Estimation and Comparative Study of Operational Costs of various Combined Tillage and Sowing Implements

ABSTRACT: Agricultural Engineer's and economists use a variety of engineering and economic principles for calculating a machinery costs. An effective farm manager must also know these principals, and apply them when deciding to buy, lease, rent or share machinery. Thus, estimating farm machinery operational costs becomes essential to farmers for sound investment analysis and useful in planning, controlling production on their farms. Therefore, study was conducted to estimate and compare operational cost of various combined tillage and sowing implement namely Rotary Plough with Seed Drill, Till Planter, Roto Till Drill and Strip Till Drill at Vaugh Institute of Agricultural Engineering and Technology. This present study concluded that operational cost of roto till drill and strip till drill was noted higher 796.57 Rs/hr and 791.66 Rs/hr on the other side operational cost of rotary plough with seed drill and till planter was estimated lower 375.40 Rs/hr and 673.66 Rs/hr. The result also shows that operational cost of implements significantly depends on their initial cost. Therefore, roto till drill and strip till drill has high operational cost because of their higher initial cost as compared to other combined implements. Thus, implements subjected to higher initial cost tend to increase the operational cost.

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Key words: Combined Tillage and Sowing Implements, Rotary Plough with Seed cum Fertilizer, Operational Cost

INTRODUCTION

Farm machinery operational costs estimation is essential assets to ascertain the suitability, feasibility, adoptability and profitability of that one for farmers. Economic assessments of machine imparts crucial role for financial management. Good management and decision making skills are very useful for proper selection of machinery on the basis their need and size in the farms **(Kepner *et al.* 1978).** Thus, estimating farm machinery operational costs is essential for farmers to sound investment analysis and useful in planning and controlling production on their farms **(Barnard *et al.* 1978).** The most important parameter influencing farm profit is the operational cost of agricultural machines and equipments in farming system **(Culpin, 1959)**. Operational cost estimation of agricultural machines plays an important role in decision making for effective farm management during field operations **(Hunt, 1973).** The Operational Cost of agricultural machines and equipments can be influenced by the physical condition and shifting time of the machine which needs to be estimated prior to commercial use of the machine **(Shculer *et al.* 1991).**

In general, farm operations mainly tillage and sowing are performed separately by conventional implements namely mould board plough, disc plough, chisel plough, seed and fertilizer drill but recently, combined tillage and sowing machinery are now being popular and proving better alternative to perform combined set of field operations and getting beneficial for farmers by enhancing crop yield results raised production costs and saving time. It can be defined as combination of two or more implements that working simultaneously performing different processes for soil preparation **(Sahu and Raheman, 2006)**.

Combined tillage machines have a number of advantages over the other conventional tillage implements. It has enough capability for significant reduction in the number of tillage operations and sowing operations necessary for achieving the required soil tilth along with finer seed bed preparation. These combined tillage tools also have greater potential for the reduction of the land preparation costs as compared to conventional tillage system. It is also one of the best complete solutions especially for marginal farmers to optimize their production and profit together with saving time by combining tilling and sowing with fertilizing operations in single pass.

However, estimation of operational cost of combined tillage and sowing machinery is necessary for commercial use in order to have effective planning in agriculture production and management **(Larry *et al.* 1997).** Combined tillage and sowing machinery requires higher initial investment as compared to other conventional machinery. Therefore, prime importance has been given to understand the knowledge of operational cost for executing farm management plans at agriculture fields and also to compare the different type of conventional machinery in terms of operational cost, which one can understand to decide the implement to be used.

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MATERIAL AND METHODS

The combined tillage and sowing machinery was designed and developed at Farm Machinery and Power Engineering, Vaugh Institute of Agricultural Engineering and Technology, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, (Uttar Pradesh). Combined tillage and sowing machinery is also named as vertical rotary plough with seed cum fertilizer drill has rotating sharp tines mounted on a vertical shaft and can be attached to the three point linkage of 18-25 hp tractors. It is powered by PTO and provided with setting of different working depth adjustment. It has two flanges spaced 390 mm apart and each flange carries two sharp blades. The other combined tillage and sowing implements namely tractor mounted till planter, roto till drill and strip till drill also selected for estimating operational cost **(Garg *et al.* 2004; Quasim *et al.* 2019),** these can attached to 33 to 35 hp tractors in which till planter machine has 9-row seed cum fertilizer drill mounted on a 1600 mm wide rotavator. The seed drill has fluted roller mechanism for metering seed, and fertilizer is metered with adjustable holes and agitator in the hopper. Furrow openers for the placement of seed and fertilizer are mounted at the rear of the rotavator in two staggered rows and row to row spacing has been kept as 175 mm. The rotavator has 36 L shaped blades mounted on six flanges and each flange has six blades. Roto till drill and strip till drill both have 9 tines with working width and row spacing 2000 mm and 200 mm respectively. The study view of side shift tiller, offset harrow, cultivators are presented in Figure 1, 2, 3, 4 respectively.

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Figure 1: Rotary Plough with Seed Drill

Figure 2: Till Planter

Figure 3: Roto Till Drill

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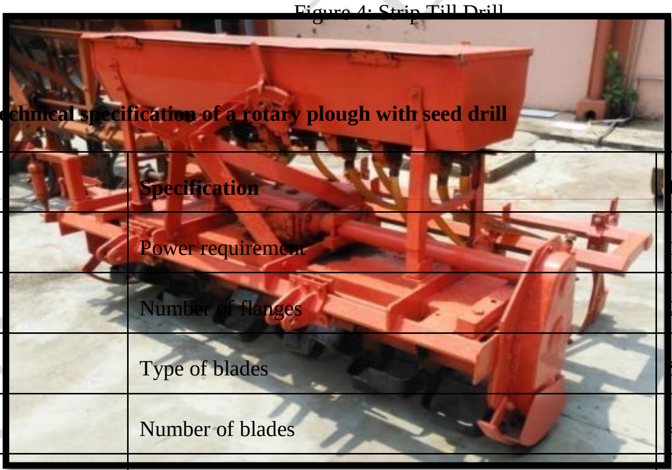

Figure 4: Strip Till Drill

List 1 : Technical specification of a rotary plough with seed drill

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S.L. No.	**Specification**	**Units**
1.	Power requirement	18 hp
2.	Number of flanges	2
3.	Type of blades	Straight Blades
4.	Number of blades	4
5.	Flange plate diameter	360 mm
6.	Rotor shaft diameter	55 mm
7.	Spacing between flange plates	390 mm
9.	The overall height of side shift tiller	1120 mm

10.	The overall width of side shift tiller	1000 mm
11.	The overall length of side shift tiller	1200 mm
12.	Number of furrow openers	3
13.	Row Spacing	220 mm
14.	Rated width of cut	750 mm
15.	Seed drill width	660 mm

Field Testing of Rotary Plough with Seed Drill

The field experiments were conducted in the Research Farm Center, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, (Uttar Pradesh). The field testing of vertical rotary plough with seed cum fertilizer drill was evaluated during the field experiment in different field conditions like unploughed field, tilled field, and grassed field respectively.

Selection of Trial Fields

The Bureau of Indian standard **(IS: 6288-1971)** recommended the minimum area for testing of tractor drawn machine should be one hectare and the ratio of width and length of the plot should be, as for as possible, 1:2. An experimental plot having 5000 m^2 area and it was divided into subplots of the size of 10×20 m.

Operational Cost Parameters

Cost Parameters

The sum of fixed cost and variable cost is operational cost. This calculation is done for estimating the operational cost per hour of any implement so that we can identify the economic viability of operation. If we want to give that implement for hiring purpose then it helps to deciding the cost for hiring. In this phenomenon two terms fixed cost and variable cost are considered.

Fixed cost

The estimated costs of depreciation, interest, taxes, insurance, and housing are added together to find the total ownership cost. If the tractor/Machinery is used 500 hours per year, the total ownership cost per hour is: Ownership cost/use hours per year.

Depreciation cost

Depreciation is the reduction in the value of a machine with time and use. It is often the largest single cost of machine ownership, but cannot be determined until the machine is sold. However, several methods are available for estimating depreciation.

$$\text{Depreciation cost} = \frac{C-S}{L \times H} \times 100 \qquad \ldots (1)$$

Where,

D = Depreciation cost (Rs./h)

C = Purchasing price (Rs.)

S = Salvage cost 10 % of purchasing cost (Rs.)

L = Useful life of tractor (years)

H = Working hours in a year

Interest cost

A charge for interest is included as a fixed cost because the money which is invested in machinery could have been invested in other productive enterprises or investments. The interest rate that is used in the "Guide to Machinery Costs" is the interest rate that can be obtained on a medium- term (5 year) investment.

$$\text{Interest cost} = \frac{(C+S)\times i}{2\ H} \times 100 \qquad \ldots (2)$$

Where,

I = Interest cost per hr.

i= Rate of interest, %

H = No of working hour per yr

Total fixed cost

$$\text{Total fixed cost} = D + i + S \qquad \ldots(3)$$

Where,

Remarks: S = Tax insurance and shelter are taken 3 % of purchase cost

Variable Cost

Fuel consumption cost

Fuel costs can be estimated by using average fuel consumption for field operations in liter per hour. Those figures can be multiplied by the fuel cost per liter to calculate the average fuel cost per h/ha.

Lubrication cost

Surveys indicate that total lubrication costs on most farms average about 15 percent of fuel costs. Therefore, once the fuel cost per hour has been estimated, it can be multiplied by 0.15 to estimate total lubrication costs.

Repair and maintenance cost

These costs are difficult to estimate as they vary greatly depending on operating conditions, management, maintenance programs, local costs, etc. It is generally agreed that repair costs will increase with age but are unlikely to increase proportionally. Repair costs per hour of use will increase with age but tend to level off as the machine becomes older **(Kepner *et al.* 1978).** It will be the 5 percent of purchasing cost.

Labour cost

Labour cost also is an important consideration in comparing ownership to custom hiring. Actual hours of labour usually exceed field machine time by 10 to 20 percent, because of travel time and the time required lubricating and servicing machines. Consequently, labour costs can be estimated by multiplying the labour wage rate times 1.1 or 1.2. Let us consider labor rate Rs 350 per hour.

Total variable cost

Fuel consumption cost + Lubrication oil cost + Repair and maintenance cost + Labour cost … (4)

Total operational cost

Total operational cost = Total fixed cost + Total variable cost … (5)

RESULTS AND DISCUSSION

Estimation of operational costs involved in various combined tillage and sowing implements

The basic parameters for operational cost estimation of different combined tillage and sowing implements were shown in Table 1 whereas operational cost of different combined implements was calculated and presented in Table 2. The variation in operational cost parameters like initial cost, depreciation cost, interest cost, shelter cost, repair and maintenance cost, total fixed cost, total variable cost and total operational cost of different combined implements were shown in Figure 4 to Figure 11, The operational cost of vertical rotary plough with seed cum fertilizer drill was calculated 375.40 Rs/hr whereas, in case of till planter, roto till drill and strip till drill, operational cost was found 673.66, 796.57 and 791.66 Rs/hr respectively. The result also indicates that operational cost of combined tillage and sowing implements significantly depends on the initial cost of implement. Therefore, operational cost of roto till drill and strip till drill was found higher because of their higher initial cost and on the other hand operational cost of rotary plough with seed drill and till planter was estimated low due to lower initial cost. Thus, finally it can be concluded that an implement subjected to higher initial cost tends to increase the operational cost.

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Sr. No.	Power Equipments	Initial Cost, Rs	Useful Life, Year	Annual Use, h	Work Capacity, h/ha

1.	Tractor with 18 hp	385000	10	1000	-
2.	Tractor with 35 hp	700000	10	1000	-
3.	Rotary Plough with Seed Drill	182000	8	300	1.45
4.	Till Planter	50000	8	300	1.25
5.	Roto Till Drill	175000	8	300	1.06
6.	Strip Till Drill	170000	8	300	1.06

Table 1: Basic parameters for Operational Cost estimation of different intercultural implements

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Table 2. Operational cost involved in various intercultural implements

Operational Cost Parameters	Combined Tillage and Sowing Implements					
	Tractor (18 hp)	Tractor (35 hp)	Rotary Plough with Seed Drill	Till Planter	Roto Till Drill	Strip Till Drill
Initial Cost, Rs	385000	700000	25853	50000	175000	170000
Depreciation Cost, Rs/hr	34.65	63.00	9.69	18.75	65.62	63.75

Interest Cost, Rs/hr	25.41	46.20	5.68	11.00	38.50	37.40
Shelter Cost @ 3 % of Purchase cost, Rs/hr	12.70	11.55	1.42	2.75	9.62	9.35
Fuel cost on diesel consumed per rate of 100/lit cost, Rs/h	150	300	-	-	-	-
Repair and maintenance cost @ 10 % of purchase cost, Rs/hr	38.50	70.00	8.60	16.66	58.33	56.66
Lubrication cost @ 30% of fuel cost, Rs/hr	45.00	90.00	-	-	-	-
Labour cost, Rs/hr	43.75	45.75	-	-	-	-
Total fixed cost, Rs/hr	72.76	120.75	16.79	32.50	113.74	110.5
Total variable cost, Rs/hr	277.25	503.75	8.60	16.66	58.33	56.66
Total operational cost, Rs/hr	350.01	624.50	25.39	49.16	172.07	167.16
Total operational cost, (Tractor + implement), Rs/h	350.01	624.50	375.40	673.66	796.57	791.66
Total operational cost, (Tractor + implement), Rs/ha	945.97	1687.83	1014.59	1820.70	2152.89	2139.62

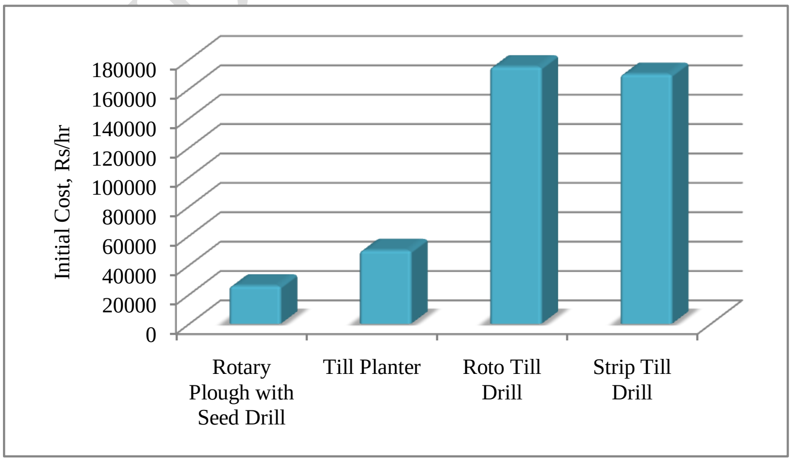

Figure 5: Variation of initial cost of different intercultural implements

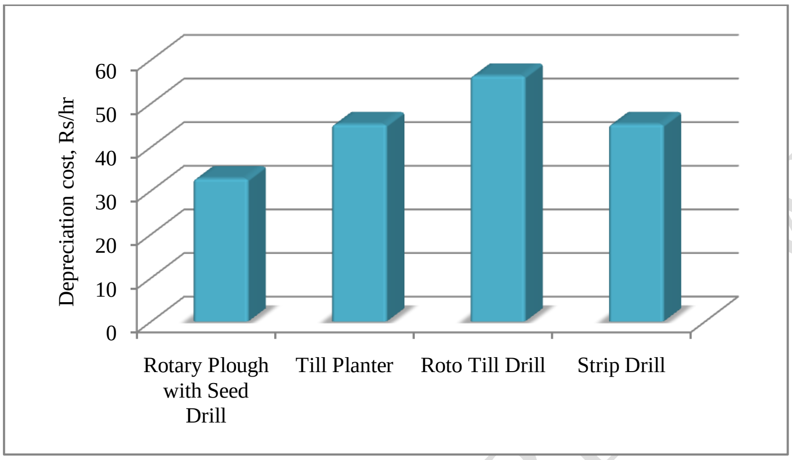

Figure 6: Variation of depreciation cost of different intercultural implements

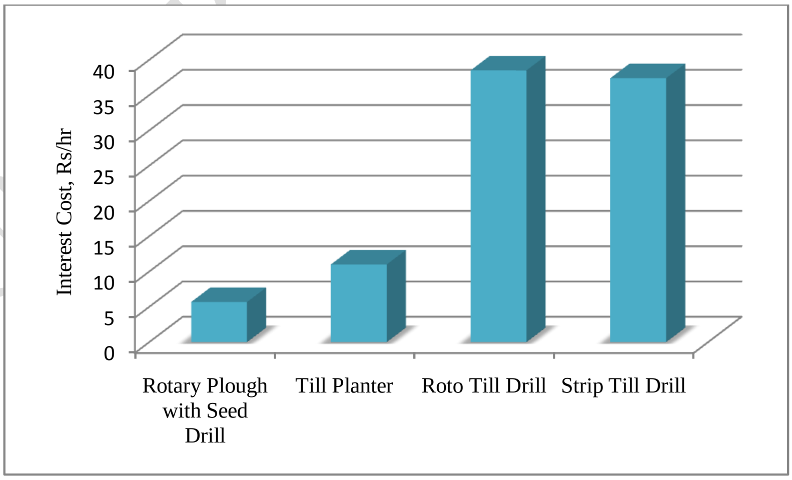

Figure 7: Variation of interest cost of different intercultural implements

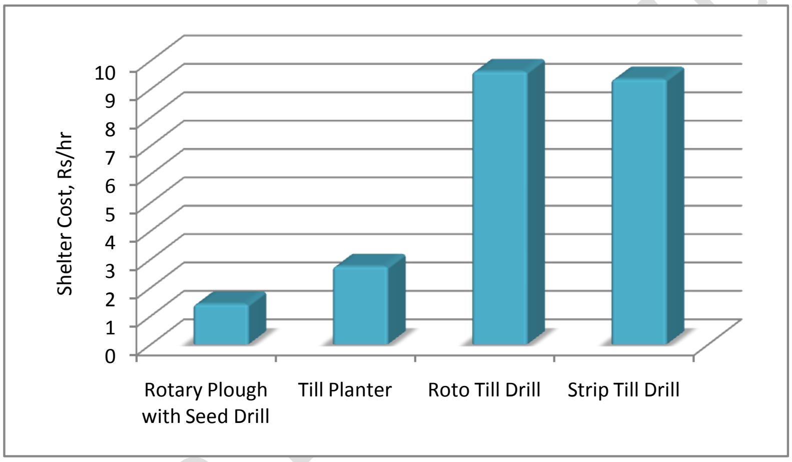

Figure 8: Variation of shelter cost of different intercultural implements

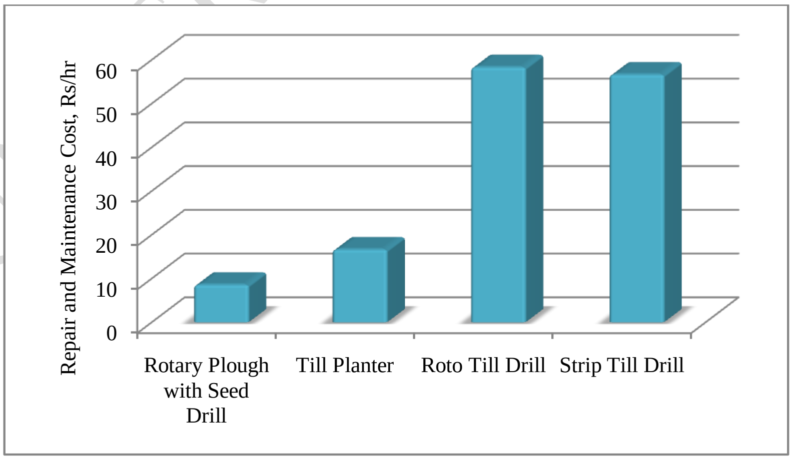

Figure 9: Variation of repair and maintenance cost of different intercultural implements

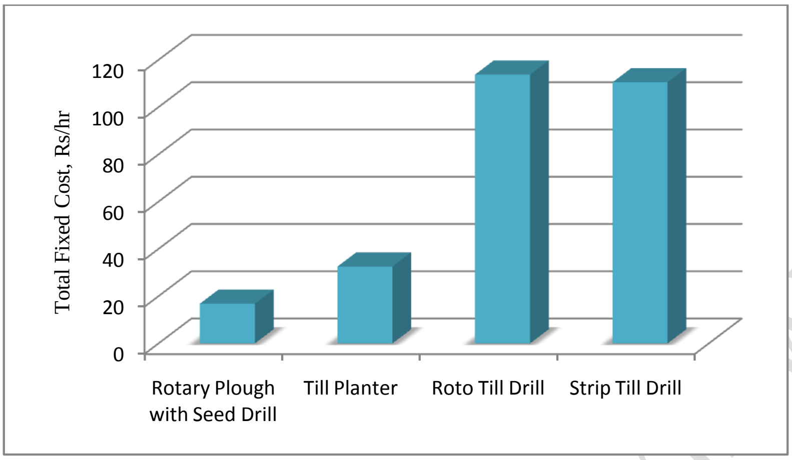

Figure 10: Variation of total fixed cost of different intercultural implements

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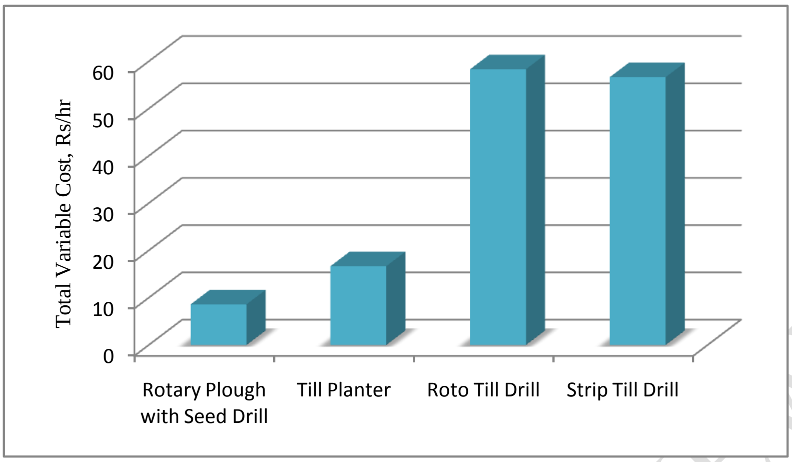

Figure 11: Variation of total variable cost of different intercultural implements

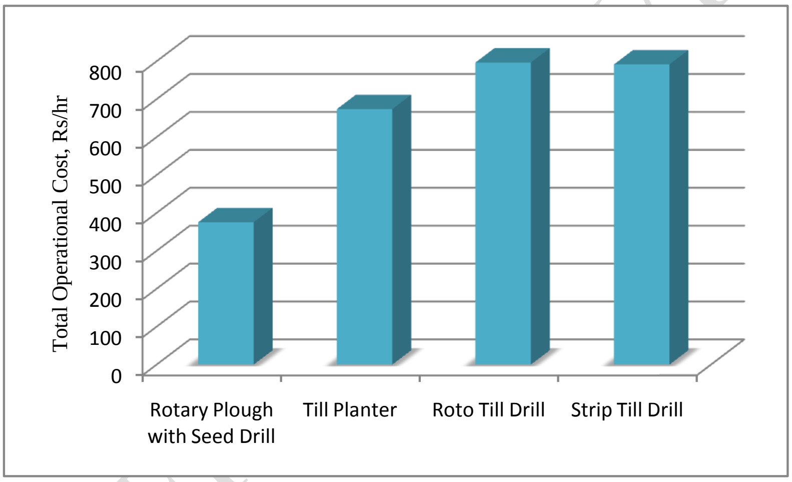

Figure 12: Variation of total operational cost of different intercultural implements

CONCLUSION

1. The study reveled that operational cost of roto till drill was found higher and on the other hand, cost of strip till drill was supposed to approximately nearest to the roto till drill while operational cost of rotary plough with seed drill and till planter was noted lower as compared to others.

2. The result showed that, operational cost of intercultural implements mainly depends on the initial cost of the implement. Therefore, roto till drll and strip till drill was subjected to higher operational cost because of its higher initial cost as compared to rotary plough with seed drill and till planter.

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