Design and Development of Turmeric Harvesting Machine Aspect

Amol Sukhadeo Khadake[1] V.B.Janjal[2] S.S.Kamble[3]
[1,2,3]Department of Agricultural Engineering
[1,2,3]College of Agriculture, Loni, India

Abstract — Turmeric is one of the important spice crops, which earns sizable foreign exchange for our country through export of its and products. By reducing the cost of production per hectare will result in increasing the benefit. The digging of turmeric crop at the proper maturity stage is an essential and important farm operation, but it is tedious, time consuming, labour intensive and costly. Also due to non – availability of skilled labour and the more wages demanded by them to digout the crop the higher field losses damage to the crop by manual digging, necessitate the need to develop a suitable mechanical tuber crop harvester for turmeric is developed based on need for the mechanization of the digging operation for turmeric crop. The tuber crop harvester consist of main frame, soil cutting blade, webs/windrowing unit and three point linkage.

Keywords: Turmeric Harvesting Machine Aspect

I. INTRODUCTION

Harvesting is the most labor intensive process in the agricultural sector .Time and availability of labor determines the price of the harvest. Turmeric is a crop that has been dominating the fields of India with almost 2.34 lakh hectare (M.Saimurugan *et al*., 2021). of land is solely dedicated to producing the spice in our country making India the largest producer and consumer of the commodity. Despite the monopoly in the production of the spice, there is no machine that covers the entire harvesting process of turmeric. The existing harvesters extract the rhizome and drop them behind as they are propelled forth, which are then segregated from the soil and collected by labours. The work aims at the design and development of a harvester that is capable of performing the entire harvesting process and is compatible to Indian agricultural fields. The machine is designed as an attachment to any small tractor (24HP) (M.Saimurugan *et al*., 2021). Zate et al. (2018) reported that the farmers are planting turmeric and ginger on raised beds. It is prepared 20 to 30 cm in height and 75 to 100 cm in width with a convenient length with at least 30 cm spacing between two rows of turmeric on the beds. Munde et al. (2010) reported that the mother rhizome or finger rhizome are either planted on raised beds of 60 to 90 cm width with 15 cm height on ridges and furrow or in flat system.

II. DESIGN CONSIDERATION

1) The ridge to ridge distance is adjustable in the range of 70-90 cm and plant to plant distance is 30 to 60 cm.
2) The plant geometry of turmeric crop is 45 x 30 cm.
3) The machine should be able to harvest the rhizomes efficiently available at different depths from 16 to 24 cm.
4) The width to depth ratio of the working blade as per the crop specification is chosen to be 6:2 (Godwin and O'Dogherty, 2006).
5) The soil moisture at the harvesting time should be in the range of 10- 25%

A. Crop Parameters

1) Crop geometry

The plant to plant spacing was 30 cm and row to row spacing was 60 cm.

2) Rhizome spread

The range of rhizomes spread laterally was 20 to 32 cm and corresponding vertical spread was 10 to 18 cm.

3) Moisture content of rhizome at digging

The average value of the moisture content was 75 per cent (wb).

4) Soil Parameters

The soil resistance values are given in (Table1)

SN	Type of soil	Soil resistance (Kg/cm2)
1	Sand soil	0.2 to 0.5
2	Sandy loam	0.3 to 0.65
3	Heavy soil	0.7
4	Clay soil	0.35 to 0.8

Table 1: Soil resistance values of soil. (Kepner *et al*. 2005).

B. Bulk Density

Bulk density of the soil for the RUGUR or black cotton soil was considered in the range from the literature as 1.16 to 1.28 g/cm3 (low and high) and average density of soil is taken in calculation (Khura, *et al.* 2011).

A turmeric harvesting machine was to be designed to be a cost-effective solution to the rising labour shortage problem. The harvesting process was studied in detail and the design was done considering the farm conditions of our country. The tractor model selected was the 15-20 kW mini tractors with a PTO of 540 rpm. The angle of approach for the entire setup was to be around 10 - 20 degrees (M.Saimurugan *et al*., 2021)

C. Working of tuber crop harvester

Developed tuber crop harvester consists of the following functional components for effective working in the field;

1) Soil cutting blade
2) Soil /crop windrowing unit/web
3) Frame to hold blade and web
4) Hitching unit

The overall conceptual element diagram of harvester is shown in the following figure 1. The developed harvester is attached to the small size tractor (18-24 hp) by three point linkage. The machine is operated on forward or pulling force principle to disturb the soil mass effectively. The soil cutting blade of trapezoidal section is inclined at an angle of $25^0$with horizontal surface of ground, which penetrates in to the soil up to the depth of 18-20 cm with the effective working width of 600 mm. The soil mass and rhizomes uprooted by the blade passes over the web which is having an inclination of $10^0$with upper surface of soil cutting blade and a length of 500 mm. The loosen soil mass and the turmeric rhizomes after travelling at 270 mm raised height at the end of web fall on the ground surface. The uprooted turmeric rhizomes are easy to collect from the field.

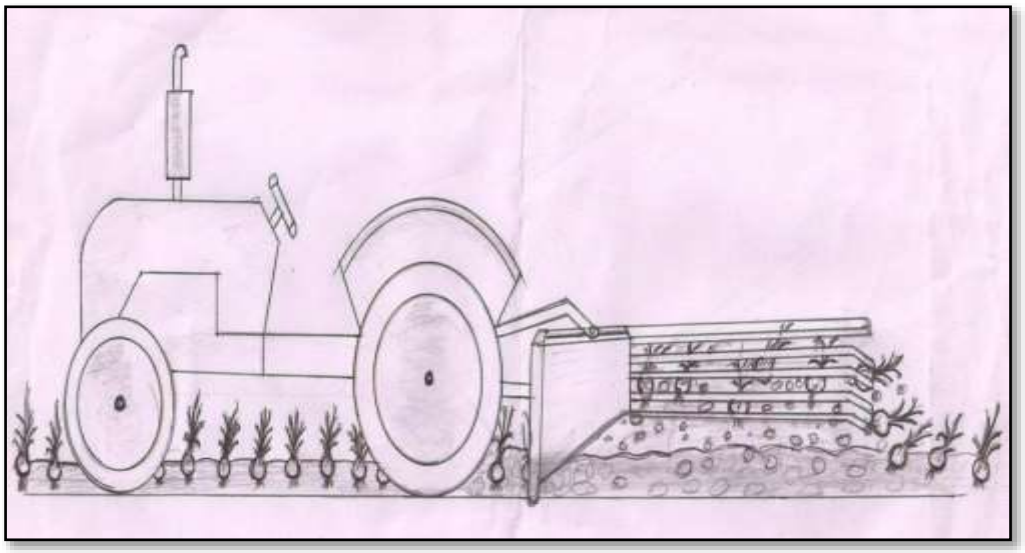

Fig. 1: Conceptual working of harvester

III. CONCLUSION

The design of various components of harvester is very crucial task. The machine has to operate in soil to disturb the soil mass for easily uprooting of turmeric rhizomes. Based on the depth requirement for the operation (20 cm), the width of the machine was decided as per literature reviewed during the study. The optimum width to depth ratio of 6:2 has been considered for the development of harvester. The important parameter also impacted on selection of blade geometry, was crop spacing (row and plant). According to the row spacing and the type of sowing of crop (i.e. ridge), a trapezoidal type blade was selected to facilitate proper failure of soil to enhance the uprooting of turmeric rhizomes.

The design evaluated showed the good structural stability of webs. From shear force and bending moment analysis it was felt that, the soil load i.e., mass has more friction in center of the machine web, which resulted in wearing. The wearing of harvester during project has been worked out and it was within a limit as per the BIS test codes for the machinery for 20 to 25 h of operation. The life of working worked out and suggested to be 1000 h.

REFERENCES

[1] A. S. KHADAKE, V.P. KHAMBALKAR, A.M. GORE2 and A. J. DHONDGE. Innovation Farm Device for Turmeric Harvesting: Design and Development Aspect. Trends in Biosciences 8(19), Print: ISSN 0974-8431, 5364-5368, 2015.
[2] India GDP share of agriculture - data, chart. The Global Economy.com. (2020). Retrieved 26 May 2020, from https://www.theglobaleconomy.com/India/Share of agriculture.
[3] Kepner,R.A., Roy bainer and E.L. Barger, 2003. Principles of Farm Machinery. CBS Publisher and Distributors Pvt. Ltd., New Delhi: 121.
[4] M.Saimurugana, B. Swarnam,P. V. Arravind Balaji,P and Mohan Sai Akhil 2021. Design and Development of Turmeric Harvesting Machine. AIP Conf.Proc.2358, JULY 30 2021.
[5] Munde, P.A., B.P. Sawant and S.A. Sawant, 2010. Optimization of blade for bullock drown turmeric digger: A practical approach. Int. J. Agri. Engg., 3(1): 17-20
[6] Zate, G.K., D.D. Tekale and K.R. Solanke, 2018. To investigate performance of bullock drawn turmeric and ginger harvesting equipment. Multilogic in Science, 8(27): 258-263.

