A STUDY ON MECHANIZATION SYSTEM APPROPRIATE FOR SMALL-SCALE FARMING COMPRISING MULTIPURPOSE MACHINERY

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Thesis submitted in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

in

AGRICULTURAL MECHANIZATION

Mechanization Department
Faculty of Agriculture
Ain Shams University

1994

APPROVAL SHEET

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ABSTRACT

A computer program has been developed to calculate the optimum size of machinery system appropriate for small farms. This model is designed to run on an IBM personal computer. Model input includes: farm size, crop type, field operation, available workday. The size of machines to complete field work within prescribed date constraints is determined. The annual cost of machines is determined. Annual cost includes aspects of: depreciation, interest, repairs, shelter, insurance, and fuel use. The model uses standard techniques to match machine productivity to farm size and available time. Available time is a function of available days and workday length. Machine productivity depends upon:

machine size, allowable operating speeds, and machine efficiency.

A small power-unit with several attachments has been evaluated opposed to manual-animal system. Future expectation for mechanization economy has been also included.

KEYWORDS

Machinery selection, cost, computer programming, mechanization systems, cotton, wheat, rice, maize, berseem, animal power, Egyptian conditions.

CONTENTS

ACKNOWLEDGMENTS

First of all, I thank the Almighty God for his bounty and guidance without which none of this work could have been accomplished.

This work was accomplished with the great help of several individuals. Of them, I would like to thank my advisor Dr. Mohammed Nabil El-Awady, Professor and Head of Agricultural Mechanization Dept., Faculty of Agriculture, Ain Shams Univ., for his supervision and instruction, also for his constant encouragements, and valuable guidance.

The help from my co-advisor Dr. Awatif Hassan, Professor of Forestry Engineering, North Carolina State Univ. was certainly appreciated. I also thank her for her generous advice and encouragement while I was in US.

The author wishes to express his great thank to his friend Eng. Abdul S. Tohmaz, North Carolina State Univ., for his help in a computer, encouragement and patience.

Finally, I would like to thank all those who have contributed in any way, to make this study possible.

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I. INTRODUCTION

Agricultural production is the main part of the Egyptian national economy. Currently the state is trying to pace with the agricultural production with the population increase and rising of living standard. Production is being expanded both vertically and horizontally. This cannot prevail without enhancing mechanization in agriculture.

The main problem facing agricultural mechanization in Egypt is that some agricultural operations such as tillage and harvesting are mostly mechanized, while others are not. Mechanization might be applied through all operations from seedbed preparation to harvesting passing by furrowing, seeding, weed control, ..etc.

Another problem is the inappropriateness of most of big-type machinery for small-scale farming, which represents a high percent from Egyptian agricultural acreage. This might be due to difficulty of maneuvering for large machines, which requires more space. Add to this increasing of drainage and irrigation channels which delays machines crossing. Moreover, their operation is uneconomical.

Economical selection of field equipment is a complex problem that has some unique characteristics. Firstly, since agricultural production is seasonal, equipment will necessarily stand idle much of the time. Also, most field implements are operated by a shared power unit, the tractor; and a change in one tractor- implement operation will affect the whole system. Consequently, the complete system of implements must be considered. Secondly, the supply and ability of farm labor, which usually includes management personnel, is quite variable.

The problem of selecting field machinery efficiently is therefore one of adjusting the factors of implement performance, power availability, labor, timeliness until an optimum economic return results.

This research is carried out to study mechanization system most appropriate for small-scale farmers. The small machines with their attachments which are used in multi-purposes (such as: cultivators, trailers, and distributors of farm materials) are compared economically against other systems which depend on big-type machinery.

The rotavator developed in the Agricultural Mechanization Division, Ain Shams Univ. (1987) was used in this study as a unit power with several attachments to improve the economy by increasing the annual working time through engaging the rotavator in other diversified operations such as trailer pulling, driving a pump, and thresher with the same engine unit as recommended by Kabany (1987).

II. REVIEW OF LITERATURE

1. Local history of development

Mechanization in Egypt is as old as the written history itself. In ancient Egypt, mechanization was comprised of using tools and implements such as scythe, and flail. Simple machines were also used such as water-lifting levers "shadouf", and oxen-powered plows. Some of those devices are still being used in the country, yet becoming obsolete.

Starting from the eighties, mechanization has acquired an enormous urgency and acceptance due mainly to scarcity of farm labor and higher productivity levels of mechanization.

The evolution of mechanization since the turn of the century is manifested in the following historical events: Awady (1986)

1900-1940: manufacture of water wheels, archimedean screws, plows, and threshing "norags".

1940-1950: centrifugal pumps.

1950-1960: engines and electrical motors.

1960-1970: assembly of tractors, knapsack sprayers, threshers, winnowers, and sprinkler-irrigation systems.

1970-1980: motor sprayers, and trailers.

1980-on: appropriate technology, Nat. Ag. Mech. Plan, establishment of the Inst. of Mechanization, and Ag. Mech. Service Stations.

However, later on and up to 1992, local manufacture of ag. machinery expanded to include more diversified assortment of machinery including: rear mounted rotavators and mowers, and a variety of grain-harvesting equipment.

2. Distribution of Land Ownership

The land tenure is highly fragmented as evidenced from Table 1 (Statistical Year Book, 1990). 53.9 % of the total area are less than 5 fed. (2.1 ha). Larger holdings, a 100 fed. and more, account for 6.5 % of the total area including organizations, companies, and individuals.

Table 1: Distribution of land ownership in Egypt in 1985.

Bracket	Land Owners (Thousands)	Area Owned (Thousands fed)	Land Owners (Percent)	Area Owned (Percent)
Total	3575	5491	100.0	100.0
Less than 5	3411	2961	95.4	53.9
5 fed	88	576	2.5	10.5
10 fed.	45	559	1.3	10.2
20 fed.	23	633	0.6	11.5
50 fed.	6	405	0.2	7.4
100 fed.	2	357	0.1	6.5

3. Machinery selection

Proper selection and matching of machines and tractors for farming operations is essential, because machinery costs usually overshadow all other costs except land. The machinery selected must have the capacity to satisfactorily complete all operations within the critical time periods available, while the tractor must provide the proper amount of power to operate the matching implements at the best speed. With machines continuing to become larger and more expensive, each unit purchased represents a major investment. Consequently, machines must be carefully filled to the farm to achieve the most economical machinery mix.

As the importance of efficient machinery management increased, a number of techniques have been proposed to assist in maximizing profit. These fall into four main categories: simulation modeling, linear programming (LP), expert system (ES), and traditional computer programming.

Linear Programming: Linear programming is a tool which can assist in the solution which is useful in selecting the best alternative from a number of available courses of action bounded with a set of constraints.

A Linear Programming problem consists of three major components (Donhue, 1991):

1) Decision variables.

2) Objective function.

3) Constraints.

The decision variables relate to the decision that must be made and are expressed with algebraic symbols.