

Research Paper :

## Optimization of blade for bullock drawn turmeric digger : A practical approach

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### ABSTRACT

Bullock operated turmeric digger was developed in the department of FMP, College of Agril. Engg and Technology. It consisted of various parts viz., Frame, Shank, Blade and Handle. The prototype was developed considering spacing and varieties used in Parbhani and Nanded districts. The newly developed bullock drawn turmeric digger was evaluated for its field performance. The field trails were conducted as per IS code (11235, 1981). The machine has shown better performance for turmeric harvesting in terms of rhizomes damage percentage, digging efficiency, field efficiency, draft requirement over existing machine and manual methods. The rhizome damage was less 10.72% in V blade with 70 degree angle. The digging efficiency was found 86-94.87% in V blade with 70 degree angle. The field efficiency was found to be 71-89.83 in V blade with 70 degree angle. Draft requirement of bullock drawn turmeric digger was found to be 108 kgf.

**Key words :** Turmeric digger, Bullock drawn, Optimization

Harvesting of turmeric rhizome is labour intensive, requiring skilled men labour to dig out the crop. The general practice in conventional method of harvesting is to wet the crop after removal of the cut foliage, which are spread in the field for drying. The conventional practice is to cut the leaf shoots upon maturity and slightly wet the field. The turmeric rhizomes are dug out after a week by skilled labour with a special fork type of spade/pick axe. Normally turmeric digging is done by contract labour that demands very high wages during peak season. The charge demanded is very high and the damage caused to rhizome by the fork type spade is 10 to 15 per cent because the labour has to dig out the clump all around and in doing so, the fork bruises the rhizome every time as it hits the rhizome. The present situation of migration of labour to various scholastic jobs and thrust for more production to feed the increasing population makes the harvesting during peak season a tiresome one.

The non-availability of such skilled labour and the high wages demanded by them to harvest the crop, the baliram plough is being used in recent years to harvest the turmeric crop. The collection of rhizomes is carried out manually. The efficiency of this operation is very low and cost required is high. The objective was to optimize the blade for bullock drawn of turmeric digger and evaluation of turmeric digger in field.

### METHODOLOGY

The bullock drawn turmeric digger was designed and developed in Department of Farm Machinery and Power College of Agricultural Engineering and Technology,

Marathwada Agricultural University, Parbhani. The design and dimensions were based upon local crop spacing and harvesting conditions. The prototype was developed considering spacing and varieties used in Parbhani and Nanded districts.

#### Design parameters:

The turmeric digger was developed by considering the following parameters

#### Crop parameters:

Whole or split mother rhizome or finger rhizome are used for planting. It is either planted on raised beds of 60 cm to 90 cm width with 15 cm height on ridges and furrow or in flat system. The spacing is kept 30 cm x 15 cm or 30 cm x 20 cm (in beds) and 40 to 60 cm x 25 cm (on ridges and in furrows) and 60 cm x 15 cm (in flat system).

Turmeric takes 9 months for harvesting, drying up of the aerial portion indicates maturity. On an average a yield of 25-30 t/ha of fresh rhizomes may be obtained.

In most of the varieties of turmeric rhizomes depth ranges from 17 to 20 cm. It was therefore necessary that the operating depth of implement would be more than 20 cms.

#### Soil parameter:

It is defined as the resistance offered by the soil to the implement while working. The soil resistance varies from soil to soil. Table 1 gives the soil resistance values for different types of soils.

Sr. No.	Type of soil	Soil resistance value in kg/cm <sup>2</sup>
01	Sandy soils	0.2
02	Sandy of silt loam	0.3
03	Clay loam	0.5 to 0.7
04	Heavy soils	0.7

(Source, www.google.com)

It is the soil resistance that mainly affects the draft of the implement. The soil resistance is maximum for heavy soils *i.e.* 0.7kg/ cm<sup>2</sup> and is considered while designing the digger.

#### **Moisture content of soil:**

Moisture content of soil will affect draft of implement and hence turmeric is generally harvested at optimum soil moisture content, which varies from soil to soil (Table 2).

Sr. No.	Different soils	Moisture (%) content
01	Sandy soil	3.5
02	Sandy or silt loam soils	5.8
03	Clay loam soils	7.18
04	Heavy soils	12.20

(Source, www.google.com)

#### **Design of functional component of turmeric digger.**

Following are various parts fabricated for turmeric digger.

- 1) Frame
- 2) Shank
- 3) Blade
- 4) Handle

**Frame:** Design of main frame was made by considering mild steel subjected to bending, torsion and shear stress,. The frame was manufactured from M.S. Angle 50x50x5 mm. The size of the frame was 60 x30 cm.

#### **Design of shank:**

Design of shank was made by considering square mild steel rod subjected to bending, torsion and shear stresses. M.S. square of 40x10mm was used for this.

#### **Design of blade:**

For design of blade M.S. flat was taken having shear stress and torsional stress greater than 150 kg/cm<sup>2</sup> and 450 kg/cm<sup>2</sup>, respectively. M.S. flat having thickness of 20 mm was used to overcome the problem of bending and breaking Three different types of blades were used. Blade 1, V blade with 70° angle ,Blade 2, V blade with 120° angle and pointers, Blade 3, Semi

circular blade.

#### **Design of handle:**

It was fabricated from M.S.angle 25x25x5 and 50mm pipe The height of the handle was kept 65 cm as per the ergonomic specification of the man (Table 3).

Sr. No.	Parts of the digger	Material used for fabrication	Material as per design
01	Frame	M.S. angle section (5cm x 5 cm)	M.S. angle section ( 5cm x 5 cm)
02	Shank	M.S. square bar (25 x 25mm)	M.S. flat ( 50 x 20 mm)
03	Blade	M.S. plate (40 x 20 mm)	M.S. plate (40 x20 mm)
04	Handle	M.S.pipe(dia.50mm) M.S.angle 25x25x5	M.S.pipe (dia.50mm) M.S.angle 25x25x5

#### **Specification of turmeric digger blade:**

1. Make - MAU, Parbhani
2. Type - Bullock drawn
3. Power source - 0.8 HP bullock pair
4. Spacing - 30, 45, 60 cm (adjustable)
5. Frame dimension- 60x20 cm rectangular

#### **Field test:**

For the field test B.S.P. farm, Sorghum Research Center, Water Management Farm, M.A.U. Parbhani, farmers field at Meshkheda were taken. The spacing between turmeric sown was observed 60 cm. Digger was adjusted according to the observed spacing of turmeric in such a way that two side shanks strike the turmeric rhizome where as middle one would loosen and uproot the rhizome. Dynamometer was used for the measurement of draft required for the digger and developed by a pair bullock and with the speed. The newly developed bullock drawn turmeric digger was evaluated for its field performance. The field trials were conducted as per IS code (11235, 1981), The field and crop conditions existed during the trials are presented in Table 4.The field trials of digging turmeric with the bullock drawn turmeric digger were conducted by using three different types of blades

Blade 1, V blade with 70° angle Blade 2, V blade with 120° angle and pointers, Blade 3, Semi circular blade.

**Table 4 : Field and crop condition during the performance trials of the developed turmeric digger**

Sr. No.	Particulars	
A)	General	
1)	Location of the trial	BSP farm
2)	Type of soil	Medium black
3)	Soil moisture content	9.23 %
4)	Bulk density	1.61
B)	Crop conditions	
1)	Variety	Salem
2)	Age of crop (days)	280
3)	Average dia. Of rhizomes, cm	3.2
4)	Average crop ht., cm	125
5)	Planting date	07-06-05
C)	Field conditions	
1)	Size of plot (mxm)	30 x 20
2)	Depth of rhizome cm	20
3)	Plant geometry cm	45 x 30
4)	Ridge to ridge distinction cm	90
5)	Topography of field	Levelled
6)	Type of weeds present	Congress, harli, ghol.

## RESULTS AND DISCUSSION

The results of trials are given in Table 5. The performance parameter of bullock drawn turmeric digger were as :

### Row spacing:

The bullock drawn groundnut digger could be used in the corp with row spacing of 30 to 45 cm. With varying

moisture content the baled gave different working depths and with that the width of operation of the digger changed. However, a blade of 45 cm width always gave a width of operation more than 30 cm.

### Depth of operation:

In case of bullock drawn turmeric digger the depths obtained were in range of 19 to 23.5 cm. This was adequate for digging the rhizomes without any damage because the rhizomes depth is about 20 cm. These depths were obtained by providing a dead load of 50 kg (sand bag) on digger.

### Speed of operation:

Here the speed of bullock is speed of operation and it was in the range of 1 km/hr to 1.5 km/hr The type of blade affects the speed of operation.

### Draft:

The average draft observed 98 to 109.5 kg for bullock drawn turmeric digger. The draft requirement for operating turmeric digger was well within the power developed by bullock pair.

### Field efficiency:

The values of field efficiency were in the range of 89%, 74% and 88% for 70, 120 and semicircular blade, respectively.

### Digging efficiency:

It varied from 94 % ,86% and 91 % for 70, 120 and

**Table 5 : Field evaluation of developed digger (average of 5 replications)**

Particulars	120 degree blade	70 degree blade	Semicircular blade
1) Plot size (30 x 20 m <sup>2</sup> )	600	600	600
2) Operating width (cm)	44	44	44
3) Operating depth cm	20.8	23.5	20.5
4) Draft kg	105	107	109
5) Soil moisture % (at 20 cm depth)	21.00	20.5	21.5
6) Speed km /hr	1.37	1.5	1.4
7) Actual time required to cover the plot min	80.62	70	75
8) Theoretical field capacity ha/hr	0.060	0.059	0.059
9) Effective field capacity	0.0446	0.053	0.052
10) Field efficiency %	74.33	89.83	88.13
11) Wt. of rhizomes dugout kg/m <sup>2</sup>	3.450	5.55	5.90
12) Wt. of rhizomes in soil kg/m <sup>2</sup>	0.560	0.45	0.53
13) Wt. of damaged rhizomes	0.430	0.45	0.630
14) Total wt. of rhizomes	4.010	5.85	6.43
15) Digging efficiency	86.03	94.87	91.75
16) Rhizome damaged	19.62	10.72	15.46
17) Un dug rhizome (%)	13.96	7.69	8.23

semicircular blade, respectively

***Rhizomes undug:***

The undug rhizome % value ranged from 7.69, 13.96, 8.23% for 70, 120 and Semicircular blade, respectively.

***Rhizome damaged:***

The average rhizome damaged due to turmeric digger were in the range of 10.72 %, 19.62% and 15.46 % for 70, 120 and Semicircular blade, respectively

***Conclusion:***

- The machine has shown better performance for turmeric harvesting in terms of rhizomes damage percentage, digging efficiency, field efficiency, draft requirement over existing machine and manual methods.
- The rhizome damage was less 10.7% for V blade with 70 degree angle
- The digging efficiency was found about average

86-95 % V blade with 70 degree angle

–The field efficiency was found to be 71-89.83% V blade with 70 degree angle

– Draft requirement of bullock drawn turmeric digger was found to be 108 kgf.

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