



**UNIVERSITI PUTRA MALAYSIA**

**DESIGN AND DEVELOPMENT OF A TRACTOR MOUNTED SWEET  
POTATO TRANSPLANTING MACHINE**

**MANSOUR WIDAA MOHAMED EL HASSAN**

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POTATO TRANSPLANTING MACHINE**

**By**

**MANSOUR WIDAA MOHAMED EL HASSAN**

**Thesis Submitted in Fulfilment of the Requirement for the  
Degree of Master of Science in the Faculty of Engineering  
Universiti Putra Malaysia**

**March 2001**



*Especially*

*Dedicated to,*

*My beloved late mum, forever in my heart.*



Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science.

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**Chairman : Associate Prof. Ir. Dr. Desa Ahmad**

**Faculty : Engineering**

Transplanting is an important method of establishing field sweet potatoes. Design of a suitable transplanting machine depends on transplanting method. A design concept for the sweet potato transplanting machine was developed using Auto CAD R14. A prototype transplanter was designed, fabricated and field tested at the Department of Biological and Agricultural Engineering, UPM, Serdang, Malaysia.



The overall construction of the machine consists of the main chassis, power transmission system, transplanting pocket and handling system of the sweet potatoes vine cuttings. The machine was ground driven and mounted on the 3-point hitch linkage system of a mini or medium size tractor of 20-40 kW. Two operators were required in the transplanting operation; a driver for the tractor and an operator to feed the sweet potato seedlings manually. The operational activities for the machine include the preparation of planting furrow, placement of seedlings horizontally in the prepared furrow, covering of the seedlings and compacting the soil around the planted seedlings.

The machine allowed all possible variations and component adjustments to ensure prompt and comprehensive field evaluation. The power requirement was about 8.9 kW for a single row machine. The machine was simple in design, easily manufactured locally and able to operate at high efficiency (77%).

Forward speeds were significant parameter for transplanting and machine efficiency. These experimental results showed that first speed of 2km/hr together with planting depth of 20 cm is the best among speeds and depths tested as it gave the lower number of missing plants.

The sweet potato transplanting machine had an average capacity of 0.19 ha/hr at low speed (2km/hr) while the vegetable transplanter had about 0.09 ha/hr at the same speed. The expected yield for this machine should be greater than the yield produced vertically.



Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia  
sebagai memenuhi keperluan untuk ijazah sarjana

**REKABENTUK DAN PEMBINAAN JENTERA PENANAMAN UBI  
KELEDEK YANG DIPASANG PADA TRAKTOR**

**Oleh**

**MANSOUR WIDAA MOHAMED EL HASSAN**

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**Pengerusi : Prof. Madya Ir. Dr. Desa Ahmad**

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Penanaman dengan cara memindahkan semaian merupakan kaedah penting bagi kejayaan tanaman ubi keledek diladang manakala rekabentuk jentera penanaman bergantung kepada kaedah pemindahan semaian tersebut. Konsep rekabentuk jentera penanam telah diwujudkan menerusi Auto CARD 14-dan jentera tersebut telah dibina dan diuji di Jabatan Kejuruteraan Biologi Pertanian UPM, Malaysia.

Pembinaan keseluruhan jentera merangkumi kerangka utama, sistem penghantaran kuasa, petak semaian dan sistem pengendalian semaian. Alat penanam dipasang pada sistem sangkutan 3 mata dan ditarik oleh traktor berkuasa 20-40 kW.

Kaedah ini memerlukan dua pekerja, seorang pemandu traktor manakala seorang lagi pekerja memasukkan semaian ubi keledek manual. Aktiviti jentera secara umumnya melibatkan penyediaan batas, penanaman semaian secara selari bersama batas dan memadatkan tanah disekeliling semaian.

Jentera yang dibina mampu diubahsuai menurut keadaan. Kuasa yang diperlukan untuk tanaman satu baris adalah 8.9kW dan didapati lebih cekap pada kelajuan pergerakan traktor yang rendah.

Keupayaan jentera penanaman ini adalah 0.19ha/jam manakala penanaman sayuran adalah 0.09ha/jam.



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I certify that an Examination Committee met on 12<sup>th</sup> March 2001 to conduct the final examination of Mansour Widaa Mohamed El Hassan on his Master of Science thesis entitled “Design and Development of a Tractor Mounted Sweet Potato Transplanting Machine” in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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This thesis submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science.



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I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.



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**MANSOUR WIDAA MOHAMED EL HASSAN**

Date: 14 - 5 - 2001

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## LIST OF ABBREVIATIONS

AMA	Agricultural Mechanization in Asia, Africa and Latin America
ASME	American Society of Mechanical Engineers
UPM	Universiti Putra Malaysia
MARDI	Malaysian Agricultural Research and Development Institute
FAO	Food Agriculture Organization
FAOSTAT	Food Agriculture Organization Statistics
NIAE	National Institute of Agricultural Engineering U.K
UNSCC	United Nations Standards Organization
ISO	International Standards Organization
ISO/TC	International Standards Organization Technical Committees
PM	Number of missing plant
P <sub>c</sub>	Number of uncovered plant
Me	Machine efficiency, %
M <sub>c</sub>	Machine capacity, ha/hr
LSD	Least significant difference
SAS	Statistical Analysis System
S	Tractor forward speed, km/hr
D	Transplanting depth, cm



R	Replication
RR	Rolling Resistance
$D_o$	Transplanter Outside Diameter, mm
$E_f$	Field Efficiency %
PI	Performance Index
Pr	Power Requirement, kW
rpm	Revolution Per Minute

## CHAPTER 1

### INTRODUCTION

Sweet potato (*Ipomoea batatas* LAM) a member of the morning glory family (Convolvulaceae) [Convolvulaceae images], is grown in the tropical, subtropical and warm temperate regions of the world. The sweet potato is a native American vegetable, it was found well established by Christopher Columbus and then back to Europe. Sweet Potato was spread through Asia, Africa and Latin America during 17<sup>th</sup> and 18<sup>th</sup> centuries. Japan and United States are the only industrialised countries that grow appreciable amounts of sweet potato today. In Malaysia sweet potato is cultivated on small scale since 17<sup>th</sup> century.

Sweet potato is the world 's seventh most important food crop after wheat, rice, maize, potato, barley and cassava with annual production of more than 100 million metric tons per year (Collins, 1995). As a matter of fact, more than 95 % of the global sweet potato crop is grown in developing countries. However, China has historically been the major consumer and is responsible for 90 % of

world wide sweet potato production. According to FAO Annual Report (1998), sweet potato is among the world's most important versatile and underexploited food crops, with more than 133 million tons in the annual production. Thus, the current studies shows that sweet potato ranks as the fifth most important food crop on a fresh-weight basis in developing countries after rice, wheat, maize, and cassava FAO Annual Report (1998). The production of sweet potato in Malaysia is still low as compared to other Asian countries. There were more than 2000 hectares of land cultivated under sweet potato in Malaysia with a production capacity of 7-15 tones per hectare (Mohamed, 1994).

**Table1: The world sweet potato production**

	Production								
	1995-1997			Average annual growth rate <sup>a</sup>					
	Production (t)	Area (ha)	Yield (t/ha)	Production (%)		Area (%)		Yield (%)	
				1	2	1	2	1	2
Asia	125.1	7.2	17.0	1.1	0.8	1.4	-0.3	2.5	1.1
Africa	7.0	1.5	5.0	2.1	0.5	2.6	0.8	-0.4	-1.3
Latin America	1.9	247.0	7.0	-1.2	-1.7	-1.0	-2.2	-0.2	0.5
Europe	55.0	5.0	12.0	-3.6	-5.7	-3.8	-5.5	0.2	-0.2
Japan	1.140	48.0	24.0	-5.0	-2.6	-5.5	-3.1	0.5	0.5
USA	604.0	34.0	18.0	-0.4	0.3	-2.3	-1.2	1.9	1.5

Source: Production, Utilisation and Consumption: FAOSTAT (June 1998).  
a : (1) 1961-63 to 1995-97 (2) 1985-87 to 1995-97



The sweet potato is grown as a commercial and home garden commodity. In the past, it has been the main food energy source for animal production. Moreover, the importance of sweet potato as human food has been gradually replaced by imported wheat (Yang *et al*, 1975). Thus, more than 95 % of the global sweet potato crops are grown in over hundred developing countries. Therefore, only in a decade ago, the crop has been the focus of intense, coordinated, global effort to realise its full potentiality as a source of food, feed, processed products and income for millions of small farmers and low-income consumers in Africa, Asia and Latin America.

Sweet potato has an abundance of usage, ranging from consumption of fresh roots or leaves to processing into animal feed, starch, flour, candy and alcohol. Recent research has documented the wide spread use of sweet potato by small farmers in their efforts to sustain local livestock production system. The steady increase in the use of sweet potato roots and vines in other livestock systems in China over the last thirty years now means that from 30 to 50 million tones or more are used annually as feed. Processed product made from sweet potato including starch, noodles, candies, desserts and flour have long been made by farm households to extend the availability, diversity the use and increase the value added for the crop. In Malaysia sweet potato is a very important crop, next to tapioca, which consumed as alternative or supplement.

As far as the nutritive value of sweet potato is concerned, it is believed to be very high. It contains 20% starch and 5% simple sugar, rich in vitamin A and also provides considerable amount of vitamin C. It is generally considered