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COMPARATIVE STUDY OF ROTAVATOR AND POWER HARROW

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Abstract:

Rotavator and power harrow is basically used for seedbed preparation and mixing the crop residues in the soil. It offers rapid seedbed preparation and reduces draft requirement compared to conventional tillage implement. The performance evaluation of tractor drawn Rotavator and power harrow was undertaken to study the performance of a secondary implement. The research work was carried out on the farms in Karad and Patan region.

The field performance was determined on the basis of effective field capacity, effective working depth, field efficiency, fuel consumption and cost economics. The seedbed quality was judged on the basis of change in bulk density, dry density, and infiltration rate and clod size distribution. The experiment was conducted as per the RNAM test code.

The mean soil clod diameter after operation of Rotavator was observed which is greater than operation of power harrow. Field efficiencies of the tractor drawn Rotavator 1 and Rotavator 2 were 84.54% and 86.79% respectively and the field efficiency of power harrow 1 and power harrow 2 was observed to be 84.98% and 87.44% respectively.

The overall cost of operation for Rotavator was worked out to be Rs.254.4/ha and Rs. 271.2/ha for Rotavator 1 and Rotavator 2 respectively and for power harrow Rs. 306.6/ha and Rs. 327.6 /ha for power harrow 1 and power harrow 2 respectively. The overall performance of power harrow was better as from field efficiency and seedbed quality point of view. The overall working depth of Rotavator was 0.16 m and working depth of power harrow is 0.27 m, which is greater than depth of Rotavator.

INTRODUCTION: Tractor drawn Rotavator is energy efficient equipment, its saves 32-35% time and energy in heavier soils. It is owned by all tractors owning farmer because of its high cost. The purpose of a Rotavator is to break up the soil so that planting can take place. They do not dig deeply into the soil, but will turn the soil up to about 9" in depth, although the depth will depend largely on the size of the machine and the type of soil it is being used on. Rotavator is a time and energy saving alternative to turning the soil over using a spade.

"Active soil cultivation" refers to soil cultivation performed by a machine equipped with implements and driven by the power take-off shaft of a tractor. Power harrows are all PTO-driven and consist of a series of bladed rotors which counter-rotate about a vertical axis. They can also be fitted with different types of rear rollers, which help the harrow, follow the contours of the ground and enable the working depth to be adjusted. Power harrows finely break up the soil, refining and evenly distributing it over the entire working width to create a perfect seed bed: are generally used for secondary tillage after ploughing or sub-soiling and can break up even the most compacted ground, often in a single pass.

The Rotavator and power harrow used for primary and secondary tillage operation which reduces the total tillage operation timing that is the separate primary and secondary tillage operation require more timing. But the initial cost for these machineries is bit too high for the farmers. So the comparative study between two would give better idea about cost of operation and also can check different working parameters.

The experiments was conducted with objectives; determination of, effective working depth of Rotavator and power harrow, field capacity and efficiency of tractor drawn Rotavator, tractor mounted power harrow and the evaluation of performance of operation and cost economics for tractor drawn Rotavator and tractor mounted power harrow.

MATERIALS AND METHODS: The present investigation of 'performance evaluations of tractor drew Rotavator' was carried out at Karad and Patan region of Maharashtra state. The main objectives of the study were to determine performance of Rotavator and Power Harrow on the basis

of field efficiency, cost of operation and seed bed quality before and after operation. The performance of Rotavator was also compared with power harrow, which are used for the seedbed preparation as like Rotavator. The soil properties, which express the effect of tillage operation on seedbed quality, are bulk density, dry density, and infiltration rate and clod size distribution. The field performance was determined on the basis of effective field capacity, effective working depth, field efficiency, fuel consumption and cost economics. The seedbed quality was judged on the basis of change in bulk density, dry density, and infiltration rate and clod size distribution. The experiment was conducted as per the RNAM test code.

At least three series of field tests for short run were carried out under different soil conditions. Depending upon the facilities available, additional series of field tests were conducted. As far as possible the tests were conducted in the field having optimum soil moisture content for tillage operations. The test at relatively dry and wet soil conditions was carried out depending upon the special features of the harrow. For determining the width and depth of cut harrow were set at minimum operating gang angle as indicated by the manufacturer, at lowest hydraulic position and without extra mass and operated it in the field covering two or three row lengths. Average of the reading obtained from maximum 10 places for measurement of width and depth of cut.

Field testing of tractor drawn Rotavator1

Field testing of tractor mounted power harrow 1

Field testing of tractor drawn Rotavator 2

Field testing of tractor mounted power harrow 2

Width of cut of tractor drawn Rotavator

Depth of cut of tractor mounted power harrow

Testing of depth of cut

RESULT: The bulk density of the soil was determined by using the core cutter method. Four samples were taken each, before and after the operation of Rotavator and power harrow on each site. The results obtained at Site 1 and Site 2 is interpreted in Table 1 The data presented in the Table 1 revealed that the bulk densities, which were reported to be 1.92 gm/cc and 1.94 gm/cc before operation, were reduced to 1.85 gm/cc and 1.87gm/cc after operation with Rotavator at Site 1 and Site 2 respectively and the bulk densities, which were reported to be 1.92 gm/cc and 1.94 gm/cc before operation, were reduced to 1.80 gm/cc and 1.82gm/cc after operation with power harrow at Site 1 and Site 2 respectively.

Table 1 Determination of bulk density before and after the operation of the Rotavator and power harrow

Particulars	Bulk density, gm/cc									
	Before operation					After operation				
	1	2	3	4	Avg.	1	2	3	4	Avg.
Site 1										
Rotavator	1.83	1.90	1.97	1.96	**1.92**	1.75	1.80	1.90	1.94	**1.85**
Power harrow	1.83	1.90	1.97	1.96	**1.92**	1.70	1.78	1.85	1.90	**1.80**
Site 2										
Rotavator	1.90	1.97	1.95	1.92	**1.94**	1.86	1.80	1.92	1.90	**1.87**
Power harrow	1.90	1.97	1.95	1.92	**1.94**	1.82	1.78	1.85	1.86	**1.82**

Table 2 Clod size distribution in the soil after the operations

Size of Aperture, mm	Diameter of soil passed the left sieve and retained on the next small aperture sieve, mm	Average size of particles retained on Retained on the sieve, mm	Weight of the soil, gm
2	<2	1	67.56
5.6	2 - 5.6	3.8	310.29
10	5.6 – 10	7.8	490.35
20	10 – 20	15	484.36
	>20	29.82	147.84

Table 3 Observation table of Rotavator 1 (Shaktiman)

Sr. No.	Particulars	Site 1	Site 2
1	Effective field capacity, ha/hr	0.24	0.25
2	Theoretical field capacity, ha/hr	0.75	0.76
3	Field efficiency, %	83.52	84.65
4	Travel speed, km/hr	5.12	5.08
5	Fuel consumption, l/ha	4.74	4.34
6	Cost of operation, Rs/hr	200	192
7	Cost of operation, Rs/ha	254.8	263.2

Rotavator 1

On site 1

The Rotavator 1 Shaktiman was tested for 30 mins. The actual area covered was about 3788.8 m^2. The effective working width of Rotavator 1 was 1.48m and the effective working depth of Rotavator 1 was about 0.16 m. Effective field capacity is 0.24ha/hr. The field efficiency is about 83.52%. The Rotavator 1 was travelling at speed of 5.12 km/hr and fuel consumed was about 3.12litres per hour and cost of operation of Rotavator 1 is 200Rs./hr.

On site 2

The Rotavator 1 Shaktiman was tested for 30mins. The actual area covered was about 3798.3 m^2. The effective working width of Rotavator 1 was 1.48m and the effective working depth of Rotavator 1 was about 0.17m. Effective field capacity is 0.25ha/hr. The field efficiency is about 84.65%. The Rotavator 1 was travelling at speed of 5.08 km/hr and fuel consumed was about 3.14 litres per hour and cost of operation of Rotavator 1 is 192Rs./hr.

Table 4 Observation table of Rotavator 2 (Tata agrico)

Sr. No.	Particulars	Site 1	Site 2
1	Effective field capacity, ha/hr	0.24	0.25
2	Theoretical field capacity, ha/hr	0.73	0.76
3	Field efficiency, %	82.52	84.25
4	Travel speed, km/hr	5.08	4.98
5	Fuel consumption, l/ha	4.56	4.64
6	Cost of operation, Rs/hr	210	197
7	Cost of operation, Rs/ha	262.00	270.00

ROTAVATOR 2

On site 1

The Rotavator 2 Tata Agrico was tested for 30 mins. The actual area covered was about 3743 m^2. The effective working width of Rotavator 2 was 1.78 m and the effective working depth of Rotavator 2 was about 0.17 m. Effective field capacity is 0.24ha/hr. The field efficiency is about 82.52%. The Rotavator 2 was travelling at speed of 5.08 km/hr and fuel consumed was about 3.36 litres per hour and cost of operation of Rotavator 2 is 210 Rs./hr.

On site 2

The Rotavator 2 Tata Agrico was tested for 30mins. The actual area covered was about 3754.6 m^2. The effective working width of Rotavator 2 was 1.78m and the effective working depth of Rotavator 2 was about 0.18m. Effective field capacity is 0.25ha/hr. The field efficiency is about 84.25%. The Rotavator 2 was travelling at speed of 4.98km/hr and fuel consumed was about 3.53 litres per hour and cost of operation of Rotavator 2 is 197 Rs./hr

Table 5 Observation table of Power harrow 1(Maschio Gaspardo)

Sr. No.	Particulars	Site 1	Site 2
1	Effective field capacity, ha/hr	0.72	0.76
2	Theoretical field capacity, ha/hr	0.81	0.83
3	Field efficiency, %	84.38	85.25
4	Travel speed, km/hr	4.72	4.36
5	Fuel consumption, l/ha	5.42	5.97
6	Cost of operation, Rs/hr	210	217
7	Cost of operation, Rs/ha	302.00	324.00

POWER HARROW 1

On site 1

The Power Harrow 1 Maschio Gaspardo was tested for 30 mins. The actual area covered was about 3490.80 m^2. The effective working width of power harrow 1 was 1.48m and the effective working depth of Power harrow 1 was about 0.28 m. Effective field capacity is 0.72ha/hr. The field efficiency is about 84.38%. The Power harrow 1 was travelling at speed of 4.72 km/hr and fuel consumed was about 3.30 litres per hour and cost of operation of Power harrow 1 is 210 Rs./hr.

On site 2

The Power Harrow 1 Maschio Gaspardo was tested for 30 mins. The actual area covered was about 3226.40 m^2. The effective working width of power harrow 1 was 1.48m and the effective working depth of Power harrow 1 was about 0.26 m. Effective field capacity is 0.76 ha/hr. The field efficiency is about 85.25%. The Power harrow 1 was travelling at speed of 4.36 km/hr and fuel consumed was about 3.57 litres per hour and cost of operation of Power harrow 1 is 217 Rs./hr.

Table 6 Observation table of Power harrow 2 (lemken perlite 5)

Sr. No.	Particulars	Site 1	Site 2
1	Effective field capacity, ha/hr	0.74	0.76
2	Theoretical field capacity, ha/hr	0.82	0.85
3	Field efficiency, %	86.56	82.75
4	Travel speed, km/hr	4.81	4.43
5	Fuel consumption, l/ha	5.53	5.82
6	Cost of operation, Rs/hr	216.00	224.00
7	Cost of operation, Rs/ha	317.00	348.00

POWER HARROW 2

On site 1

The Power Harrow 2 Lemken was tested for 30 mins. The actual area covered was about 3547 m^2. The effective working width of power harrow 2 was 1.75 m and the effective working depth of Power harrow 2 was about 0.28 m. Effective field capacity is 0.74ha/hr. The field efficiency is about 86.56%. The Power harrow 2 was travelling at speed of 4.81 km/hr and fuel consumed was about 3.35 litres per hour and cost of operation of Power harrow 2 is 216 Rs./hr.

On site 2

The Power Harrow 2 Lemken was tested for 30 mins. The actual area covered was about 3341 m^2. The effective working width of power harrow 2 was 1.75m and the effective working depth of Power harrow 2 was about 0.27 m. Effective field capacity is 0.76 ha/hr. The field efficiency is about 82.75%. The Power harrow 2 was travelling at speed of 4.43 km/hr and fuel consumed was about 3.47 litres per hour and cost of operation of Power harrow 1 is 224 Rs./hr.

Table 7 Comparison of Power harrow and Rotavator

Particulars	R 1	P 1	R 2	P 2
1. Actual operating time, min	30	30	30	30
2. Actual area covered,m^2	3793.55	3358.6	3748.8	3444
3. Effective working width, m	1.48	1.48	1.78	1.75
4. Effective working depth, m	0.165	0.27	0.175	0.275
5. Effective field capacity, ha/hr	0.762	0.672	0.895	0.808
6. Theoretical field capacity, ha/hr	0.901	0.794	1.031	0.924
7. Field efficiency, %	84.54	84.98	86.79	87.44
8. Travel speed, km/hr	5.15	4.54	5.03	4.62
9. Fuel consumption, lit/hr	3.23	3.435	4.05	4.41
10. Fuel consumption, l/ha	4.24	5.11	4.52	5.46
11. Cost of operation, Rs/hr	193.8	206.1	243	264.6
12. Cost of operation, Rs/ha	254.4	306.6	271.2	327.6

From the table 7 it was seen that, Rotavator 1 and power harrow 1 was working depth 0.165 m and 0.27 m respectively and effective field capacity 0.762ha/hr and 0.672ha/hr, respectively. The fuel consumption of Rotavator 1 and power harrow 1 were 3.23 lit/hr and 3.43lit/hr, respectively. The cost of operation Rotavator 1 and power harrow 1were 254.4Rs/ha and 306.6Rs/ha respectively.

The Rotavator 2 and power harrow 2 was working depth 0.175 m and 0.275 m respectively and effective field capacity 0.895ha/hr and 0.808ha/hr, respectively. The fuel consumption of Rotavator 2 and power harrow 2 were 4.05 lit/hr and 4.41 lit/hr, respectively. The cost of operation Rotavator 2 and power harrow 2 were 271.2 Rs/ha and 306.6Rs/ha respectively.

From the above result it was seen that, if the initial cost and cost of operation of power harrows was more than the initial cost and cost of operation of Rotavator but the working depth of power harrows was more than the Rotavator. The power harrow gives less bulk density and small sizes of clod after the operation than the Rotavator. According to quality of work the power harrow was better than Rotavator.

CONCLUSIONS: The above study concludes that, the Rotavator and power harrow was operated at same time at site 1 and site 2. The overall effective field capacity for Rotavator and power harrow at site 1 and site 2 was same as 0.762ha/hr and 0.805 ha/hr respectively.

The effective working depth of Rotavator was 0.165 m and 0.175 m at site 1 and site 2 respectively and the effective working depth of power harrow was 0.27 m and 0.275 m at site 1 and site 2 respectively which is greater than working depth of Rotavator. Field efficiency of the tractor drawn Rotavator were 84.54% and 86.97% at site 1 and 2 respectively and power harrow also 84.98% and 87.44% at site 1 and site 2 respectively. The value of field efficiency of power harrow is greater than Rotavator. The higher field efficiency of power harrow were observed due to reduced time loss and lower forward speed of operation. The values of effective field capacities were compensated by higher values of field efficiency.

The diesel consumption during Rotavator operation was observed 3.23 litre per hr and 4.05 litre per hr at Site 1 and Site 2 respectively. The diesel consumption during power harrow operation was observed 3.43 litre per hr and 4.41 litre per hr at site 1 and site 2 respectively.

The cost of operation for Rotavator was worked out to be Rs.196 and Rs. 246.5 per hr at site 1 and 2 respectively. The cost of operation for power harrow was worked out to be Rs.206.1 and Rs.264.6 per hr at site 1 and site 2 respectively. The resultant seedbed quality obtained by the power harrow was far superior to Rotavator. The power harrow works horizontally the Rotavator thumps downward compacting the sub soil so, working quality of power harrow is better than Rotavator. The overall performance of power harrow was better than performance of Rotavator.

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