MODIFICATION OF NCAM CASSAVA LIFTER

BY

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NIGER STATE.

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DECLARATION

I hereby declare that this work "Modification of NCAM Cassava Lifter" was conducted by me under the supervision and guidiance of Dr. M. G. Yisa and Dr. E .S .A Ajisegiri of the department of Agricultural Engineering, Federal University of Technology, Minna during the 1997/98 academic session.

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CERTIFICATION

This is to certify that this project was carried out by " Olota Anthony Adeleye" (92/2650) in Agricultural Engineering Department .

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DEDICATION

TO GOD BE ALL THE GLORY.

This work is dedicated to my dearest sister - TEMITOPE MORENIKEJI OLOTA.

AKNOWLEDGEMENT

I am grateful to Almighty God for His provision and for His divine presence with me throughout the years of my study.

I am greatly indebted to DR. M.G. Yisa who was my project Supervisor, for his dedication and motivational drives. Same goes to DR. A. Ajisegiri for his co-operation and advise throughout the project work.

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The Almighty God shall reward you all.

LIST OF FIGURES

PAGES

FIGURE 1: Flowchart of the processes involved in cassava harvesting 4

FIGURE 2: Determination of length of frame 17

FIGURE 3(a): Forces acting on frame 19

FIGURE 3(b): Forces acting on frame 20

FIGURE 3(c): Forces acting on frame..20

FIGURE 3(d): Forces acting on frame.. 20

FIGURE 4: Bending moment diagram acting on frame.. 22

FIGURE 5(a):Determination of diameter of shaft 30

FIGURE 5(b): Determination of diameter of shaft.. 31

FIGURE 6: Bending moment diagram acting on the shaft 33

LIST OF TABLES

PAGES

TABLE 1:Cost of machine 12

TABLE 2: Determination of average weight of cassava tubers on stand 13

TABLE 3: Determination of average diameter of cassava stem 13

TABLE 4: Determination of average depth of cassava tuber below the ground 14

TABLE 5(a): Result of the lifting test 35

TABLE 5(b): Result of the lifting test 36

TABLE 5(c) : Result of the lifting test 37

TABLE OF CONTENTS

		PAGES
	TITLE PAGE:	i
	DECLARATION:	ii
	CERTIFICATION:	iii
	DEDICATION:	iv
	ACKNOWLEDGEMENT:	v
	LIST OF FIGURE AND TABLE:	vi - vii
	TABLE OF CONTENTS:	viii - ix
	ABSTRACT:	x
CHAPTER ONE		
1.0	INTRODUCTION	1
1.1	JUSTIFICATION	2
1.2	OBJECTIVES	2
CHAPTER TWO		
2.0	LITERATURE REVIEW	3
2.1	CASSAVA HARVESTING	3 - 5
2.2	EXISTING CASSAVA LIFTERS	5 - 6
2.2.1	BASIC COMPONENTS AND FUNCTIONS OF NCAM CASSAVA LIFTER	6 - 7
CHAPTER THREE		
3.0	METHODOLOGY	8
3.1	TESTING OF EXISTING LIFTERS	8
3.2	MODIFICATION PROCEDURES	9
3.3	DESIGN FEATURES AND MATERIAL SELECTION	9 - 11

3.3.1 COSTING 12

3.4 DESIGN CALCULATIONS .... 13 - 33

CHAPTER FOUR

4.0 TESTING AND RESULTS 34

4.1 FIELD TEST 34

4.2 RESULTS .... 35 - 37

4.2.1 OBSERVATION AND DISCUSSION OF RESULTS 38

CHAPTER FIVE

5.0 CONCLUSION 39

REFERENCES 40

ABSTRACT

The work centred on the identification of problems associated with NCAM cassava lifter and making modifications where applicable. The incorporation of two wheels for easy movement of the lifter, the ability to adjust the lifter for use on flat ground and on ridges, the ease of detaching the lifter after use, the covering of gripping jaws with rubber to reduce breakage of stem and linning on the handle to prevent blistering of palms during operation all form the modification procedures that were adopted. Despite the fact that the field tests were carried out at the time of the season when the soil particles were more compacted and hard, results show that a considerable amount of cassava tubers without cuts or bruises were lifted to the soil surface with the average efficiency of 65.82%.

CHAPTER ONE

1.0 INTRODUCTION

Cassava, (MANIHOT ESCULENTA CRANTZ) is a dicotyledonous perennial plant belonging to the botanical family Euphorbiaceae. It is a starchy root crop that is grown entirely in the hotter lowland tropics. The crop is also known under a variety of names according to the region in which it is cultivated.

Cassava cultivation has been seen to bring a lot of benefit to numerous users in Nigeria and tropical Africa as a whole but it is still unfortunate that the process of harvesting it as at when due is still done by tedious traditional means. This system is slow, ineffective, leads to lot of tuber breakage as well as high physical exertion.

Although Cantamby (1932), Odigbo and Ahmed (1978) and some others have developed some cassava harvesters but these harvesters are still largely under modifications either because of inefficiency or the level of wastage

The NCAM cassava lifter appears to hold the key for intermediate technology transfer for cassava harvesting by the average peasant farmers which forms the majority of the farming population in Nigeria. However, the present NCAM design is rather too heavy and does not have wheels incorporated in it making it more difficult and strenous to be moved within and outside the farm, it leads to a lot of stem breakage due to the fact that the gripping jaws are made purely of metal. It is also not easy to detach after use thus making it difficult to handle. In addition, the upper part of the handle (which is purely metal) is not covered with any protective feature, thus leading to blistering of palms of the hands during operation. The NCAM lifter does not have any adjusting ability to facilitate its use effectively for harvesting cassava planted on different heights of ridge.

All the above mentioned problems associated with the NCAM lifter affects its adoption by many farmers. Thus, modifications were made to justify the objectives of this project.

1.1 JUSTIFICATION

Achieving the objectives will bring about easy and effective harvesting of cassava tubers and in turn lead to attainment of maximum productivity and utilization at a greatly reduced expense of time, energy and cost.

1.2 OBJECTIVES OF THE PROJECT

(1) To modify the existing NCAM model so as to achieve:

(A) Ease of transportation on the farm.

(B) Reduction in breakage of cassava stem

(C) Easy of detaching the lifter after use.

(D) It's ability to be adjusted for use on flat grounds and on ridges.

(E) Ease of operation without blistering of palms.

(2) To use the available local materials for the construction of the lifter in order to be easily affordable and to reduce the weight of the lifter.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 CASSAVA HARVESTING

Cassava is harvested as soon as tuberous roots have acumulated sufficient amount of starch but not too late, when the tuberous roots becomes woody and fibrous. Harvesting of cassava is also easier if planting is on ridges or in beds and in loose or sandy soils, rather than on flat ground and in clay or heavy soils.

Optimum time for harvesting cassava varies according to the time of planting, variety and climatic /soil conditions. Early-maturing varieties are ready for harvesting at 7 months, while late maturing varieties are ready at 12 months after planting. Most cassava varieties attain optimum weight about 18 months after planting when starch accumulation is highest.

Farmers do not usually harvest all the plants on a plot at the same time, because cassava remains in good condition for only a few days after harvest, farmers harvest only the quantity required for immediate use.

In traditional farming, farmers harvest manually. Farmers cut the stems a few centimeters above the ground with a machet , then loosen the soil around the tuberous roots, and pull the stub of the stem to lift out the root. Mechanical harvesters are available to uproot tuberous roots, which are then picked by hand.

The processes involved in harvesting of cassava can be illustrated with the following flowchart:-

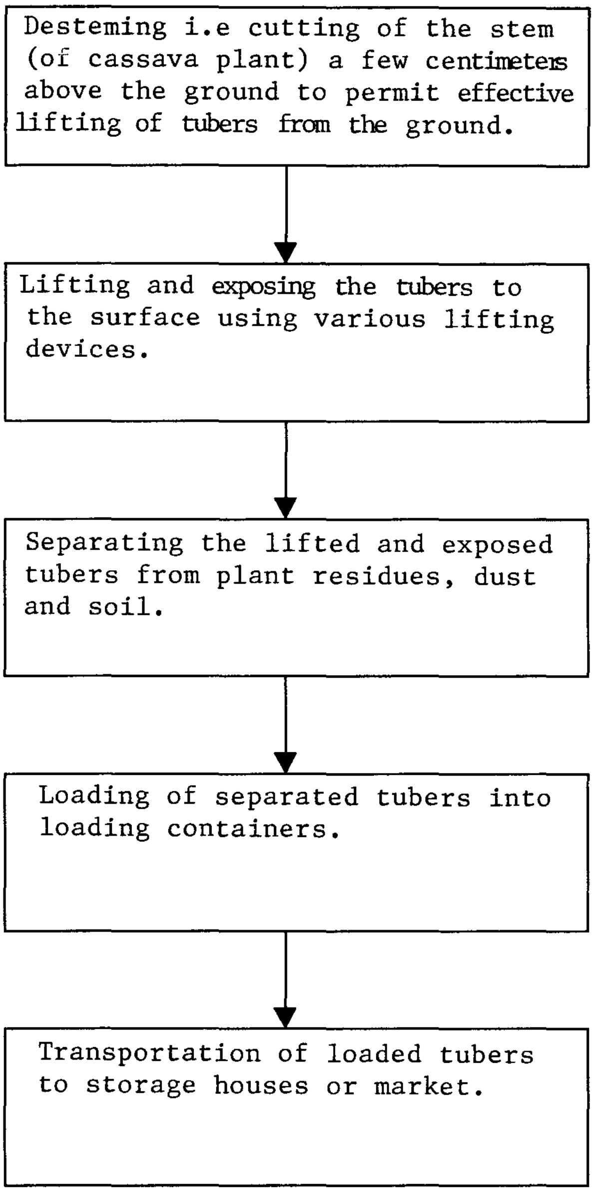

Fig. 1: FLOWCHART OF THE PROCESSES INVOLVED IN CASSAVA HARVESTING.

Desteming done traditionally using a machet or cutlass to cut off the stem a few centimeters above the ground. Mechanically, a mounted heavy screen in front of a tractor could be used. The screen pushes down the top of the stems while a rotary mower behind the tractor cuts them down.

A rotary saw or hedge trimmer mounted in front of a tractor and powered by a separate

problem of excessive draft that resulted from soil accumulation.

3.2 MODIFICATION PROCEDURES

(1) Incorporation of two wheels for easy transportation of the lifter within and outside the farm.

(2) A linning to cover the upper part of the metal handle to prevent blistering of palms.

(3) Rubber to cover serated gripping jaws to reduce the breakage of stem.

(4) Ease of detaching the lifter after use.

(5) Ease of adjusting the lifter to permit its use on flat ground as well as on ridges.

3.3 DESIGN FEATURES AND MATERIAL SELECTION

From the design view point, the basic features of the cassava lifter consists of:

(1)The handle

(2) The frame

(3)The gripping jaws (movable and fixed)

(4)The wheels

(5)The shaft

(6)The footboard

(7)The handle to push the lifter on the farm

(8)The support.

THE HANDLE.

The handle transmits energy from the user to the lifter, it functions like a lever. A hollow rectangular pipe made of mild steel was chosen. A hollow circular pipe covers the upper part of the handle. This is also made of mild steel and the circular pipe permits good grip of the palm on the handle. The circular pipe is covered by rubber to prevent blistering of palm. The dimensions of the chosen hollow rectangular and circular pipes are shown in the design calculations.

THE FRAME.

The frame carries the bulk of the whole weight of the lifter. It is made to be in horizontal position and on it is attached the footboard, the adjustable portion, the gripping jaws. The handle is also pivoted to the frame. A solid rectangular pipe made of mild steel was chosen as the frame with its dimension shown in the design and design calculations.

THE GRIPPING JAWS.

These aids in the lifting of cassava from the ground by the stem of cassava being held between the fixed and the movable gripping jaws. The fixed gripping jaws is part of the frame while the lower end of the handle forms the movable gripping jaw. The gripping jaws are covered with rubber so as to reduce the breakage of stem by the metal of the gripping jaws. They are made of serated mild steel. The dimensions of the gripping jaws are shown in the design.

THE WHEEL.

The entire weight of the lifter lies on the two wheels which also permits easy transportation of the lifter within the farm. Mild steel was chosen for the wheels because of its rigidity, strength and resistance to puncture when compared to the alternative wheels like wheel barrow tyres, bicycle tyres etc. As the dimension of the wheels is shown in the design and design calculation they are made up of adequate diameter to permit its effectiveness in loose soils and other forms of soil.

THE SHAFT.

The shaft aids in the rotation of the wheels and carries the weight of the wheels . It is made of adequate dimension as shown in the design and design calculation

THE FOOTBOARD

This is the part on which the human foot is placed when the lifter is being used. It aids in the rigidly of the lifter on the ground and also forms part of the lifting device. A hollow rectangular pipe made of mild steel was chosen with its dimension shown in the design and design calculation. It lies in a horizontal position on the ground.

THE HANDLE FOR PUSHING THE LIFTER

This permits the easy transportation or movement of the lifter within and outside the farm. A hollow rectangular pipe made of mild steel was chosen and a hollow circular pipe also of mild steel was welded to the top of the rectangular pipe. The dimensions of these materials are shown in the design and design calculation. The handle also aids in the lifting of the tubers.

SUPPORT

This permits the rigidity and stability of the frame and the entire cassava lifter. A hollow rectangular pipe made of mild steel was chosen. The dimensions of this material is shown in the design calculation.

3.3.1 COST OF MACHINE

TABLE 1

S/N	DESCRIPTION	MATERIAL	QTY	SIZE	PRICE (₦:K)
1	Handle	Mild Steel	1	650mm	150.00
2	Frame	"	1	300mm	90.00
3	Fixed gripping jaw	"	1	250mm	80.00
4.	Movable gripping jaw	"	1	250mm	80.00
5	Wheel	"	2	300mmØ	180.00
6	Bolt and nut	"	3	60mm long and 20mmØ	90.00
7	foot board	"	1	400mm	120.00
8	Handle	"	1	550mm	140.00
9	Adjustable frame	"	1	650mm	150.00
10	Shaft	"	1	300mm	80.00
11	Electrode		1 dozen	2.5by 350mm	250.00
12	Paint		1 tin	small tin	120.00
			TOTAL =		1,730.00

Cost of materials used for the lifter = ₦1,730.00

Workmanship = 30% of cost of lifter

Workmanship = $\frac{30}{100} \times 1730$ = ₦519

Total cost of lifter = 1730 + 519 = ₦2,249

3.4 DESIGN CALCULATIONS

DETERMINATION OF AVERAGE WEIGHT OF A CASSAVA TUBER

Samples of different sizes of cassava tuber were obtained from eight stands of cassava and each sample was cleaned by removing the soil and dust particles on it. The cassava tubers were then places on a weigh balance one after the other and the corresponding weight of each recorded. The average weight of a stand was then obtained by dividing the total weight by the number of stands The results obtained are shown in Table 2.

TABLE 2 DETERMINATION OF AVERAGE WEIGHT OF CASSAVA TUBER ON STAND BASIS

Stands of Cassava	Total Weight of Tubers on Stand Basis (Kg)	Average Weight of Tubers on Stand Basis(kg)
First	14.70	$\frac{89.30}{8}$ = 11.1621kg
Second	10.30	= 11.16kg
Third	9.90	
Fourth	12.40	
Fifth	10.60	
Sixth	10.30	
Seventh	7.90	
Eigth	13.20	
TOTAL	**89.30**	

DETERMINATION OF AVERAGE DIAMETER OF CASSAVA STEM

Eight samples of different sizes of cassava stems were obtained from eight stands of cassava and each sample was cleaned by removing the soil and dust particles on it. Vernier callipers was used to measure the diameter of each stem and the corresponding diameter of each recorded. The average diameter of cassava stem was obtained by dividing the total diameter by the number of samples. The results obtained are shown in Table 3.

TABLE 3. DETERMINATION OF AVERAGE DIAMETER OF CASSAVA STEM

Cassava Stands	Stem Diameter (m)	Average Diameter of Stem (m)
First	0.0294	$\frac{0.2598}{8}$ = 0.03247m
Second	0.0399	= 0.0325m
Third	0.0321	
Fourth	0.0373	
Fifth	0.0261	
Sixth	0.0321	
Seventh	0.0354	
Eigth	0.0275	
TOTAL	**0.2598**	

DETERMINATION OF AVERAGE DEPTH OF CASSAVA TUBER BELOW THE GROUND

The ground was dug round eight stands of cassava to permit easy access to the tubers which were removed from the ground at a point. A meter rule was used to measure the depth of the longest tuber from each stand below the ground and the corresponding depth of each recorded. The average depth of tuber was obtained by dividing the total depth by the number of samples. The results obtained are shown in Table 4.

TABLE 4 DETERMINATION OF AVERAGE DEPTH OF CASSAVA TUBER BELOW THE GROUND

Cassava Stands	Depth of Longest Tubers(m)	Average Depth below Ground(m)
First	0.322	$\frac{2.321}{8} = 0.2901m$
Second	0.347	
Third	0.189	$= 0.2901m$
Fourth	0.277	
Fifth	0.316	
Sixth	0.295	
Seventh	0.298	
Eigth	0.277	
TOTAL	**2.321**	

CALCULATIONS

The total force required to pull cassava stand from the ground =

Total force required = Average weight of cassava tubers on stand basis + weight of soil on cassava tuber.

Average weight of cassava tubers on stand basis (from Table 1) = 11.16kg

Weight of soil on cassava tuber = pressure of soil on cassava tuber.

$$\text{Pressure} = \frac{\text{force}}{\text{Area}} = \rho gh$$

Where ρ = Bulk density of soil (kg/m^3)

g = acceleration due to gravity (m/s^2)

h = average depth of tuber below the ground (m)

$\rho = 1.99\ kg/m^3$ = bulk density of sandy soil.

$g = 9.81 m/s^2$

$h = 0.2901 m$

pressure = ρgh

$$= 1.99 \frac{(kg)}{m^3} X\ 9.81 \frac{(m)}{s^2} X\ 0.2901(m)$$

$= 5.6604\ kg/ms^2 = 5.6604$ Pa; where $1N = kgm/s^2$

and 1 pascal = $1N/m^2$, $= 5.66N/m^2$

∴ Pressure of soil on cassava tubers = $5.66N/m^2$

Average weight of cassava tubers on stand basis = 11.16kg

= 11.16 X 9.81 = 109.479 = 109.48N

∴Total force required to pull cassava from the ground

= (5.66+109.48)N

= 115.14N

AVERAGE FORCE DEVELOPED BY MAN

Average force developed by man = $0.125 X 10^3$ cal/s

1 calorie = 4.19N

$0.125 X 10^3$ cal/s = $(0.125 X 10^3 X 4.19)$N

= 523.75N

For the design of the lifter,

The average height work for a man = 2.5kcl/min

= 41.67 cal/s

but 1 calorie = 4.19N

= 41.67 cal/s X 4.19N = 173.304N

DESIGN CALCULATIONS

THE HANDLE

Using rectangular hollow pipe with dimensions =

Length = 800mm = 0.8m

Breadth = 40mm = 0.04m

Thickness = 20mm = 0.02m

Cross - sectional area of the rectangular hollow part of handle = length X breadth = (0.8 X 0.04)m^2 = 0.032m^2

volume of the rectangular hollow part of handle = thickness X cross - sectional area = (0.02 X 0.032)m^3 = 6.4 x $10^{-4}m^3$

Mass of rectangular part of handle = volume of handle x density of material (steel)

$= 6.4 \text{ X } 10^{-4}(m^3) \text{ X } 7830 \frac{(kg)}{m^3}$

= 5.0112kg = 5.01kg

Weight of rectangular hollow part of handle = mass of rectangular part of handle X acceleration due to gravity = 5.01 (kg) X 9.81 (m/s^2) = 49.15N

for the hollow circular pipe which forms the upper part of the handle, dimensions =

length = 100mm = 0.1m = height

larger diameter = 50mm = 0.05m = D

Thickness = 5mm = 5 X 10^{-3} m

Smaller diameter = 45mm = 0.045m = d

∴Cross - sectional area of the circular pipe which forms the upper part of the handle = $\frac{\pi(D^2 - d^2)}{4}$

$= \frac{3.142 \{(0.05)^2 - (0.045)^2\}}{4}$

$= \frac{3.142 (2.5\text{X}10^{-3} - 2.025 \text{ X } 10^{-3})}{4} = \frac{3.142 \text{ X } 4.75 \text{ X } 10^{-4}}{4}$

$= \frac{1.49226}{4} = 3.73 \text{ X } 10^{-4} \text{ m}^2$

Volume of the circular pipe = thickness X cross - sectional area

$= (5 \times 10^{-3} \times 3.73 \times 10^{-4})m^3 = 1.865 \times 10^{-6}m^3$

Mass of circular pipe which forms the upper part of the handle = volume X density of material (steel)

$= 1.865 \times 10^{-6}\ (m^3) \times 7830\ \frac{(kg)}{m^3}$

$= 0.0146kg$

Weight of the circular pipe = mass X acceleration due to gravity

$= 0.015(kg) \times 9.81\ (m/s^2)$

$= 0.143N$

Total mass of handle = mass of rectangular hollow pipe of handle + mass of circular hollow pipe of handle.

$= (5.01 + 0.0146)kg = 5.0246kg = 5.025kg$

Total weight of handle = Total mass of handle X acceleration due to gravity.

$= 5.025\ (kg) \times 9.81\ (m/s^2) = 49.29N$

THE FRAME

DETERMINATION OF LENGTH OF FRAME

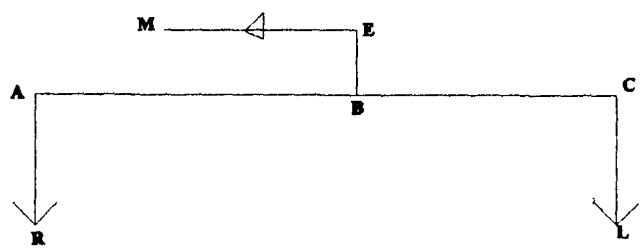

Fig.2

AC = Length of frame to be determined

R = Reaction on foot board

E = Effort applied

M = Moment

L = Load to be overcomed

Y = Distance

Taking sum of moment about C,

$=\Sigma Mc = 0$

$= L \times Ac + M = 0$

$= L \times Ac = - M$

$Ac = \frac{-M}{L}$, where M = EY

i.e moment = force X distance

$\therefore AC = \frac{-EY}{L}$, where E = effort = 173.30N

Y = distance = 0.20m

L = load to overcomed = 115.14N

$\therefore AC = \frac{-EY}{L} = -\frac{173.30\ (N) \times 0.20\ (m)}{-115.14\ (N)}$

$= \frac{173.30 \times 0.20}{115.14}\ (m)$

$AC = \frac{34.66}{115.14}\ (m)$

AC = 0.30m

FORCES ACTING ON FRAME

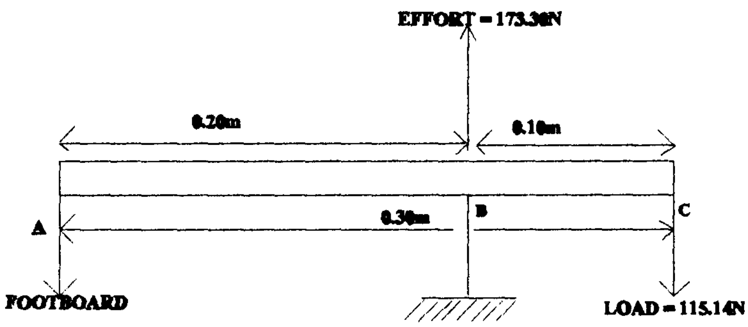

Fig 3 (a)

Σ f y

= 0 R_A = reaction at point A

Σm = 0 R_B = reaction at point B

ΣMB = 0

Taking moment at point B,

$- R_A (0.20) - 115.14 (0.10) = 0$

$- R_A (0.20) - 11.514 = 0$

$-R_A (0.20) = 11.514$

$- R_A = \frac{11.514}{0.20} = 57.57N$

R_A = reaction at point A = -57.57N

Σfy = 0

$= - R_A + R_B + 173.30 - 115.14 = 0$

$= -57.57 + R_B + 173.30 - 115.14 = 0$

$R_B + 0.59 = 0$

$R_B = 0.59N$

Reaction at point B, $R_B = -0.59N$

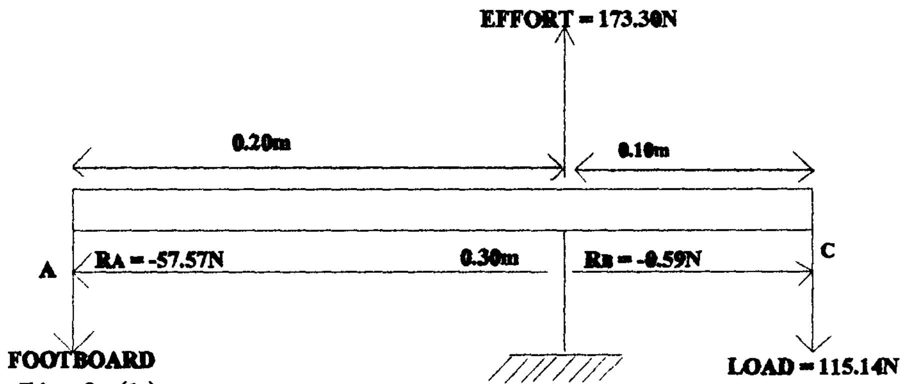

Fig.3 (b)

Sectioning between A and B, and taking moment,

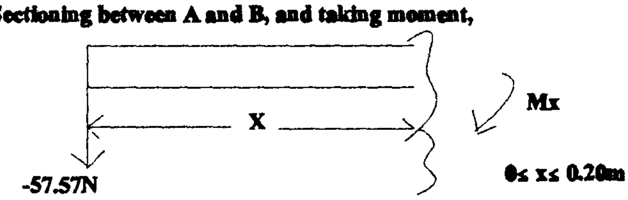

Fig.3 (c)

∴Taking moment = 57.57 X x - M X x = 0

Mx = 57.57x

x = 0, M = 0N

x = 0.10, M = 5.57N

x = 0.20, M = 11.514N

Sectoring between B and C, and taking moment.

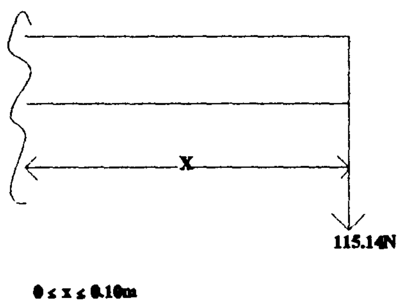

Fig.3 (d)

Taking moment = 115.14 X x - M x x = 0

$$Mx = 115.14x$$

$x = 0$, M = 0N

$xn = 0.05$, M = 5.757N

$x = 0.10$, M = 11.514N

∴ For the forces to being equilibrium, the sum of the upward forces must equal the sum of downward forces = 173.30 - 57.57 - 0.59 - 11514 = 0

= 173.30 - 173.30 = 0

Thus, forces are in equilibrium.

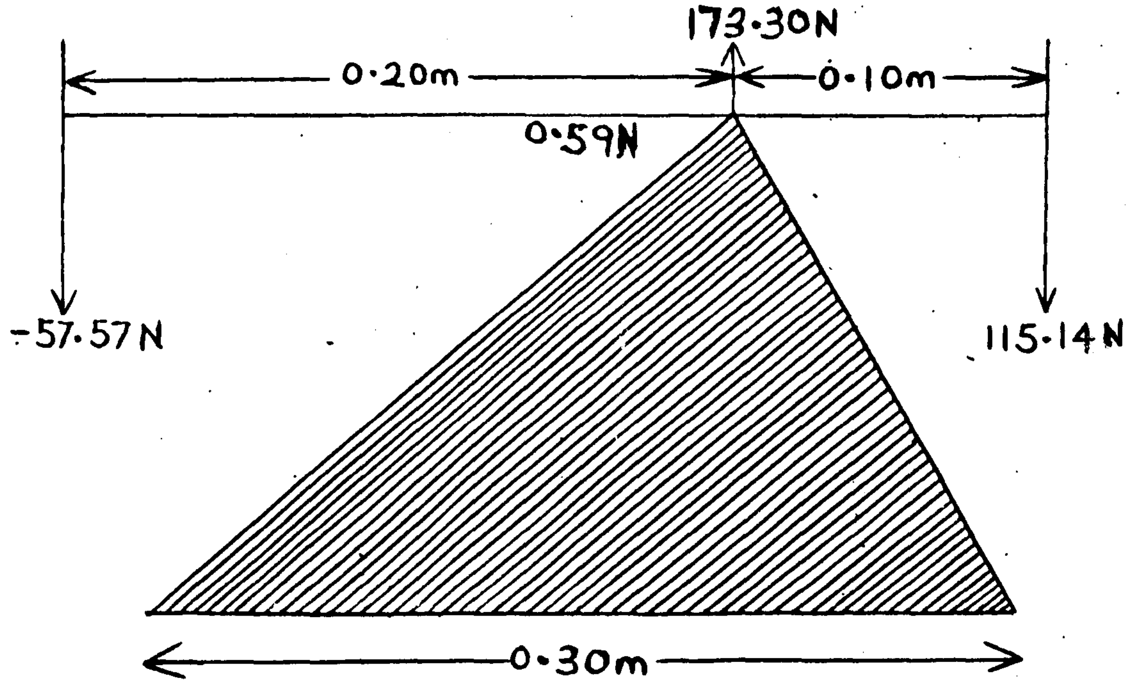

Fig.4 BENDING MONMENT DIAGRAM ACTING ON FRAME

THE FRAME

A. Using rectangular solid pipe with dimensions = length of horizontal frame chosen = 0.3m

Breadth = 0.05m

Thickness = 0.025m

Cross - sectional area of the rectangular horizontal frame = length X breadth = $(0.3 \text{ X } 0.05)m^2$

$= 0.015m^2$

volume of horizontal frame = thickness x cross - sectional

$= (0.025 \text{ X } 0.015)m^3 = 3.75 \text{ X } 10^{-4}m^3$

Mass of horizontal frame = volume X density of material(steel)

$= 3.75 \text{ X } 10^{-4} (m^3) \text{ X } (7830 \frac{(kg)}{m^3}$

$= 2.936kg$

Weight of horizontal frame = mass X acceleration due to gravity

$= 2.936 \text{ (kg) } 9.81 \text{ } (m/s^2)$

$= 28.80N$

B. For the solid frame that forms the fixed gripping jaw.

length = 0.25m

Breadth = 0.05m

Thickness = 0.025m

∴ Cross - sectional area of the rectangular shaped, vertical frame = length X breadth = $(0.25 \text{ X } 0.05)m^2$

$= 0.0125m^2$

Volume of vertical frame = thickness X cross - sectional area.

= (0.025 x 0.0125)m3

$= 3.125 \times 10^{-4} m^3$

Mass of vertical frame = Volume X density of material (Steel)

$= 3.125 \times 10^{-4} (m^3) \times 7830 \frac{(kg)}{m^3}$

= 2.44kg

Weight of vertical frame that forms the fixed gripping jaw = mass X acceleration due to gravity

$= 2.44\ (kg) \times 9.81\ (m/s^2) = 23.94N$

C. For the vertical frame on which the footboard is attached, it is divided into two parts:-

i. The fixed part made of hollow rectangular pipe with dimensions =

Length = 0.35m

Breadth = 0.06m

Thickness = 0.03m

Cross - sectional area of the fixed part = length X breadth

$= (0.35 \times 0.06) m^2 = 0.021 m^2$

Volume of fixed part of frame = thickness X cross - sectional area

$= (0.03 \times 0.021) m^3 = 6.3 \times 10^{-4} m^3$

Mass of the fixed part of vertical frame on which the footboard is attached = mass X acceleration due to gravity

= Volume x density of material (Steel)

$= 6.3 \times 10^{-4} (m^3) \times 7830 \frac{(kg)}{m^3} = 4.93kg$

Weight of the fixed part = mass X acceleration due to gravity

$= 4.93\ (kg) \times 9.81\ (m/s^2)$

= 48.39N

ii. For the adjustable part made of hollow rectangular pipe with dimensions = length 0.3m

breadth = 0.05m

thickness = 0.025m

Cross- sectional area of the adjustable part = length X breadth

= $(0.3 \times 0.05)m^2$

= $0.015m^2$

Volume of the adjustable part = thickness X cross - sectional area

= $(0.025 \times 0.015)m^3$

= $3.75 \times 10^{-4}m^3$

Mass of the adjustable part = Volume X density of material (Steel)

= $3.75 \times 10^{-4} (m^3) \times 7830 \frac{(kg)}{m^3}$

= 2.936kg

Weight of the adjustable part = mass X acceleration due to gravity

= $2.936 (kg) \times 9.81 (m/s^2)$

= 28.80N

∴ The total mass of the vertical frame on which the footboard is attached = mass of the fixed part + mass of the adjustable part.

= (4.93 + 2.936)kg = 7.866kg = 7.87kg

Total weight of the vertical frame on which the footboard is attached = total mass X acceleration due to gravity

= $7.87 (kg) \times 9.81 (m/s^2)$

= 77.16N

The total mass of frame = (2.936 + 2.44 + 7.87)kg

= 13.25kg

Total weight of frame = Total mass X acceleration due to gravity

= 13.25(kg) X 9.81 (m/s^2)

= 129.98N

GRIPPING JAWS

Length of griping jaw = 0.03m

Breadth = 0.05m

Thickness = 0.01m

Cross - sectional area of gripping jaw = length X breadth

= (0.03 X 0.05)m^2 = 1.5 X 10^{-3} m^2

Volume of gripping jaw = thickness X cross - sectional area

= (0.01 X 1.5 X 10^{-3})m^3 = 1.5 X $10^{-5}m^3$

Mass of one gripping jaw = (Volume of gripping jaw X (density of steel + density of rubber covering gripping jaw))

Mass of one gripping jaw = {1.5 X 10^{-5} (m^3) X (7830$\frac{(kg)}{m^3}$ + 1200 $\frac{(kg)}{m^3}$)}

= 1.5 X 10^{-5} (m^3) X 9030 $\frac{(kg)}{m^3}$ = 0.1354kg

Mass of one gripping jaw = 0.1354kg

Mass of two gripping jaws = (0.1354 X 2)kg

= 0.2708kg

Weight of one gripping jaw = Mass of one gripping jaw X acceleration due to gravity

= 0.1354 (kg) X 9.81 (m/s^2) - 1.32N

Weight of the two gripping jaws = (1.32 X 2)N

= 2.64N

The gripping force of one gripping jaw = mass of the gripping jaw X acceleration due to gravity

= 0.1354 (kg) X 9.81 (m/s^2)

= 1.32N

Gripping force of one gripping jaw = 1.32N

Total gripping force = gripping force of the two gripping jaws

= (1.32 X 2)N = 2.64N

WHEELS

Chosen height of wheel = 0.3m

Diameter of wheel chosen = 0.3m

Thickness after folding = 0.03m

Area of circular wheel = πr^2

Where r = radius = 0.15m

Area = πr^2

= 3.142 X $(0.15)^2 m^2$

= 3.142 X 0.225 X $10^{-3} m^2$

= $0.018 m^2$

volume of wheel = area X thickness after folding

= $(0.018 \text{ X } 0.03) m^3$

= 5.4 X 10^{-4} m^3

Mass of one wheel = volume X density of material (steel)

= 5.4 X 10^{-4} (m^3) X 7830 $\frac{(kg)}{m^3}$

$= 4.23kg$

Mass of the two wheels = $(4.23 \times 2)kg$

$= 8.46kg$

Weight one wheel = $4.23 \times 9.81 = 41.49N$

Weight of the two wheels = $(41.49 \times 2)N$

$= 82.99N$

FOOTBOARD

Length chosen = 0.4m

Breadth = 0.05m

Thickness = 0.025m

Area = Length X breadth = $(0.4 \times 0.05)m^2 = 0.02m^2$

Volume = Area X thickness = $(0.02 \times 0.025)m^3$

$= 5 \times 10^{-4} m^3$

Mass of footboard = Volume X density of steel

$= 5 \times 10^{-4} (m^3) \times 7830 \frac{(kg)}{m^3}$

$= 3.92kg$

Weight of footboard = mass X acceleration due to gravity

$= 3.92 (kg) \times 9.8 (m/s^2)$

$= 38.40N$

HANDLE FOR PUSHING LIFTER

length = 0.3m, breadth = 0.05m

thickness = 0.025m

Area = l X b = $(0.3 \times 0.05)m^2 = 0.015m^2$

Volume = area X thickness = $(0.015 \times 0.025)m^3$

$= 3.75 \times 10^{-4} m^3$

Mass = Volume X density

$= 3.75 \times 10^{-4} (m^3) \times 7830 \frac{(kg)}{m^3} = 2.936kg$

∴ Total mass of the two components of the handle for pushing the lifter = (2.936 X 2)kg

= 5.872kg

Total Weight of the handle to push lifter

$= 2.936 (kg) \times 9.81 (m/s^2)$, where $9.81m/s^2$ is acceleration due to gravity

= 28.80N

THE SUPPORT

Using rectangular hollow pipe with dimensions:-

Length = 0.3m

Breadth = 0.05m

Thickness = 0.025m

Area of support = length X breadth

$= (0.3 \times 0.05)m^2 = 0.015m^2$

Volume of support = Area X thickness

$= (0.015 \times 0.025)m^3$

$= 3.75 \times 10^{-4} m^3$

Mass of the support = Volume X density of material (steel)

$= 3.75 \times 10^{-4} (m^3) \times 7830 \frac{(kg)}{m^3}$

$= 2.936kg$

Weight of support = Mass X acceleration due to gravity

$= 2.936 \times 9.81 = 28.80N$

DETERMINATION OF DIAMETER OF SHAFT

Let T_w = total weight on the shaft = 360.98N

L = length of shaft chosen = 0.3m

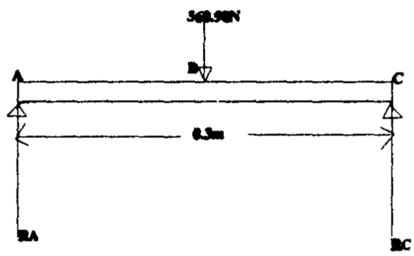

Fig. 5 (a)

To determine the reaction at the wheels:-

Summation of vertical forces, $\sum vf = 0$

$\sum vf = 0 = R_A + R_C - 360.98$

$R_A + R_C = 360.98$ ----------(1)

Taking moment about point C,

$$\sum MC = 0 = R_A (0.3) - 360.98 \frac{(0.3)}{2}$$

$$R_A = \frac{360.98 \times (0.3)/2}{0.3} = 180.49N$$

From equation (1),

R_C (360.98 - 180.49)N

= 180.49N

To determine the bending moment of the shaft:-

The maximum bending moment for a point load acting at the centre of the shaft occurs at the mid-point.

i.e $M_{max} = \frac{Wa}{L}(L - a)$

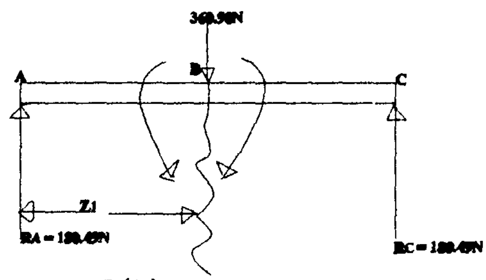

Fig.5(b)

$\sum M_A = 0 - M_1 + 180.49Z_1 - 360.98N\,(l/2 - Z_1)$

$M_1 = 180.49Z_1 - 360.98\,(0.15 - Z_1)$

At point B, $Z_1 = 0.15$m

$M_1 = 180.49\,(0.15) - 360.98\,(.015 - 0.15)$

M = 27.07Nm

To determine the diameter of the shaft:-

Bending moment, $\sigma b = M/Z$

Where $Z = \pi d^3/32$

$\sigma_b = M/\pi d^3/32$

$\sigma_b = \frac{32M}{\pi d^3}$ where σ_b for mild steel = 55×10^6 N/m²

$$d = \left[\frac{32M}{\pi\sigma_b}\right]^{1/3} = \left\{\frac{32 \times 27.07}{3.142 \times 55 \times 10^6}\right\}^{1/3} \frac{\{Nm\}}{(N/m^2)}$$

$= (5.013322834 \times 10^{-6})^{1/3}$m

$= 0.017$m

Diameter of shaft = 17mm

For safety, the chosen diameter of shaft to be used for the wheel is 19mm.

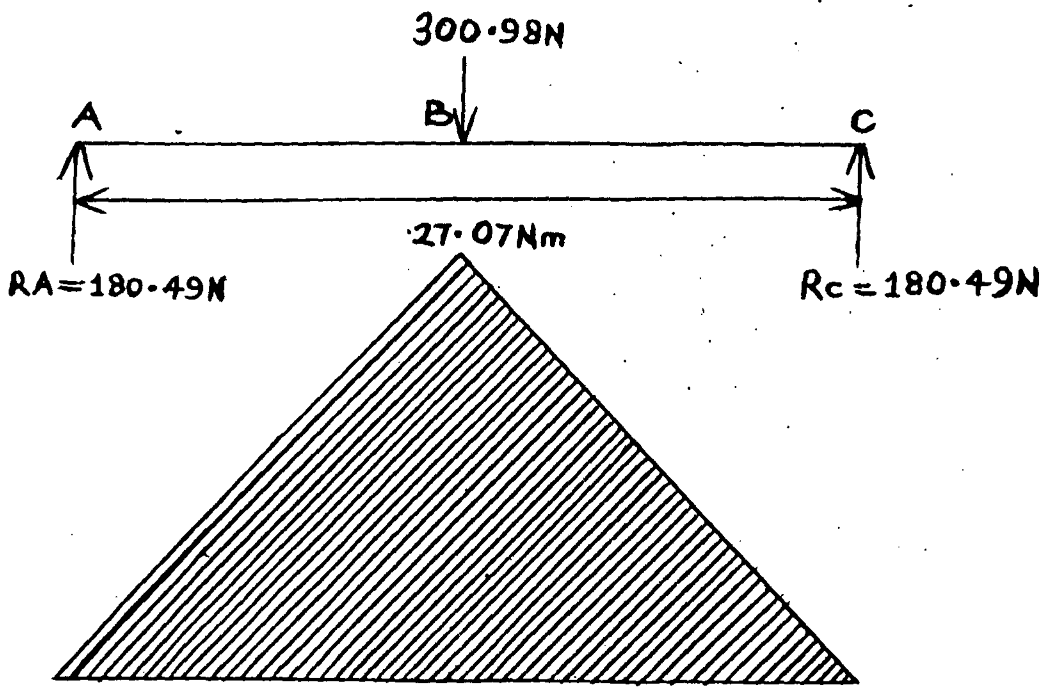

Fig.6: BENDING MOMENT DIAGRAM ACTING ON THE SHAFT.

CHAPTER FOUR

4.0 TESTING AND RESULT

4.1 FIELD TEST

The cassava lifter was tested for performance in terms of the lifting efficiency on stand basis and the lifting efficiency on tuber basis on a two year old cassava plot. The cassava plants were first destemed to just a little above the ridge level, enhancing the free movement of the gripping jaw. The gripping jaw were adjusted until the cassava stem was held between them. On attaining a firm grip on the stem, the footboard was pressed down bringing about the lifting of the cassava and in turn, the exposure of the cassava tubers to the surface.

Twenty separate tests were performed and the results are shown in table 5.

4.2 RESULT

TABLE 5 (a):- RESULT OF THE LIFTING TESTS ON A TWO YEAR OLD CASSAVA PLOT USING THE MANUALLY OPERATED LIFTER.

NO	TEST PARAMETERS	1ST	TRIAL	2ND	TRIAL	3RD	TRIAL	4TH	TRIAL	5TH	TRIAL
		QTY	%	QTY	%	QTY	%	QTY	%	QTY	%
	LIFTING EFFICIENCY ON STAND BASIS										
1.	Numbers of stands lifted	1	100	1	100	1	100	1	100	1	100
2.	Numbers of stands not lifted	0	0	0	0	0	0	0	0	0	0
	Total number of stands	1	100	1	100	1	100	1	100	1	100
	LIFTING EFFICIENCY ON TUBER BASIS										
1.	Numbers of tubers lifted to soil surface	3	60	3	60	3	75	5	100	3	75
2.	Number of tubers left in the soil	1	20	0	0	0	0	0	0	0	0
3.	Number of tubers partially buried	1	20	2	40	1	25	0	0	1	25
	Total number of tubers	5	100	5	100	4	100	5	100	4	100
	QUALITY OF LIFTED TUBERS										
1.	Number of tubers without cuts or bruises	2	66.67	3	100	2	66.67	3	60	3	100
2.	Number of tubers with cuts only	0	0	0	0	1	33.33	1	20	0	0
3.	Number of tubers with briuses only	1	33.33	0	0	0	0	1	20	0	0
4.	Number of tubers with both cuts and bruises	0	0	0	0	0	0	0	0	0	0
	Total number of Lifted tubers.	3	100	3	100	3	100	5	100	3	100

3LE 5 (b):- RESULT OF THE LIFTING TESTS ON A TWO YEAR OLD CASSAVA PLOT USING THE MANUALLY OPERATED LIFTER.

TEST PARAMETERS	6TH TRIAL		7TH TRIAL		8TH TRIAL		9TH TRIAL		10TH TRIAL		11TH TRIAL		12TH TRIAL		13TH TRIAL	
	QTY	%	QTY	%	QTY	%	QTY	%	QTY	%	QTY	%	QTY	%	QTY	%
<u>LIFTING EFFICIENCY ON STAND BASIS</u>																
Numbers of stands lifted	0	0	1	100	1	100	1	100	1	100	0	0	1	100	1	100
Numbers of stands not lifted	1	100	0	0	0	0	0	0	0	0	1	100	0	0	0	0
Total number of stands	1	100	1	100	1	100	1	100	1	100	1	100	1	100	1	100
<u>LIFTING EFFICIENCY ON TUBER BASIS</u>																
Numbers of tubers lifted to soil surface	0	0	3	75	5	100	4	80	4	100	0	0	4	100	4	80
Number of tubers left in the soil	4	100	0	0	0	0	0	0	0	0	4	100	0	0	1	20
Number of tubers partially buried	0	0	1	25	0	0	1	20	0	0	0	0	0	0	0	0
Total number of tubers	4	100	4	100	5	100	5	100	4	100	4	100	4	100	5	100
<u>QUALITY OF LIFTED TUBERS</u>																
Number of tubers without cuts or	0	0	2	66.67	3	60	1	25	3	75	0	0	4	100	3	75
bruises	0	0	0	0	1	20	1	25	0	0	0	0	0	0	0	0
Number of tubers with cuts only	0	0	1	33.33	1	20	1	25	1	25	0	0	0	0	1	25
Number of tubers with briuses only	0	0	0	0	0	0	1	25	0	0	0	0	0	0	0	0
Number of tubers with both cuts and bruises	0	0	3	100	5	100	4	100	4	100	0	0	4	100	4	100
Total number of Lifted tubers.																

LE 5(c) :- RESULT OF THE LIFTING TESTS ON A TWO OLD CASSAVA PLOT USING THE MANUALLY OPERATED LIFTER.

TEST PARAMETERS	14TH TRIAL		15TH TRIAL		16TH TRIAL		17TH TRIAL		18TH TRIAL		19TH TRIAL		20TH TRIAL		AVERAGE
	QTY	%	QTY	%	QTY	%	QTY	%	QTY	%	QTY	%	QTY	%	
LIFTING EFFICIENCY ON STAND BASIS															
Numbers of stands lifted	1	100	1	100	1	100	1	100	1	100	1	100	1	100	90
Numbers of stands not lifted	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
Total number of stands	1	100	1	100	1	100	1	100	1	100	1	100	1	100	100
LIFTING EFFICIENCY ON TUBER BASIS															
Numbers of tubers lifted to soil surface	3	75	5	100	3	75	3	75	2	40	3	75	3	75	71
Number of tubers left in the soil	0	0	0	0	0	0	0	0	1	20	1	25	1	25	15.5
Number of tubers partially buried	1	25	0	0	1	25	1	25	2	40	0	0	0	0	13.5
Total number of tubers	4	100	5	100	4	100	4	100	5	100	4	100	4	100	100
QUALITY OF LIFTED TUBERS															
Number of tubers without cuts or bruises	2	66.67	2	40	2	66.67	2	66.67	1	50	1	33	2	66.67	65.82
Number of tubers with cuts only	0	0	1	20	0	0	1	33.33	1	50	1	33	0	0	13.03
Number of tubers with briuses only	1	33.33	1	20	1	33.33	0	0	0	0	1	34	1	33.33	18,64
Number of tubers with both cuts and bruises	0	0	1	20	0	0	0	0	0	0	0	0	0	0	2.51
Total number of Lifted tubers.	3	100	5	100	3	100	3	100	2	100	3	100	3	100	100

4.1.1 DISCUSSION OF RESULTS

It was observed that the footboard which is part of the lifting device reduce the amount of energy that was expended during the lifting of the tubers when compared to the traditional way of using bare hands and matchet. The rubber covering the gripping jaws reduced the breakage of stems . The wheels also facilitated the easy movement of the lifter within and outside the farm .

Although the tests were carried out at the time of the season when the soil is hard and more compacted together, the result shows that a considerable amount of cassava stands and tubers were lifted to the soil surface with the average lifting efficiency of 90% and 71% respectively . The average number of tubers left in the soil, (15.5%) were more than the number of tubers partially buried in the soil, (13.5%).

The quality of tubers lifted were grouped and recorded as follows: Free of cuts and bruises, 65.82% ;with cuts only , 13.03% ; with bruises only , 18.64% ; with both cuts and bruises, 2.51% .

Comparing this result with that of the earlier work done shows that more number of tubers without cuts and bruises , 65.82% were lifted to the soil surface than that of the earlier result of 42.1% . The number of tubers lifted with cuts only , 13.03% and those lifted with cuts and bruises only , 2.51% were reduced compared to that earlier result of 30.2 % and 30.2% respectively.

In addition to the above , the weight of the NCAM lifter is 21kg and the weight of this modified lifter is 16.6kg without the wheels and the addtional handle , that were incorporated as part of the modification procedures.

These results shows an improvement over the earlier cassava lifter.

CHAPTER FIVE

5.0 CONCLUSION

A modification of the existing manually operated NCAM cassava lifter has been designed , constructed and tested . Despite the fact that the field tests with the machine were carried out at the time of the season when the soil is hard and more compacted ,the result showed that a considerable amount of cassava tubers were lifted to the soil surface with the average lifting efficiency of 71%. 65.82% of cassava tubers were free of cuts and bruises; 13.03% with cuts only ; 18.64% with bruises only and 2.51% with both cuts and bruises. This result shows and improvement over the earlier cassava lifter.

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