Full Length Research Paper

The Study of suitable effective use of machinery in farming research station (Elrawakeeb) –west of Khartoum - Sudan

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An experiment was carried out at Elrawakeeb Research Station, south west Omdurman City - Khartoum State, for two successive seasons to study the effect of Five tillage treatments (Offset disc harrow + ridging, Disc plough + ridging, Chisel plough + ridging, Ridger plough and Animal drawn plough) on some soil physical properties (soil moisture content, soil bulk density, soil aggregate stability and infiltration rate), while the tillage implements were measured included; draft force, fuel consumption, theoretical field capacity, effective field capacity and field efficiency, were investigated. Generally, the results obtained showed that there were highly significant differences between all machinery parameters were investigated. The results also showed that chisel plough gave the highest field efficiency (88.24%), while the lowest field efficiency (12.82 %) and lowest fuel consumption (2.50L/ha) were recorded by animal drawn plough and the ridger plough respectively. The highest effective field capacity recorded by ridger plough (0.45ha/h), while lowest effective field capacity (0.15 ha/h) and the lowest theoretical field capacity (0.17 ha/h) were recorded by chisel plough. However, the best implement gain the highest effective field capacity and at the same reduced the fuel consumption is the ridger plough.

Key words: Tillage implements, chisel plough, ridger plough, animal drawn plough.

INTRODUCTION

Land preparation is one of the most important operations of agricultural mechanization and the most expensive operation consuming high cost of the tractor power (Andersson et al., 2005).

Farm mechanization has been helpful to achieve a significant improvement in agricultural productivity. Thus, there is strong need for mechanization of agricultural operations.

Soil tillage is carried out by many different implements and it’s the one of the most determinant of operations agricultural product. The success or failure of crop production is primarily determined by tillage practice. In addition Tillage operations alter soil physical properties attributing the effect of structural properties of soil to the process of farming or breaking down of aggregates; these physical properties are of great importance to crop growth (FAO, 1990).

The objective was studied through:

i. Determined the most suitable system practices under the marginal lands of Elrawakeeb area.
ii. To minimize and reduced the high cost of uses of conventional practices.
iii. To protect the marginal lands and to minimized the risk of soil erosion by wind and water.

MATERIALS AND METHODS

Experimental site

The experiment was carried out in Elrawakeeb Dry land Research Station operated by the National Center for Research in the Khartoum State. It is located west of Omdorman between latitudes 15°.2, 15°.36 and longitude 32°, 32.10 Easts. It lies in the tropical part of Sudan, which was characterized by short rainy season (100-200 mm), high temperature (40°C) and high evaporation (1850 mm).
Soil moisture regime is aridic, (Fadul, 1986). The classification of some physical and chemical properties of the site soil is loamy sand.

**Tractors and implement**

Two tractors were used in this experiment, one as the tested (Massy Ferguson 80 h/p) and the other as auxiliary (International Case 70 h/p). The specifications of each one are shown in Table 1. Two primary ploughs (Disc plough and Chisel plough), two secondary implements (Offset disc harrow and Ridger) and Animal drawn plough, were used in the experiment. The specifications of these ploughs are shown in Table 2.

**Other equipments**

1. Plastic measuring tape (20 m) was used for the measurement of experimental area, distances for ploughing, ploughing speed, and ploughing width and length of cut.
2. Steel pegs were used for determining the distances during the experiment.
3. Steel chain used for pulling the tested tractor by the auxiliary one for implement draft measurement.
4. A plastic jarican four galloons used to keep stock of fuel in the field for refilling the tractor tank after each operation.
5. A hydraulic type dynamometer filled with oil No 27 and a gauge in the middle was used for measuring the draft.
6. Stop watch for determining the productive time, turning time, and time required for speed calculation.

**Experiment design**

The experimental design used was complete randomized block design composed of five treatments replicated four times giving a total of twenty plots. Each plot is thirty meters long and three meters wide. Plots were one meter apart while the blocks were two meter apart (Figure 1).

**Experimental area preparation**

of feddan was a signed for the experiment, it was divided in to four blocks (30 ×15 m) representing the replicates within which the following treatments were distributed.

1. Chiseling tillage carried out by the chisel plough to depth of 25 cm followed by ridging.
2. Harrowing tillage carried out by the harrow plough to depth of 15 cm followed by ridging.
3. Discing tillage carried out by the disc plough to depth of 20 cm followed by ridging.
4. Ridging plough which was be done by the Ridger only to depth (25 cm).
5. Animal drawn ploughing carried out by the animal drawn plough only to a depth of 13 cm.

**Measurement of implement draft**

1. A hydraulic type dynamometer was attached to the front of the tested tractor on which the implement was linked.
2. An auxiliary tractor was linked to the tested one through the dynamometer.
3. The auxiliary tractor pulled the tested tractor while the latter was positioned in the neutral state but with the implement unloaded, i.e. the idle position.
4. The draft was recorded for a measured distance of 30 m.
5. Then the implement was put in operation position (loaded) and the tested tractor was pulled to record the draft force of the implement.
6. The difference between the two values gives the value of the implement draft using the following equation:

   Draft force (KN) = draft of tractor loaded – draft of tractor unloaded

The draft measurements were contained out for different implements used in the experiment.

**Measurement of field capacities and efficiencies:**

1. Distance of 30 m was measured on each plot.
2. The started ploughing was carried out the first gear.
3. The width of cut was measured using the measuring tape.
4. The time of ploughing each plot in seconds was recorded using the stop watch.
5. Time for turnings was also recorded for each plot.
6. The speed was then calculated as follows;

\[
\text{Speed (m/s)} = \frac{30 \text{m}}{\text{Time required for full coverage (sec)}}
\]

The required time to finish the plot was then figured out as follows:

Total time = time for turns + the productive time

The productive time was computed from actual time used for carrying out the specific work.

\[
T \cdot F \cdot C (\text{ha/h}) = \frac{\text{Average speed (m/sec) x width of cut (m) x 3600(sec)}}{10000(\text{m}^2)}
\]
Table 1. Specifications of the tractors.

<table>
<thead>
<tr>
<th>Specifications</th>
<th>Tractor</th>
<th>Tractors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mark</td>
<td>Massy Ferguson 80 h/p</td>
<td>International Case 70 h/p</td>
</tr>
<tr>
<td>Make</td>
<td>England</td>
<td>England</td>
</tr>
<tr>
<td>Engine type</td>
<td>Diesel</td>
<td>Diesel</td>
</tr>
<tr>
<td>No. cylinders</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Stroke cycle</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Cooling system</td>
<td>Water</td>
<td>Water</td>
</tr>
<tr>
<td>Rear tires size</td>
<td>14.8 / 13.38</td>
<td>13.6 / 12.38</td>
</tr>
<tr>
<td>Front tires size</td>
<td>9.20</td>
<td>7.5-16</td>
</tr>
</tbody>
</table>

Table 2. Specification of Implement.

<table>
<thead>
<tr>
<th>Implement</th>
<th>No. of. units</th>
<th>Mark</th>
<th>Depth of cut</th>
<th>Make</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chisel plough</td>
<td>3</td>
<td>Ransoms</td>
<td>20-25</td>
<td>England</td>
</tr>
<tr>
<td>Disc harrow (offset)</td>
<td>20</td>
<td>Agrimec- Nardi</td>
<td>13-15</td>
<td>England</td>
</tr>
<tr>
<td>Disc plough</td>
<td>3</td>
<td>Modelo: AF/03</td>
<td>20-23</td>
<td>Brazil</td>
</tr>
<tr>
<td>Ridger</td>
<td>3</td>
<td>Perugia</td>
<td>25-30</td>
<td>Italy</td>
</tr>
<tr>
<td>Animal Drawn plough</td>
<td>1</td>
<td>Modification by (ITDG)</td>
<td>10-13</td>
<td>Sudan</td>
</tr>
</tbody>
</table>


The effective field capacity was calculated as follows:

\[
E. F. C (\text{ha/h}) = \frac{\text{Area of the plot (m²)}}{\text{Time required for full coverage (h)} \times 10000(\text{m²})}
\]

The field efficiency was calculated as follows:

\[
F. E\% = \frac{E. F. C(\text{ha/h})}{T. F. C(\text{ha/h})} \times 100
\]

Measurement of fuel consumption

1. The tractor started to work in the plot with full tank.
2. After finishing the work operation, refilled the tank by a measuring cylinder and the amount of fuel used to refill was recorded.
3. The time to finish the plot was also recorded.

Then the fuel consumption was calculated as follows:

\[
\text{Fuel consumption (L/ha)} = \frac{\text{Reading of the cylinder (lit)}}{\text{Plot area in (ha)}}
\]

RESULTS AND DISCUSSION

The highest draft force was recorded by the chisel plough tillage treatment (7.50KN), followed by disc plough treatment (6.50 KN) ridger plough (6 KN), and the offset disc harrow treatment (5 KN), respectively a shown in Table 3.

Chisel plough treatment recorded the highest draft force which may be attributed to greater and deep working depth of the implement. While the offset discs harrow treatment recorded the lowest draft which may be attributed to the shallow and surface working depth. This result in line to the findings of Balel and Dahab (1997). highly significant differences between treatments. The ridger plough treatment resulted in the highest effective field capacity which recorded 0.45 ha/hr, followed by the

Effect of tillage practices on effective field capacity

Based on William (2005), the performance of a machine often depends on the skill of the operator, or on weather and soil conditions. Nevertheless, differences among machines can be evaluated through field trials, research
Figure 1. Layout of the experimental area.
Treatments:
DH + R: Offset disc harrow + Ridger plough
CH + R: Chisel plough + Ridger plough
DP + R: Disc plough + Ridger plough
R: Ridger plough
An: Animal drawn plough

Table 3. Means of machinery parameters.

<table>
<thead>
<tr>
<th>Implement</th>
<th>Draft (KN)</th>
<th>EFC (ha/hr)</th>
<th>TFC (ha/hr)</th>
<th>FE (%)</th>
<th>Fuel Consumption (L/ha)</th>
<th>Fuel Consumption (L/hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chisel Plough</td>
<td>7.50 a</td>
<td>0.15 b</td>
<td>0.17 c</td>
<td>88.24</td>
<td>7.60 a</td>
<td>1.14 a</td>
</tr>
<tr>
<td>Disc plough</td>
<td>6.50 b</td>
<td>0.22 a</td>
<td>1.27 b</td>
<td>81.48</td>
<td>4.60 b</td>
<td>1.01 b</td>
</tr>
<tr>
<td>Ridger plough</td>
<td>6.00 c</td>
<td>0.45 b</td>
<td>0.66 e</td>
<td>68.18</td>
<td>2.50 c</td>
<td>1.13 b</td>
</tr>
<tr>
<td>(Off set) Disc Harrow</td>
<td>5.00 d</td>
<td>0.34 b</td>
<td>0.70 d</td>
<td>49.10</td>
<td>3.30 d</td>
<td>1.12 c</td>
</tr>
<tr>
<td>Animal Drawn</td>
<td>___</td>
<td>0.15 b</td>
<td>1.17 a</td>
<td>12.82</td>
<td>___</td>
<td>___</td>
</tr>
<tr>
<td>LSD of treatment</td>
<td>0.086</td>
<td>0.024</td>
<td>0.039</td>
<td>15.692</td>
<td>0.105</td>
<td>0.07</td>
</tr>
</tbody>
</table>

reports and personal experience. The results showed offset disc harrow treatment 0.34 ha/hr, disc plough treatment 0.22 ha/hr, chisel plough treatment 0.15 ha/hr, and animal drawn plough treatment 0.15 ha/hr. These
results may be attributed to the obvious difference in the implements width of cut. These results were according to Raper (2002).

**Effect of tillage practices on field efficiencies (%)**

The results showed that the highest field efficiency was recorded by the chisel plough treatment 88.24%; followed by disc plough treatment 81.48%, ridger plough treatment 68.18%, offset disc harrow treatment 49.10 %, and animal drawn plough treatment 12.82%, respectively. The chisel plough treatment recorded the highest efficiency while the animal drawn plough treatment recorded the lowest efficiency. These results were according to the results of Hammad (2001), this has also been the case in previous studies of Gorton and Davidova (2004). The high-scale efficiencies on average of chisel plough were also found in a study by Bokusheva and Hockmann (2006).

**Effect of tillage treatments on tractor fuel consumption L/ha and L/hr**

The results of tractor fuel consumption as affected by tillage treatments showed highly significant differences at level 1%. The highest fuel consumption was recorded by the chisel plough treatment (7.60 L/ha), followed by disc plough treatment (4.60 L/ha), offset disc harrow (3.30 L/ha), while ridger plough treatment was recorded the lowest fuel consumption (2.50 L/ha), respectively. These results are in line with the findings of Balel and Dahab (1997).

**Conclusion**

The chisel ploughing recorded the highest draft, field efficiency, fuel consumption and the lowest field capacities whereas the ridger recorded the lowest fuel consumption, while the offset disc harrow recorded the lowest draft and the animal drawn plough recorded the lowest field capacities and field efficiency.

**Recommendations**

1. It is better to avoid the use of tillage in deep depths because it increases bulk density and therefore cause compaction.
2. According to results of using the different methods of tillage, the appropriate suitable technique is the ridger plough method.
3. Costing of tillage operations should be studied for selecting the most economical tillage system for fodder production.

**REFERENCES**


