

PAPER • OPEN ACCESS

Effect of locally manufactured implement on energy utilization efficiency and operating costs

To cite this article: F J Taha and S Y Taha 2019 *J. Phys.: Conf. Ser.* **1294** 092018

View the [article online](#) for updates and enhancements.



IOP | ebooks™

Bringing you innovative digital publishing with leading voices to create your essential collection of books in STEM research.

Start exploring the [collection](#) - download the first chapter of every title for free.

Effect of locally manufactured implement on energy utilization efficiency and operating costs

F J Taha¹ and S Y Taha²

^{1,2}Dept. of Techniques Agricultural Machinery and Equipment

Technical College, Al-Mussaib – Al-Furat Al-Awsat Technical University, 51009 Babylon, Iraq

Email : alsaady2011@yahoo.com.

Abstract. This experiment was conducted at the field of Al-Mussaib technical institute dating 2018, to study effect of locally manufactured implement on soil disturbing and tillage costs, by using (Foton Lovol TB 450) tractor in this research with combined plow locally manufactured in the various tillage depths in clay loam soil. The research was studied two factors: - included tillage depths (10, 15 and 20 cm) and three practical speeds of the tractor (3.17, 4.39 and 5.48 km·hr⁻¹), the properties which were studied including power required for plowing, energy utilization efficiency, lost power due to slippage and operating costs. The research was performed by applying the factorial experiment according to completely randomized design with four replications. The results showed the following: increasing tillage depth from 10 to 15 and 20 cm caused an increasing in power required for plowing, energy utilization efficiency, lost power due to slippage and operating costs. Tillage depth 10 cm indicated significant superiority up on tillage depths 15 and 20 cm achieved lower power required for plowing, energy utilization efficiency, lost power due to slippage and operating costs. Increasing practical speeds of tractor from 3.17 to 4.39 and 5.48 km·hr⁻¹ caused an increasing in power required for plowing and lost power due to slippage, and decrease energy utilization efficiency and operating costs.

Keywords: locally manufactured implement, power required for plowing, energy utilization efficiency, lost power due to slippage, practical speeds and tillage costs.

1. Introduction:

The preparation of soil for agriculture requires the preparation of a good cradle of the seed helps the growth of seeds and the extension of roots in the soil to take enough water, air and nutrients and for this purpose are used different types of soil preparation equipment primary and secondary noted by AL-Jubory [4] and Marta [13]. The choice of suitable tillage equipment to create such conditions is of great importance in determining the quality of tillage and choosing the size of the suitable equipment must be accompanied by the most appropriate and best size for the tractor which is suitable for pulling this machine at the speed that suits it and the suitable working width which leads to increase productivity and reduce the cost of agricultural production. Primary tillage has always been one of the larger power consuming operations on a farm. Abdullah [2] reported that the speed of operation, width of implement, depth of tillage, type of soil and skill of operator affecting upon on power required for plowing. Draft and power requirements are very necessary parameters for evaluating the performance of tillage implements, as well as are considered as essential data when attempting to correctly match



tillage implement to a tractor such as indicated by Okoko et al [15]. Whereas, at present there is widespread combined agricultural equipment, which performs many agricultural operations with one passage, characterized by their economic importance including: rapid in completion of operation, minimize the time taken for any agricultural operations as well as reducing the number of tractors and equipment passing over the surface of soil thus reducing the cost of tillage reported by Boydas [6]. That causes the formation of (hard pan) in soil thus prevents the penetration of irrigation water through it confirmed by Nassir et al. [14]. In addition, it is very important to find out an early way leading to get the most out of plowing operation, one way to bypass these problems is the use of combined tillage implements in one field operation such as reported by ALkhafaji et al [5]. Purpose of manufacturing combined plow is to break up soil so that it facilitates free movement of the air into the soil which encourages the efficiency of microorganisms in the soil. Singh [16] reported that the penetration resistance is a measure of soil strength and an indicator of how easily roots can penetrate into soil, and thus a measure of plant growth and crop yield. Khorshid [10] noted that the soil resistance force to cutting and consistency increased with increasing tillage depth due to increased draft requirements due to increased tillage depth, which in turn increased soil resistance to cutting and consistency. The objective of the research is to study the effect of tillage depth and practical speed of tractor on energy requirements (power required for plowing, energy utilization efficiency) and evaluation the plowing by using locally manufactured implement (soil resistance force and tillage costs).

2. Methods and material

The experiment was carried out in the field of Al-Mussaib technical institute at April 2018, the soil moisture was 17 %. The research executed by using the factorial experiment design with (CRD) and four replications to study factors:

1-Practical speed of tractor: including (3.17, 4.39 and 5.48 km·hr⁻¹) by using Foton Lovol TB 450 tractor China origin 2009 with 60hp, weight of tractor 2140 kg., length 3980mm, width 1650mm and drawbar height is 62 cm.

2-Tillage depths: including (10, 15 and 20 cm) by using combined plow locally manufactured, which was designed by us and manufactured in a locally workshop for agricultural equipment in the district of Essaouira affiliated to the governorate of Kut, according to the engineering plans we have been provided them. Frame of this plow consists of two sections are the first section moldboard plow followed by second section with two gangs of flat disk harrows (8 disk) as shown in the figure below, weight of combined plow is 420 kg., plow dimensions (100 * 220) cm².

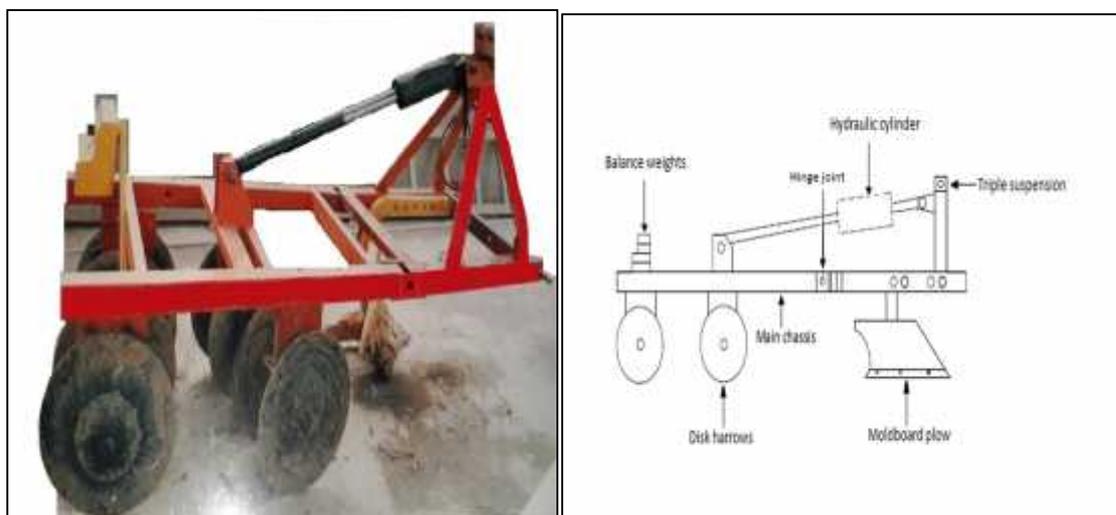


Figure (1) combined plow locally manufactured

Indicators Studied:

1- **power required for plowing:** The power could be calculated according to the following equation which was suggested by the researcher Khadr [9]:

$$P = D * P_s \quad \dots (1)$$

$$P = p \cdot r \cdot f \cdot p \quad (k)$$

$$D = d \quad (K)$$

$$P_s = p \cdot s \quad (m \cdot s^{-1})$$

The draft force estimated by using dynamometer, the practical speed of tractor (plowing speed) was calculated by running the tractor with the locally combined plow as an one mechanism unit in the field of the experiment and according to the tillage depth and speed determined for the purpose of determine the working time and for a distance of 40 m by leaving a distance of 10 m from the beginning of the allocated field line for the experiment of stability at the required speed and tillage depth, The plowing speed could be calculated according to the following equation which was suggested by the researcher Himoud [7]:

$$S_p = \frac{d}{T_p} \quad \dots (2)$$

$$S_p = p \cdot s \quad (m \cdot s^{-1})$$

$$d = L \cdot h \cdot d \quad (30)m.$$

$$T_p = p \cdot t_i \quad (s)$$

2- **Energy utilization efficiency:** The amount of energy used to disassemble the soil at a certain size; it was calculated according to the following equation which was estimated by the researcher Abdullah [2]:

$$\eta = \frac{1}{S_R} * 1 \quad \dots (3)$$

$$\eta = e \cdot \text{utili} \cdot e \cdot m^3 \cdot M^{-1}$$

$$S_R = q \cdot r \quad (Kn \cdot M^{-1})$$

Quality resistance could be calculated from the following equation:

$$S_R = \frac{F}{A} \quad \dots (4)$$

$$F = f \quad (K)$$

$$A = r \cdot a \quad (m^2)$$

Energy utilization efficiency was calculated by taking the inverse of the quality resistance by multiplying the numerator and denominator by distance unit (m) to convert KN to KJ and then multiplying the output by (1000) for the purpose of converting the energy utilization efficiency to MJ.

3- Lost power due to slippage: it was calculated from the following equation as indicated Abdul-Kreem [3]:

$$L_s = \frac{D * (S_T - S_P)}{3.6} \dots\dots (5)$$

$$L_s = k \cdot p \cdot d \cdot t_s \quad (K)$$

$$S_T = The \quad s \quad (K \cdot hr^{-1})$$

$$S_P = p \quad s \quad (K \cdot hr^{-1})$$

4- Tillage costs: it was calculated from the following equation as indicated [17] :

$$T_c = \frac{T_c + P_c}{P_r} \dots (6)$$

$$T_c = T \quad c \quad (l \cdot ha^{-1})$$

$$T_c = t \quad o \quad c \quad (l \cdot hr^{-1})$$

$$P_c = p \quad o \quad c \quad (l \cdot hr^{-1})$$

$$P_r = p \quad p \quad ha \cdot hr^{-1}$$

3. Results and discussion:

Table 1 shows the effect of practical speed and tillage depth on the power required for plowing (Kw). As the results of the statistical analysis showed that there are significant effect tillage depths by using L.S.D at the 0.05 level where the superiority tillage depth 10 cm achieved the less power required for plowing registered 5.638 KW, also the practical speed of tractor 3.17 km·hr⁻¹ achieved less power required for plowing 4.176 KW. The reason due to increasing the practical speed of the tractor with the penetration of plow weapons led to an increasing in the tractor horsepower consequently increased power required for plowing. As shown in table 1 that tillage depth 10 cm and 3.17 km·hr⁻¹ registered less power required for plowing amounted 3.655 KW, while tillage depth 20 cm and practical speed of tractor 5.48 km·hr⁻¹ registered high power required for plowing amounted 10.634 KW. The reason an increasing the power required for plowing with increasing tillage depth due to increasing the soil volume disturbed by plow weapons whenever the tillage depth is increased led to increase in the weight of accumulated soil opposite plow weapons, consequently increase power required for plowing that agreement with the researchers [11].

Table 1 Effect of practical speed and tillage depth on the power required for plowing (Kw)

Tillage depth (cm)	Practical speed (km·hr ⁻¹)			Means
	3.17	4.39	5.48	
10	3.655	5.756	7.503	5.638
15	4.194	6.452	8.748	6.465
20	4.680	7.842	10.634	7.719
LSD		0.495		0.208
Means	4.176	6.683	8.962	
LSD		0.237		

Table 2 shows the effect of practical speed and tillage depth on the energy utilization efficiency (m³·Mj⁻¹). As the results of the statistical analysis showed that there are significant effect tillage depths by using L.S.D at the 0.05 level where the superiority tillage depth 10 (cm) achieved the less energy utilization efficiency amounted 21.855 (m³·Mj⁻¹), also the practical speed of tractor 5.48 km·hr⁻¹ achieved less energy utilization efficiency 25.002 (m³·Mj⁻¹). As shown in table 2 that tillage depth 10 cm and 5.48 km·hr⁻¹ registered less energy utilization efficiency amounted 20.284 (m³·Mj⁻¹), while tillage depth 20 cm and practical speed of tractor 3.17 km·hr⁻¹ registered high energy utilization

efficiency amounted 37.651 ($\text{m}^3 \cdot \text{Mj}^{-1}$). The reason due to an increasing both of practical speed of tractor and tillage depth led to reducing energy utilization efficiency required where encountered by the plow to the soil thereby minimizing energy utilization efficiency this is consistent with the results found by the researchers [1,12].

Table 2 Effect of practical speed and tillage depth on the energy utilization efficiency ($\text{m}^3 \cdot \text{Mj}^{-1}$)

Tillage depth (cm)	Practical speed ($\text{km} \cdot \text{hr}^{-1}$)			Means
	3.17	4.39	5.48	
10	24.102	21.178	20.284	21.855
15	31.513	28.339	26.096	28.649
20	37.651	31.09	28.625	32.455
LSD		0.721		0.518
Means	31.089	26.869	25.002	
LSD		0.654		

Table 3 shows the effect of practical speed and tillage depth on the lost power due to slippage (Kw). As the results of the statistical analysis showed that there are significant effect tillage depths by using L.S.D at the 0.05 level where the superiority tillage depth 24 cm achieved less lost power due to slippage amounted 3.612 KW, also practical speed of tractor 3.17 $\text{km} \cdot \text{hr}^{-1}$ achieved less lost power due to slippage 2.937 KW. As shown in table 3 that tillage depth 10 cm and the practical speed of tractor 3.17 $\text{km} \cdot \text{hr}^{-1}$ showed less lost power due to slippage amounted 2.570 KW, while tillage depth 20 cm and practical speed of tractor 5.48 $\text{km} \cdot \text{hr}^{-1}$ registered high lost power due to slippage amounted 5.493 KW., the reason due to the tillage depth is directly proportional to the lost power due to slippage, also the theoretical speed of tractor it's one of the vehicles involved in calculating the lost power due to slippage this is consistent with the results indicated by the researchers [2,8].

Table 3 Effect of practical speed and tillage depth on the lost power due to slippage (Kw)

Tillage depth (cm)	Practical speed ($\text{km} \cdot \text{hr}^{-1}$)			Means
	3.17	4.39	5.48	
10	2.570	4.39	3.876	3.612
15	2.949	4.132	4.519	3.867
20	3.291	5.021	5.493	4.602
LSD		0.244		0.112
Means	2.937	4.514	4.629	
LSD		0.172		

Table 4 shows the effect of practical speed and tillage depth on the operating costs ($\text{ID} \cdot \text{ha}^{-1}$). As the results of the statistical analysis showed that there are significant effect tillage depths by using L.S.D at the 0.05 level where the superiority tillage depth 10 cm achieved the less operating costs amounted 31119 ($\text{ID} \cdot \text{ha}^{-1}$), also practical speed of tractor 5.48 $\text{km} \cdot \text{hr}^{-1}$ achieved less operating costs 24914 ($\text{ID} \cdot \text{ha}^{-1}$). As shown in table 4 that tillage depth 10 cm and 5.48 $\text{km} \cdot \text{hr}^{-1}$ registered less operating costs amounted 22255 ($\text{ID} \cdot \text{ha}^{-1}$), while tillage depth 20 cm and practical speed of tractor 3.17 $\text{km} \cdot \text{hr}^{-1}$ registered high operating costs amounted 59055 ($\text{ID} \cdot \text{ha}^{-1}$). The reason due to the practical speed of tractor that considered main element to determine the operating costs, also tillage depth is directly proportion to the operating costs this is consistent with the results indicated by the researchers [14,17].

Table 4 Effect of practical speed and tillage depth on the operating costs (ID·ha⁻¹)

Tillage depth (cm)	Practical speed (km·hr ⁻¹)			Means
	3.17	4.39	5.48	
10	40983	30120	22255	31119
15	49668	33185	25510	36121
20	59055	40540	26978	42191
LSD		36.93		33.72
Means	49902	34615	24914	
LSD		45.12		

4. Conclusions

- 1- The use of combined plow led to a reduction in the passage of tractor in the field this reduced formation (hard pan) in the soil.
- 2- The combined plow minimized the time required for the tillage process by carrying out flipping and pulverization the soil at the same time.

5. References:

- [1] Abdalla, O.A., A.I. Hamid, A.M. El-Naim and M. B. Zaied. 2017. Tractor Performance as Affected by Tilt Angle of Disc Plough under Clay Soil. Science and Technology Publishing .1(1): **13-21**.
- [2] Abdullah, A.A and G. A. Dahham.2014. Studying locally made moldboard plow shares performance and it's effect on some power requirements and plowing criteria. *Mesopotamia J. of Agric.* 42(1): **187-201**.
- [3] Abdul-Kreem, T. T. 2017. Studying of some Mechanical Indictors for Different Mechanized Units of Tillage Systems under Gypsiferous Soil Conditions. *Tikrit university journal of Agricultural sciences.*17 (2): **202-213**.
- [4] AL-Jubory, R. A.A., A. K.A.AL-Neama and A. M.A. Ali. 2012. Calculated fuel consumption and some mechanical parameters to New Holland tt75 front wheel assist tractor. *Diyala Journal of agricultural sciences.* 4(2): **137-144**.
- [5] ALkhafaji, A. J., A. A. Almosawi and K. M. Alqazzaz.2018. Performance of combined tillage equipment and it's effect on soil properties. *International Journal of Environment, Agriculture and Biotechnology.* 3(3): **799-805**.
- [6] Boydas, M. G. and N. Turgut .2007. Effect of tillage implements and operating speeds on soil physical properties and wheat emergence. *Turk J Agric For.*31: **399-412**.
- [7] Himoud, M. S. 2018. Evaluation of some performance indicators for the tractor (case jx75T). *Iraqi Journal of Agricultural Sciences.* 49(5):**609-621**.
- [8] Jebur, H.A., M. M. Mostafa, E. A. ElSahhar, M. A. El-Attar and M. A. Elnono .2013. Evaluation of farm tractor using variable weights on rear wheels during ploughing and sowing operation. *Misr. J. Ag. Eng.*, 30(3): **645 -660**.
- [9] Khadr, A. A. Khaffaf. 2008 .Effect of some primary tillage implement on soil pulverization and specific energy.*Misr journal of agricultural engineering.* 25(3): **731-745**.
- [10] Khorshid, F. F. 2016. Effect of Soil moisture content and tillage depth on tractor performance with using moldboard plow in silty-clay soil. *Journal of Zankoy Sulaimani.*www.jzs.universul.edu.iq.18-1 (part A):**221-226**.
- [11] Manjeet, P. R. Swarnkar, V.D. K.Kantilal, P.S. K. Jeetsinh and K. B. Chitharbhay .2016. Combined Tillage Tools– A Review. *Current Agriculture Research Journal.* 4(2):**179-185**.

- [12] Mankhi, M. M. and A. Jasim. 2012. Tractor speed, tillage depth and evaluation of performance power requirements and the pulling efficiency of the locally modified plow. *The Iraqi J. of Agric.Sci.*43 (5): **122-126**.
- [13] Marta, B. 2014. Book of Soil tillage. http://ljesnjak.pfos.hr/~jdanijel/literatura/Book_of_Soil_Tillage.pdf**108**.
- [14] Nassir, A.J., M. N. Ramadhan and S.D. Mohssein.2016. Studying Draft Requirements and Plowing Specifications for Chisel Plow in Silty Clay Soil. *AL-Muthanna Journal of Agricultural Sciences.* 4(1):**100-119**.
- [15] Okoko, P., E. A. Ajav and W. A. Olosunde. 2018. Draft and power requirements for some tillage implements operating in clay loam soil. *CIGR Journal Open access* at <http://www.cigrjournal.org>. 20(1): **95-102**.
- [16] Singh, M. U. 2018. Field Performance Evaluation of Tractor Drawn Tillage Implement Used in Hilly Regions of Arunachal Pradesh. *Indian Journal of Hill Farming.*31 (1): **87-94**.
- [17] Tahir, H. T. and A. H. Jarad. 2017. study the effect of front speed and working width on some performance indicators, power requirement and economic costs for different sizes of agricultural tractors. *The Iraqi Journal of Agricultural Sciences.*48 (6): **1782-1795**.