MECHANIZATION POSSIBILITIES FOR CASSAVA PRODUCTION IN MALAYSIA

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ABSTRACT

This paper looks at the needs and potential for mechanized operations in the production of cassava on mineral soils in Malaysia. It briefly explains the planning considerations and the availability of machines for these operations. Almost all field operations in the production of cassava on mineral soil can be mechanized; however, a few operations may still need to be done manually. The scale of production determines the extent of mechanization to be adopted. Careful planning is required because mechanized production involves a large amount of capital. Planning should involve establishing a suitable schedule to carry out field operations and selecting the appropriate machines. Local environmental and topographical factors at the farm also need to be considered in the planning of mechanized cassava production.

INTRODUCTION

One of the major sources of starch is cassava *(Manihot esculenta* Crantz*)*. Cassava starch is widely used in Malaysia in various industries such as food processing, textiles and paper production. It is also used in the production of certain chemicals such as acetone, alcohol and acetic acid. Cassava is also used in the livestock feed industry. The demand for cassava starch is growing rapidly; it was estimated at 90,000 tonnes (valued at US$ 14 million) in 1996, and has been increasing at a rate of about 27.8% per year over the last ten years (Tan, 1998). Technologies for growing cassava also have been well established (Tan and Chan, 1994). Even though cassava is an important crop for the starch industry, the area cultivated in Malaysia has sharply decreased, from 20,000 ha in 1988 to about 2,000 ha in 1997 (Anon, 2000; Tan, 2000), and has remained at this level since then. This decline has been attributed to scarcity of land and labor.

Machines for field operations for cassava, such as for land preparation, planting, fertilizer application, weed control, harvesting and transportation have been developed and reported (Sukra and Tan, 1994). In Malaysia mechanization for cassava is currently limited to land preparation, herbicide spraying and digging of roots. Mechanization for the other operations is needed for more cost-effective commercial production of the crop in view of labor shortages. The traditional method of production is too labor intensive. It requires about 81 man-days/ha **(Table 1)**.

Considerations for Mechanized Cassava Production

Planning for mechanized production of cassava is different from that of manual production. A large amount of capital is required in mechanized production. Also attention need to be given at the planning stage to several important aspects, such as terrain, infrastructure, soil type, rainfall, labor quality and capital.

Soil and terrain

For ease of mechanized operations, areas with a loam type of soil should be selected, while heavy clays should be avoided. Also, field plots should not have slopes of more than 8%, nor should they be laid on low-lying and flood-prone areas. Plots may need to be graded to ensure good drainage. If cassava needs to be planted on slopes then

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it would be advisable that the plots be laid across the slope, or slightly inclined to the contours so as to minimize soil erosion in the plots.

Table 1. Labor utilization for traditional cassava production.

	Labor utilization per hectare	
Field operation	Man-days	% of total
Land preparation*	-	-
Harvesting of stems	1	1.2
Preparing stem cuttings	1	1.2
Planting	9	11.2
Weed control		
Pre-emergent spraying	1	1.2
Hand weeding at 2-3 months	10	12.3
Pre-harvest spraying	2	2.5
Fertilizer application	5	6.2
Harvesting a 30 t/ha yield	50	61.7
Clearing fields	2	2.5
Total	81	100

*This operation is contracted out and done using 4-wheeled tractors
Source: *Adapted from Chan et al., 1983.*

Rainfall distribution pattern

Generally, it is difficult for tractors to work in wet sticky soils. Hence the interplay between soil texture and rainfall distribution pattern in any production area will determine the number of workdays available throughout the year. This parameter influences the formulation of cropping schedules, and hence the capacity and number of machines required in any mechanized cassava production that would determine its economic viability. It is best if field operations could be undertaken all year round so as to maximize the use of each machine, thereby requiring less machines for the whole farm. Areas with low but adequate amount of rainfall that is well distributed throughout the year are suitable for mechanized cassava production. On the other hand, areas with very high rainfall throughout the year are not suitable. Areas with a long wet period would require a larger number of machines for each farm as compared to those with no specific wet period.

Machinery for Field Operations

Based on our studies, we are of the opinion that it is possible to mechanize fully the production of cassava roots. The machines considered suitable for the various field operations are listed in **Table 2**. Most of the machines are imported, while a few have been developed locally. The majority of these machines have been tested on local loam soils. The optimum machinery for collecting and handling of harvested roots in the field, prior to being transported to the factory, still needs to be developed further.

Land preparation

Initial land clearing, land levelling and the construction of field roads and drains can be done using standard machines or tractor implements such as bulldozer, motor grader, digger-shovel/back hoe, and rotary disk trencher.

Table 2. Machines which may be used for different operations in the production of cassava on mineral soils.

Field operation	Prime mover*	Implement/machine*
Primary tillage	Tractor 4W**	- Disk plow
		- Moldboard plow
Secondary tillage	Tractor 4W**	- Rotary tiller
		- Disk harrow
Other operations (as needed)	Tractor 4W**	- Cambridge roller
		- Ridger
		- Rotary ditcher
		- Subsoiler
		- Mole drain plow**
		- Dump rake**
		- Spring tine
Stem harvesting	Manual	- Machete
	Tractor 4W	- Stem harvester**
Stem gathering, stacking	Tractor 4W and manual	- Trailer
Making stem cutting	Engine	- MARDI stem cutter[1]
	Manual	- Machete
	Manual	- Hand saw
	Engine	- Chain saw
Transport to field	Tractor 4W	- Trailer
Planting	Tractor 4W	- Modified 'API' planter[2](1/2/3 rows)
		- 'GMD' planter**
		- 'BONEL' automatic planter**
		- 'Whole stem planter**
		- 'Nigeria' automatic planter**
		- 'Cuban planter**
Fertilizer application	Tractor 4W	- Simultaneous with above planters
		- Spinner/bander
Pre-emergence herbicide spraying	Tractor 4W/2W[3] /Motorcycle[4]	- Boom sprayer-hydraulic or DA****
	Manual	- Manual knapsack sprayer
		- CDA sprayer
		- Motorized knapsack sprayer
		- Portable motorized sprayer
Post-emergence berbicide spraying	Tractor 2W	- High clearance CDA sprayer[3]
		- Portable motorized sprayer + long hose
	Tractor 4W	- Boom sprayer + long hose
		- Manual knapsack sprayer
		- Motorized knapsack sprayer
Inter-row weeding	Tractor 4W	- Duck foot spring tines
		- Inter-row rotary tiller**
		- 'Hammer' flail pulverizer
		- Rotary slasher
		- Oil palm bunch mulcher
Root digging	Tractor 4W	- MARDI 1-row digger[5]
		- 1-row elevator digger: 'API'/'Righter'[6] / 'GMD'**
		- CIAT ½ row digger
	Manual	- IITA-MARDI lever[7]

Table 2 (Continued)

Field operation	Prime mover*	Implement/machine*
Root gathering	Tractor 4W	- MARDI collection trailer c/w crane - Front-end loader - 'GMD' pickup loader**
Complete harvester	Self-propelled	- Combine harvester 'Righter'**
De-stumping	Manual	- De-stumping axe or machete
Transportation to factory	Tractor 4W	- Trailer

Notes:
* = Each tractor or implement is of various capacities.
** = Performance of this machine has not been tested locally.
*** = 4W or 2W refers to four-wheeled or two-wheeled.
**** = CDA refers to controlled droplet applicator.

Sources:
[1] Sukra *et al.,* 1993
[2] Sukra *et al.,* 1990
[3] Anas, A.N., Agric. Engin. Div., MARDI, Serdang, *pers. comm*., 1990.
[4] Anas, 1990
[5] Sukra, 1994
[6] Kemp, 1978
[7] Sukra, 1986

Soil cultivation

To control weeds, prior to soil tillage operations the ground cover ought to be sprayed with a suitable herbicide using a tractor-mounted boom sprayer. The implements to be chosen for cultivating the soil depend on the soil texture, soil moisture status, ground slope, grass cover and other factors. Primary cultivation can be done using a disk plow or moldboard plow. Secondary soil cultivation can be done using a disk harrow or rotary tiller. Cambridge roller can be used for breaking large soil clods or for compaction of over-loosened soil. On low ground areas with possibility of flooding during heavy rains, planting on wide beds or high ridges is recommended. Wide beds can be constructed using ridger or furrower implements. However, it is better if such areas are provided with sufficient drainage to prevent flooding.

Harvesting stems for cuttings

Before the mature crops are harvested, good stems are collected for use as cuttings in the next crop season. The stems are cut and gathered manually and kept in standing stacks. While tractor-drawn trailers may be used in transporting the cut and gathered stems, no fully mechanized means have been found for the cassava stem harvesting operation.

Preparing cassava stem cuttings

Cassava is planted from stem cuttings of about 20 cm in length. A large amount of cuttings are required (about 10,000 cuttings/ha). For mechanized planting, the cuttings used need to be uniform in length, size and shape with their ends being cut cleanly. The preparation of stem cuttings could be done manually using simple tools such as hacksaw or a motorized small chain saw. A prototype engine-driven cassava stem-cutting machine has been developed at MARDI. The machine's quality of work was satisfactory. It was capable of preparing up to 3,300 cuttings/hour. One worker was

required to operate the machine. The prototype machine developed in 1993 was estimated to cost about US$1,316 per unit (Sukra *et al.*, 1992).

Planting and fertilizing

An imported semi-mechanical single-row planter for cassava has been modified and tested by MARDI (Sukra *et al.*, 1990). The modified planter performed satisfactorily. However, its performance was affected adversely by sticky soil conditions as well as by very fine or very chunky soil tilth. Long or large-sized stem cuttings (more than 25 cm) are not suitable for use with the planter. Compared to manual planting, the planter reduced the planting time by about 70%. The planter could be attached to the tractor singly or in a gang of three. The single row planter has a work rate of 0.18 ha/hour and uses one operator. A fertilizer hopper attached to the machine applies granular fertilizer along the planted row.

Weed control

Pre-emergence herbicide spraying needs to be done immediately after planting. A mixture of two herbicides can be used for that purpose. Two liters of Alachlor or Metolachlor + 2 kg Fluometuron can be applied on a hectare planting area. This mixed herbicide can be spread using a tractor-mounted boom sprayer immediately after the planting operation. With good land preparation practice, the pre-emergent sprays would be adequate till the crop ground cover is complete. If the crop ground cover is not too good at about two months after planting or if the weed infestation is high, an inter-row cultivator or spring tine cultivator can be used for weeding in between the rows of young cassava plants. Alternatively, at three months after planting, a contact herbicide can also be sprayed in between planting rows using CDA (controlled droplet application) applicators attached to a power-tiller mounted on a high-clearance tool bar (Anas, 1990).

Pre-harvesting tops removal

Before the cassava roots are harvested mechanically, the part of the cassava plant that is above the ground need to be removed so as not to hinder the progress of the tractor with harvester (digger). A tractor-mounted rotary pulverizer or shredder implement could be used for this purpose.

Cassava root digging

Two types of root diggers have been evaluated at MARDI, i.e. the MARDI root digger and API root digger-elevator. The MARDI root digger is a tractor-mounted implement with field capacity in the range of 0.13-0.18 ha/hour, and field efficiency of 80-92% (Sukra, 1986). The API root digger-elevator is a semi-mounted tractor implement that digs, elevates and shakes the root clumps free of soil clods, and deposits them on the ground ready for manual picking and gathering. Compared with the traditional method, the implement could give 92- 95% saving in labor requirement for the root digging operation (Sukra, 1994).

Root gathering and transporting

Root gathering still need to be done manually, unless the scale of production warrants the use of a cassava combine harvester. However, the operation could be partly mechanized by using a tractor mounted collecting bucket *cum* loader. Under this method, the clumps of roots would be manually picked from the ground and thrown on to the collecting bucket, which is mounted in front of the tractor. Once full, the bucket

could be raised and the content loaded on a lorry or a tractor-drawn trailer that travels along the root picking team.

CONCLUSIONS

Mechanized production of cassava roots is possible on mineral soils. Most of the machines needed for it are known or available in the market. However, a few field operations still need to be done manually. A suitably developed mechanized production system has the potential to reduce the manpower requirement and operational cost. The most suitable combination of machines for any particular production farm need to be determined on a case-by-case basis, due to the number of factors that affect the performance and economic viability of mechanized operations. Local factors such as rainfall and soil physical conditions need to be taken into consideration when planning such an operation.

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