PROCEEDING OF INTERNATIONAL SYMPOSIUM ON

AGRICULTURAL AND BIO-SYSTEMS ENGINEERING FOR ASIA SUSTAINABILITY: OPPORTUNITY AND CHALLENGE (ABEASOC)

Co-organized by
the Nong Lam University Hochiminh city
Ministry of Education and Training, Vietnam
and International Farmers Participation

March 29-30, 2012
Nong Lam University, Hochiminh city, Vietnam
Research and Development of a Cassava Digger Attached to 50 hp Tractor

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ABSTRACT

This study summarizes current status of cassava harvesting and elaborates the development of a cassava digger suitable for a 50 hp tractor for continuous working. Study shows that two common harvesting practice patterns were common: a) mostly using human labor with simple tools, and b) using of cassava digger attached to tractor and then processed by human labor. Analysis shows that about 37% of the labor cost and 10% of the harvesting cost could be saved by using of the latter pattern. The existing cassava diggers used in Thailand represent diverse designs depending on geographical location of planted areas, socio economic and tractor size (20-70 hp). Nonetheless, majority of them seem to have scope of design improvement, mainly to reduce draft, fuel consumption, wearing of tractor and harvesting loss. To address the limitations of existing machines, a new design of cassava digger capable of continuous working was envisaged and developed. The main features in the proposed design are its curve type shear (55 cm) with adjustable length and angle of moldboard for versatile use in vivid planted areas. Performance evaluation of the newly developed machine showed its field capacity of 0.23 ha/hr and harvesting loss of 1.0-4.0%. This loss are fairly low as compared to the other existing designs. This developed cassava digger is accepted by private sector for its commercial production.

Keywords: cassava, cassava digger, harvesting, Thailand

INTRODUCTION

Cassava is considered as one of the most important economic crops of Thailand. It is utilized as raw material in various industries of the country viz., food, feed mill and other continuous industries (Sri norakut, 2002). It is also the important energy crop for ethanol production, which is used for gasohol production and substitutes importing of Methyl Tertiary Butyl Ether (MTBE) in bio-diesel production (Kongsawa, 2006; Srirot, 2009). Thailand is the fourth cassava producer in the world following Nigeria, Brazil and Indonesia; but it is the world largest exporter with exported value of over THB 29 billion per year. Thailand’s cassava planted area is 1.2 million ha which is the fourth following rice, maize and rubber tree, with production yield of 26.9 million ton (OAE, 2010).

Harvesting cost is the largest contributor to cassava production cost due to the high labor requirement and labor shortage problems (Jarernrat et al, 2007). Like other important economic crops of the country, except for rice where rice combine harvester is available and popularly used (Chamsing, 2007), cassava do not yet enjoy luxury of adequate mechanization. Despite several designs of cassava diggers have been developed since over 30 years, yet at present, cassava diggers are not popularly used as expected. However, researchers continuously attempted to bring about necessary modifications in existing designs (Mongkol tanatas et al, 1992; Mongkol tanatas and Chamsing, 2007). Lack of adequate cooperation among cassava producers, farmers, researchers and extension officers as well as technical complexity of cassava digger itself are possibly the prime causes of current challenge. Therefore, in this research, to lower the harvest cost and address the labor shortage problems in cassava production, study on the current situation and resulting development of a suitable cassava digger to address current problems was felt necessary.

METHODOLOGY

Study on the current situation of cassava harvesting and use of cassava diggers
Information on current situation of cassava harvesting and current challenges was collected through secondary (literature review) and primary (field survey data collection) sources. Provinces with larger planted area of cassava viz., Nakorn Sawan, Nakorn Ratrasima, Burirum, Chachernsoa, Sra Keaw, Utahi Thanee and Kungangphet were selected for field survey. Issues in the study of current situation of cassava harvesting and use of existing available cassava diggers included the problems, constraints and farmer's perceptions.

**Design and development a cassava digger**

A much-reported constraint of cassava harvesting by using a cassava digger attached to a 50 hp tractor or larger is its limitation in continuous operation. Main reason for this limitation is because the cassava rhizomes that were dug in previous pass are pressed by tractor wheel in the following pass - causing to increase damage and yield losses. As a current practice, a number of laborers are required to wait along the digging rows to collect the dug rhizome out immediately after digging before continue with the next row. Retain link operation, harvesting loss and high fuel consumption are thus very commonly reported problems in the current situation.

To develop and evaluate a cassava digger attached to 50 hp tractor, a testing unit was developed for examining related components including shear blade (type, size and blade angle), moldboard (type and size). Harvesting loss, produce damage, fuel consumption and field capacity were among the major assessment indicators.

**RESULTS AND DISCUSSION**

**Current status of cassava harvesting and use of cassava diggers**

Recommended age of cassava harvesting is 8-14 months; survey revealed that in the study area harvesting in range of 10-12 months is commonly practiced. Usually cassava harvesting in Thailand is done throughout the year. Over 10% of cassava in a year was harvested during November to March of the next year (OAE, 2010).

**Harvesting system:**

Four harvesting operations are commonly practiced viz.: a) stem cutting before harvesting cassava, cassava stems are both cut and collected for using as stock for the next crop planting or some farmers just remove it from farms; b) digging or pulling cassava rhizome from the soil; c) collecting and cutting of cassava tuber from the stem; and d) carrying to truck for transporting and sale. Two harvesting patterns were categorized which are a) employing of human labor for all harvesting operations, and b) using cassava digger attached to tractor combine with employing human labor after digging. The later system saved labor requirement and harvesting cost about 37 and 10% respectively (Anuchit, 2007). Survey results showed that only digging operation was mechanized while the rest harvesting operations were based on human labor. Labor shortage and hiring cost were among the major problems faced. Therefore, mechanization of harvesting operation after digging cassava rhizome up from the soil can be considered as a bottle neck of the harvesting system.

**Using cassava digger attached to larger tractors**

Cassava diggers have been developed by various sectors since long time to present. There are various types and sizes of the cassava designs in use, depending on geographical planted areas, socio economic characteristics and tractor size (20-70 hp). Reported field capacity ranged between 0.32-0.64 ha/h with harvesting loss in range of 5-10% (Seangpunta, 2005).

The most distinguishing component among the existing cassava diggers is the bottom digging part especially for shear and digging operation. Fork shear type and curve blade shear type are commonly used (Fig. 1). Fork shear and non-turning type are popularly used in planted areas of Sakeaw, Prajin Buri and Chachern Soa provinces provinces. Both turning and non-turning (only lift up) soil with cassava rhizome types are available during digging operation (Fig. 2). In case of turning type, two designs are available namely, turning both left and right sides, and only one side of the digging bottom (Fig.3). The former type (both sides turning) may cause problems of unable to continuous working, especially when attached to medium and large size tractors. This is due to wheel pressing on dug cassava rhizomes that causes to increase damage and harvesting loss as well as requires additional labor to collect and move out cassava rhizome from the previously dug row. Although cassava diggers are commercial produced and accepted...
for use by some farmers, some modification/adjustment after buying were still needed. Moreover, results showed that by fabrication structure and working operation trend to require high draft force, difficult for depth control and may cause damage to hydraulic system of tractor. Over turning of soil and cassava rhizome also caused high harvesting loss and labor requirement. Therefore, improvement over existing designs was required.

Figure 1 Various type of cassava digger in use

Figure 2 Harvesting by (a) turning type cassava digger and (b) by non-turning type

Figure 3 Turning soil and cassava rhizome for (a) both sides and (b) turning only one side
Research and development a cassava digger

Fabrication of testing unit and primary test: A cassava digger in form of testing unit was developed to study the important factors. It was able to adjust and replace of some components viz., type and angle of shear blade, type and size as well as angle of moldboard, distant between bottom set to tractor and adjustable of cross beam (Fig. 4). The results show that the testing unit was capable to work. Digging result was different depend on soil type, soil moisture content and soil hardness. However, size of main structure need to be increased.

![Testing unit to identify design values of major components](image)

Study on bottom set

Different types of shear blade (Fig. 5), angle and length of shear blade from land side were studied. Results reveal that curve shear blade type, which was made from the furrow wheel of standard disk plow (55 cm diameter), appeared to be the most appropriate type. This was due to its versatility in dry and hard soil, availability in local market and non-requirement of machining. The shear blade angle of 30 degree to landside and length of 6 cm lower than landside gave the best results.

Study on type and size of moldboard

To select the most appropriated moldboard for the purpose of moving dug soil and cassava rhizomes away to the right hand side position as much as possible and still keep vertical standing for increasing of collecting efficiency and reducing harvesting loss, various types of moldboard were studied. Curve radius and width of moldboard as well as length of shear blade’s support were varied in the study (Fig. 6). The results show that straight vertical moldboard with 20 cm long supporter to shear blade from its top edge of was the most appropriate. The curve moldboard could move dug soil and cassava rhizome but in form of overturning which caused to increase harvesting loss. However, soil accumulated/obstructed on the bottom set while harvesting in high moisture soil. Therefore, adjustable moldboard was developed to make it at wider angle for expanding its use in wide range of soil conditions.

![Types of shear blades studied](image)

Prototype development and performance assessment

The prototype of cassava digger was designed based on the design values obtained from the preliminary tests and survey (Fig. 7). Adjustments were made to match with harvesting row and the frame was designed for allowing attachment to larger size of tractor. Durability test was done for various conditions of soil types and tractor sizes. Testing results revealed average values the field capacity as 0.23 ha/hr, fuel consumption as 20.63 liter/ha and harvesting loss as 1.0-4.0%. These losses are fairly low as compared to the other existing designs.
CONCLUSIONS

Literature review and primary field survey showed that four harvesting operations are commonly practiced: a) stem cutting before harvesting cassava; b) digging or pulling cassava rhizome from the soil; c) collecting and cutting of cassava tuber from the stem; and d) carrying to truck for transporting and sale. Two harvesting patterns were categorized, which are a) employing laborers for all harvesting operations, and b) using cassava digger attached to tractor combined with employing laborers after digging operation. About 37% of labor requirement and 10% of harvesting cost were saved by using of the latter pattern. The existing cassava diggers used in Thailand had various types and sizes depending on geographical planted areas, socio economic characteristics and tractor size (20-70 hp). However, existing cassava digger designs still required to reduce draft, fuel consumption, wearing of tractor and harvesting loss. A new design of cassava digger capable of continuous working was developed. The main features were curve type shear (55 cm) with adjustable length, and angle of moldboard for versatile use in wide soil conditions. The field capacity was 0.23 ha/h and harvesting loss were between 1.0-4.0% which was low compared to the existing designs. The developed cassava digger was readily accepted by private sector for commercial production.
REFERENCES


