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ENERGY USE IN CASSAVA TUBER HARVESTING USING A SEMI-AUTOMATIC CASSAVA HARVESTER

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Abstract

The economy of many countries of the world depends on agriculture, which demands technological breakthroughs to lead to the required significant increase in the level of production. Cassava is one of such crops that although, ranks as one crop being produced in high scale but with technological enhancement can do better. Harvesting cassava roots is usually done by hand; it is easy if the soil is sandy or during the rainy season. In heavier soils or during the dry season, harvesting usually requires digging around the roots to loss/free them and lifting the plant. To facilitate lifting with the device, the plant stem is usually cut down about 30 to 50 cm. The reduced stem length is used to lift the roots out of the ground. While lifting, care is taken not to break the roots, as this will lead to losses if broken roots are not retrieved from the soil. A cassava lifting device developed by the National Centre for Agricultural Mechanization (NCAM), Ilorin, Kwara State, Nigeria was evaluated to determine its performance based on the time losses and energy utilization/stress impact. The test was carried out both in the raining and the dry season.

On the average, the NCAM cassava lifter average harvesting rate is 21.44 man-hr/ha in the raining season and 24.01man-hr/ha in the dry season. The losses were 3.3kg at the raining season and 3.0kg at the dry season. The stress impact of the cassava lifter on the users showed that it is less stressful harvesting cassava with the lifter than harvesting with hand. This is evident in the heart rate, harvesting the same area of land the rate was 75/min average using cassava lifter and 98/min average for traditional method, using the same subject.

Keywords: Cassava, Efficiency, Harvesting, Lifter, Losses and Traditional,

INTRODUCTION

Cassava, (*Manihot Esculenta*) is a woody shrub of the Euphorbiaceous (Spurge family) native to South America, that is extensively cultivated as an annual crop in the tropical and subtropical regions, for its edible, starchy, tuberous root. It is the third largest source of carbohydrates for human food (Claude and Denis, 1990). It is also the most important root crop in terms of tonnage input in developing countries. Apart from being the source of calories for more than 500 million people worldwide, cassava has become a vital raw material and chemical additives for the production of industrial starch, ethanol, additives, animal feeds, and many other export products. The rapidly growing demand for cassava food products as well as developing the lucrative export market of its by-products has induced the need for an increase in production of the root crop. (Odigbo, 1983).

Nigeria, Brazil, The Democratic Republic of Congo, Thailand and Indonesia are the world's largest producers of cassava, with Thailand ranking as the largest exporter. In the year 2002 alone Nigeria produced over 25 million tons of cassava (IITA 2004). According to FAO, (2008), the world's cassava production has been growing at over 2 percent per year, with Nigeria producing the largest quantity. Cassava has been reported to demonstrate an ability to provide food security to populations in the tropical world, particularly in Africa. To realize these potentials, the government of Nigeria has launched a campaign for the increase in production through improvement in the mechanization of cassava production processes.

Harvesting of cassava tuber is a very laborious operation which requires a lot of strength as well as care. The tuber is held tightly in the soil and often spread out at varying angles to the stem. There are usually wastages resulting from pulling up the stock of the plant during harvesting or digging round with cutlass or hoe. The tubers usually are bruised in the process resulting in loss in quality and in some cases a few fingers detached into the soil thus lost, resulting in loss in quantity. The methods of hoe and cutlass harvesting, therefore involves much wastages and drudgery, hence, the need to develop

appropriate tool and techniques that can reduce the drudgery as well as the losses usually encountered by the local farmers in the course of harvesting cassava tubers.

In order to mitigate against these challenges, NCAM developed the NCAM Cassava Lifter to reduce drudgery and tuber losses in harvesting cassava roots. The NCAM Manual Cassava lifter was developed to reduce the energy involved in cassava harvesting by utilizing little force with minimal damages sustained. It effectively minimizes human drudgery while maintaining average time economy.

OBJECTIVE OF THE STUDY

The objective of this study is to evaluate

- Lifting (harvesting) efficiency of the lifter
- Determining the lifting capacity of the simple machine in man/hour
- Convenience and level of fatigue caused to the user
- To encourage the use of the lifter by the peasant farmer who do not have the financial muscle to get the imported machines

MATERIALS AND METHODS

The harvesting efficiency, timeliness, conveniences and energy/power utilization by the operator/user of NCAM cassava lifter was evaluated on the field. An area of land (12m x 4m) cultivated with cassava was used. There were four ridges all together within the land area with matured cassava plants, soil conditions just before harvesting was determined by measuring relevant soil properties such as soil moisture content, soil shear strength and soil bulk density. The soil type is sandy loamy.

Soil moisture content was determined by gravimetric method, soil shear strength was measured using shear vane, while bulk density was determined by cone sampler method.

The time taken to harvest all the cassava stands contained in each ridge was measured using stop watch for both traditional hand method and modern lifter method. The quantity of cassava tubers completely pulled out without breakage

as well as the quantity that were left out in the soil (i.e. those that got broken or detached while harvesting) for both hand method and lifter method were determined.

The convenience of the lifter and level of fatigue caused to the user were determined simply by taking pulse rate of the users of the cassava lifter before and after operation.

DESCRIPTION OF THE CASSAVA LIFTER

The manual cassava lifter is made-up of a long handle, a landside and two grip jaws. One of the jaws, the moveable one is attached to the end of the handle, while the second one is attached to the landside. The handle is made up of a 0.0064m pipe of about 1.5 – 2.0 meters length. The landside is made with a rectangular pipe of 0.45m length. The device works by the principle of forces through a fulcrum. The force applied on the handle acts at the jaws to pull up the cassava tubers via the stock, with the fulcrum at the free end of the landside. (Hall, et. al, 1982).

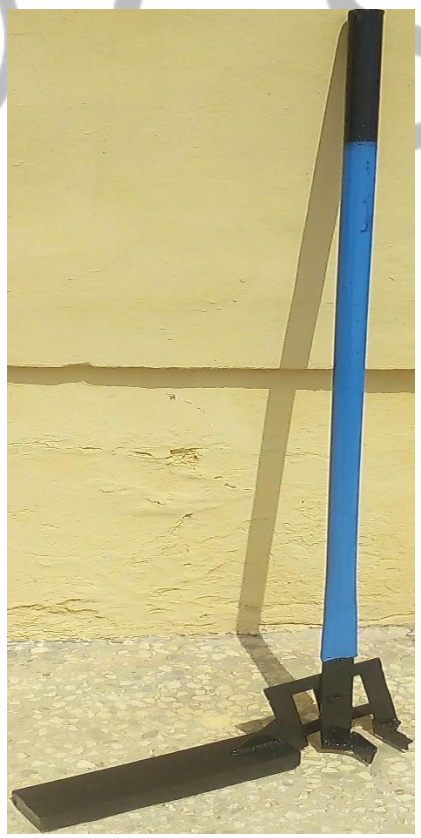

Figure: Pictorial view of the Cassava Harvester

EVALUATION CRITERIA FOR CASSAVA HARVESTER

There are majorly two broad methods of harvesting cassava tubers; they are the traditional method of hoe and cutlass and the mechanized method of tractor drawn cassava harvester/semi mechanized cassava lifter for the low income farmers.

Parameters such as ease of operation, machine efficiency, moisture content, field losses, energy expenditure, power and labour requirements were put into consideration in determining the worthiness of this equipment to replace the traditional method of harvesting of cassava tubers. (Adebija J A, 1997.)

FIELD TEST AND DATA COLLECTION

Pre-harvest parameters such as size of the field, soil bulk density, soil moisture content at the time of test, crop yield and labour input were noted. Other parameters considered at beginning of the test are the body conditions of the operators, the average thickness of the cassava stock.

LIFTER OPERATION

The cassava lifter requires constant use to make the operator perfect/skilful in the use of the tool. It does not require strength or any complex skill to get a good result.

The lifter is gently fixed to the base of the stem to be harvested. The jaw firmly gripping the stem and one leg of the operator placed on the rectangular base of the lifter and both hands holding the pole. The pole is shaked gently and pulled towards the operator. If this is done repeatedly over a length of time, it will lead to the perfection in the use of the lifter.

EFFICIENCY

To save time and enhance efficiency in the field where the cassava lifter is to be used for harvesting, plant spacing of 45cm within ridges is to be adopted. This will make for easy movement of the lifter within the plant. The weight of lifter should be light so as to make it easy to carry. The fulcrum point of the tool should be made free i.e. collapse easily to enhance speed in the course of use.

RESULTS AND DISCUSSION

a) Stress impact on the body

The characteristics of the test subjects were not completely taken note of but to determine impact of the operation on the subject using the traditional and the semi mechanized method (the lifter) the heart beat rate of the subjects were noted. Analyses of the heart rate showed that with traditional method of harvesting the heart rate was 98/min on the average while using the lifter it was75/min on the average.

b) Soil condition

Table 1 Soil condition for Dry and Wet season

S/N	Condition	Rainy season	Dry Season
1	Moisture content MC d.b	7.42%	3.40%
2	Shear strength	3.7 Kp	44.6 Kp
3	Bulk density	1.58 g/cm^3	1.56 g/cm^3

Table 2: Labour Requirements and Harvest Losses

Data	***Soil moist. Cont. (%)d.b.***	***Soil shear strength kPa***	***Soil bulk density g/cm³***	***Field area***		***Man – hr-ha – 1***	**Harvested tubers Kg**	**Losses Kg**
				L (m)	**B (m)**	**Lifter**	**Lifter**	**Lifter**
1a	7.42	27.06	1.58	12	4	21.52	75.12	3
2a	7.42	27.06	1.58	12	4	21.36	74.17	4
3a	7.42	27.06	1.58	12	4	21.43	74.41	3
						21.44	**74.57Kg**	**3.3kg**
1b	3.4	44.06	1.56	10	5	24.32	81.07	3
2b	3.4	44.06	1.56	10	5	23.44	78.13	4
3b	3.4	44.06	1.56	10	5	24.26	80.87	2
						24.01	**80.02 Kg**	**3 kg**

Where a=Rainy season, b=Dry season

The physical impact of the use of the lifter

Table 3: Lifter harvesting

Heart beat rate/sec before operation	Heart beat rate/sec after operation	Time taken
37	43	2.21min
42	46	3.22min
44	46	3.13min

Table 4: Manually harvesting the cassava

Heart beat rate/sec before operation	Heart beat rate/sec after operation	Time taken
41	46	2.25
42	45	3.36
44	49	6.35

Table 5: Group Statistics

	GROUP	N	Mean	Std. Deviation	Std. Error Mean
TIMEINP	.00	6	22.7217	1.4425	.5889
	1.00	6	5.9650	.8644	.3529
MANHRHA	.00	6	77.2950	3.1796	1.2980 1.2359
	1.00	6	19.7817	3.0273	
LOSSES	.00	6	3.1667	.7528	.3073
	1.00	6	3.0000	.8944	.3651

Table 6: Independent Samples Test

		Levene's Test for Equality of Variances		***t-test for Equality of Means***						
									95% Confidence Interval of the Difference	
		F	***Sig.***	***T***	***df***	***Sig. (2-tailed)***	***Mean Difference***	***Std. Error Difference***	***Lower***	***Upper***
TIMEINP	Equal variances assumed	9.908	.010	24.408	24.408	.000	.000	16.7567	15.2270	15.1796
	Equal variances not assumed			10	8.181	16.7567	.6865	.6865	18,2863	18.3337
MANHRHA	Equal variances	.047	.832	32.089	32.089	.000	.000	57.5133	53.5198	53.5185

	assumed Equal variances not assumed			10	9.976	57.513 3	1.7923	1.7923	61.5069	61,5082
LOSSES	Equal variances assumed Equal variances not assumed	.160	.698	.349 10	.349 9.717	.734 .1667	.734 .4773	.1667 .4773	-.8967 1.2301	-.9010 1.2343

c) Time Consideration

From table 2, the harvesting capacity of a field of area 48m^2 using the lifter is 21.44 man-hr/ha in the raining season. The same field area was harvested using the lifter during dry season at the capacity 24.01man-hr/ha.

d) Losses

The losses incurred during the use of the lifter are minimal, with losses in the raining season being 3.3kg and the dry sea being 3kg.

CONCLUSION

The NCAM cassava lifter has an advantage of reducing drudgery as well as back pains which is associated with farming operations. It is very important in that removal of the source of waist pain prolong the life span of the farmer. It also enhances increase in output of the farmers. Considering the fact that, from the test, the heart beat rate was high when the subjects harvested manually than when the lifter was used in harvesting the same number of stands of cassava field. This by implication shows that using the lifter reduces the stress involved in harvesting cassava.

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