DEVELOPMENT OF POTATO CROP HARVESTER SUITABLE FOR SMALL HOLDINGS

By

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THESIS

Submitted in Partial Fulfillment of the Requirements for the Degree of

DOCTOR OF PHILOSOPHY

In

Agricultural Sciences
(Agricultural Engineering)

Department of Agricultural Engineering
Faculty of Agriculture
Cairo University
EGYPT

2019

APPROVAL SHEET

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Department: Agricultural Engineering Department. **Approval:** 7 / 4 / 2019

ABSTRACT

Potato crop (*Solanum tuberosum*) is one of the major vegetable crops in Egypt, cultivated area is 437386 feddan (183702 ha), and quantity of production is 4955445 tons. The farming structure in Egypt has totally changed during the past 50 years. It has gone from a small number of very large holdings to very large number of small holdings. The main objectives of this research were to develop, manufacture and evaluate self-propelled potato harvesting machine suitable for small holdings. A potato harvester self-propelled machine (single row) was developed; the potato harvester blade was designed, manufactured and evaluated. The developed self-propelled machine was evaluated at three levels of forward working speed (1.5, 2.0 and 2.5 km/h) and three levels of digging depth (16, 20 and 24 cm). Evaluation depended on the following parameters: machine field capacity, harvesting efficiency%, damaged potato tubers, consumed energy and cost of harvesting operation. The obtained results can be summarized as follows: percentage of damaged potato tubers increased by increase the forward speed from 1.5 to 2.5 km/h, but damaged percent decreased with increasing the digging depth, The highest value of field capacity was at operating speed of 2.5 Km/h with depth 16cm, The highest harvesting efficiency was at the digging depth of 24 cm and operating speed 1.5 Km/h. The harvesting efficiency decreased by increasing the forward speed from 1.5 to 2.5 km/h at different digging depths, The lowest value of the consumed energy was found at the digging depth of 16 cm and operating speed of 1.5 Km/h, The consumed energy increased with increasing digging depth. The highest value of the missing tubers percentages was at the digging depth 16 cm and operating speed 1.5 Km/h. By increasing the digging depth the missing tuber decreased. The minimum costs of were found at digging depth of 16 cm and operating speed 2 Km/h. The lowest value of harvesting time was by using the self-propelled machine compared to manual harvesting and traditional plough. While the harvesting time using the self-propelled machine decreased to 54.4% and 48.75% compared to manual harvesting and traditional plough respectively. The harvesting costs value of the self-propelled machine was 250 L.E /fed., according to 2017. So, it was decreased by about 68.75% and 60% comparing to manual harvesting costs and traditional plough respectively.

Keywords: potato, self-propelled machine, development, tubers damage, small holdings.

DEDICATION

I dedicate this work to whom my heartfelt thanks, to my parents, brothers and sisters for all the support they lovely offered along the period of my post graduation, as well as to my wife Samah for her patience and help throughout my thesis program. as well as to my sons Mohammad and Mostafa. Also, i dedicate it to my cousin Mr. Mahmoud Hasanin Al-Awny to help in manufacturing and testing the machine.

I would also like to thank my friends for their loving guidance and technical support during this work.

ACKNOWLEDGMENT

I wish to express my gratitude and appreciation to ***Dr. Gamal El-Din Mohamed Nasr****, Professor of Agricultural Engineering, Faculty of Agriculture, Cairo University for his sincere guidance, valuable advice and stimulating supervision during the development of the thesis.*

I wish to express my appreciation to ***Dr. Mohamed Naguib Rostom****, lecturer of Agricultural Engineering, Faculty of Agriculture, Cairo University,* ***Dr. Mohamed Morsy Mohamed Housien*** *Professor Of Water Relation and Field Irrigation, Agricultural and Biological Division, National Research Centre, and* ***Dr. Ahmed El-Fateh Farrag Ahmed*** *Professor Of Mechanical Engineering, Engineering Division, National Research Centre, for their effort, advice and numerous discussion, guidance, sincere deep help and encouragement during this work, who supported and sustained me in build this work. Thanks for them, for considering me as their younger brother.*

I am sincerely thankful to the friendly professional help of all the staff of Agricultural Engineering Department, Faculty of Agriculture, Cairo University.

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INTRODUCTION

Potato (*Solanum tuberosum*) occupies an important place among food crops in many countries of the world, as it is in terms of nutritional value, is the first alternative to cereal crops in solving the food problem (Horton and Sawyer, 1985).

The cultivated area is estimated to be the world's potato crop 91.9 million fed. (38.6 million ha), and the amount of produce is estimated 649.4 million ton. (Paul *et al.* 2012).

The potato is the world's fourth most important food crop after maize, wheat and rice with 381 million ton (fresh weight) of tubers produced in 2014 (FAO, 2017). Potatoes are cultivated in 149 countries (Bradshaw et al., 2010). In 2013, the top 10 potato producers were China, India, Russia, Ukraine, the USA, Germany, Bangladesh, Poland, France, and The Netherlands. They accounted for 65% of world production (FAO, 2017).

The cultivated area is estimated to be the Egypt's potato crop 437386 feddan (183702.1 ha), and the amount of produce is estimated 4955445 ton. (Agricultural Statistics Yearbook 2016).

The quality of potato tubers is closely connected to the physical and chemical characteristics of plant tissues and varies also in other factors such as climate, growing conditions, cultivar and maturity at harvest time and harvesting method (Bentini *et al.*, 2006).

Harvesting potato crop is a very important process of the potato production and marketing operation. Damage occurs during harvesting

(digging, loading, and transporting operations). The damage resulting of impact on tubers during harvesting operations alone may cause losses in excess of 20% (Storey and Davies, 1992).

Egyptian agriculture is characterized by a large base of very small holders of less than 1.9 feddans (0.8 hectare), referred to by the World Bank as poor holders, whose holdings represent about 66.35 % of the total number of holdings (FAO, 2010).

As a result of small holdings, these holdings require mechanization to suit them.

Therefore, the main objectives of this research were to develop, manufacture and evaluate a self-propelled Potato harvesting machine suitable for small holdings under Egyptian agricultural conditions.

To achieve this aim, the present study covered the following items:

1. Determination of some physical properties of potato tuber.

2. Developing and manufacturing a self-propelled potato harvester.

3. Testing and evaluating the designed harvester in actual field operation.

REVIEW OF LITERATURE

1. International production of potato

Paul *et al.* (2012) mentioned that Potato is produced on all continents except Antarctica and is the world's third most important food crop. Potato production has increased dramatically in developing countries in the past two decades, and has now overtaken that in the developed world, underlining the growing importance of potato as a staple food crop to meet the demands of increasing human populations. Also Potato is an important source of carbohydrate. Fig. (1) and table (1) show the Potato production by world regions. (FAO 2012).

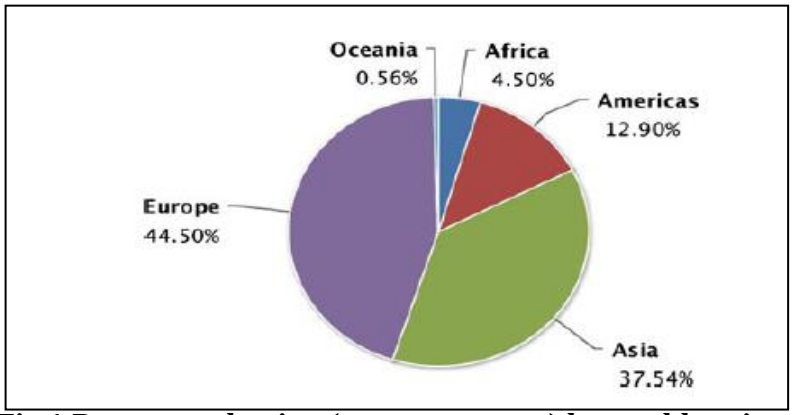

Fig.1 Potato production (as a percentage) by world regions.

Table .1 Yields of potato by world regions.

	Harvested area 2007 (M ha)	*Harvested area 2010 (M ha)*	*Quantity 2007 (Mt)*	*Quantity 2010 (Mt)*	*Yield 2007 (t/ha)*	*Yield 2010 (t/ha)*
World	19.16	18.5	325.5	324.4	16.8	17.4
Africa	1.50	1.80	16.7	22.3	10.8	12.2
Asia	8.70	9.10	137.3	154.3	15.7	16.9
Europe	7.40	6.10	130.2	108.1	17.4	17.7
Latin America	0.96	1.00	15.7	16.6	16.3	16.2
North America	0.60	0.50	25.3	22.8	41.2	41.2