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Research Article

INFLUENCE OF PHYSICAL PROPERTIES OF CASSAVA SETTS ON CO-EFFICIENT OF STATIC FRICTION

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Abstract- Cassava (*Manihot esculenta)* is a major staple food in the developing world. The manual planting of cassava demands a large quantity of human labour. It is a time-consuming, unpleasant, and arduous job. The labor shortage is one of the major constraints in manual cassava planting. In order to design and develop the cassava planter, the selection of material is important. The study is important for the selection of hopper material for the planter. This is found out by using the friction apparatus designed based on the physical properties (moisture content) of the cassava setts. By considering the physical properties, a test rig was fabricated. The test rig consists of feed trough, angle indicator and screw shaft. The angle of feed trough can be adjusted manually by screw conveyor shaft. Cassava setts were placed on a feed trough. In order to evaluate the co-efficient friction with different moisture contents, two different cassava sett lengths of 65mm and 100mm were selected based on the number of nodes. The samples were placed against the different material surface like mild steel, galvanised steel sheet, aluminium, acrylic sheet. Observation was taken for consecutive four days. It was observed that the co-efficient of static friction and moisture content was found to be directly proportional. Decrease in the Moisture content decreased the co-efficient of static friction.

Keywords- Cassava setts, Moisture content, Coefficient of friction.

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Introduction

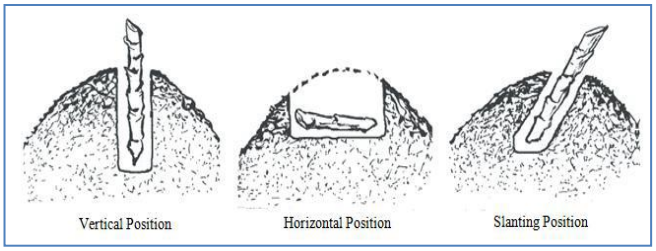
Cassava (*Manihot esculenta)* is a major staple food in the developing world, providing a basic diet for over half a billion people. It is one of the most drought-tolerant crops, capable of growing on marginal soils. In Tamil Nadu, India, there are many cassava processing factories alongside highway between Thalaivasal and Attur. Cassava is widely cultivated and eaten as a staple food in Andhra Pradesh and in Kerala.

Friction Apparatus: An apparatus is described in which the sliding friction between a small rider and a flat surface was accomplished. The apparatus may be used widely to study the dynamic motion of sliding bodies under miscellaneous frictional conditions.

The manual planting of cassava demands a large quantity of human labour. It is a time-consuming, unpleasant, and arduous job. The labor shortage is one of the major constraints in manual cassava planting. In order to design and develop the cassava planter, the selection of material is important. The material is selected based on the coefficient of static friction. This is found out by using the friction apparatus designed based on the physical properties (moisture content) of the cassava setts. By considering the physical properties, a test rig was fabricated. The test rig consists of feed trough, angle indicator and screw shaft. The angle of feed trough can be adjusted manually by screw conveyor shaft.

In order to select the material for designing a cassava planter, static friction of co-efficient was found based on the moisture content of the cassava setts. Based on some preliminary experiments coefficients of static friction were introduced as the key characteristics for the selection of material for cassava planter. There was no published work relating to physical properties (moisture content-dependent) of cassava sett so they have been measured for this study. Planting materials for cassava is obtained from stem cuttings. It is best to select only fresh, mature and healthy stems. If the latex or sap comes out within six (6) seconds after cutting, they are identified as fresh stem. If the diameter of the pitch or cork is not more than half the diameter of the cortex, they are identified as mature stem. Healthy stem should be pest free and the diameter not less than 1.5cm. The recommended length of stakes is 20-25 cm with 5 or more nodes. Cutting of the stems is usually done with a sharp cutlass or a saw making sure that cuttings are handled carefully to avoid damage to the nodes (Adekunle *et al.,* 2004; Philippine Root Crops Information Service, 2005)[1,11].

Many researchers and institutions were investigated and reported the cassava sett length required for during planting a stake length of 25-30 cm was found to be ideal for obtaining high root yield CTCRI (1968), Sett of 15 to 20 cm were planted at a spacing ofeither75 x 75 or 90 x 90 cm between the rows and between the plants. (Edison et al., 2006) [6]. Cassava stem cuttings (also referred to as 'stakes') could be planted 1 per hole in a horizontal, vertical or slanting position to a depth of 5-10 cm depending on soil type and condition as shown in [Fig-1][1,8].



Source: Adekunle *et al*, 2004
Fig-1 Different planting positions of cassava

Materials and Methods:

The cassava planting materials of various varieties were obtained from the multiplication plots of the Root and Tuber Improvement and Marketing Programme (RTIMP) under the Ministry of Food and Agriculture (MoFA), Kumasi. The cassava sticks containing at least 4-5 nodes were cut into sizes 20-25 cm before planting. For design of hopper and metering mechanism length of setts place important role for uniformity. Hence it is decided to conducted the basic study review that with minimum length of setts four to six node (65,100 mm) the metering was trouble free and uniformity was maintained .hence the sett length of 65,100 mm was taken up for this study. Based on the review and physical properties analysed, test rig was developed. The test rig was evaluated for different moisture content using different surface materials namely aluminium, acrylic sheet, mild steel and galvanized steel sheet.

The physical properties determined for cassava setts were length, diameter of sett based on node and coefficient of static friction. The methods adopted for estimating these parameters are given below.

Determination of sett size:

Cassava sett was randomly chosen for measuring dimensions. Length and thickness of each cassava sett was measured using vernier calliper (least count 0.01 cm). Fifteen sett sample observations were made to get average values of length and thickness of cassava sett.

Determination of Moisture content:

The moisture content of cassava stem was measured using hot air oven method. The initial weight of cassava stem sample was measured by the electronic weighing balance with the accuracy of 0.1 g and it was kept in oven at 104°C. The weight of the sample was continuously measured at an interval of 4 hour till a constant weight was recorded. The sample was removed from the oven and the constant weight was taken as a final weight of sample. The moisture content was computed as per cent value on wet basis using formula 1.

$$M = \frac{W_i - W_f}{W_i} \times 100 \quad \text{----------} \quad [1]$$

M = Moisture content of cassava stem (per cent)
W_i = Initial weight of cassava stem (g)
W_f = Final weight of cassava stem (g)

Apparatus to measure static co-efficient of friction:

The components of friction apparatus were trapezoidal frame, feed trough, shaft, design of bush, screw shaft, angle indicator. For designing static friction apparatus, those above mentioned components were designed in solid work designing software 2016 [Fig-2].

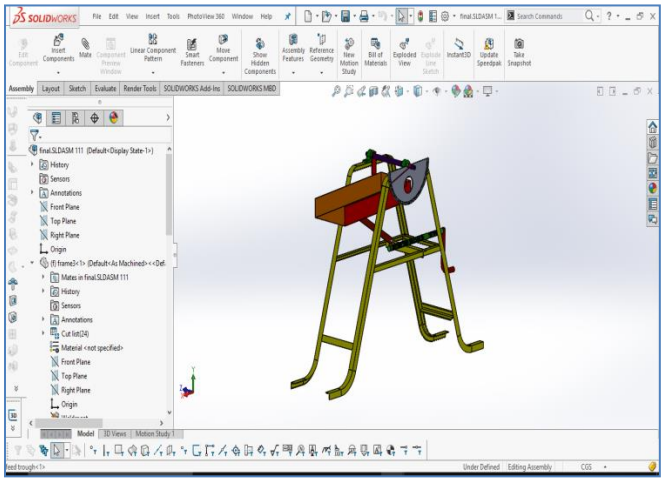


Fig-2 Design of co-efficient of static friction apparatus using solid works software.

Coefficient of Static Friction

This is the ratio of force needed to start sliding the sample over a surface by the weight of the sample. The static coefficient friction against different surfaces includes galvanized iron sheet, mild steel, aluminium and acrylic sheet was determined using coefficient static friction apparatus. Each cassava sett was placed on the horizontal surface and raised gradually by screw until the cassava begins to slide down. Protector (semi-circular) with angle range from 0 to 90^0 degree was fitted to one end of the frame which shows angle of cassva slide down. The angle θ of the inclined surface with the horizontal platform at the beginning of the sliding was measured as shown [Fig-2]. The coefficient of static friction (μ_s) was calculated using the following equation. (Ghasemi Varnamkhasti *et al.,* 2008. Dhinesh Kumar, 2016) [15, 4].

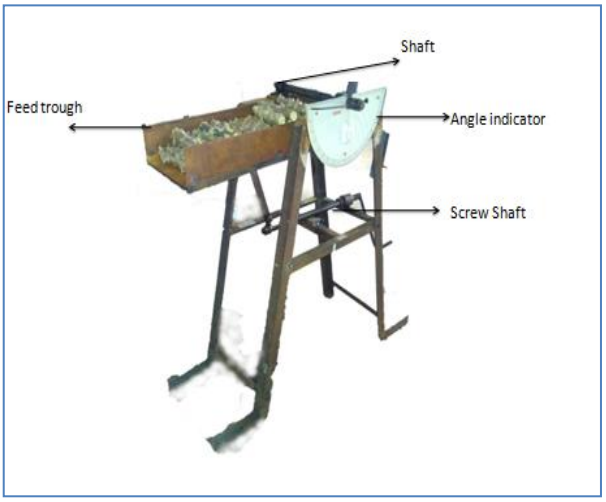


Fig-3 Co-efficient of static friction Measuring Apparatus

[Fig-3] Co-efficient of static friction Measuring Apparatus

$$\mu_s = \tan(\alpha) \quad \text{----------} \quad [2]$$

Whereas, α is angle that cassava start to slide down.

Results and Discussion

Coefficient of static friction was found out for each group of cassava sett length, using a co-efficient static friction apparatus at different moisture content. Cassava sett was selected based on number of nodesviz.2,4,6 and 8 which having average sett length of 47, 74,112 and 142 mm and diameter 32, 35, 34 and 34mm respectively as shown in [Table-1]. The coefficient of static friction and the angle repose found based on the size of the setts, test rig was developed and evaluated. Evaluation was done based on the coefficient of static friction found for different moisture content (measured for consecutive four days) to different surface materials selected namely, aluminium ,acrylic sheet, Mild steel and galvanized steel sheet.

Setts of four nodes:

It was observed that the setts selected with 4 nodes and length 65 mm showed decreased co-efficient of static friction with decreasein moisture content. Dutta et al. (1988), Joshi et al. (1993), Carman (1996), Ogut (1998), Peker (1996), Aydin (2003) and Razavi et al.(2010) reported that the coefficient of static friction was directly proportional to moisture content. The angle of static friction with respect to moisture content i.e. 63.59, 61.69, 53.77, and51.59. The coefficient of static friction with respect to this range of moisture content on different material surface viz., acrylic sheet (0.6-0.5), aluminium (0.62-0.53), mild steel sheet (0.65-0.57) and Galvanized steel sheet (0.67-0.57) was depicted in [Table-2] and [Fig-3]. It was found that the coefficient of friction for acrylic sheet is lowest. This may be due to the smoother and more polished surface of acrylic sheet as compared to other frictional surfaces.

Table-1 *Different length of Cassava sett based on the number of nodes*:

Sl.No	2 node		4node		6 node		8 node	
	Length mm	Diameter mm	Length mm	Diameter mm	Length mm	Diameter mm	Length mm	Diameter mm
1	44	33	65	38	104	35	134	32
2	51	31	68	34	98	35	150	33
3	49	32	64	35	107	32	115	34
4	45	35	66	37	105	34	160	37
5	43	32	67	30	102	30	147	32
6	47	33	68	36	85	32	150	31
7	48	30	66	36	105	34	157	38
8	58	27	60	35	80	35	140	34
9	45	33	63	35	112	34	123	32
10	52	33	65	37	114	34	160	33
11	47	30	64	35	78	34	122	38
12	48	30	62	35	102	35	165	38
13	45	30	69	35	120	33	130	32
14	50	32	67	30	108	35	147	34
15	40	32	68	34	112	33	130	37
Average	**47**	**32**	**65**	**35**	**102**	**34**	**142**	**34**

Table-2 *Coefficient of static angle friction of cassava sett with 65 mm length and 4 nodes*

Sl. No	Day	Sett length (mm)	Weight of sett (gram)	Moisture content (%)	Mean value of static angle coefficient of friction for different Materials			
					Galvanized steel sheet	Mild steel	Aluminium	Acrylic sheet
1.	First day	65	153	63.59	0.67	0.65	0.62	0.60
2.	Second day	65	131	61.69	0.64	0.61	0.59	0.57
3.	Third day	65	117	53.77	0.59	0.58	0.57	0.56
4.	Fourth day	65	110	51.59	0.57	0.57	0.53	0.50

Table-3*Coefficient of static angle friction of cassava sett with 100mm length and 6 nodes*

Sl.No	Day	Sett length (mm)	Weight of sett (gram)	Moisture content (%)	Mean value of static angle coefficient of friction for different Materials			
					Galvanized steel sheet	Mild steel	Aluminium	Acrylic sheet
1.	First day	100	247	66.45	0.62	0.60	0.59	0.57
2.	Second day	100	222	64.06	0.58	0.55	0.56	0.54
3.	Third day	100	207	55.08	0.48	0.53	0.50	0.48
4.	Fourth day	100	197	53.65	0.45	0.46	0.45	0.45

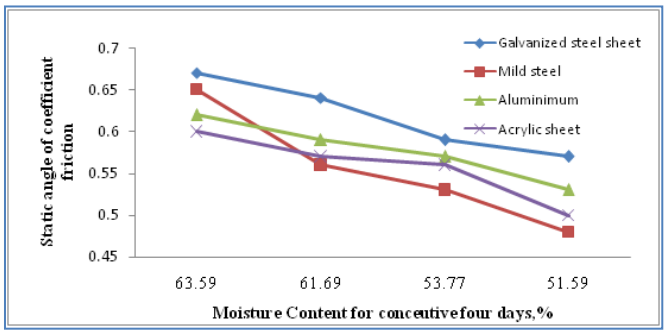


Fig-4 Cassava sett length of 65 mm with 4 nodes

Setts of six nodes:

The coefficient of static friction was relation with length of 100 mm with 6 nodes for different moisture content. The angle of static friction with respect to moisture content of 66.45, 64.06, 55.08 and 53.65. The coefficient of static friction with respect to this moisture content on different structural surface were recorded as acrylic sheet (0.57-0.45), aluminium (0.59-0.45), mild steel sheet (0.6-0.46) and Galvanized steel sheet (0.62-0.45) respectively [Table-4] and [Fig-5]. It was found that the coefficient of friction for acrylic sheet and aluminium was in the lower range

Conclusion

It was concluded from the study that the co-efficient of static friction and moisture content of cassava sett are directly proportional to each other and also with the length of cassava sett. Hence, coefficient of static friction with respect to moisture content and length of cassava setts may be considered for the selection of materials and design of feed hoppers for design and development of cassava planter.

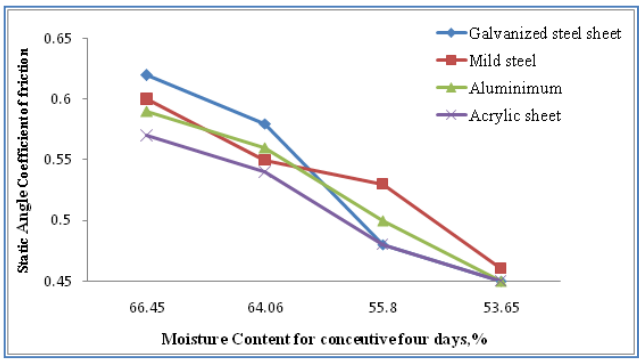


Fig-5 Cassava sett length of 100 mm with 6 nodes

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Author contributors: All authors are equally contributed

Conflict of Interest: None declared

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