

Development and evaluation of multipurpose tool carrier for power tiller

Agricultural productivity is linked with the availability of farm power. Bullocks meet power requirement of marginal and small farms (less than 2 ha) with associated limitations. Tractors meet requirements of large farms (above 6 ha). Power tillers are visualized as appropriate source of farm power of medium farms (2-6 ha). The use of animal power is becoming costlier day by day as they are required to be maintained throughout the year even if there is no work round the year. Moreover, working rate of draft animals is very slow resulting in delayed farm operations.

The tractors and the other large machineries are beyond the reach of small and medium farmers due to their high initial cost. Under these circumstances, power tiller becomes the most promising power source for agricultural operations at the level of small and medium farmers. Power tillers, as a source of farm power on small and medium farms are quite popular in Japan, Republic of China, Korea and other countries of South East Asia. Power tillers were introduced in Indian agriculture in early sixties only for preparing seed bed and paddy cultivation. Utility wise comparison of power tillers with bullocks and tractors indicated that the ploughing, harrowing and tillage operations by bullocks is slow and consumes more time. The power tiller, if used judiciously can perform almost all the operations except deep tillage. The compact structure of power tiller offers an advantage for its utility in various operations like spraying, dusting and transportation.

The concept of using power tiller drawn wheeled multipurpose tool carrier was introduced newly as it is a development over the animal drawn wheeled tool carrier. Though, the initial cost of equipment is slightly high, it offers several advantages like timeliness in farm operation, quality and precision of work, increased work rate, efficient utilization of machine power, reduction in human drudgery and allow for year round use due to its multipurpose utility. The popularity of these models among farmers is limited. The multipurpose tool carrier can be used for different operations like ploughing, harrowing, tillage etc. by attachment with suitable implements.

A multipurpose tool carrier was developed as an attachment to the power tiller. The general requirements of the machine, the conceptual design, fabrication methods and procedure adopted for field trials are presented below. The frame was made out of hollow square bar of 40 mm sides. This square bar helps in

mounting of cultivator sweeps and blade harrow at different row spacings and working height. A hollow square made out of channel section with telescopic action is attached at both ends of the frame which facilitates the height adjustment of the depth cum transport wheel on either side of the unit. The depth cum transport wheels were fabricated out of a mild steel flat with a width of 5 cm and was bent to a circular form and its ends were welded together. Spikes made out of 13 mm rods were welded with a hub of 4.5 cm diameter in the center of the rim. A shaft of 2.5 cm was welded at one end of a square over which the wheels can rotate freely. The square bar can slide up and down by rotating the wheel provided over the telescopic bar.

A 'V' shaped sweep of 19 cm width is made out of the selected MS sheet. A tyne of 58 cm length and 2.5 cm square section is made out of mild steel and is bent at 45° angle at 10 cm above from the bottom in order to fix the sweep to tyne with nut and bolt arrangement. The end of the tyne is fixed to the tool frame with the help of clamp. The material of construction of harrow was mild steel flat. The mild steel flat is sharpened gradually from centre with 10 mm to 2 mm thickness towards edge. A tyne of 58 cm length and 2.5 cm square section made out of mild steel was bent with 45° angle at 10 cm above from the bottom in order to fix harrow blade to the tyne with nut and bolt arrangement. Two tynes are fixed to the harrow blade one at each end. The hitching mechanism was designed taking into consideration the way it is hitched to the power tiller and easy maneuverability, the hitch mechanism is fixed to the front end of the main frame by welding rigidly. Provision is also made for varying the height of hitch to obtain good performance at different operating depths and also it helps in hitching the unit to different makes of power tiller.

The material of construction of clamp was chosen as 8 mm thick mild steel flat. The mild steel flat of 30 cm length and 6 cm width is bent into 'U' shape and the screw arrangement is made at the centre of the clamp in order to fix the tyne with tool frame. Tests were conducted to evaluate the performance of the multipurpose tool carrier in field conditions. Tests were conducted to determine the draft requirements, field capacity, field efficiency, fuel consumption, area coverage, cost economics etc. The performance of the tool carrier was evaluated by conducting field trials for harrowing and tilling operation. The draft requirement was measured by hitching the tool carrier with the power tiller and this in turn was pulled by a tractor with a hydraulic dynamometer attached in between and again the draft requirements of pulling the power tiller alone was recorded. The actual draft of the tool carrier was the difference between the two observations recorded. The draft was measured with the help of a 0 to 500 kg hydraulic dynamometer.

The actual time taken by the tool carrier to cover the required area was recorded at the time of operation. The time lost due to turning and other field adjustments were recorded and hence the field efficiency of the tool carrier was calculated. The field coverage of the unit was measured in terms of theoretical and actual field capacity. The performance results of the multipurpose tool carrier are presented in Table.1. for tilling and harrowing

Table 1. Field performance of multipurpose tool carrier for tilling and harrowing

Parameters	Tilling	Harrowing
Average effective field capacity, ha/h	0.20	0.23
Average theoretical field capacity, ha/h	0.30	0.33
Field efficiency, per cent	66.66	69.88
Average speed, km/h	2.00	2.20
Average draft, kg	70	60
Average power, hp	0.518	0.488
Depth of operation, cm	5.20	4.00
Width of operation, cm	150	150
Fuel consumption, l/h	1.05	0.95
Cost of operation, Rs/ha	231.86	201.20

operations respectively. The tool carrier was operated at an average working speed of 2.0 km per hour for tilling operation with the average depth of operation of 5.15 cm. The average draft of the unit was found to be 70.0 kg. The theoretical and actual field capacity of the tool carrier was found to be 0.30 ha/h and 0.20 ha/h respectively. The field efficiency is calculated by considering the theoretical field capacity and actual field capacity. The field efficiency was observed to be 66.66 per cent. The average fuel consumption was observed to be 1.05 litres per hour for tilling operation. The cost of operation was observed to be Rs.231.86 per hectare for tilling operation. The tool carrier was operated at an average working speed 2.2 km per hour for harrowing operation with average depth of operation of 4 cm. The average draft of the unit was found to be 60 kg. The theoretical and actual field capacity was observed to be 0.033 ha/h and 0.23 ha/h respectively. The field efficiency of the power

tiller operated multipurpose tool carrier was observed to be 69.88 per cent for harrowing. The average fuel consumption was observed to be 0.95 litres per hour for harrowing operation. The cost of operation was observed to be Rs.201.20 per hectare for harrowing operation.

It can be concluded that the power tiller drawn multipurpose tool carrier is a promising equipment. The different operations like tilling, harrowing and other agricultural operations can be carried out efficiently with a single unit and hence this equipment is suitable for year round use. It also helps in reducing drudgery on the field and also carries out the operations timely. By using the multipurpose tool carrier as an attachment with the power tiller, the small and medium farmers can avoid the year round maintenance of bullocks and also the high investment in tractors. There is also scope for using a seed cum fertilizer drill, bund formers and other tools as an attachment with the tool carrier.

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