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Performance Evaluation of Selected Tillage Implements under Saline-Sodic Soils

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Abstract: The study was carried out at Sindh Agriculture University Tandojam in May, 2007. In order to evaluate the performance of selected tillage implements under the saline-sodic soils, the performance of five tillage implements (Mouldboard plow, Disc plow, Sat-Hari, Disc harrow and Cultivator) were studied. Infiltration rate before operation was 0.276 cm/hr, which increased to 0.74, 0.82, 0.60, 0.57 and 0.55 cm/hr when soil operated with Mouldboard plow, Disc plow, Sat-Hari, Disc harrow and cultivator respectively. Bulk density before operation was 1.31-1.34 g.m^{-3} at 0-45cm depth, after operating with Mouldboard plow 1.15-1.33, Disc plow 1.12-1.32, Sat-Hari 1.08-1.32, Disc harrow 1.07-1.32 with Cultivator the bulk density was 1.10-1.32 g.m^{-3}. The field capacity of Mouldboard plow, Disc plow, Sat-Hari, Disc harrow and cultivator was 0.190, 0.181, 0.350, 0.53 and 0.429 ha/hr, while Soil Volume Disturbance was 266.83, 233.33, 351.10, 482.93 and 342.93 m^3/hr respectively. The highest field capacity and soil volume disturbed was recorded in operating disc harrow, while lower field capacity and soil volume disturbed was noted in Mouldboard plow. The fuel consumption for cultivating was significant (P < 0.01) when compared different tillage implements. Maximum fuel consumption for plowing was recorded in case of Disc plow, while the minimum in case of Disc harrow. The result with Disc harrow is the most effective tillage implements for the saline-sodic soils.

Key words: Tillage Implements · Soil Volume Disturbance · Field Capacity · Mechanical Manipulation · Physical Properties

INTRODUCTION

Pakistan is an agricultural country with total geographical area of 79.61 million hectares or 197.0 million acres, out of which total cultivated area is 22.16 million hectares, about 22.04 million hectares of the cultivated area is used for crop production and nearly 17.13 million hectares of the cropped area is irrigated [1]. Salt affected soils are mainly situated in this plain. About 6.30 million hectares of land are salt-affected and of which 1.89 hectare is saline, 1.85 million hectares is permeable saline-sodic, 1.02 million hectares is impermeable saline-sodic and 0.028 million hectares is sodic in nature. Out of 19.3 mha area available for farming, irrigated agriculture is practiced only on about 16 million hectares [2]. Saline-sodic soil restricts the hydraulic properties due to dispersion, translocation and deposition of clay platelets in the conducting pores as the dominant mechanism. The maximum improvement in hydraulic conductivity is only possible with proper tillage and gypsum-saturated solution [3]. Tillage practices increases infiltration rate, Decrease bulk density and help in leaching the salts and reclaiming the saline soils [4].

Tillage is the mechanical manipulation of soil; the goal of proper tillage is to provide a suitable environment for seed germination, weed control, excess moisture removed and reduction of surface runoff by increasing infiltration. The degree of soil compaction, soil bulk density and soil moisture condition are important factors that influence seedling emergence and crop yield. Tillage implements depend on the soil type, soil surface conditions, vegetative growth, required depth of cultivation and crops to be grown. It transforms the soil physical properties by pulverizing, macerating, overturning and mixing the soil layers that provide proper aeration and oxygen to the soil also uses plow based methods that over turn the soil that in turn mixes the organic matter and decomposes the organic contents into the surface layers. This addition of organic matter in the top soil, improves its fertility and productive capability that results in greater yields and plant health [5].

Tillage implements are used to modify soil in order to accomplish one or more objectives such as: (i) deepen the root and water penetration zone; (ii) loosen dense subsoil layers, for better root growth, water movement and aeration; (iii) mix portions of the soil profile, to provide

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more uniform texture. The tillage equipment may cause soil compaction and upset the balance between the air and water components of soil, the compaction cause due to tillage implements may increase the soil strength and restrict root growth. However, a slight compaction is needed to gain good contact between seed and soil particles. This can be achieved by well planed tillage practices that can provide means for creating congenial soil environment, which is particularly necessary for seed germination and effective plant growth.

MATERIALS AND METHODS

Field experiment was conducted at Latif experimental farm of Sindh Agriculture University Tandojam in May, 2007 to evaluate the performance of selected tillage implement under the saline-sodic soils and for evaluation of the soil physical properties. The experiment was laid down on fifteen plots each measuring 20m x 20m (400 m^2) in size.

Experimental Design: Experiment was established at site, five treatments were set up in randomized complete block design with.... replicates; this resulted in a total of 15 plots. The treatments and their labels were T_1 (Moldboard plow), T_2 (Disc plow), T_3 (Disc harrow), T_4 (Cultivator), T_5 (Sat-Hari).

These five commonly used implements were selected to investigate their effect on soil with respect to soil physical properties and implements performance. The parameters of study were soil texture, Soil moisture content, Bulk density of soil, Infiltration Rate, Traction, Plowing width and depth, Fuel consumption, Field capacity, soil volume disturbance. The soil analyzed from the department of the Agricultural Chemistry A.R.I. Tandojam. This department shows the result as the data textural class was found silty loam and type of soil is highly saline sodic soil.

Soil Texture: Soil samples were collected at the depths of 15, 30 and 45 cm to determine soil texture. Soil texture was found silty loam soil.

Soil Moisture Content: The soil moisture content was determined on wet weight basis, soil sample were collected randomly in each plots. The core sampler of 2 cm diameter was derived into the soil at three depth of 15, 30 and 45 cm. Soil samples were dried in oven for 24 hours at 105°C. The dried samples were re- weighed and the weight was recorded. The soil moisture content (wet weight basis) was calculated by using the formula: [6].

$$M.C = \frac{Wd}{Ww} \times 100$$

Bulk density of soil: Undisturbed soil cores were collected by driving with a wooden hammer 5-cm diameter metal cylinder into the soil to the depth specified for each plot. Bulk densities were calculated based on the volumes, calculated from the length and diameter of the section and dry weights of the soil samples. Samples were collected in a cylindrical pot of known volume (19.64 cm^3) which was fitted in core, from layers above and within the compacted horizon (15, 30 and 45 cm), samples were taken from depth of the soil profile that corresponds with these horizons. Bulk density (g cm^{-3}) was measured with the help of the following formula.

$$\text{Bulk density} = \text{Mass of oven dried soil/Volume of soil (g cm}^{-3}\text{)}$$

Infiltration Rate: The infiltration rate of the soils was determined using the method as described in [7]. According to this method, 2 infiltrometer rings (iron cylinders), each 35.56 and 27.94 (cm) in diameter and 40.64 (cm) long were obtained. First, 35.56-cm ring diameter ring was driven in the soil by hammering up to a depth of 20.32 (cm) and then the other ring having 27.94 (cm) diameter was also driven in the center of first ring at the same depth. A staff gauge was erected in the center second ring and water was filled up to the depth of 15.24 (cm) in the second (inner) ring. To avoid evaporation losses, few drops of oil were put on the surface of the filled water ring. Reading were recorded after 5, 15 and 30 minutes, 1, 2, 3, 4, 5, 6 and 7 hours. Averaging the readings divided by average time made calculations. The infiltration ate is expressed as centimeters per hour (cm/hr).

Effective Field Capacity: The time lost in every event such as turning; adjustment and change gear was recorded. For the calculating field capacity, the time consumed and time lost for real work should be used. The field capacity was calculated by using the formula: [6].

$$C = \frac{A}{T_p + T_t}$$

Where:

C = Effective field capacity (ha/Hr)
A = Area tilled (ha)
T_p = Productive time (hr)
T_t = Non-Productive time (hr)

Fuel consumption: The tractor tank of M.F-375 diesel tractor was filled up to top level before testing Mouldboard plow, disc plow, Tandem disc harrow, cultivator and sat-Hari in each plot. After plowing a 20 x 20 meter plot the fuel tank of the tractor was refilled up to the same fuel level with 1000 millimeter graduate cylinder. The total quantity of diesel fuel needed to refill the fuel tank up to the same mark was recorded and the total time taken to plow the test plot. The fuel consumption per hour for hectare was calculated from the data.

Soil Volume Disturbed: The total soil volume disturbed was calculated in cubic meters per hour calculated by multiplying the field capacity with the depth of cut and 10000. It was assumed whether the implements disturbed the soil up to its recorded depth and no undisturbed patch of land was left.

$$V = 10000\ CD$$

Where:

V = Soil volume disturbed m^3/hr
C = Field capacity, ha/hr
D = Depth of cut, m

RESULTS

The experiment was conducted to evaluate the performance of selected tillage implements under the saline-sodic soils at Latif experimental Farm, Sindh Agriculture University Tandojam in May, 2007. Five plowing implements i.e. Mouldboard plow, Disc plow, Sat-Hari, Disc harrow and Cultivator were investigated for soil bulk density, soil moisture, infiltration rate, wheel slippage, effective field capacity, soil volume disturbed, fuel consumption. The statistically analyzed data on the above parameters are interpreted under the following headings:

Soil Analysis: The experimental soil was analyzed for EC, pH and SAR (Table 1) and soil samples were obtained at the depths of 0-15 cm, 15-30 cm and 30-45 cm for each observation.

Electrical Conductivity (EC): The Electrical Conductivity (EC) of the soil of plot-I at 0-15, 15-30 and 30-45 cm depths was 5.36, 16.23 and 4.71 dS/m. The EC of the soil in plot-II at 0-15, 15-30 and 30-45 cm depths was 9.82, 12.62 and 7.98 dS/m. The EC of the soil in plot-III at 0-15, 15-30 and 30-45 cm depths was 5.44, 7.32 and 7.32 dS/m. The EC of the soil in plot-IV at 0-15, 15-30 and 30-45 cm depths was 4.62, 5.51 and 7.07 dS/m. The EC of the soil in plot-V at 0-15, 15-30 and 30-45 cm depths was 5.12, 12.86 and 4.10 dS/m. It was noted that soil differed in EC concentration in surface soil as well as sub-surface soil layers.

Table 1: Soil analysis of experimental site prior to experimentation

Treatments	EC (dS m^{-1})	pH	SAR %
Plot-I			
0-15 cm	5.36	7.50	17.00
15-30 cm	16.23	8.40	18.00
30-45 cm	4.71	8.00	16.00
Plot-II			
0-15 cm	9.82	8.40	17.00
15-30 cm	12.62	8.50	20.00
30-45 cm	7.98	8.30	23.00
Plot-III			
0-15 cm	5.44	8.10	17.00
15-30 cm	7.32	8.30	23.00
30-45 cm	7.32	8.20	24.00
Plot-IV			
0-15 cm	4.62	8.10	17.00
15-30 cm	5.51	8.20	18.00
30-45 cm	7.07	8.30	16.00
Plot-V			
0-15 cm	5.12	8.20	17.00
15-30 cm	12.86	8.40	18.00
30-45 cm	4.10	7.80	17.00

EC = Electrical Conductivity
pH = Presence of Hydrogen
SAR = Sodium Adsorption Ratio

Presence of Hydrogen (pH): The pH of the soil of plot-I at 0-15, 15-30 and 30-45 cm depths was 7.50, 8.40 and 8.00. The pH of the soil in plot-II at 0-15, 15-30 and 30-45 cm depths was 8.40, 8.50 and 8.30. The pH of the soil in plot-III at 0-15, 15-30 and 30-45 cm depths was 8.10, 8.30 and 8.20. The pH of the soil in plot-IV at 0-15, 15-30 and 30-45 cm depths was 8.10, 8.20 and 8.30. The pH of the soil in plot-V at 0-15, 15-30 and 30-45 cm depths was 8.20, 8.40 and 7.80. The experimental soil varied slightly in pH in surface soil as well as sub-surface layers.

Sodium Adsorption Ratio (SAR): The SAR of the soil of plot-I at 0-15, 15-30 and 30-45 cm depths was 17.0, 18.0 and 16.0%. The SAR of the soil in plot-II at 0-15, 15-30 and 30-45 cm depths was 17.0, 20.0 and 23.0%. The SAR of the soil in plot-III at 0-15, 15-30 and 30-45 cm depths was 17.0, 23.0 and 24.0%. The SAR of the soil in plot-IV at 0-15, 15-30 and 30-45 cm depths was 17.0, 18.0 and 16.0%.

Table 2: Average Moisture content (%) after operating tillage implements at 0-45cm soil depths

	After Operation				
Depth	Mouldboard plow	Disc plow	Sat-Hari	Disc harrow	Cultivator
0-15* cm	11.70	11.61	10.98	10.22	10.15
15-30** cm	16.06	15.96	15.77	15.38	15.22
30-45*** cm	20.30	20.24	20.18	20.26	20.19

S.E* ± 0.3802 Prob.0.0054 S.E**. ± 0.5729Prob.0.1732 S.E***.± 0.5521Prob.0.0443

Table 3: Infiltration rate (cm/hr) after operating tillage implements

	After operation				
S.No.	Mouldboard plow	Disc plow	Sat-Hari	Disc harrow	Cultivator
1	0.75	0.82	0.60	0.57	0.53
2	0.79	0.80	0.63	0.61	0.58
3	0.68	0.85	0.59	0.55	0.54
Average	0.74	0.82	0.60	0.57	0.55

S.E.±0.0123, Prob.0.0001

Table 4: Average Bulk density (g. cm^{-3}) after operating the tillage implements at 0-45 cm soil depth

	After Operation				
Depth	Mouldboard plow	Disc plow	Sat-Hari	Disc harrow	Cultivator
0-15* cm	1.15	1.12	1.10	1.05	1.07
15-30** cm	1.27	1.26	1.25	1.21	1.22
30-45*** cm	1.33	1.32	1.32	1.32	1.32

* S.E.± 0.0050 Prob. 0.0001 ** S.E.± 0.0102 Prob. 0.0001 *** S.E.± 0.0043 Prob. 0.0001

Table 5: Wheel slippage on traction of tillage implements

Observations	Mouldboard plow Wheel slippage %	Disc plow Wheel slippage %	Sat-Hari Wheel slippage %	Disc harrow Wheel slippage %	Cultivator Wheel slippage %
1	16.250	17.700	15.970	6.600	10.940
2	16.080	21.880	15.440	6.330	10.800
3	15.360	18.500	16.380	7.080	10.100
4	16.410	19.270	14.580	7.080	11.110
5	16.860	19.050	14.970	6.470	10.410
Average	16.190	19.280	15.460	6.710	10.670

S.E.±0.4039 Prob.0.0001

Table 6: Effective field capacity and Soil volume disturbance produced by operating of tillage implements

	Mouldboard plow		Disc plow		Sat-hari		Disc Harrow		Cultivator	
Observation	F. C* ha/h	S.V.D** m^3/h	F. C* ha/h	S.V.D** m^3/h	F. C* ha/h	S.V.D** m^3/h	F. C* ha/h	S.V.D** m^3/h	F. C* ha/h	S.V.D** m^3/h
1	0.190	285.000	0.180	198.000	0.349	349.000	0.524	471.600	0.421	378.900
2	0.193	250.900	0.182	254.800	0.358	393.800	0.546	546.000	0.437	305.900
3	0.189	264.600	0.181	217.200	0.345	310.500	0.539	431.200	0.430	344.000
Average	0.190	266.830	0.181	223.330	0.350	351.100	0.530	482.930	0.429	342.930

S.E.± 0.0023 17.1246,

Prob. 0.0001 0.00030,

* =Field capacity, ** =Soil Volume Disturbance

Table 7: Fuel consumption by operating of tillage implements

	Mouldboard plow		Disc plow		Sat-hari		Disc harrow		Cultivator	
S.No.	Fuel consumed (Lit/hr)	Fuel consumed (Lit/ha)	Fuel consumed (Lit/hr)	Fuel consumed (Lit/ha)	Fuel consumed (Lit/hr)	Fuel consumed (Lit/ha)	Fuel consumed (Lit/hr)	Fuel consumed (Lit/ha)	Fuel consumed (Lit/hr)	Fuel consumed (Lit/ha)
1	3.605	18.750	3.542	19.677	6.550	12.500	3.680	10.544	4.914	11.550
2	3.570	18.300	3.454	18.978	6.835	12.475	4.017	11.221	4.945	11.250
3	3.512	18.525	3.636	20.088	6.837	12.650	4.051	11.742	5.160	12.000
Aver	3.562	18.525	3.543	19.581	6.740	12.541	3.916	11.169	5.010	11.600
S.E.±	0.0531	0.1536								
Prob.	0.0001	0.0001								

The SAR of the soil in plot-V at 0-15, 15-30 and 30-45 cm depths was 17.0, 18.0 and 17.0%. A considerable variation in SAR concentration was analyzed in surface soil as compared to sub-surface soils.

Soil Moisture Content: Soil moisture content at various depths in unplowed soil and soil plowed with Mouldboard plow (T1), Disc plow (T2), Sat-Hari (T3), Disc harrow (T4) and Cultivator (T5) was recorded in Tables 2. The average soil moisture in the experimental soil before operation was 10.96, 15.95 and 20.26 percent at 0-15, 15-30 and 30-45 cm depth respectively. After tillage treatment with Moldboard plow, the soil moisture was 11.70, 16.06 and 20.30 percent at 0-15, 15-30 and 30-45 cm soil depth respectively. After tillage treatment with Disc plow, the soil moisture content was found 11.61, 15.96 and 20.24 percent at 0-15, 15-30 and 30-45 cm soil depths respectively. After tillage treatment with Sat-Hari soil moisture of 10.98, 15.77 and 20.18 percent, at 0-15, 15-30 and 30-45 cm soil depths respectively. After tillage treatments with Disc harrow the soil moisture 10.22, 15.38 and 20.26 percent at 0-15, 15-30 and 30-45 cm soil depths respectively. Cultivator was used in soil moisture 10.15, 15.22 and 20.19 percent at 0-15, 15-30 and 30-45 cm soil depths respectively. The results indicated that soil moisture retention differed significantly ($P<0.01$) after tillage treatments with different implements. However, tillage operation with Moldboard plow retained more moisture at 0-15 and 30-45 cm depths than rest of the tillage implements, while at 15-30 cm depths the soil operation with Disc plow caused greater moisture retention than rest of the tillage implements. The soils operated with Cultivator retained the lowest percentage of moisture in all soil depths as compared to rest of the tillage implements.

Infiltration Rate (cm/hr): The infiltration rate of soil was measured before operation and after plowing with Moldboard plow, Disc plow, Sat-Hari, Disc harrow and Cultivator and is presented in Table 5. The results in Table 5 indicated that average soil infiltration rate before operation was 0.276 cm/hr, while infiltration rate was markedly increased with Moldboard plow 0.74 cm/hr and infiltration rate with Disc plow was 0.82 cm/hr, Sat-Hari infiltration rate was 0.60 cm/hr, Disc harrow was 0.57 cm/hr and cultivator was 0.55 cm/hr. The differences in infiltration rate within treatments after operation and before operation were significant level ($P<0.01$).

Bulk Density (g. cm^{-3}): The bulk density of soil was measured before operation and after plowing the soil with Mouldboard plow, Disc plow, Sat-Hari, Disc harrow and Cultivator and is presented in Tables 4. The bulk density reflects the soil condition disturbed by various tillage implements. The soil bulk density before operation at 0-15, 15-30 and 30-45 cm depths was 1.31, 1.32 and 1.34 g.cm^{-3}. After tillage treatment with Mouldboard plow, the bulk density at 0-15, 15-30 and 30-45 cm depths was 1.15, 1.27 and 1.33 g. cm^{-3}, with Disc plow at 0-15, 15-30 and 30-45 cm soil depths was 1.12, 1.26 and 1.32 g. cm^{-3} while soil plowed by Sat-Hari at 0-15, 15-30 and 30-45 cm depths he bulk density was 1.10, 1.25 and 1.32 g. cm^{-3}, with Disc harrow was 1.05, 1.21 and 1.32 g.cm^{-3}at 0-15, 15-30 and 30-45 cm soil depths, respectively and with Cultivator the bulk density was 1.07, 1.22 and 1.32 g.cm^{-3}. The results showed that bulk density was significantly affected ($P<0.01$) by tillage implements as well as soil depths. However, at 0-15 and cm soil depth, the bulk density was relatively higher in soil plowed up with disc harrow and at 15-30 and 30-45 cm soil depths; the bulk density was found increasing under tillage operation with Moldboard plow, disc plow, sat-hari and disc harrow. The overall lower bulk density was found in plots treated with disc harrow.

Wheel Slippage: The data on wheel slippage for Mouldboard plow, Disc plow, Sat-hari, Disc harrow and cultivator were found 16.19, 19.28, 15.46, 6.71 and 10.67 percent respectively. The wheel Slippage of tractor was mainly associated with the depth and width of implements and statistically the differences in wheel Slippage between various tillage implements were highly significant ($P<0.01$). The wheel Slippage was highest on operating Disc plow, while minimum wheel Slippage was recorded in Disc harrow.

Effective Field Capacity and Soil Volume Disturbance: Effective field capacity produced by operating various tillage implements was worked out and such results are presented in Table 6. An area of 0.04 hectare was tilled, result indicated the productive time of Mouldboard plow was 12.52 minutes, producing field capacity of 0.190 ha/hr and soil volume disturbance of 266.83 m^3/hr; while productive time of disc plow was 13.24 minutes, producing field capacity of 0.181 ha/hr and soil volume disturbance of 233.33 m^3/hr, productive time of Sat-hari was 6.83 minutes, producing field capacity of 0.350 ha/hr and soil volume disturbance of 351.10 m^3/hr, productive time of Disc harrow was 4.47 minutes, producing field capacity of 0.53 ha/hr and soil volume disturbance of 482.93 m^3/hr, productive time of cultivator was 5.58 minutes, producing field capacity of 0.429 ha/hr and soil volume disturbance of 342.93 m^3/hr, respectively.

The results indicated that the highest field capacity and soil volume disturbed was recorded in operating disc harrow, while lower field capacity and soil volume disturbed was noted in operating Mouldboard plow. Statistically, the differences in productive time, field capacity as well as soil volume disturbed between different tillage implements were highly significant ($P<0.01$).

Fuel Consumption: The results indicated that the fuel consumption was 3.562 liters per hour, 18.525 liter per hectare by operating Mouldboard plow, 3.543 liters 12.541 liters, 19.581 liter per hectare by Disc plow, 3.916 liters/hour, 12.541 liters per hectare by Sat-hari, 3.916 liters per hour, 11.169 liters per hectare by disc harrow, 5.01 liters per hour, 11.60 liters per hectare by cultivator. The results further suggested that fuel consumption for cultivating one hectare land was significant ($P<0.01$) when compared different tillage implements. The maximum fuel consumption for plowing one hectare land was recorded in case of Disc plow, while the minimum in case of Disc harrow.

DISCUSSION

The tillage implements are used to modify soil in order to deepen the root and water penetration zone; loosen dense subsoil layers, for better root growth, water movement and aeration; mix portions of the soil profile to provide more uniform texture. Soil modification is often required prior to sowing of crops, particularly for the saline-sodic and compacted soils. Several types of tillage implements are in practice for the manipulation of compact soils to break the hardpans in the soil profile due to saline and sodic condition. Tillage operation is mainly physical soil manipulation achieved by Disc plow, Disc harrow, Cultivator, Mouldboard plow, Sat-hari, rotavator etc. to prepare a fine seed bed for proper germination along with other benefits like better aeration, moisture conservation, friability, biomass incorporation and weed control. In present study, performance and evaluation of different primary tillage implements (Mouldboard plow, Disc plow, Sat-Hari, Disc harrow and Cultivator) were examined under saline sodic conditions to determine the most appropriate implements under such soils that can give better performance and is most economical to the farmers.

The results of the present study indicated that infiltration rate found 17% by Disc plow compared to Cultivator. These results are in line with those of Bruce *et al.* [8] who found 51% greater infiltration rate in the no-till plots compared to conventional tillage plots.

Bulk density before operation was 1.31-1.34 $g.cm^{-3}$ at 0-45cm depth and after operating with Moldboard plow 1.15-1.33, Disc plow, 1.12-1.32, Sat-Hari 1.10-1.32, Disc harrow 1.07-1.32 and with cultivator the bulk density was 1.05-1.3 $g.cm^{-3}$. These results are in concurrence with those of Bukhari *et al.* [9] who recorded Mouldboard operating soil bulk density of 1.35-1.38 $g.cm^{-3}$, while Al-Ghazal [10] reported that soil bulk density ranged between 1.55-1.79 $g.cm^{-3}$ at the first site and 1.44-1.75 $g.cm^{-3}$ at the second site. Soil bulk density increased proportionally with repeated compaction and was related to soil moisture contents at time of application of compaction force.

In the present study Operating speed by traction of Mouldboard plow was less while more by Disc harrow[11] tested various types of Mouldboard plows and several combinations of plows and tractors were used and several quality and energetic indexes were recorded and assessed. The results showed that the best combination was that of the semi mounted Mouldboard plow having 5 plow furrows.

The highest field capacity and soil volume disturbed was recorded in operating disc harrow, while lower field capacity and soil volume disturbed was noted in operating Mouldboard plow. The above results are in agreement with Sadiq et l [12] who evaluated amelioration of saline-sodic soil observed that disc plow was the most efficient field implement which not only ensured good yields but also enhanced soil improvement because he incorporate the application sulfuric acid at 20% requirement ($CaSO_4$ H2O) gypsum.

Operating the Mouldboard plow, disc plow, sat-hari, disc harrow and cultivator fuel consumed for plowing land was recorded in case of disc plow, while the minimum in case of disc harrow. Similar results have also been reported by Arvidsson *et al*. [13], who calculated fuel consumption and speed during tillage with a Mouldboard plow and a chisel plow set to working depths of 13, 17 and 21 cm and a disc harrow and concluded that Mouldboard plow is energy efficient for loosening soil, while the disc harrow is energy efficient for soil fragmentation during primary tillage.

CONCLUSION

- The more field capacity and soil volume disturbed was recorded in operating disc harrow, while less field capacity and soil volume disturbed was less in operating Mouldboard plow.
- The minimum fuel consumption was recorded in case of disc harrow, while operating the Moldboard plow, disc plow, sat-hari and cultivator fuel consumed was recorded more.
- The results indicates that infiltration rate was found 17% more by Disc plow compared to Mouldboard plow, disc plow, sat-hari and cultivator. These results are in line with [8] who found 51% greater infiltration rate in the no-till plots compared to conventional tillage plots.

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