# PERFORMANCE EVALUATION OF GIAD CHISEL PLOW CP007 UNDER DIFFERENT TYPE OF SOILS

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**ABSTRACT:** Chisel plow is widely used by farmers as a primary tillage tool. Performance data for chisel plow operation is essential in order to optimize its performance and reduce the cost of tillage operation. Field experiments were conducted using Armatrac852e tractor to evaluate the performance of GIAD chisel plow (CP007) in two types of clay soils (a light clay soil in Khartoum state (soil-1) and heavy dark clay soilGadarif state(soil-2)). The fuel consumption, effective field capacity, and field efficiency were measured and recorded.
The results of the statistical analysis showed a significant difference in the two types of soils (P<0.05)between the measured parameters. the fuel consumption (lit/ha) for the soil 2 is found to be greater by 15.78% than soil 1, while soil (1) recorded belter results in actual field capacity and field efficiency by (6.02%) and (5.81%) respectively.
Generally, the results of fuel consumption, field effective capacity and field efficiency for the tested implement it recorded normal or better results compare to the results found by other researchers.

**Keywords**: Chisel plow, fuel consumption, effective field capacity and field efficiency.



## INTRODUCTION

Tillage is defined as a process aimed at creating a desired final soil condition for seeds from some undesirable initial soil condition through manipulation of soil with the purpose of increasing crop yield (Gill and Vanden Berg, 1967).

The tillage of soil is considered to be one of the biggest farm operations as it requires the most energy spent on farms (Finner and Straub, 1985; Abbaspur andGilandeh et al., 2006). Therefore, the efficiency and economy of the tillage operation could be evaluated from the mechanics of tillage tools/soil interaction which would provide a method by which the performance of the tillage implements could be predicted and controlled by the design of a tillage tool or by the use of a sequence of tillage tools (Gill and VandenBerg ,1967).

The selection of tillage implements for seedbed preparation and weed control depends on soil type and condition, type of crop, previous soil treatments, crop residues and weed type (Raper, 2002).

The use of heavy agricultural equipment and tractors and the continuous plowing of agricultural soil at the same depth create plow sole or a hardpan immediately below the normal plowing depth. The hardpan forms a barrier which hinders the penetration and circulation of water into the ground and prevents tap roots of plants to grow downwardly into the soil where they can utilize the subsoil nutrients and moisture.Soil compaction is the main form of soil degradation which affects 11% of the land area (Ahmed eta al., 2007). It can have adverse effects upon plants by increasing field saturated hydraulic conductivity (Iqbal et al., 2005; Solhjou and NiaziArdekani, 2001).

Srivastava et al. (1993) reported that one of the tillage implements widely used by farmers is the chisel plow which is considered to be a primary tillage implement because it is mainly used for the initial soil working operations.

Moreover, Chisel plough is used for primary tillage. They are good tillage implements in conditions such as hard dry soil and soils containing heavy roots, stones and trashes. Chisel ploughs complete loosen the hard soil, saving water in lower layers of soil and maintaining moisture and help roots to absorb nutrition, water and air without soil inversion.

ASAE standard S414.1 (ASAE, 1994) indicated that a chisel plow could be classified as either a primary or a secondary tillage implement. The plow shatters the soil without complete burial or mixing of surface materials. Multiple rows of staggered curved are mounted either rigidly, with spring-cushions, or with spring rests on plow frames. Interchangeable sweep, chisel, spike, or shovel tools are attached to each shank.

In most farming system of Middle, Northern and Western Sudan, Chisel Plow (CP) is becoming very popular among farmers. CP is used as a primary tillage implement in the ordinary course of land preparation for most of the summer, winter and fodder crops; it can be used for primary tillage of the field and most suitable for soils such as compacted, hard, dry and sticky, where disk plow and moldboard plough will not scour work.

The main objectives of the present study, was toevaluate the performance parameter of the GIAD Chisel plow (CP007) such as the actual field capacity, the theoretical field capacity, the field efficiency and fuel consumption. Moreover to follow up the performance of the chisel plough and its suitability under Sudan field and climatic conditions.



## MTERIALS AND METHODS

### 2.1 Experimental sites:

The experiments were conducted during May- 2015 at two different sites at Giad Agriculture farm – Khartoum State and Gadarif University Farm at Gadarif state in Eastern of Sudan. At both sites, the soil was clay soil. The clay ratio varied significantly from one site to the other. Soils from the two fields were classified by mechanical analysis. Soil samples were collected during the tillage experiments to determine the soil texture and the average moisture contents for both sites. Soil texture was light clay soil in the Khartoum site (Soil1) while, it was heavy dark clay soil in Gadarif site (Soil 2) and the soil moisture content in both sites was less than 10%.

## 2.2 Tillage implements

The experiment implement is a mounted chisel plowassembled locally by GIAD – Sudan with seven shanks. The specifications of the implement are presented in Table (1).

## 2.2 Experimental layout and treatment applications

An experimental plot consisting of one treatment and five replicates was laid out in both experimental sites,the size of the plots in each site were (0.84) hectare (2 Feddan). During the field operations, the speed selected for the two experiments was5.2 km/hr. An experimental plot length of 100 m was used for each replicatein both fields. Approximate length of 30 m was used as a practice area prior to the beginning of the experimental runs to enable the tractor and the implement to reach the required speed and depth.

The Armatrac, 852e, 2WD tractor was used to pull the tested implement in the two sites. The specification of the tractor is presented in Table 2. Other tools and implements, which were used in the study include: steel chain, measuring tape (50m), ranging poles, stop watch, hundred milliliters graduated cylinder and fuel container.

**Table1: Some of the GIAD Chisel plow CP007 specifications:**

| Parameter | value |
|---|---|
| Type: | Giad chisel plough. |
| Model: | CP 007 |
| Country: | Sudan |
| Number of tines (mm): | 7 |
| Body distance (mm): | 300 |
| Weight (kg): | 415 |
| Working width (mm): | 1900 |
| Working depth (mm): | 450 |
| Chassis height: | 630 |
| Power requirement (hp): | 60-80 |

**Table 2: Tractor specifications:**

| Parameter | value |
|---|---|
| Name: | Armatrac, 2WD |
| Model: | 852e , |
| Country of origin: | Turkey |
| Power: | 61.5 KW / 83 hp. |
| PTO power: | 52 kW @2200 rpm |
| Volume: | 4.4 lt |
| Max Lift capacity @ link ends: | 2600 kg or 3000 kg |
| Wheel and tires: | Front: 7.5-18. |
| . | Rear:18.4-30 |
| Ungallant weight: | Canopy: 3088 kg |
| | Cab: 3228 kg |

**2.3 Measurement:**

**1- Fuel consumption measurement:**

The fuel tank of Armatrac 852e tractor was filled up to its top level before field testing. After ploughing each replicate the tractor engine was stopped and the fuel tank was re filled up to the same level with the graduate cylinder quantity of diesel fuel needed to refill the tractor tank up to the same level, fuel consumption per hectare was calculated from data obtained, and following formula was used:

$$Total\ fuel\ consumption\ (\frac{lit}{ha}) = \frac{fuel\ consumed\ (lit)}{area\ covered\ (ha)}$$

**Effective field capacity (EFC)**

The time lost in the field such as turning, adjustment and change of gear was recorded and time used for real work also recorded. The field capacity was calculated by using the equation given by (RANAM, 1995)

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

*Where: EFC* = effective field capacity (ha/h); *A* = Area tilled, ha; $T_p$= productive time, h; $T_t$ = non- productive time, h.

**Theoretical field capacity and field efficiency:**

Theoretical field capacity and field efficiency: were measured by the method described by Hunt (1995) and were calculated by following relation

$$(\text{TFC}) = \frac{w \times sp}{c}$$

$$(\text{E }\%) = \frac{EFC}{TFC} \times 100$$

*Where: **TFC***= theoratical field capacity (ha/h); *w* = chisel width, ***sp***= forward speed; ***c***= constant (10 for hectare); E = field efficiency.

## RESULTS AND DISCUSSION

In order to measure the specific fuel consumptionand to determine the actualfield capacity and field efficiency of the GIAD chisel plough in two different soils the variance analysis are given in Table3 3.

**Table 3: T-test Statistical description of variation for all observed parameters:**

| Observed parameter | DF | P. value | Std Error | T value |
|---|---|---|---|---|
| fuel consumption (lit/hr) | 4 | 0.0228 | 1.0467 | -3.60 |
| Effective field capacity (ha/hr) | 4 | 0.0216 | 0.0535 | 3.66 |
| Field efficiency (%) | 4 | 0.0185 | 1.3038 | 3.83 |

Fig.2 showed the average fuel consumption (lit./ha) and (lit./hr) of the GIAD chisel plow in soil (1) (light clay soil- Giad project in Khartoum state) and soil (2) (Giad project in Gadarif state). The statistical analysis in Table 3 shows that there are significant differences (P>0.05) in fuel consumption in the two type soils.

The average values of fuel consumption for the soil (1)was 9.82 lit/ha and 8.16 lit/hr while in soil (2) it was 11.66lit/ha and 11.9 lit/hr.

If comparisons are made fromFigure2between both sites,it is clear that, the fuel consumption for the soil2 is found to be greater by 15.78% than site 1 in term of lit/ha and by 31.4% in term of lit/hr, and this may be attributed to the greater draft of the soil at the Gadarifsite. Moreover,it was more firm and compact and higher values of clay ratio, moisture content and cone index leading to increase the machine draft, and with an increase in soil draft leads to increase the fuel consumption. This result agrees with the findings of (Al-Suhaibani and Al-Janobi, 1997) who found that, with an increase in machine draft lead to increase the fuel consumption.

Generally, the results of fuel consumption for the tested implement recorded normal consumption compared to the results found byMeselhy, (2014) who conducted an experiment to compare different types of chisel plow under different forward speed in sandy clay loam soil; he found that, the fuel consumption recorded values of 9.2lit/h, 10 lit/hr and 11.1 lit./hr for speeds of 3.5 km/hr, 5.5 km/hr and 7.5 km/hr respectively ,

The differences in field capacity for the two type of soils were statistically significant ($P<0.05$) (Table 3). From the results shown in figure (2) found that the average of actual field capacity (ha/hr) that obtained from the tested implement at two soil types, was (1.03 ha/hr) for the soil (1) and (0.83ha/hr) for soil (2). Generally it is clear that the soil (1) recorded better results in actual field capacity by (19.4%) compare to the soil (2)

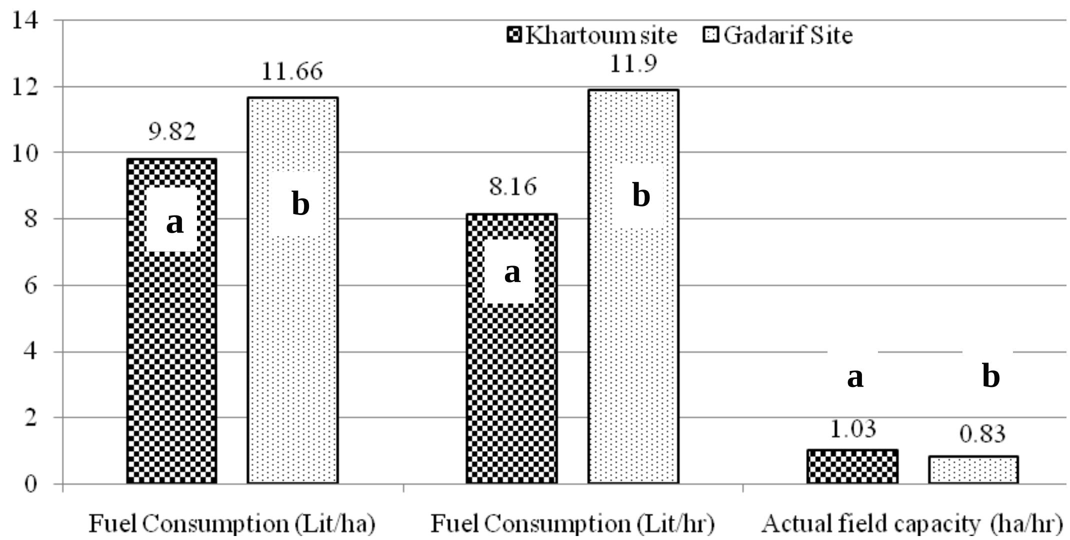


Fig. 2. Means of fuel consumption, actual field capacity and the working width of the Giad chisel plow at two sites.
(means followed by the different letter differ significantly according to LSD test



The average values for field efficiency of the tested implement during the tillage experiment at different type of soils are given in figure(3).The statistical analysis showed significance difference in the two types ofsoil ($P<0.05$) (Table 3). As shown in figure (3), the average value of field efficiency obtained from the field for both siteswas 86% and 81% for Soil (1) and soil (2) respectively. This shows a satisfactory performance as it is above the range of values obtained for cultivating operation by various researchers. The average increasing percentage for field efficiency at soil (1) was (5.81%) compared with soil (2).

In general, the results of effective field capacity and field efficiency for the tested implement it recorded normal performance as it was in or above the range of values obtained by other research for the chiseling operation. Meselhy, (2014) foundthat the field effective capacity and field efficiency were(0.53 ha/hr) and 64% of a traditional chisel plow with seven shanks, which was work in sandy clay soil with a speed of 5.5 respectively.

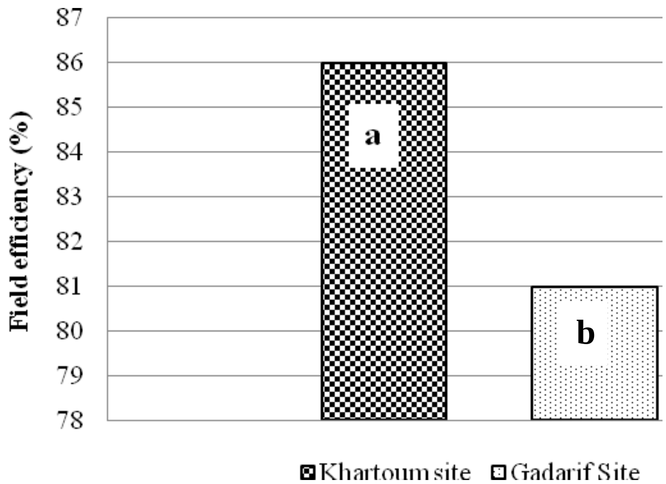


Fig. 3. Means of Field efficiency of the Giad chisel plow at two sites.
(means followed by the different letter differ significantly according to LSD test

## CONCLUSIONS

1) The performance evaluation parameters of the GIAD Chisel plow (CP007) such as the actual field capacity, the theoretical field capacity, the field efficiency and fuel consumption were measured and determined.
2) Generally, the results showed that, the fuel consumption was greater in soil2 than the soil 1 for the tested implement, while the cutting width, EFC and machine efficiency were greater in soil 2 than soil2.
3) The results of fuel consumption for the tested implement recorded normal or better consumption compared to the results found by others.
4) In general, the results of effective field capacity and field efficiency for the tested implement recorded normal performance as it was in or above the range of values obtained by other research for the chiseling operation.
5) GIAD chisel plow (CP 007) depending on results obtained could be working well under the various types of clay soils.

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