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Development and Performance Evaluation of Tool Bar Operated Multipurpose Power Tiller Attachment

V. P. Khambalkar
Assistant Professor,
Deptt. of Farm Power and Machinery,
Dr. Panjabrao Dsshmukh Krishi Vidhyapeeth,
Akola, Maharashtra

D. S. Karale
Assistant Professor,
Deptt. of Farm Power and Machinery,
Dr. Panjabrao Dsshmukh Krishi Vidhyapeeth,
Akola, Maharashtra

S. H. Thakare
Head,
Deptt. of Farm Power and Machinery,
Dr. Panjabrao Dsshmukh Krishi Vidhyapeeth,
Akola, Maharashtra

Abstract

Agricultural production intensification is characterized mainly by an increase in the mechanized soil tillage operations. In the view of proper land preparation a tool bar operated multipurpose power tiller attachment was developed at Department of Farm Power and Machinery, Dr. PDKV, Akola. Its performance evaluated for ploughed land and orchards field for seed bed and broad bed furrow formation. Depth of cut set prior to operation in all cases was observed equals to the set depth. The average speed of operation was found as 4.0 km/h which was most suitable for operator. The actual field capacity was found as 0.137 ha/h with 79.5 % field efficiency where as actual field capacity by traditional method (bullock drawn blade harrow) was 0.03 ha/h. The operation cost was found as Rs. 430/- per hectare where as cost of operation by traditional method (bullock drawn blade harrow) was 2070 Rs/ha. The actual field capacity of tiller attachment for BBF formation was found to be 0.46 ha/h with field efficiency of 79 %. The cost of operation for BBF formation was found to be 280 Rs./ha. Soil pulverization index was found to be 5.66.

Keywords: Field Test, Performance, Evaluation, Tool bar.

Introduction

Mechanization cost share ranges between 25 and 30% of the total farm costs. Those related to soil tillage are estimated between 50 and 70% of the mechanization costs (Vitlox, 1997). Agricultural production intensification is characterized mainly by an increase in the mechanized soil tillage operations (Vitlox and Loyen, 2002). Maharashtra has 86 per cent dry land agriculture and 90 per cent are the small and marginal farmers. Kaspar et al. (1990) found that soil moisture and soil temperature within the seedbed zone (top 5 cm) can promote or delay seed germination and plant emergence. To make the dryland agriculture sustainable, in-situ moisture conservation is most important through various tillage practices like, proper tillage with respect to crops, making ridges and furrow across the slope and on counter. Similarly, the most precision in-situ moisture conservation practice is forming the BBF on the contour or across the slope. Forming ridges and furrow, BBF requires deep and fine tillage which cannot be made by the traditional tillage practices by bullock or tractor drawn tillage implements. Preparing land with deep and fine tillage requires more time and the money for plain sowing the land cannot be prepared by single operation. Similarly, in dryland before receipt of rain no tool can prepare the land in one operation for any moisture conserving practice. The small and marginal farmers do not have the capital of maintaining the tractor, inspite of this due to the small size farm the tractor are not economical and beneficial to the farmers. Asian farmers commonly have small-scale and narrow fields of less than 0.3 ha in traditional farming district and hilly areas. In such cases, hand tractor are quite handy to use and can attain higher working efficiency and accuracy than four-wheel tractors (Sakai, 1999).

In view of the above, a power tool bar operated multipurpose tiller attachment has been developed to perform the tilling of soil of any condition, making ridges and furrows and formation of BBF for water conservation. The investigation was undertaken to study with the objectives to development of power tool bar operated tiller attachment for its multipurpose use and to evaluate the power tool bar operated multipurpose tiller attachment.

Review of Literature

Related review of this study has been reviewed as follows

Natsis et al. (2002) investigated the influence of the fore ploughshare and disk coulter on the tillage quality found that the best tillage quality was obtained when both the disc coulter and fore ploughshare were used. He found that the plant residue left on the soil surface was considerably reduced and clods size category larger. than 15 cm did not appear at all. Reduced soil disturbance of disc harrowing gave better water storage unlike the chisel and particularly the moldboard plough where the soil disturbance subjected deeper wet layers to rapid desiccation.

Pechon R R. et, al, (2007) a developed non-power rotary tiller implement (NPRT) was to pulverize soils after first plowing for seedbed preparation. Field performance of NPRT, power rotary tiller (PRT) and traditional comb tooth harrow (CTH) were compared. Results showed that highest pulverization was attained by PRT due to higher power transmitted directly from the engine to the rotary blades.

Material and Methods

Development of power tool bar operated multipurpose tiller attachment is basically design to make the soil preparation of ridges and furrows, formation of BBF. The said tiller was designed kinematically for the required motion during operation at main shaft of the tiller. For tilling the soils by tillers needs 16 blades mounted on the shaft in different direction, however for making of BBF or ridges and furrow with the same tiller the arrangement of tiller blades was altered to throw the soil particles on both side of the tiller to make the furrow of required cross section for ridges and furrow and BBF.

Shaft and Blade Assembly

Shaft is specially designed to accommodate the various arrangements of the blades to do the various operations. The five flanges are arranged on the shaft; out of which four flanges are arranged on shaft at equal distance from each other. However one flange is arranged in the centre of the shaft. Eight left and eight right 'J' type blades are arranged for tilling land. So in total 16 'J' type blade arrangements on shaft for tilling the land. For making ridges and furrow only eight blades are arranged on the two plates. However, the four 'S' blade are to be arranged on the same shaft so as to throw the soil from the furrow to both side.

Furrower

To shift the soil both direction and to give the shape to the furrow a furrower is provided whose depth can be adjusted to spread the pulverised soil on the bed. Two wings are provided which help to make this arrangement.

The Cover

All the blades are covered with the help of MS sheet of 10 guage. Depth adjusting guage wheels are also provided on the both side of the cover, which can be adjusted by lowering down or raising these wheels.

Specification of the Tiller

Detail regarding the specifications of the tiller attachment is given in Table 1. Plate 1 shows the isometric view of multipurpose tiller attachment.

Testing of Multipurpose Tiller Attachment

Multipurpose tiller attachment trails were carried out in ploughed land and orchard field for land preparation. Field observations like moisture content, bulk density, soil conditions, depth of operation, operational speed, width of operation, time recorded during field evaluation trails and it was analyzed to determine the actual field capacity, field efficiency, pulverising index and fuel consumption.

Cost Economics

In concern cost involved for field preparation by using of power tiller multipurpose tool bar was calculated as per s BIS.

Result and Discussion

For Secondary Tillage Operation (Breaking of Big Soil Clods)

The power tool bar operated multipurpose tiller attachment was tested in field as secondary tillage operation. Details regarding the testing are given in Table 2. The soil moisture was recorded and it was 12 per cent. The width and depth of operation was 0.36 m & 15 cm respectively. The fuel consumption per hour was observed to be 1.5 litres. The theoretical field capacity was found to be 0.15 as in secondary tillage operation. Field efficiency of the tiller attachment was observed 88 per cent. The cost of operation per hectare was calculated Rs. 775. The cost saving over traditional operation was observed 63 per cent. The pulverization index (PI) was 5.69 for this field. Plate 2 shows the multipurpose tiller attachment in field operation.

Tilling in the Orchard Crop

The power tool bar operated multipurpose tiller attachment was tested in orchard field for the land preparation and management practices of the crop. Details regarding the testing are given in Table 2. The soil moisture was recorded and it was 16 per cent. The width and depth of operation was 0.43 m & 14.5 cm respectively. The fuel consumption per hour was observed to be 1.6 litres. The theoretical field capacity was found to be 0.163 as in orchard crop operation. Field efficiency of the tiller attachment was observed 87.7 per cent. The cost of operation per hectare was calculated Rs. 790. The cost saving over traditional operation was observed 62 per cent. The pulverization index (PI) was 5.63 for orchard crop field.

Making BBF of 1.5 m

The same arrangement of blades as made for tilling were used for the BBF former in additional to this the marker provided on the front was used for BBF making. The spacing between two furrows was kept as 1.5 m. The observations in respect of formation of bed and machine performance parameter were recorded. Details of field operation in BBF formation is shown in Plate 3.

Conclusions

Tool bar operated multipurpose power tiller attachment was fabricated at Deptt. of Farm Power and Machinery, Dr. PDKV, Akola. Prototype tool bar multipurpose power tiller attachment evaluated in

ploughed field and orchard field and on the basis of result of performance of machine following conclusion could be drawn.

1. Depth of cut set prior to operation in all cases was observed equals to the set depth.
2. The average speed of operation was found as 4.0 km/h which was most suitable for operator.
3. The actual field capacity was found as 0.137 ha/h with 79.5 % field efficiency where as actual field capacity by traditional method (bullock drawn blade harrow) was 0.03 ha/h.
4. The operation cost was found as Rs. 430/- per hectare where as cost of operation by traditional method (bullock drawn blade harrow) was 2070 Rs/ha.
5. The actual field capacity of tiller attachment for BBF formation was found to be 0.46 ha/h with field efficiency of 79 %.
6. The cost of operation for BBF formation was found to be 280 Rs./ha.
7. Soil pulverization index was found to be 5.66.

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Plate 1: View of Test Plot Before and After Tilling Operation (Harrowing)

Plate 2 : View of Weed Infected Lemon Field : View of Tiller in Filed Operation

Plate 3: View of Field during Broad Bed Formation Operation

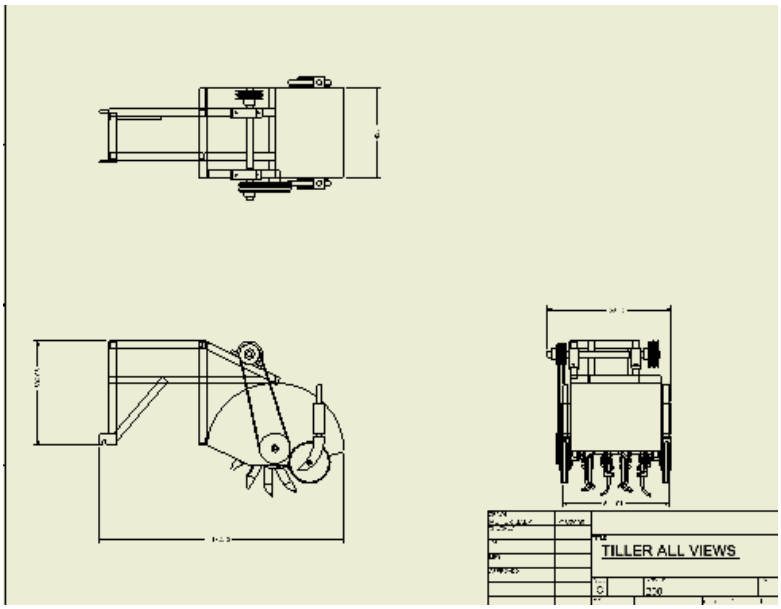

Fig 1: Orthographic Views of Multipurpose Tiller Attachment

Table 1
Specification of Power Tool Bar Operated Multipurpose Tiller Attachment

S.N.	Particulars	Specifications
1	Main frame	Made from MS angle of 35x35x5 mm of dimension 750x1000 mm with attachment arrangement
2	Rotor cover	Made from MS sheet 750x600 mm
3	Guage wheel	MS flat of diameter 160x50 mm adjustable by vertical support of 25 mm square bar
4	Tiller rotor	Assembly mounted on shaft of 50 mm diameter. The 'J' type blades are mounted on flanges welded to the shaft. Total 16 blades are for tiller and 8+4 blades for ridge/BBF frame
5	Transmission	By 'V' belt and pullies
6	Speed of rotation to the shaft	270 rpm
7	BBF attachment	Made from sheet for spreading the loose soil on bed
8	Weight of attachment	86 kg

Table : 2
Performance Result of Power Tiller Attachment Tool Bar

S.N.	Particulars	Tilling operation		BBF operation
		Ploughed Land	Orchard crop	
1	Field details			
	Length of plot	84 m	87 m	50 m
	Width of plot	30 m	32 m	50 m
	Area	0.25 ha	0.28 ha	0.25 ha
	Soil moisture	12 %	16 %	11 %
	Type of soil	Deep soil clay soil covered	Medium soil with grass covered	Medium soil
	Condition of soil	Big clods	--	Single harrowing operation
2	Operational details			
	Width of operation	0.36 m	0.43 m	1.5 m
	Depth of operation	15 cm	14.5 cm	15 cm
	Speed of operation	4.2 km.hr	3.8 km/hr	3.9 km/hr
	Time lost during operation	15.5 min	12 min	13 min
	Fuel consumption	1.5 lit/h	1.6 lit/h	2.0 lit/h
3	Operational performance			
	Theoretical field capacity ha/h	0.15	0.163	0.58
	Theoretical time required h/ha	6.71	6.15	1.72
	Actual field capacity, ha/h	0.132	0.143	0.46
	Actual time required, h/ha	7.7	7.0	2.17
	Field efficiency	88 %	87.7 %	79.30
	Cost of operation Rs/ha	775	790	280
	PI	5.69	5.63	----
4	Visual observations			
	Damage occurred to machine	Nil	Nil	Nil
	Fatigue to operator	10 min. rest after one hour operation	10 min. rest after one hour operation	10 min. rest after one hour operation
	Quality of operation	Well pulverised	Well pulverised and removal of weeds	BBF of 1.5 m form
5	Saving in time over traditional (%)	78	80	---
6	Saving in cost (%)	63	62	---