

EFFECT OF CUTTING VELOCITY / STEM SIZE ON THE EFFICIENCY OF NRCRI CASSAVA STEM CUTTING MACHINE

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ABSTRACT

The developed NRCRI (National Root Crops Research Institute) cassava stem cutting machine was evaluated. The cassava stems from the variety TME 419 were used. The sizes of the stem used were 1.8, 2.0, 2.3 and 2.6cm. Also, different cutting velocities of 1.20, 1.23 and 1.32m/s were used. The stakes produced has length of 2.5cm. Analysis of variance in RCBD was used to evaluate the effect of the cutting velocity and the stem size on the efficiency of the cutting machine. The result of the analysis showed that the cutting velocity had very highly significant effect, while the stem size had no significant effect at 5% level on the efficiency of the cutting machine. The data obtained also showed that the highest and least cutting efficiencies of 99.42 and 94.71% were obtained with the machine cutting velocities of 1.2 and 1.32m/s respectively.

KEYWORDS: Effect, Cutting velocity, Stem size, Cassava, Efficiency, Machine

1. INTRODUCTION

Cassava (*Manihot esculenta*) is one of the most important food crop grown in tropical regions of the world. The crop originated in South America, where its tubers have been used throughout the ages as a basic food; from there it spread to regions of the world. It is now the most widely cultivated crop in Africa and is grown by small holder farmers, who depend on seasonal rainfall.

In Africa, cassava is the second most important food after maize in terms of calories consumed. In the 1990s, Nigeria replaced Brazil as the largest cassava producer worldwide. Nigeria has been the world leading producer of cassava with an estimated annual production of 36.8 million tons from an estimated area of 3.78 million hectares (FAOSTAT, 2009). The major problem of cassava is that it is extremely perishable and the harvested root must be processed to reduce post harvest losses (Davies, 1991). Cassava can grow in poor marginal soil where most crops cannot grow (Ali, 2005). Cassava matures in 12 to 18 months after planting. Cassava can be processed into variety of products such as *gari*, *fufu*, *tapioca*, cassava chips and flour. Recently cassava has occupied a prominent place in National non – oil export commodity, especially exports in Sub – Saharan Africa that international demand is far above the supply (Fresco, 1993; Nweke et al., 2002). This increase in cassava export has also negatively affected local supply. It is also important to note that cassava production is mostly done by rural small holder farmers using low – level production techniques (Omonona, 2009; Onyegbami et al., 2010; Nweke et al., 2002).

In Africa, cassava has proven to be a powerful poverty fighter by driving down the real price of food to millions of consumers. In Nigeria, during the rapid diffusion of the new IITA's (International Institute for Tropical Agriculture) TMS (Tropical Mosaic Selection) varieties, from 1984 to 1992, inflation adjusted cassava prices fell by 40 percent compared with the period before the diffusion (Nweke, 2004). This dramatic reduction in cassava prices represents a significant increase in the real income of millions of the rural and urban households who consume cassava as their most important food. Cassava has many other benefits (Fresco, 1986). Cassava is widely grown in Africa by a large number of small holders across several

ecological zones because it is a robust crop that can be grown under stress conditions. Cassava also has wide applications as feed and industrial raw material.

However, in Africa, around 90 percent of cassava production is used as food and 10 percent as livestock feed and industrial raw material compared with 45 percent as food and 55 percent livestock feed and industrial raw material in Brazil (FAOSTAT, 2009). In Africa, the challenge is to increase cassava productivity, by implementing the relevant R & D (Research and Development), in order to feed the growing population and play an expanded role as livestock feed and industrial raw material. In Nigeria, with the demand for cassava both for food and industrial uses, mechanization of cassava field operations has become imperative if the huge demand is to be met locally.

Mechanization reduces drudgery, thus making farming an attractive enterprise. It therefore, has the potential for national economic growth, food self- sufficiency, industrial growth and employment leading to poverty reduction. The presidential initiative on cassava in Nigeria aimed to create awareness among farmers on the opportunities in the cassava market worldwide. In order to encourage the mechanization of cassava production operations, NRCRI cassava stem cutting machine was developed to reduce drudgery in stake production operation involved in cassava production. The objective of this paper is to evaluate the effect of the cutting velocity and stem size on the efficiency of the developed machine.

2. MATERIALS AND METHODS

Analysis of variance (ANOVA) in RCBD was used to analyse the effect of the cutting velocity and the stem size. Cassava stems of TME 419 variety were used. The stem sizes used were 1.8, 2.0, 2.3 and 2.6cm.

The speed of the machine was varied by using three different sizes of driving motor pulley diameter. The cutting speeds used were 1.20, 1.23 and 1.32m/s. The stem sizes used at a particular machine speed were replicated three times to obtain the average cutting efficiency. The numbers of damaged and viable stakes at each replication were noted. These values were used to calculate the efficiency of the machine.

a) The Machine Output Capacity (Mc)

This is the rate at which the machine cut the cassava cuttings loaded into it and is calculated as:

$$M_c = Q/t \dots\dots\dots 1$$

Where M_c = Machine capacity (stakes produced/min)

Q = Quantity of cassava stakes produced

t = Time for cutting to be completed (min)

b) The Cutting Efficiency (Ce)

This is defined as the percentage by output of viable quantity of stakes over the total quantity of stakes produced.

$$C_e = \frac{T-X}{T} \times 100 \dots\dots\dots 2$$

Where C_e = Cutting efficiency (%)

T = Total quantity of stakes produced

X = Non viable stakes produced

c) The Cutting Velocity (Cv)

This is the speed at which the cutting blades rotate and cut the cassava cutting and it is expressed as:

$$C_v = \frac{\pi DN}{60} \dots\dots\dots 3$$

Where C_v = Cutting velocity (m/s)

D = Diameter of the machine pulley

N = Speed of rotation of the machine pulley

3. RESULTS AND DISCUSSIONS

The data obtained in table 1, showed that the highest average cutting efficiency of 99.42% was obtained with the cutting velocity of 1.2m/s and cassava stem size of 1.8cm, while the least average cutting efficiency of 94.71% was obtained with the cutting velocity of 1.32m/s and stem size of 2.6cm. The data obtained also showed that increase in the cutting velocity increases the output capacity, but decreases the efficiency of the stem cutting machine.

The result of the ANOVA table shows that the cutting velocities used had very highly significant effect at 1% level ($P < 0.01$) on the efficiency of the stem cutting machine.

- That the stem sizes used had no significant difference at 5% level ($P < 0.05$) on the efficiency of the stem cutting machine.

Table 1: Data Obtained on the Machine Efficiencies (%)

Cutting Velocity (m/s)	Output Capacity (stakes produced/min)	Stem Sizes (cm)			
		1.8	2.0	2.3	2.6
1.20	896	99.42	99.33	99.21	98.88
1.23	944	99.26	99.15	98.94	98.83
1.32	984	96.75	95.93	95.33	94.71

Table 2: ANOVA for the Machine Efficiencies

Source	Sum of Squares	df	Mean Square	F-Cal
Cutting Velocity	31.75	2	15.875	105.8333***
Stem Size	1.66	3	0.553	3.6886 ^{ns}
Error	0.9	6	0.150	
Total	34.31	11		

F- tab	5%	1%
F _{2,6}	5.14	10.92
F _{3,6}	4.76	9.78

4. CONCLUSION

The cutting velocities used had very highly significant effect on the efficiency of the cassava stem cutting machine. Also, the stem sizes within the range of 1.8 to 2.6cm had no significant difference on the efficiency of the cutting machine. The performance of the machine was found to be very satisfactory with high cutting efficiency at the machine cutting velocities of 1.20 and 1.23m/s. These velocities should be recommended to obtain the maximum cutting efficiency of the machine.

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