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Development of Tractor Operated Tie-ridger

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Abstract: *Tie ridging is one of the soil and water conservation practice. It control runoff, prevents erosion, conserves moisture and there by increases crop production. There is necessity to have an implement which will form basin to conserve rain water in Indian dry land condition. Keeping in view above things the present study has been undertaken in the Department of Farm Machinery and Power Engineering, Mahatma Phule Krishi Vidhyapeeth, Rahuri. Main component of tractor operated tie ridger are Main frame, Tie ridging unit, Main ridger, Ground wheel, Rack and pinion mechanism, Locking roller. Rack and Pinion mechanism used for to stop the rotation of blade during field operation and main ridger creating the main ridges on both side. The 55 hp tractor is used for to drive this implement. The maximum field efficiency of the implement was observed as 75.94 per cent. The maximum draft required for the implement is 3336.22 N. Test result in field evaluation of the tie ridger indicated that it could form tie ridges of 6.02 × 2.01 m size. Per hour cost of operation of tie-ridger is Rs. 750.54. This implement is found suitable to form the basin in well prepared land.*

Key words : *Tie ridger, rack and pinion, Main ridger.*

INTRODUCTION

Furrow dikes are small dams formed periodically between the beds along the furrow bottoms. The furrow diking practice is known by many names including tied ridges, furrow damming, basin tillage, basin listing and micro basin tillage. Furrow diking is a soil and water conservation practice, which is very adaptable to dry land crop production. It is most often used on gently sloping terrain in arid and semi-arid areas where crops are grown under water deficit condition (Jones and Baumhardt, 2003). Furrow diking in the Mexican plateau for wheat production on conventional-till raised-bed was first used in 2000 by Mr. Emigdio Taboada, a wheat farmer at Nanacamilp, Tlaxcala state. The farmer has modified his conventional drill removing three planter and replacing them by three small furrow openers connected to an eccentric wheel which caused trip movement to form small dikes. The application of furrow diking technology in bed planting system is of particular importance in many semi-arid regions where rainfall is often of high intensity and short duration (Lyle and Dixon, 1997).

Soil is a non-renewable resource over the human time scale. It is dynamic and prone to rapid degradation with land misuse. Productive lands are finite and represent only less than 11 per cent of earth's land area but supply food to more than six billion people increasing at the rate of 1.3 per cent per year (Eswaran *et al.*, 2001). Thus, widespread degradation of the finite soil resources can severely jeopardize global food security and also threaten quality of the environment. Conserving soil has many agronomic, environmental and economical

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benefits. The on-site and off-site estimated costs of erosion for replenishing lost nutrients, dredging or cleaning up water reservoirs and conveyances, and preventing erosion are very high about US$ 400 billion in the world annually (Uri 2000, Pimentel *et al.*, 1995).

The need to maintain and enhance multi-functionality necessitates improved and prudent management of soil for meeting the needs of present and future generations. The extent to which soil stewardship and protection is professed determines the sustainability of land use, adequacy of food supply, the quality of air and water resources and the survival of human kind. Soil conservation has been traditionally discussed in relation to keeping the soil in place for crop production. Now, soil conservation is evaluated in terms of its benefits for increasing crop yields, reducing water pollution, andmitigating concentration of greenhouse gases in the atmosphere.

From the point of agricultural production, however, the single most effective supply side constraint is that irrigation coverage still extends to only about 40 per cent of net sown area. In particular, slow expansion of surface irrigation through investment in major and medium projects has been the main reason why public investment in agriculture has declined since the early 1980s. While there are genuine problems that make it difficult to initiate new irrigation projects quickly, a concentrated effort is required to expedite ongoing but unfinished projects that involve 13.4 million hectares of potential, and bring under irrigation about 14 million hectares in command areas of completed projects that lie unirrigated due to lack of field channels, silting of reservoirs and similar problems.

MATERIALS AND METHODS

Development consideration of tractor operated tie-ridger" is undertaken keeping in view the following points

1. The tie-ridger should uniformly scrap and collect the soil from an area of given plot size *i.e.* 6 × 2 m.
2. It should distribute the collected soil proportionately to form the main ridges and tie-ridges.
3. The tie-ridges should connect the two adjacent main ridges at right angle and at the regular interval of 6 m.
4. It should be easy to operate and to move from one place to another.
5. It should be simple in design and construction.
6. Small scale industries having general workshop facilities should be able to manufacture and repair it by using locally available material and standard parts.
7. The tie ridger developed should be simple in design and construction, involve minimum maintenance and repair and should be capable of high speed trouble free operation.

Functional component of tractor operated tie ridger

1. Main Frame

A main frame of 2100 × 500 mm size was made from square pipe of 60 × 60 × 3 mm. The ground wheel, spur gear, rack and pinion have been attached to main frame. The height of main frame from ground is 710 mm. Three point linkage attachments were provided to main frame for attaching to power source.

2. Ground Wheel

Ground wheel assembly welded below the main frame with the help of angle of size 40 × 40 × 6 mm. A ground wheel of 383 mm diameter was main source of power from which power was transmitted to tie ridging unit with help of spur gear, idler, rack and pinion mechanism. 12 numbers of lugs have provided on the periphery of ground wheel in order to avoid slippage. Dimensional details are given in Figure. The ground wheel consisting of four number of flats welded at center. Lengths of lugs provided on periphery of ground wheel measures to 100 mm. The ground wheel rotated the shaft on which they had mounted. The lugs provided at the outer rim developed better traction on the soil.

3. Spur Gear Assembly

Spur gear assembly consist of two spur gears

(a) Drive gear

(b) Driven gear

(a) Drive gear

Drive gear of internal diameter 19 mm and outer diameter 65 mm was made of cast iron. Number of teeth provided on drive gear measure to 11. The lock key have provided inside the gear to lock gear on shaft of size 25 × 4 mm. Drive gear and ground wheel are mounted on same shaft. Drive gear takes drive from ground wheel and transmitted to large gear with the help of idler.

(b) Driven gear

Driven gear consist of material cast iron of internal diameter 35 mm and outer diameter 285 mm. Number of teeth provided on driven gear measure to 55. The lock key have provided inside the gear to lock gear of shaft of size 25 × 4 mm. Driven gear takes drive from drive gear and transmitted to the pinion for operating rack.

4. Idler

Idler was made of cast iron having 60 mm diameter and 10 numbers of teeth on its periphery. Idler has inserted between drive and driven gear. Idler does not affect the gear ratio between the input and output shafts of gear. However, idler change the direction of rotation between driven and driver gear. The direction of drive gear is same as ground wheel but direction.

5. Rack and Pinion Mechanism

Rack and pinion mechanism consist of.

(a) Rack

(b) Pinion

(a) Rack

Rack consisting of M. S. material having length 510 mm and diameter 40 mm. 15 number of teeth are provided on middle part of shaft. Rack has mesh with pinion on upper side to make continues reciprocating motion. Spring have attached to rack on one side and locking roller attached another side. Rack was compress the compression spring during forward motion of pinion.

(b) Pinion

Pinion is also known as timing gear. Pinion was made of cast iron material having diameter 67.5 mm. Only eight number of teeth's provided on periphery of pinion and remain surface is plane. Pinion takes drive from spur gear assembly and transmitted to rack. Lock key have provided inside the pinion to lock pinion shaft of size 20 × 4 mm provided inside the pinion.

3.3 WORKING MECHANISM

Before using the tie-ridger in a field, land should be ploughed and harrowed. There should not be any clods in the field. The tie-ridger have attached to the tractor through the three point linkage provided to the implement. As the weight of implement has 330 kg. The tractor required to trail it should be of 55 hp. When ground wheel had rotated, the drive gear started to rotate which have situated on same shaft. Rotation of drive gear transferred to the driven gear using idler provided between them. Driven gear and pinion have placed on same shaft. When ground wheel start to rotate on soil, this motion transmitted to drive gear and from there to driven gear and finally to pinion. Then pinion start to rotate and make reciprocating movement of rack due to this spring placed on front side of rack made compressed.

The back side of rack provided locking roller for making rotation of blades of tie-ridging unit. When spring is in compressed state then blade should be locked position and soil should be collected after full movement of pinion spring will come to original position and creating ridges. Two main ridges have attached to main ridge frame for developing main ridge.

RESULTS AND DISCUSSION

Table 1
Specification sheet of machine

Name of machine	*Tractor operated tie-ridger*
Color of machine	*Light blue*
Overall dimension of machine	
1. Length, mm	2100
2. Width, mm	1170
3. Height, mm	710
4. Weight of machine, kg	330

Cont. table 1

Figure 1: Tie-ridger in operation

Name of machine		*Tractor operated tie-ridger*
Color of machine		*Light blue*
Tie ridging unit		
1. Material		M.S sheet
2. Number of blade		4
3. Thickness of blade, mm		3
4. Dimension, mm		2100 × 207
Spur gear assembly:	*Number of teeth*	*Diameter, mm*
1. Drive gear	11	60
2. Driven gear	55	284
3. Idler	10	65
4. Pinion	8	67.5
Ground wheel		
1. Number of lugs		12
2. Diameter of wheel, mm		383

Table 2
Test results of performance evaluation of tractor operated tie-ridger

		Value			
Sr. No.	*Particulars*	*Test I*	*Test II*	*Test III*	*Total area*
1.	Total area covered, m^2	2250	2500	1750	6500
					Average
2.	Actual operation time, h	0.23	0.26	0.19	0.22
3.	Time lost, h	0.07	0.07	0.05	0.06
4.	Effective field capacity, ha-h^{-1}	0.73	0.70	0.72	0.71

Cont. table 2

		Value			
Sr. No.	*Particulars*	*Test I*	*Test II*	*Test III*	*Total area*
5.	Theoretical field capacity, ha-h^{-1}	0.97	0.92	0.94	0.94
6.	Draft required to pull the implement, N	3229.23	3357.40	3418.79	3336.22
7.	Effective working width, m	2.03	1.99	2.02	2.01
8.	Height of main ridge, cm	19.00	20.00	19.85	19.61
9.	Width of main ridge, cm	38.00	39,00	37.43	38.14
10.	Height of tie-ridge, cm	15.63	16,00	15.11	15.58
11.	Width of tie-ridge, cm	31.99	32.00	30.01	31.33
12.	Distance between successive tie-ridges, m	5.97	6.07	6.02	6.02
13.	Field efficiency, %	75.25	76.08	76.59	75.94
14.	Fuel consumption, *l*-*h*$^{-1}$	8.45	9.01	8.88	8.78
15.	Fuel consumption, *l*-*ha*$^{-1}$	11.57	12.87	12.33	12.36
18.	Cost of operation, Rs-*h*$^{-1}$	728.76	766.26	757.14	750.54
19.	Cost of operation, Rs-*ha*$^{-1}$	998.30	1094.65	915.91	1002.95

CONCLUSIONS

- The tie ridger can be used to form the tie-ridged basin of 6.02 × 2.01 size in the prepared field.
- A tractor operator alone operated this tie-ridger at an average forward speed of 3.7 km-h^{-1}.
- The average draft of 3336.22 N was required while operating the implement.
- The average cost of operation was Rs. 750.54 per hour.

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