distribution uniformity for center pivot irrigation system

- 1- The estimation of actual crop evapotranspiration (ET_a) using crop coefficient.
- 2- The seasonal cumulative ET_a estimated by single- k_c approach of El Salhyia and Wadi El-Natrun (1875 and $1520\text{ m}^3\text{ f.}^{-1}\text{season}^{-1}$).
- 3- Yield: the highest of crop potatoes for El Salhyia and Wadi El-Natrun (16.2 and 14.7 t.fed^{-1}).
- 4- Water use efficiency: the maximum value of water use efficiency for El Salhyia and Wadi El-Natrun (8.64 and 9.67 kg m^{-3}).

Keywords: Expert system, Evapotranspiration, potatoes, climwat 2

ACKNOWLEDGMENT

Firstly, I would like to express my sincere gratitude to my advisor Prof. **Prof. Dr. Abdel Ghany M. El-Gindy**, Prof. of Agric. Eng., Faculty of Agriculture, Ain Shams University, for the continuous support of my Ph.D study and related research, for his patience, motivation, and immense knowledge. His guidance helped me in all the time...

I would like to express my sincere appreciation to supervisor **Prof. Dr. Mahmoud Ahmed El-nono**, Prof. of Agric. Eng., Faculty of Agriculture, Ain Shams University, for his support, valuable suggestions and frequent discussion throughout the study.

I would say thanks to my supervisor **Prof. Dr. Hazem Sayed Mehawed**, Head Researches., Irrigation and drainage engineering Dept., Agricultural Engineering Research Institute, ARC, Egypt, to guide me well throughout the research work from title's selection to finding the results. Their immense knowledge, motivation and patience have given me more power and spirit to excel in the research writing

My very warm thanks go to the members of the Department of Agricultural Engineering, Fac. of Agric, Ain Shams Univ. to which I belong for their support and personal encouragement.

Warm thanks are due to my wife and my one children for their continuous encouragement and support

LIST OF CONTENTS

	Page
LIST OF TABLES -----	III
LIST OF FIGURES -----	IV
I. INTRODUCTION -----	1
II. REVIEW OF LITERATURE -----	4
2.1 Expert system -----	4
2.1.1 Definitions of expert system -----	4
2.1.2 Advantages and disadvantages of expert system -----	4
2.1.3 Expert systems components -----	5
2.2. Center pivot management -----	9
2.3 Irrigation management -----	12
2.4 Evapotranspiration -----	13
2.4.1 Reference evapotranspiration -----	13
2.4.2 Net radiation -----	14
2.4.3 Temperature -----	14
2.4.4 Relative humidity -----	14
2.4.5 Wind (regional advection of energy)-----	14
2.5 Irrigation system -----	15
2.6 yield potatoes-----	18
2.7 Soil management-----	20
2.8 The Crop coefficient-----	20
2.9 Applications of Expert system on irrigation management	22
III. MATERIAL AND METHODS -----	23
3.1 Materials -----	23
3.1.1 Building up CPISM-ES program-----	23
3.1.2 User interface -----	23
3.1.3 Structure of CPISM-ES-----	23
3.1.4 Database -----	24
3.1.5 Description of the CPISM-ES program -----	26
3.2 Verification of the developed ES -----	27

	Page
3.2.1 Experimental site description -----	27
3.2.2 Soil properties and irrigation water analysis-----	27
3.3 Center pivot sprinkler irrigation systems Description	28
3.4 Potato cultivation -----	30
3.5 meteorological data -----	31
3.5.1 Calculation of irrigation water requirements -----	35
3.6 Methods -----	36
3.6.1 The formulas used by the program-----	36
3.6.2 Evapotranspiration (ET) -----	37
3.6.3 Reference evapotranspiration (ET _o) -----	37
3.6.4 Crop evapotranspiration (ET _c) -----	37
3.6.5 Single crop coefficient (single-K _c) -----	38
3.6.6 Methodology and Equations to calculate the Coefficient of Uniformity -----	38
3.6.7 Distribution Uniformity (DU 1/4) -----	39
3.6.8 Water Use Efficiency (WUE) -----	39
IV. RESULTS AND DISSCUSSION -----	41
4.1 Comparison of evapotranspiration model-----	41
4.2 Crop evapotranspiration ET _c -----	43
4.3 Coefficient of Uniformity (CU) and Distribution Uniformity	45
4.4 The CPISM-ES program application	46
4.5 Water Use Efficiency (WUE)	50
V. SUMMARY -----	52
VI. REFERENCES -----	54
ARABIC SUMMARY -----	

LIST OF TABLES

Table No.		Page
Table 1	Some soil physical properties at the experimental site	28
Table 2	Description Center pivot sprinkler irrigation system in El - Salhyia and Wadi Elnatroon.	29
Table 3	The properties for center pivot system.	30
Table 4:	Reference values for crop coefficient (Doorenbos et al., 1977) and root depth for potato crop at different stages of growth	31
Table 5:	Average meteorological data at the experimental sites from the weather station	34
Table 6:	Average meteorological data at the experimental sites from the CLIMWAT 2.0 for CROPWAT	35
Table 7:	Calibration values for irrigation system (present study)	39
Table 8:	ETo-Model-values in comparison to CLIMWAT- values	41
Table 9:	Calculated ETc-values (plant water requirement) for research crop	43
Table 10:	Calculated Water Use Efficiency	51

LIST OF FIGURES

Fig. No.	Page
Fig. (1): Process schema of method of calculating the irrigation water demand	25
Fig.(2): Program-Code for calculating reference evapotranspiration according to process in Figure 2, by python-3.7.2-amd64	26
Fig (3): Area covered by each sprinkler increases as the distance from pivot center increases.	29
Fig (4): Flow chart components of proposed program for management of water requirement.	33
Fig (5): Program-Execute for calculating reference evapotranspiration will be calculated instead of crop-evapotranspiration	36
Fig (6): Comparison between ET_0 -model-values and the values of CLIMWAT for El-Salhyia	42
Fig (7): Comparison between ET_0 -model-values and the values of CLIMWAT for Wadi EL-Natroon	42
Fig (8): Comparison between ET_c values of Penman-Motheith (FAO.56) and the values of CLIMWAT for El-Salhyia	44
Fig (9): Comparison between ET_c -model-values and the values of CLIMWAT for Wadi EL-Natroon	45
Fig (10): Calculate the coefficient of uniformity	46
Fig (11) : The applied depth of water and time for full rotation curves following during irrigation center pivot system.	47
Plat (12): Input Data center pivot system	48
Plat (13): Input data pump power requirement for center pivot system	48

Fig. No.		Page
Plat (14):	Input data fuel consumption and cost for center pivot system	48
Plat (15):	Output screen of the CPISM-ES program for center pivot irrigation system.	49

INTRODUCTION

Integrated water management in agricultural sector has the majority role for either compensating agricultural resources shortage or to maximize the water unit productivity. These criteria need a highly qualified data in order to achieve its goal. However, an expert system may be considered as an effective tool in these areas of study.

Growing land and water scarcity are the two main structural to Egypt's sustainable agricultural development. The amount of arable land available in the country is almost fixed, with limited capacity to expand it. Hence, the Egyptian government strategy has focused on the sustainable use of existing agricultural land, reclaiming desert areas, and increasing productivity through improved irrigation and cultivation methods. The government could also consider devoting scarce land area to grow crops higher in economic value but lower in water use.

Expert systems is one of the important application oriented branches of Artificial Intelligence in last four decades, a great deal of expert systems had been developed and applied to many fields such as office automation, science, medicine and agriculture, agriculture is the occupation of major portion of population. However, agricultural practices are more manual and technically non- advanced in comparison to developed countries.

Agricultural production has evolved into a complex business which requires the accumulation and integration of knowledge and information from many diverse sources. For decision making the farmer often relies on agricultural specialists and advisors for providing critical information. Agricultural specialist assistance is not always available when the farmer needs it. Hence, expert systems were identified as powerful tool with extensive potential in agriculture. Knowledge based agricultural, expert system becomes more powerful since it collects expertise from not one, but a number of experts. An expert system or a