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Performance evaluation of resource conservation machineries under rainfed condition of North-Gujarat region for greengram [*Vigna radiata* (L.)]

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ABSTRACT

Field experiment was conducted to evaluate tractive parameters among resource conservation machineries and conventional practice under leveled and unleveled plots for three consecutive years from *kharif*-2012 to *kharif*-2014, The field trials involved two main treatments *i.e.* No Leveling (L_0) and Leveling with laser land leveler(L_1) and five sub treatments *viz.*, zero till drill (M_1), roto till drill (M_2), strip till drill (M_3), raise bed planter (M_4) and conventional practices (M_5). The five sub-treatments *i.e.*, M_1, M_2, M_3, M_4 and M_5 were performed uniformly under L_0 and L_1. The experiments were carried out for greengram crop in the research farm of Centre for Watershed Management and Participatory Research and Rural Engineering, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Gujarat State. The result revealed that the treatment leveling with leser land leveler (L_1) offered 5.79 per cent higher effective field capacity (EFC), 0.77 per cent higher tractive efficiency, 6.50 per cent more fuel efficiency and 6.33 per cent less energy requirement than unlevelled plot (L_0). Among resource conservation machineries zero till drill (M_1) recorded higher effective field capacity and tractive efficiency of 0.504 ha/hr and 71.87 per cent, which was correspondingly 51.78 and 2.05 per cent more than conventional practices (M_5). Among all treatments, zero till drill (M_1) presented lowest Fuel consumption and energy requirement with corresponding value of 7.60 l/ha and 77.96 kWh/ha, which were 47.94 and 47.76 per cent lesser than conventional practices (M_5). The treatments strip till drill (M_3) and roto till drill (M_2) stood second and third reporting fuel consumption equivalent to 8.51 and 8.91 l/ha, respectively.

Key words: Resource conservation, tractive efficiency, power delivery efficiency, fuel efficiency, energy requirement, root profile.

The major research and development efforts in the 'green revolution' era focused on enhancing productivity of selected food grains and few other crops. The conventional mode of agriculture through intensive agricultural practices was successful in achieving goals of production, but simultaneously led to degradation of natural resources. The new challenges demand that efficient resource use and conservation receive high priority to ensure earlier gains can be sustained and further enhanced to meet the emerging needs. (Rao, 2013).

Resource conserving machineries refer to those practices that enhance resource or input-use efficiency. Zero or reduced tillage practices that save fuel and improve plot-level water productivity may also be considered RCTs, as may land leveling practices that help save water. Conservation tillage practices reduce the cost of operation, fuel consumption and time for operation of various crops (Sharma *et al.*, 2005). Recourse conservation technology offers the possibility of conserving natural resources and optimizing crop productivity through controlled soil erosion, reduced soil compaction, increased water use efficiencies and reduced energy costs (Hobbs, 2007).

The greengram [*Vigna radiata* (L.)], also known as mungbean is one of the important legume crops grown for their seed under rainfed condition. Kharif greengram was sown at the onset of monsoon with seed rate of 17.5 to 20 kg/ha with 45 cm distance between two

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rows. Objectives of the study was to study the effect of selected resource conservation machineries on tractive, fuel, power delivery efficiencies and energy requirement for rainfed greengram crop.

MATERIALS AND METHODS

The experiment was conducted in the Research Farm of Centre for Watershed Management Participatory Research and Rural Engineering, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar in three successive years of 2012, 2013 and 2014 during kharif season (July to October).

Four resource conservation machines i.e., Zero Till Drill (ZTD), Roto Till Drill (RTD), Strip Till Drill (STD), Raise Bed Planter (RBP) were selected under study. Laser beam guided Land Leveler (LLL) was chosen to identify the effect of land leveling on tractive, root profile and crop parameters. Cultivator and manually metered seed cum fertilizer drill which are largely used in the region were selected as a Conventional Practice (CP).

A 50 HP, 4 cylinder agricultural tractor was selected as a power source to conduct the study The parameters like speed of operation, slip, drawbar pull, fuel consumption and soil disruption were measured to study the effect of resource conservation machineries on effective field capacity, fuel efficiencies, energy requirement and soil volume disturbance. Experiment detail is shown in Table 1. The experiment was conducted in six replications and each replication plot was termed as main plot. Each main plot was divided into two treatments L_0 and L_1. L_0 stands for normal unleveled plot and L_1 was the plot subjected to leveling operation by means of laser land leveler. Five sub-treatments i.e., M_1, M_2, M_3, M_4 and M_5 were performed uniformly under L_0 and L_1. All agronomical parameters and agricultural operations were followed uniformly as per best recommendations laid down in the region for green gram crop.

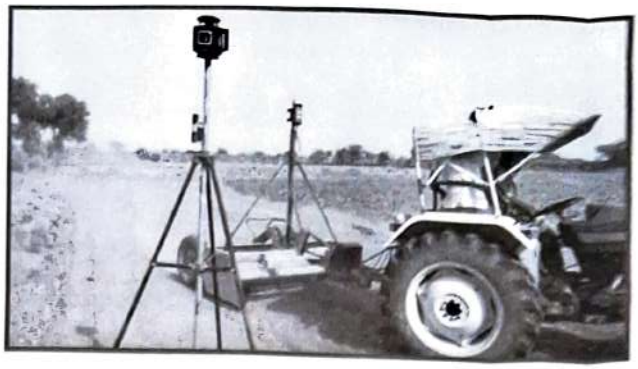
Table 1 Experiment details

Sr. No.	Code	Treatment details	Machinery / Equipment
		Main plot treatments	
1	L_0	No leveling	-
2	L_1	Leveling	Laser beam guided land leveler
		Sub plot treatment	
1	M_1	Zero till drilling	Zero till drill
2	M_2	Roto till drilling	Roto till drill
3	M_3	Strip till drilling	Strip till drill
4	M_4	Raise bed planting	One pass of cultivator + Raise bed planter
5	M_5	Conventional practice	Two pass of cultivator + Manually metered seed cum fertilizer drill

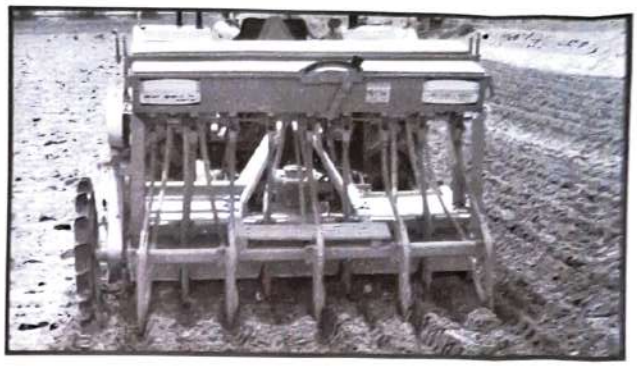
Field survey was conducted before commencing the experiment to undertake leveling operation in October-2011. Table 2 shows, the total area of experimental plot and area under precision land leveling.

Table 2 Particulars of the selected fields

Parameters	Size of experimental plot	Area under precisionlaser land leveler
Length of the field	100 m	
Width of the field	70 m	16.5 x 35 x 6 replication = 3465 m^2
Area of the field	7000 m^2	

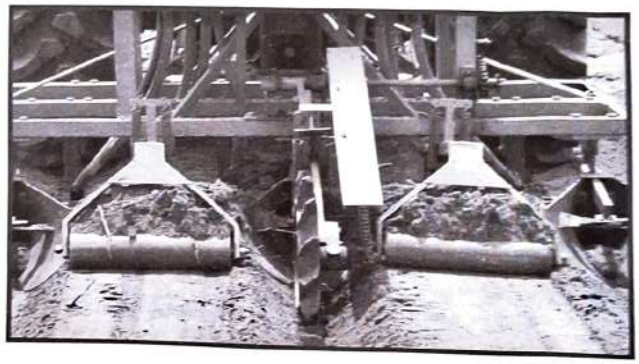


(i) Zero Till Drill (M_1)

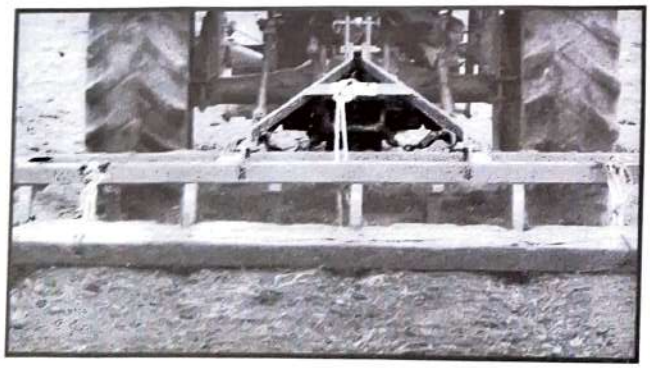


(ii) Roto Till Drill (M_2)

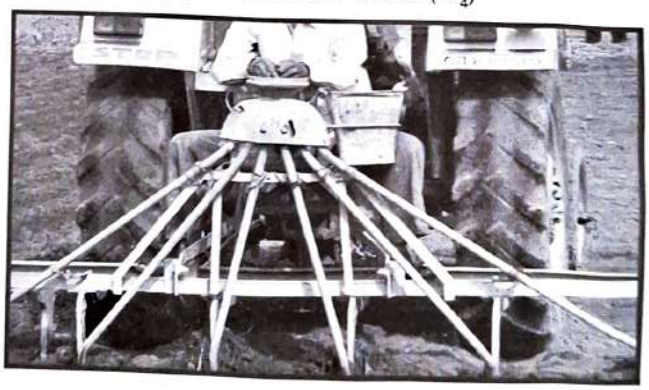
(iii) Strip Till Drill (M_3)



(iv) Raised Bed Planter (M_4)



(v) Cultivator with Wooden Plank (M_5)



(vi) Manual Seed Drill (M_5)

Fig. 1 Field survey and resource conservation practices in operation

A tractor operated laser land leveler was engaged for precision land leveling of the plot under treatment L_1. The experiment was conducted using split plot design. The analysis was carried out at significance level of 5 per cent.

RESULTS AND DISCUSSION

Field survey was carried out using Auto Level. The operating speed of laser land leveler, recorded for ten different observations and its average was taken as the travelling speed, which was found as 2.85 km h^{-1}. The average value of TFC, EFC and FE were calculated as 0.58 ha/hr, 0.21 ha/hr and 36.35 per cent, respectively. Average value of fuel consumption calculated for laser land leveler operation was found to be equivalent to 4.15 liter per hour. Fig. 2 shows the contour map of the experiment plot before and after leveling operation.

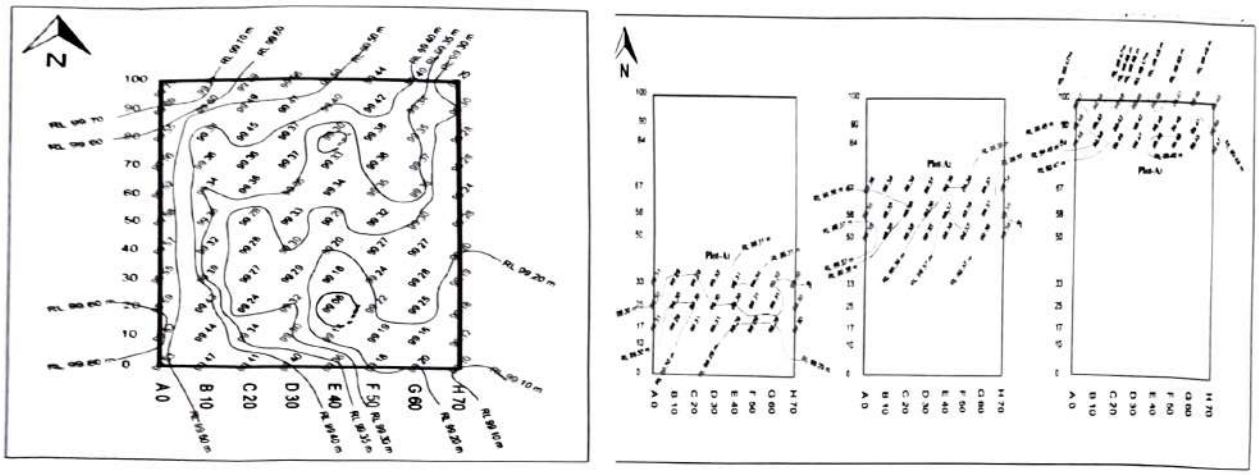


Fig. 2 Contour map before and after leveling operation

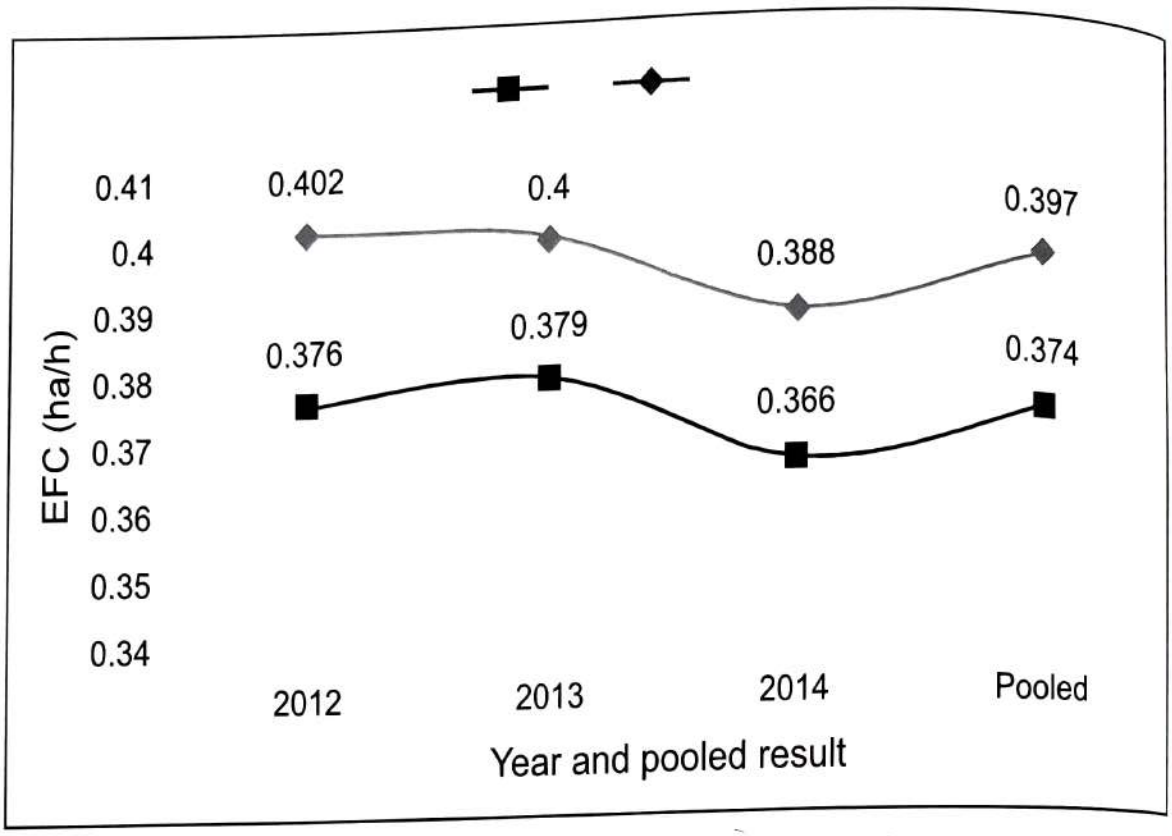
Effect of Resource conservation machineries on effective field capacity

The result revealed that effective field capacity was found significant and reasonably higher for the leveled experimental plot during all three year (i.e., 2012, 2013 and 2014) and in pooled result. Table 3 and Fig. 3 shows that, leveled plot witnessed upper value of effective field capacity in all three years with a pooled value of 0.397 ha/hr. The pooled result revealed that, leveled field presented 5.79 per cent higher EFC than no leveling treatment which was 0.374 ha/hr.

Pooled result obtained for sub plot depicted that zero till drill achieved highest EFC in all three years (0.504, 0.516 and 0.492 ha/h, respectively) as well as in pooled result (0.504 ha/h). Conventional practices took 51.78, 47.40, 45.75 and 9.66 per cent extra time to finish operation as compared to treatment ZTD, STD, RTD and RBP respectively.

Table 3 Treatment wise effective field capacity (ha/h)

Treatments	Years			Pooled
	2012	2013	2014	
Main plot				
L_0	0.376	0.379	0.366	0.374
L_1	0.402	0.4	0.388	0.397
S.Em. ±	0.006	0.007	0.006	0.004
C.D.	0.023	0.022	0.021	0.012
C.V.(%)	8.9	8.04	8.33	8.42
Sub-plot				
M_1	0.504	0.516	0.492	0.504
M_2	0.45	0.456	0.438	0.448
M_3	0.467	0.467	0.452	0.462
M_4	0.27	0.27	0.266	0.269
M_5	0.253	0.239	0.237	0.243
S.Em. ±	0.009	0.008	0.007	0.005
C.D.	0.026	0.023	0.021	0.015



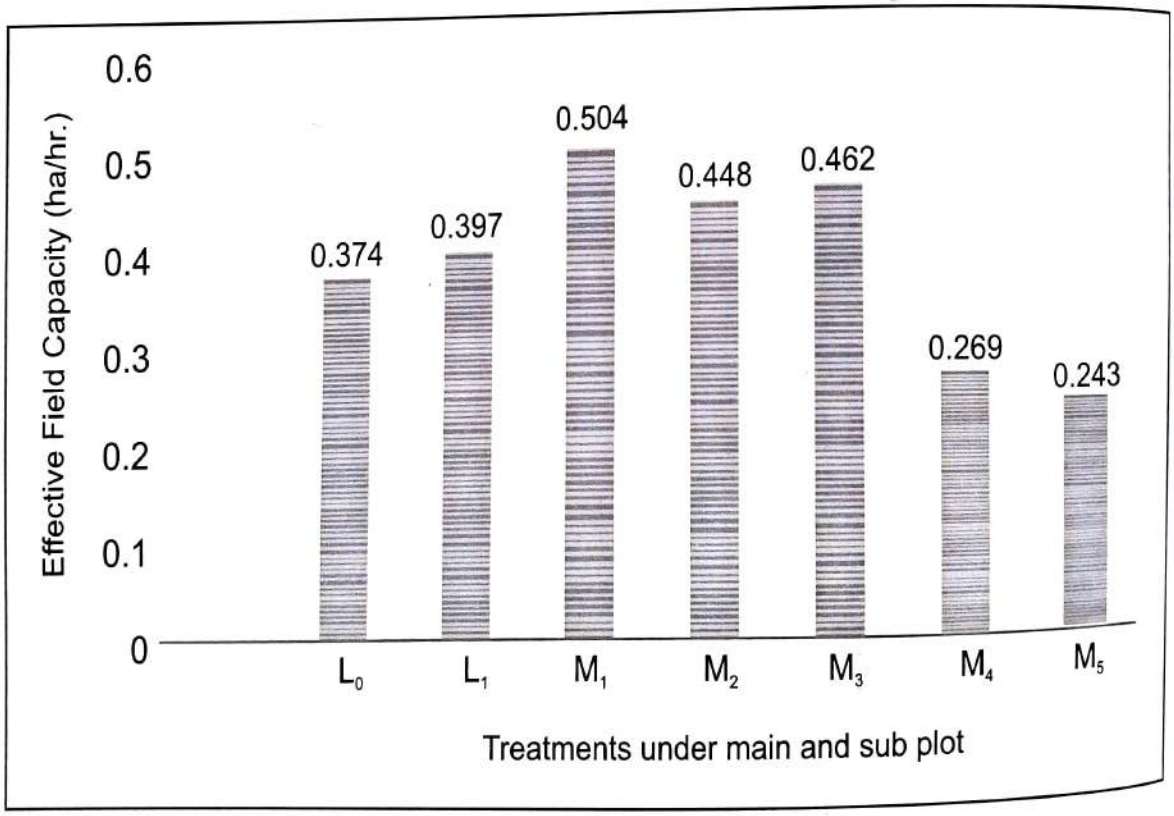


Fig. 3 Effective field capacity

Effect of Resource conservation machineries on tractive efficiency

Tractive efficiency found consistently higher for precisely levelled experimental plot than unleveled plot for three consecutive year of field experiment. Pooled result showed that leveled plot observed 0.77 per cent more tractive efficiency as compared to its counterpart. The reason may be the lesser slip exhibited by all treatments under precision leveled field. Pooled result shown in Table 4 and Fig. 4 revealed that Zero Till Drill (ZTD) registered highest value of tractive efficiency of 71.87 per cent, while raise bed planter and conventional practices recorded lower value of tractive efficiency equivalent to 70.07 and 70.39 per cent respectively. All the treatments comprising RCM and CP have shown significant effect on tractive efficiency. Dahab and Mohmmed (2000) also reported 1% higher practical tractive efficiency for field.

Table 4 Treatment wise tractive efficiency (%)

Treatments	Years			Pooled
	2012	2013	2014	
Main plot				
L_0	70.7	70.67	70.53	70.63
L_1	71.23	71.19	71.13	71.18
S.Em. ±	0.14	0.14	0.16	0.085
C.D.	0.5	0.52	0.57	0.256
C.V. (%)	1.06	1.11	1.21	1.14
Sub-plot				
M_1	72.13	71.84	71.71	71.89
M_2	70.88	70.87	70.86	70.85
M_3	71.31	71.36	71.32	71.3
M_4	69.83	70.24	70.15	70.07
M_5	70.7	70.35	70.12	70.39
S.Em. ±	0.2	0.18	0.21	0.11
C.D.	0.56	0.52	0.59	0.31

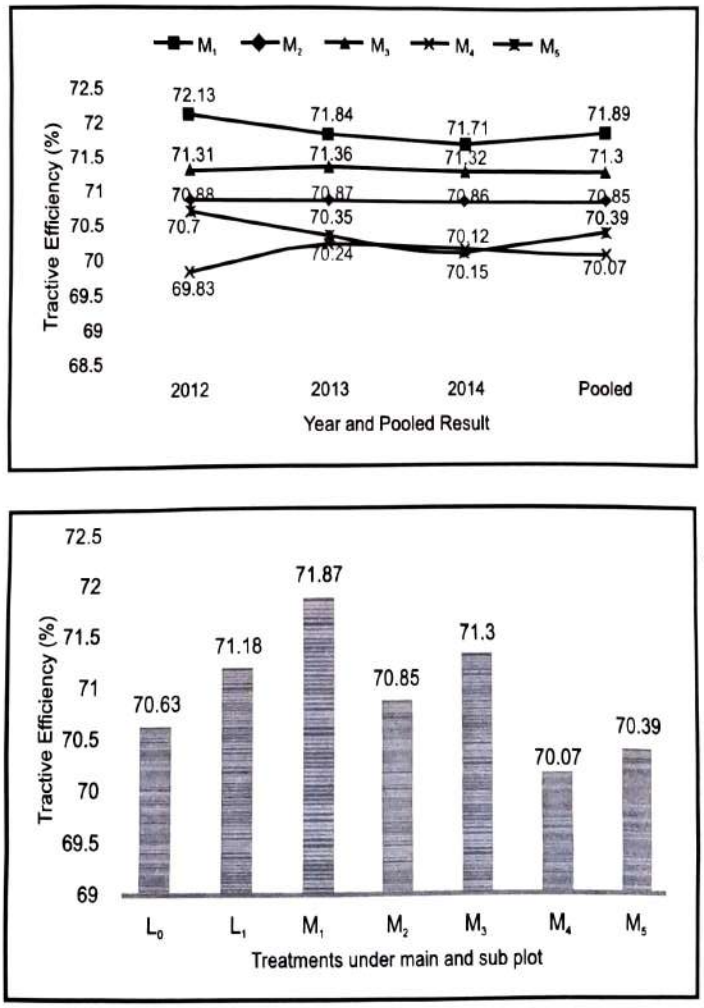


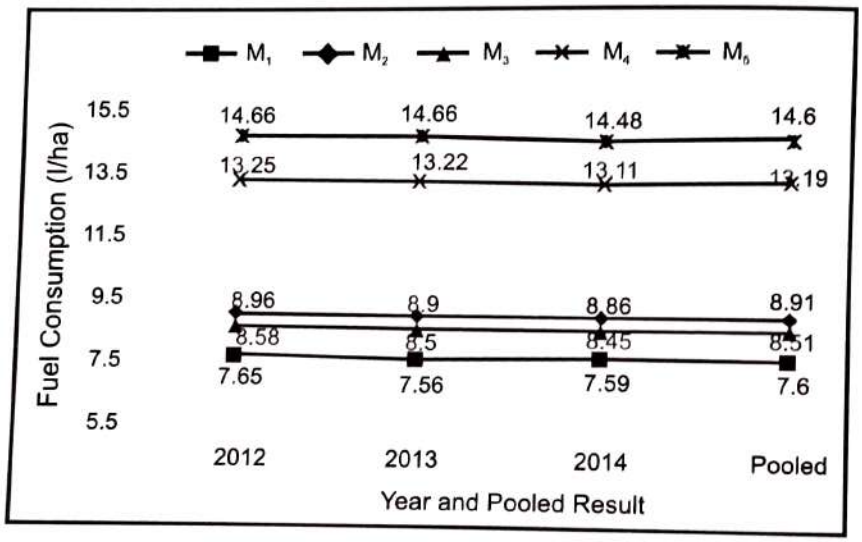
Fig. 4: Effect on tractive efficiency

Effect of Resource conservation machineries on Fuel efficiency

Pooled result of the trials showed significant effect on fuel consumption with a value of 10.92 l/ha and 10.21 l/ha found under unleveled and leveled plot, respectively. Table 5 and Fig. 5 presented that conventional practices recorded maximum fuel consumption of 14.66 l/ha which was attributed to longer duration of tractor work to accomplish farm operation (Two pass of cultivator followed by seed cum fertilizer drill). In terms of fuel consumption resource conservation machines contributed greater role. Zero till drill recorded minimum fuel consumption of 7.60 l/ha, brought down 47.94 per cent of fuel consumption as compared to conventional practices. Griso *et al.* (2003) also found the similar kind of result. Pankhurst (2000) and Coasts (2000) also confirmed that conventional tillage system are more energy intensive.

Table 5 Treatment wise fuel efficiency (l/ha)

Treatment	Years			Pooled
	2012	2013	2014	
Main plot				
L_0	10.95	10.98	10.82	10.92
L_1	10.29	10.16	10.18	10.21
S.Em. ±	0.15	0.12	0.14	0.069
C.D.	0.54	0.45	0.5	0.219
C.V. (%)	7.62	6.4	7.18	7.06
Sub-plot				
M_1	7.65	7.56	7.59	7.6
M_2	8.96	8.9	8.86	8.91
M_3	8.58	8.5	8.45	8.51
M_4	13.25	13.22	13.11	13.19
M_5	14.66	14.66	14.48	14.6
S.Em. ±	0.21	0.15	0.19	0.16
C.D.	0.6	0.43	0.53	0.51



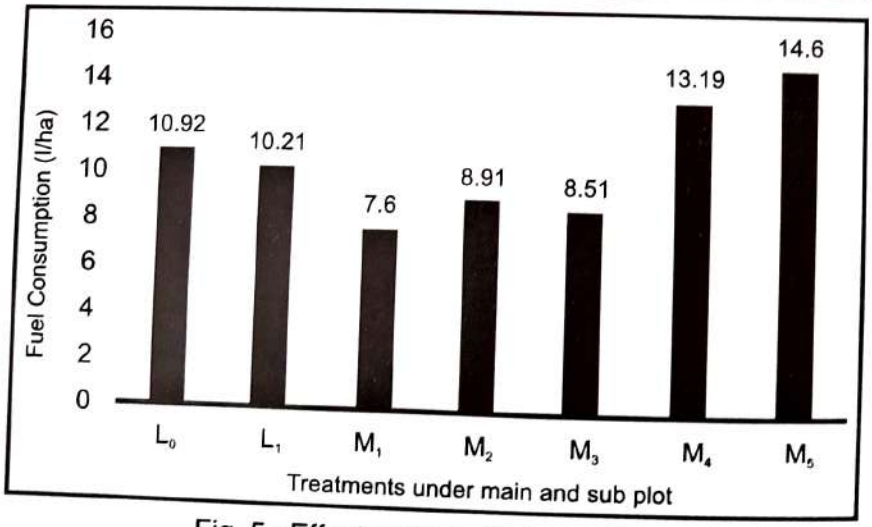


Fig. 5 : Effect on fuel efficiency (l/ha

Effect of Resource conservation machineries on energy requirement

Energy requirement is an important consideration in selecting farm machine/implement. Fig. 6 shows that maximum and minimum values of energy requirement recorded under L_0 and L_1 were 112.38 kWh/ha and 103.87 kWh/ha, reported in the year 2013 and 2014, respectively. Pooled result revealed that leveled field registered 104.51 kWh/ha energy against its counterpart which claimed 111.58 kWh/ha of energy requirement. The leveled plot found to have 6.33 per cent lesser energy requirement than unleveled plot.

Pooled result showed that zero till drill found to be efficient with lower energy requirement of 77.96 kWh/ha which was 47.76 per cent less than energy consumed by conventional practices.

Table 6 Energy consumption (kWh/ha)

Tretment	Years			Pooled
	2012	2013	2014	
Main plot				
L_0	112.25	112.38	110.12	111.58
L_1	105.49	104.16	103.87	104.51
S.Em. ±	1.26	1.24	1.17	0.70
C.D.	4.60	4.50	4.24	2.14
C.V. (%)	6.36	6.26	5.98	6.20
Sub-plot				
M_1	78.49	77.50	77.89	77.96
M_2	91.63	90.77	90.38	90.93
M_3	87.99	87.15	86.70	87.28
M_4	135.87	135.56	132.98	134.80
M_5	150.37	150.38	147.02	149.26
S.Em. ±	1.88	1.49	1.59	1.58
C.D.	5.38	4.25	4.54	5.16

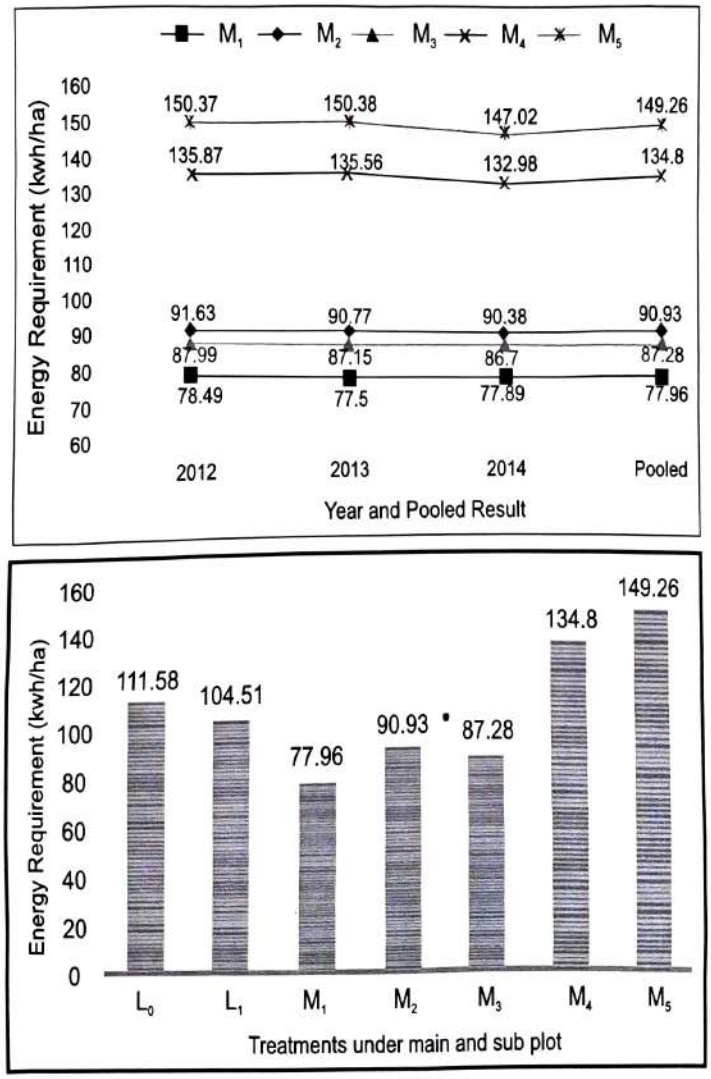


Fig. 6 Energy consumption (kWh/ha)

Table 7 Economics of different treatments.

Sr. No.	Parameters	ZTD	RTD	STD	CU+ RBP	CP	LL+ ZTD	LLL+ RTD	LLL+ STD	LLL+ CU+ RBP	LLL+ CP
		L_0M_1	L_0M_2	L_0M_3	L_0M_4	L_0M_5	L_1M_1	L_1M_2	L_1M_3	L_1M_4	L_1M_5
1.	Purchase price (₹)	39000	132000	102000	92000	28000	39000	132000	102000	92000	28000
2.	Salvage price (₹)	3900	13200	10200	9200	2800	3900	13200	10200	9200	2800
3.	Total life in years	10	10	10	10	10	10	10	10	10	10
4.	Depreciation (₹/hr)	11.70	39.60	30.60	27.60	8.40	11.70	39.60	30.60	27.60	8.40
5.	Interest (₹/hr)	7.15	24.20	18.70	16.87	5.13	7.15	24.20	18.70	16.87	5.13
7.	Repair and maintenance(₹/hr)	2.60	8.80	6.80	6.13	1.87	2.60	8.80	6.80	6.13	1.87
8.	Operator + Tractor charges (₹/hr)	274.37	280.33	277.97	259.84	258.12	271.90	282.90	279.12	254.63	256.35
9.	Cost of laser leveler (₹/hr)	0.00	0.00	0.00	0.00	0.00	841	841	841	841	841
10.	Total operating cost (₹/ha)	603	819	745	1185	1161	1408	1606	1546	1950	1928
11.	Cost of input and labour										
	i) Seed	1600	1600	1600	1600	1690	1600	1600	1600	1600	1669
	ii) Fertilizer	2160	2160	2160	2160	2296	2160	2160	2160	2160	2271
	iii) Labour(₹/hr)	2490	2465	2423	2211	2807	2515	2480	2495	2241	2896
12.	Total cost of input and labour (₹/ha)	6250	6225	6183	5971	6793	6240	6275	6255	6001	6836
13.	Total cost of crop production (₹/ha) (10 + 12)	6853	7044	6928	7156	7954	7648	7881	7801	7951	8764
14.	Greengram seed income (₹/ha)	36253	38752	37459	32740	35604	41630	43584	42257	37690	40199
15.	Straw income (₹/ha)	742	796	764	669	731	831	892	859	780	820
16.	Net Realization (₹/ha)	30143	32504	31295	26253	28381	34813	36595	35315	30519	32255

The economic analysis showed the zero till drill reported lowest cost of operation of ' 603.00 among all treatment. However yield of greengram seed was highest under roto till drill for both the condition of leveled and unleveled land, hence net realization found was also maximum for roto till drill with corresponding value of ' 32504 and ' 36595 on hectare basis.

CONCLUSION

The study concluded that all the resource conservation machineries responded well under leveled land condition when tested for the parameters *i.e.* effective field capacity, tractive efficiency, fuel efficiency and energy requirement. Among resource conservation machineries, zero till drill was found most efficient in terms of effective field capacity, tractive efficiency, fuel consumption and energy requirement with corresponding value of 0.504 ha/h, 71.89 %, 7.60 l/ha and 77.96 kWh/ha. When compared with conventional practices, zero till drill reported 51.78 % better effective field capacity, 2.05 % more tractive efficiency, 47.94 % less fuel consumption and 47.76 % less energy requirement.

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