

# DEDICATION

*To the soul of my parents*

*To my wife, daughters and sons*

*To my sisters and brothers*

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## TABLE OF CONTENTS

<b>Title</b>	<b>Page</b>
DEDICATION.....	I
ACKNOWLEDGEMENT.....	II
TABLE OF CONTENTS.....	III
LIST OF TABLES.....	IX
LIST OF FIGURES.....	XIII
LIST OF ABBREVIATIONS.....	XIV
ABSTRACT ( English ) .....	XVI
ABSTRACT ( Arabic ).....	XX
<b>CHAPTER ONE.....</b>	<b>1</b>
<b>INTRODUCTION.....</b>	<b>1</b>
1.1. Background and Justification.....	1
1.2 Problem difinition.....	4
1.3 Study Objectives: .....	7
1.4 Study Scope: .....	8
<b>CHAPTER TWO.....</b>	<b>9</b>
<b>LITERATURE REVIEW.....</b>	<b>9</b>
2.1 Machinery Management: .....	9
2.2 Computers And Agric. Machinery Management:.....	10

<b>Title</b>	<b>Page</b>
2.3 Machinery Performance: .....	20
2.3.1 Machinery capacity: .....	21
2.4 Timeliness, scheduling and duration of field operations .....	27
2.4.1 Timeliness: .....	27
2.4.2 Scheduling of field operations: .....	29
2.4.3 Duration of field operations: .....	30
2.5 Costs of owning and operating machinery: .....	31
2.6 Machinery cost factors: .....	32
2.6.1 Fixed costs (Ownership costs): .....	33
2.6.2 Operating (variable) costs: .....	42
2.6.3 Total costs of performing a field operation: .....	52
2.7 Hire or purchase option: .....	54
2.7.1 Rent: .....	54
2.8 Linear programming technique: .....	55
2.8.1 Application of linear programming in agriculture: ...	58
2.8.2 Assumptions of linear programming: .....	59
2.8.3 Advantages and limitations of linear programming: .....	60
2.9 Critical Path and Pert: .....	61
2.10 Financial and Technical Evaluation: .....	62

<b>Title</b>	<b>Page</b>
2.10.1 Financial evaluation: .....	62
2.10.2 Technical evaluation: .....	67
2.11 Post – Optimality analysis: .....	68
<b>CHAPTER THREE</b> .....	<b>71</b>
<b>MODEL DEVELOPMENT</b> .....	<b>71</b>
3.1 General: .....	71
3.2 Program main features: .....	71
3.3 Computer model description.....	76
3.4 The program Limitations.....	79
3.5 Program Structure:.....	80
3.5.1 Program technique and Style: .....	80
3.5.2 Program technical specifications: .....	80
3.6 Program Logic and Flow Chart: .....	85
3.6.1 Input data requirements: .....	85
3.7 The Program Process and transformation functions.....	92
3.7.1 Machinery performance module: .....	92
3.7.1.1 Machinery capacity: .....	92
3.7.1.2 Field capacity:.....	92
3.8 Field operation cost determination module: .....	92
3.8.1 Tractor cost calculations: .....	93
3.9 The optimization module: .....	97
3.9.1 Integer linear programming model structure: .....	101

<b>Title</b>	<b>Page</b>
3.10 Technical and financial evaluation module:.....	103
3.10.1 Technical evaluation:.....	103
3.10.2 Financial evaluation:.....	103
3.11 Pert – Critical Path Method:.....	105
3.12 Model output:.....	106
<b>CHAPTER FOUR</b> .....	<b>108</b>
<b>MATERIALS AND METHODS</b> .....	<b>108</b>
4.1. Rahad Scheme study area.....	108
4.2 Wad Salman Project .....	110
4.3 Data collection and analysis:.....	118
4.3.1 Data collection:.....	118
4.3.2 Data analysis:.....	122
<b>CHAPTER FIVE</b> .....	<b>124</b>
<b>RESULTS AND DISCUSSION</b> .....	<b>124</b>
5.1 Model Verification:.....	124
5.2 Model validation:.....	129
5.2.1 Satisfaction of purpose of model building:.....	130
5.2.2 Evaluation of implementation of Machinery scheduling program:.....	143

<b>Title</b>	<b>Page</b>
5.2.2.1 Improvement of control over machinery management system:.....	143
5.2.2.2 Improvement of implementation of machinery management system:.....	150
5.3 Model application :.....	152
5.3.1 Comparison of model performance with current four –course crop rotation of Rahad scheme :.....	152
5.4 Model utilization for design of machinery service unit: .....	156
5.5 Sensitivity analysis: .....	156
5.5.1 Model response to changes of single input:.....	156
5.5.1.1 Effect of changing cultivated area:.....	156
5.5.1.2 Effect of changing total costs of operations by 10, 20%.....	161
5.5.2 Estimation of response function of changing multiple input on model output .....	162
<b>CHAPTER SIX</b> .....	163
<b>SUMMARY, CONCLUSIONS AND RECOMMENDATIONS</b> .....	163
6.1 Summary: .....	163

<b>Title</b>	<b>Page</b>
6.2 Conclusions: .....	166
6.3 Recommendations : .....	167
<b>REFERENCES</b> .....	170
<b>APPENDICES</b> .....	184



## LIST OF TABLES

<b>Table</b>	<b>Title</b>	<b>Page</b>
2.1	Field efficiency, field speed, repair and Maintenance factors for field operations.....	23
2.2	Timelines loss factors.....	28
2.3.a	Remaining salvage value as percentage of new list price.....	37
2.3.b	Remaining salvage value as percentage of new list price.....	37
2.4	Accumulated repair costs as a percentage of new list price.....	45
2.5	Amount of fuel needed for various operations.....	47
2.6	Repair cost estimated.....	47
2.7	Average energy fuel requirementsfor selected machinery operations ( ASAE, 1993 , Deer & company,1994 and Johnson, 1997 ).....	51
3.1	Machinery program data.....	81
3.2.a	Machinery costs data.....	82
3.2.b	Tractor costs data.....	82
3.3	Program technical specifications.....	84

<b>Table</b>	<b>Title</b>	<b>Page</b>
3.4.a	Input data - Machinery performance data.....	88
3.4.b	Input data - Economic parameters data.....	91
3.5	Model output .....	107
4.1	Rahad Scheme     agricultural operations program ( Season : 2002- 2003).....	111
4.2.	Rahad Scheme agricultural operations program (Season2003-2004) .....	112 .
4.3	Rahad Scheme agricultural Operations Program (Season2004-2005) .....	113
4.4	Agricultural Operations (Rahad Data – Season 1999 -2000).....	114
4.5	Program of Work(input Data) for (Wad Salman Project ).....	119
5.1	Number of tractors before and after optimization.....	132
5.2.	Total costs of operations before and after optimization.....	133
5.3.a	Total direct costs before and after optimization (2- course rotation).....	134
5.3.b	Total direct costs before and after optimization (3-course rotation).....	135
5.3.c	Total direct costs before and after optimization (4-course rotation).....	136

<b>Table</b>	<b>Title</b>	<b>Page</b>
5.4.a	Number of machines before and after Optimization (4 course rotation).....	137
5.4.b	Number of machines before and after Optimization (3 course rotation) .....	138
5.4.c	Number of machines before and after optimization (2 course rotation).....	139
5.5 .a	Cost of operations before and after optimization ( 4-course rotation).....	140
5.5 .b	Cost of operations before and after optimization ( 3-course rotation).....	141
5.5 .c	Cost of operations before and after optimization ( 2 - course rotation).....	142
5.6.a	Financial evaluation before and after optimization (Four - course rotation).....	146
5.6.b	Financial evaluation before and after optimization (Three course rotation).....	146
5.6.c	Financial evaluation before and after optimization (Two Course rotation).....	146
5.7.a	Technical evaluation (Four - course rotation).....	147
5.7.b	Technical evaluation (Three course rotation) .....	147
5.7.c	Technical evaluation (Two Course rotation) .....	148
5.8.	Probability analysis for four , three and two course rotation.....	149

<b>Table</b>	<b>Title</b>	<b>Page</b>
5.9	Number of critical paths for three crop rotations.....	151
5.10.a	Total direct cost before and after optimization (Four-course rotation) Wad Salman project .....	154
5.10.b	Technical evaluation for Wad Salman project before and after optimization.....	154
5. 11	Comparison of Model performance with Rahad current crop rotation.....	155

## LIST OF FIGURES

<b>Figure</b>	<b>Title</b>	<b>Page</b>
2.1	Process in obtaining a solution.....	57
3.1	Program start menu.....	72
3.2.a	About the expert system program for machinery management.....	74
3.2.b	Crop rotation options.....	75
3.3	Program main flowchart.....	78
3.4	Crop rotation main menu.....	87
3.5	Optimization module standard matrix.....	98
3.6	Structure of integer linear program.....	106
4.1	Rahad agricultural project map.....	116
4.2	Wad Salman Agricultural Project map.....	123
5.1	Machine scheduling for three rotation.....	125
5.2.a	Machine distribution before and after optimization (four course rotation).....	126
5.2.b	Machine distribution before and after optimization (three course rotation).....	127
5.2.c	Machine distribution before and after optimization (two course rotation).....	128
5.3	Sensitivity analysis of fuel cost (Area).....	157
5.4	Sensitivity analysis of IRR (Area).....	158
5.5	Sensitivity analysis of fuel cost ( total cost).....	159
5.6	Sensitivity analysis of IRR (total cost).....	160

## **LIST OF ABBREVIATIONS**

ASAE	American Society of Agricultural Engineers.
BEP	Break – Even Point.
CP	Critical Path.
CPM	Critical Path Method.
CPMS	Crop Production Machinery System.
DBP	Draw bar Power.
EFC	Effective Field Capacity.
FAO	Food and Agriculture Organization of the United Nations.
Fed	Feddan = 0.42 hectare for area
GDP	Gross Domestic Product.
Hp/ha	Horse power per hectare.
HQ	Head quarters.
ILP	Integer linear Programming.
K	Timeliness factor.
Km/hr	Kilometer per hour.
KN/m	Kilonewton per meter.
Kw	Kilowatt.
L	litre.
LP	linear Programming.
M	Meter.

Machiner	Micro Computer Model for Agricultural Machinery Management.
MACHSEL	Acomputer Model for Selection and Evaluation of Machinery Complements.
QSB	Quantitative System for Business.
R. & M.	Repair and maintenance.
SI	System Internationale.
TE	Tractor Distribuation Efficiency.
VBA	Visual Basic Application.
\$	American dollar sign.

## **ABSTRACT**

Machinery management is a complex process that deals with optimization of mechanized operations for agricultural production in a dynamic and in uncertain weather conditions. The complexity arise from high investment and operating costs, presence of diversified and intensified cropping pattern and timeliness factor.

At the start of each season the agricultural manager is confronted with the questions of : (1) what is the optimum machinery seasonal scheduling plan to follow under the prevailing constraint of limited resources (strategic plan). (2) How to operate and implement the seasonal plan in order to physically achieve the maximum profit with resilient machinery. Thus , this study was directed to develop a sound analytical user- friendly computer model to aid decision – makers to prepare their machinery strategic plan.

To achieve these objectives the developed algorithm consists of submodels that combine in overall unified expert model. It starts by initialized set of input data to construct machinery scheduling program and bar–chart. A submodel was developed to estimate all elements of machinery costs.

For the purpose of evaluating the program financial and technical factors were determined. Then, linear programming and Pert techniques were employed to improve the utilization of material, money and man resources. Consequently, the scheduling program was revised, updated and revaluated after determning the cost elements.

For the purpose of model verification, validation and application input data was collected from primary and secondary sources using



various sampling technique from Rahad irrigation Scheme and Wad Salman Agricultural Project ( Sinar Estate ) for the last five years .

The model was verified by comparing its outputs with Rahad existing machinery scheduling program for two, three and four course rotation. The model succeeded in reducing the peak number of required tractors in July by 30, 29 and 16 % for two, three and four course rotation respectively. Comparison of the model output with performance of Rahad four course rotation by an overall index that capture peak number of tractors, cost of operations, execution time and machine utilization indicated a significant difference between the simulated results and the current status in Rahad Scheme.

Comparing actual with prediction was tested by comparing the output with existing scheduling program of Rahad Scheme with respect to satisfaction of the purpose of model building to minimize wastage of resources and a better utilization of resources during program implementation.

Application of the optimization models resulted in reducing the demand for total number of tractors and costs of operations to execute the program. During implementation phase financial (NPV, B/C and IRR), material and money (Labor, Power utilization and distribution and their maximum number at critical period) were evaluated. Analysis of the financial indicators showed a positive status for the running Rahad scheduling program. Technical indicators reflected the increase in labor demand by the increase in crop intensity while power utilization per area and maximum number of tractors were inversely related to crop intensity.

The power distribution efficiency was improved slightly by optimization technique for the various crop rotations.

Examination of resource utilization during implementation by Pert technique in order to coordinate program execution, time planning and taking corrective action indicated that : disc harrowing is the most critical activity. Using the Pert technique resulted in saving of time for all crop rotation and help to assess risk in time management by calculating different levels of probability of execution . Utilization of the optimization model resulted in time saving of 9, 11 and 13% at 100% level of probability of program implementation for two, three and four course rotation respectively.

The model was utilized for the purpose of designing a new machinery unit for Wad Salman Agricultural Project. The model succeeded in generating the basic element to develop this new unit. These elements include machinery scheduling program, their costs and the technical and financial indicators of performance.

The model sensitivity to changes at 10% and 20% step of each single input (cultivated area and total cost of operations ) and their interactions on the outputs of maximum number of machines, total fuel costs, machine utilization factor and IRR for the Rahad four- course rotation using analysis of variance.

For the case of single input changes of the cultivated area reveals that there was significant (P.0.05) increase in maximum number of machines, total fuel costs and IRR with increase in cultivated area while there was no significant effect on machine utilization. The total costs, maximum number of machines and total costs of fuel were found to be

significantly increased with costs increase. In contrast, there was no significant increase in both IRR and machine utilization.

For the case of multiple inputs effect of the area was found to be more dominant for the results indicate significant effects with maximum number of machines, total fuel costs and IRR and no significant effect for machine utilization.

The policy making recommendations generated from the model building and its application for the cases studied includes the benefits of application of the experts system as pre requisite for improving performance of scheduling and managing Rahad machinery set up, ability to compare alternative crop rotations with respect to machinery utilization. The model also offer aviable tool for decision – maker to control resources during implementation of machinery schedule and to build a new machinery service unit.

For future research the text indicated four areas that need to be studied in depth and to be added as submodels to the program.

## ملخص الاطروحة

تهدف إدارة الآلات الزراعية إلى تنفيذ العمليات الزراعية الممكنة بطريقة مثلى تحت ظروف ديناميكية ومناخية متقلبة. وتواجه إدارة الآلات الزراعية بعدة عوامل معقدة ومركبة تنشأ من :-

توظيف رأس المال ، تكاليف تشغيل الآلات الزراعية ، تنوع وتكثيف الدورة الزراعية ، وعامل الزمنية .

كما يواجه المسئول عن تنفيذ برنامج الآلات الزراعية بعدة تحديات منها نوعية الخطة الموسمية المثلى لبرمجة آلياته تحت قيود الموارد المحددة ، وبطريقة تشغيل وتطبيق هذه الخطة الموسمية وذلك للحصول على اكبر ربحية مالية .

لذا تهدف هذه الدراسة إلى :

- بناء نموذج لمساعدة متخذ القرار لإعداد خطة لتشغيل الآلات الزراعية ، ويبدأ النموذج بإدخال المعلومات ( الإحصائية ) المطلوبة وذلك لتكوين برنامج لجدولة العمليات الزراعية ، وتحديد تكلفتها الكلية لجميع محاصيل الدورة الزراعية .
- تقييم برنامج العمليات الزراعية مالياً وفنياً .
- تم استخدام البرمجة الخطية وبيروت لتحسين إستغلال الموارد .
- للتحقق من دقة البرنامج وتطبيقه جمعت المعلومات من مشروع الرهد الزراعي ومشروع ود سلمان الزراعي كمصادر أولية وثانوية للمدخلات .
- تمت مقارنة مخرجات النموذج مع برنامج مشروع الرهد الزراعي الحالي للدورة الثنائية والثلاثية والرابعة .
- أظهرت نتائج النموذج تخفيض فى العدد الأقصى للجرارات بنسب ٣٠% ، ٢٩% ، ١٦% وذلك للدورة الثنائية والثلاثية والرابعة .
- بمقارنة مخرجات النموذج مع أداء مشروع الرهد الزراعي للدورة الرباعية وبدلالة عدد الجرارات القصوى ، تكاليف العمليات الزراعية ، فترة تنفيذ العمليات ، إستغلال الآلات ، أظهرت النتائج فرقاً معنوياً .
- أظهر تطبيق النموذج نقصان عدد الجرارات المستخدمة ، تقليل تكلفة العمليات الزراعية .
- تم تقييم مخرجات النموذج بإستخدام مؤشرات مالية (NPV, B/C, IRR) وفنية ( العمالة - إستغلال القدرة وكفاءة توزيعها - أقصى قدرة عند الفترات الحرجة ) .
- التحليل المالى أشار إلى حالة موجبة لبرنامج مشروع الرهد الزراعي الحالي ، وأظهرت المؤشرات الفنية زيادة فى طلب العمالة بزيادة الكثافة المحصولية ، كما أشارت إلى وجود علاقة عكسية بين أقصى عدد للجرارات وزيادة الكثافة المحصولية .
- كما أظهرت النتائج تحسن طفيف فى كفاءة توزيع القدرة فى كل انواع دورات المحاصيل الزراعية .

- أظهر إستخدام إستلوب بيرت لتنفيذ البرنامج وتخطيط الوقت أن عمليات التمشيط القرصية هي أنشطة حرجة ، كما أظهر إستلوب بيرت تقليل الزمن فى كل أنواع الدورات الزراعية ، وأنه يمكن تقييم مخاطر إدارة الوقت وذلك بإيجاد مستويات مختلفة لإحتمالية تنفيذ البرنامج .
- أظهر النموذج تقليل الزمن بنسب ٩ % ، ١١ % ، ١٣ % عند إحتمالية (١٠٠%) لكل من الدورة الزراعية الثنائية ، الثلاثية ، والرابعة .
- أستغل النموذج لتصميم وحدة للآلات الزراعية لمشروع ود سلمان الزراعي ، وذلك لبرمجة العمليات الزراعية ، وتقدير التكاليف وأيضاً تحديد قيم مؤشرات الأداء المالى والفنى للمشروع .
- تم تطبيق تحليل الحساسية للنموذج بزيادة قيم مدخلات المساحة المبرمجة ، والتكلفة الكلية للعمليات الزراعية لمشروع الرهد الزراعي بنسب ١٠% و ٢٠% ، وذلك لقياس تأثيرها على أقصى عدد للآلات ، تكاليف الوقود الكلية ، معامل إستغلال الآلات الزراعية ، ومعدل العائد الداخلى (IRR) وذلك بإستخدام تحليل التباين .
- فى حالة زيادة المساحة المبرمجة أظهر التحليل زيادة معنوية فى العدد الأقصى للآلات ، تكاليف الوقود ومعدل العائد الداخلى للمشروع ، كما أظهر التحليل عدم وجود أثر معنوى على معامل إستغلال الآلات الزراعية .
- فى حالة زيادة التكاليف الكلية للعمليات أظهر التحليل زيادة معنوية فى العدد الأقصى للآلات ، تكاليف الوقود ، ولايوجد تأثير ( فرق معنوي) لزيادة التكاليف الكلية على معدل العائد الداخلى (IRR) ، ومعامل إستغلال الآلات .
- فى حالة تعدد المدخلات أظهر التحليل ان المساحة المبرمجة لها تأثير معنوى على العدد الأقصى للآلات ، تكلفة الوقود ، ومعدل العائد الداخلى ، ولايوجد اثر معنوى على كفاءة إستغلال الآلات الزراعية .
- يوصى بإستخدام النموذج لتحسين أداء و إدارة الآلات الزراعية بمشروع الرهد الزراعي ولمقارنة بدائل دورات المحاصيل الزراعية .
- يستخدم النموذج كأداة قابلة للتطبيق للتحكم فى الموارد خلال تنفيذ جدولة العمليات الزراعية ، وأيضاً نشاء مراكز خدمة للآلات الزراعية .
- فى مجال البحوث المستقبلية أظهرت الدراسة أربعة مجالات يمكن أن تبحث فيها مستقبلاً وإضافتها للنموذج .