# EVALUATION THE EFFECT OF TRACTOR SPEEDS AND TILLAGE DEPTHS ON SOME TECHNICAL INDICATORS FOR PLOW LOCALLY MANUFACTURED

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## ABSTRACT

**This research was conducted at the field of Al-Mussaib technical institute dating April 2018, to study effect of tractor speeds and tillage depths on some technical indicators for plow locally manufactured, by using (New Holland TD5) tractor and (Massey Ferguson 375) tractor with combined plow locally manufactured in the various tillage depths as well as effect of tractor speeds in clay loam soil. This research was studied two factors: included three tillage depths (15, 20 and 24 cm). Moreover three practical speeds of the tractor (3.77, 5.19 and 6.45 km·hr$^{-1}$), the experiment was applied using factorial experiment according to the (CRD) with four replications. The results showed the following: increasing tillage depth from 15 to 20 and 24 cm caused an increasing in pulling force, drawbar power and soil volume disturbed, and decrease in the practical productivity. Tillage depth 15 cm indicated significant superiority up on tillage depths 20 and 24 cm achieved lower pulling force, drawbar power, while tillage depth 24 cm achieved higher soil volume disturbed and practical productivity. Increasing practical speeds of tractor from 3.77 to 5.19 and 6.45 km·hr$^{-1}$ caused an increasing in pulling force, drawbar power, soil volume disturbed and practical productivity. The practical speed of tractor 3.77 km·hr$^{-1}$ indicated significant superiority up on practical speeds of tractor 5.19 and 6.45 km·hr$^{-1}$ achieved lower pulling force, drawbar power, while the practical speed of tractor 6.45 km·hr$^{-1}$ achieved higher soil volume disturbed and higher practical productivity._**

**Keywords: pulling force, drawbar power, soil volume disturbed and practical productivity.**

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# تقييم تأثيرسرع الجرار وأعماق الحراثة على بعض المواصفات الفنية للمحراث المصنع محليا"

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## المستخلص

**نفذت الدراسة في أحدى الحقول الزراعية التابعة للمعهد التقني المسيب في شهر نيسان للعام 2018 لدراسة تقييم سرع الجرار وأعماق الحراثة على بعض المؤشرات الفنية للمحراث المصنع محليا,حيث تم في البحث أستعمال نوعين من الجرارات الزراعية (نيو هولاند تي دي 5) و (ماسي فوركيسن 375) والمحراث المركب المصنع محليا" مع تأثيرأعماق حراثة مختلفة تضمنت 15, 20 و 24 سم أستعمال سرع عملية مختلفة للجرار تضمنت 3,77 ، 5,19 و 6,45 كم ساعة$^{-1}$ مختلفة في تربة طينية مزيجية. نفذ البحث بأستعمال التجربة العاملية وفق التصميم العشوائي الكامل وبأربعة مكررات, أظهرت النتائج مايلي: زيادة عمق الحراثة من 15 سم الى 20 سم ثم الى 24 سم أدى الى الزيادة في قوة السحب وقدرة السحب وحجم التربة المثار والى الأنخفاض في الأنتاجية العملية للوحدة الميكنية (الجرارمع المحراث). أن عمق الحراثة 15 سم تفوق على عمق الحراثة 20 و24 سم في تسجيل أقل قوة للسحب وقدرة للسحب, بينما عمق الحراثة 24 (سم) حقق أعلى حجم للتربة المثار وللأنتاجية العملية. أن الزيادة في السرع العملية للجرار من 3,77 الى 5,19 ثم الى 6,45 كم ساعة$^{-1}$ أدى الى زيادة قوة السحب ,قدرة السحب ,حجم التربة المثار و الأنتاجية العملية, حيث تفوقت السرعة العملية للجرار 3,77 كم ساعة$^{-1}$ على السرع العملية للجرار 5,19 و 6,45 كم ساعة$^{-1}$ في تحقيق أقل قوة للسحب وقدرة للسحب, بينما السرعة العملية للجرار 6,45 كم ساعة$^{-1}$ في تحقيق أعلى حجم للتربة المثارة وأعلى أنتاجية عملية للوحدة الميكنية.____**

**الكلمات المفتاحية: قوة السحب , قدرة السحب , حجم التربة المثار و الأنتاجية العملية للوحدة الميكنية.**

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## INTRODUCTION

Tillage is one of the agricultural operations which aimed to create several soil conditions for seed growth through treatment of soil under unsuitable conditions for germination and then led to increase in production by using plowing equipment that reported by Akbarnia (1) and Al-Hashimy (3). 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. That causes the formation of (hard pan) in soil thus prevents the penetration of irrigation water through it confirmed by Altahan (4). 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. The pulling force required to pull a certain equipment towards the movement direction of the power source indicated by Jasim (10). Sometimes the line between the draw points on the tractor and the drawbar points on the equipment are not parallel to a movement that reported by Nassir (17).Requires agricultural tractors to provide high horsepower on drawbar during low velocities for drag without sliding. An important indicator to determine the performance efficiency for the actual practical productivity of the mechanistic unit it is considered the productivity the main factor in assessing the performance of plows and agricultural machines this is consistent with what has been showed by Nofal (18) and Nkakini (15). The practical productivity of the mechanistic unit is affecting by the following: machine type, machine, design, working width, practical speed, soil type and its physical properties. An increasing the forward speed of tractor (tillage speed) leads to disintegration and fragmentation of the soil into small granules.

## MATERIAL AND METHODS

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 (3.77, 5.19 and 6.45 $km \cdot hr^{-1}$) by using New Holland TD5 tractor Italian origin 2015 with 75hp, weight of tractor 3500 kg., distance between front and rear wheel is 270 cm., distance between front wheel is 175 cm., and drawbar height is 58.30 cm. By using Massey Ferguson 375 tractor 1995 with 75 hp, weight of tractor 3650 kg., distance between front and rear wheel is 269.5 cm, distance between front wheel is 172 cm, and drawbar height is 58 cm.

**2-Tillage depths:** including (15, 20 and 24 cm) by using combined plow locally manufactured which frame of this plow consists of three sections are the first section moldboard plow followed by second section with two gangs of flat disk harrows (8 disk), weight of combined plow is 485 kg., plow dimension (80 * 220) $cm^2$.

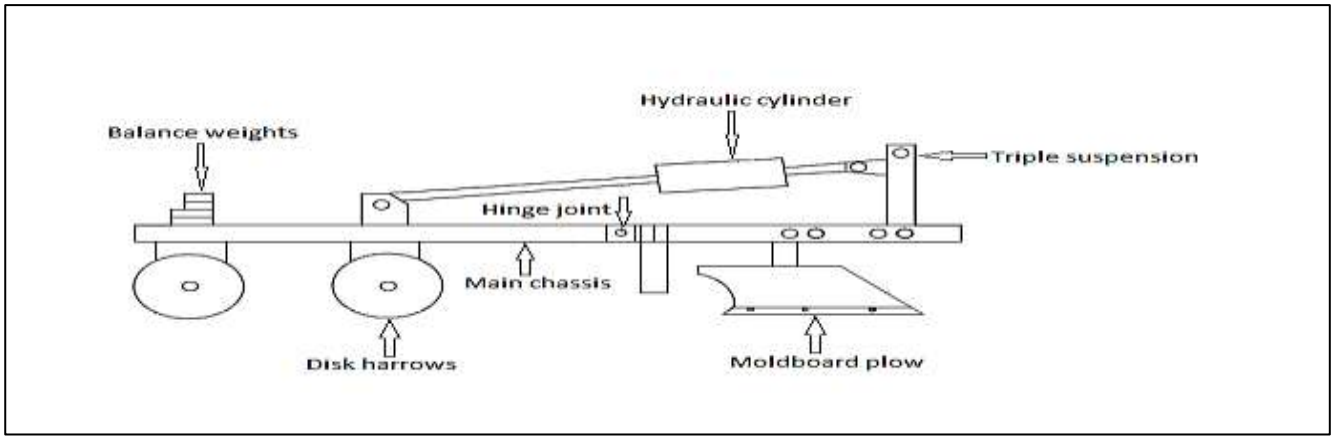


**Figure 1. combined plow**

**Indicators Studied:**

**1- Pulling force:** the pulling force was calculated by linking combined plow with second tractor (Massey Ferguson 375) then the two tractors moved in the field where the dynamometer is connected between them and the plow is almost touching the ground from it was measured rolling resistance force. Where tractors moved in the field and the dynamometer linked between them, and the plow in case of plowing according to required tillage depths and practical speed of tractor which it's measured pushing force, the pulling force was calculated by the following such as indicated by (11):

$$F_t = F_{pu} - F_{rm} \quad \ldots\ (1)$$

$F_t = pulling\ force\ \ (KN)$

$F_{pu} = plow\ pushing\ force\ during\ plowing\ operation\ \ (kn)$

$F_{rm} = rolling\ resistance\ force\ where\ plow\ is\ almost\ touching\ the\ ground\ \ (KN)$

**2-Drawbar power:** its actual tractor power which is used to drag agricultural equipment, the drawbar is measured at the end of the drag arm calculated by the following such as indicated by (8):

$$P_{et} = F_t * \frac{V_p}{3.6} \quad \ldots\ldots\ (2)$$

$P_{et} = drawbar\ power\ (kw)$

$F_t = pulling\ force\ \ (kw)$

$V_p = \ practical\ speed\ of\ tractor\ (km/hr.)$

**3-Soil volume disturbed:** It's the size of the soil that was raised by the plow during the fixed time, calculated by the following such as indicated by researchers (2, 5):

$$S.V.D = \frac{D_p * P_p * 10000}{100} \quad \ldots\ldots\ (3)$$

$S.V.D = soil\ volume\ disturbed\ \ (m^3/hr.)$

$D_p = actual\ tillage\ depths\ \ (cm)$

$P_p = practical\ productivity\ \ (ha/hr.)$

**4-Practical productivity:** The actual practical width was measured by measuring tape for each treatment separately. The practical productivity calculated by the following equation (19):

$$P_p = \frac{B_p * V_p * S * 1000}{10000} \quad \ldots\ldots\ (4)$$

$P_p = 0.1 * B_p * V_p * S\ \ (ha/hr.)$

$P_p = practical\ productivity\ \ (ha/hr.)$

$B_p = actual\ plow\ depth\ \ (m)$

$V_p = practical\ speed\ \ (km/hr.)$

$S = time\ utilization\ coefficient\ about\ 0.80\ (km/hr.)$

## RESULTS AND DISCUSSION

Table 1 shows the Effect of practical speeds of tractor and tillage depths on the pulling force KN. 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 15 cm achieved the less pulling force registered 4.534 KN, also the practical speed of tractor 3.77 km·hr$^{-1}$ achieved less pulling force 4.625 KN. 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 pulling force. As shown in table 1 that tillage depth 15 cm and 3.77 km·hr$^{-1}$ registered less pulling force amounted 4.149 (KN), while tillage depth 24 cm and practical speed of tractor 6.45 km·hr$^{-1}$ registered high pulling force amounted 5.955 KN. The reason an increasing the pulling force with increasing tillage depth due to increasing volume of soil block disturbed by plow weapons whenever the tillage depth is increased led to increase in the weight of accumulated soil opposite plow weapons, consequently increase pulling force that agreement with the researchers (16,17).

**Table 1. Effect of practical speeds of tractor and tillage depths on the pulling force (KN)**

| Tillage depths (cm) | Practical speeds of tractor (km·hr$^{-1}$) | | | Means |
|---|---|---|---|---|
| | 3.77 | 5.19 | 6.45 | |
| 15 | 4.149 | 4.622 | 4.830 | 4.534 |
| 20 | 4.614 | 5.050 | 5.319 | 4.994 |
| 24 | 5.113 | 5.573 | 5.955 | 5.547 |
| L.S.D | | 0.451 | | 0.175 |
| Means | 4.625 | 5.082 | 5.368 | |
| L.S.D | | 0.196 | | |

Table 2 shows the Effect of practical speeds of tractor and tillage depths on the drawbar power. 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 15 (cm) achieved the less drawbar power amounted 4.463 KW, also the practical speed of tractor 3.77 km·hr$^{-1}$ achieved less drawbar power 5.726 KW. As shown in table 2 that tillage depth 15 cm and 3.77 km·hr$^{-1}$ registered less drawbar power amounted 3.359 KW, while tillage depth 24 cm and practical speed of tractor 6.45 km·hr$^{-1}$ registered high drawbar power amounted 13.686 KW. The reason due to an increasing both of practical speed of tractor and tillage depth led to an increasing pulling force required where encountered by the plow to the soil thereby increasing drawbar power this is consistent with the results found by the researchers(10,20).

**Table 2. Effect of practical speeds of tractor and tillage depths on the drawbar power (KW)**

| Tillage depths (cm) | Practical speeds of tractor (km·hr$^{-1}$) | | | Means |
|---|---|---|---|---|
| | 3.77 | 5.19 | 6.45 | |
| 15 | 3.359 | 4.497 | 6.532 | 4.463 |
| 20 | 5.552 | 7.725 | 8.917 | 7.398 |
| 24 | 9.268 | 11.469 | 13.686 | 11.474 |
| L.S.D | | 0.212 | | 0.139 |
| Means | 5.726 | 7.897 | 9.712 | |
| L.S.D | | 0.148 | | |

Table 3 shows the Effect of practical speeds of tractor and tillage depths on the soil volume disturbed. 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 the high soil volume disturbed amounted 885.93 m$^3$/hr., also practical speed of tractor 6.45 km·hr$^{-1}$ achieved high soil volume disturbed 783.52 m$^3$/hr. As shown in table 3 that tillage depth 24 cm and the practical speed of tractor 6.45 km·hr$^{-1}$ showed high soil volume disturbed amounted 938.82 m$^3$/hr., while tillage depth 15 cm and practical speed of tractor 3.77 km·hr$^{-1}$ registered less soil volume disturbed amounted 513.11 m$^3$/hr., the reason due to the practical speed of tractor is directly proportional to the soil volume disturbed, also tillage depth it's one of the vehicles involved in calculating the soil volume disturbed this is consistent with the results indicated by the researchers (9,15).

**Table 3. Effect of practical speeds of tractor and tillage depths on the soil volume disturbed (m$^3$/hr.)**

| Tillage depths (cm) | Practical speeds of tractor (km·hr$^{-1}$) | | | Means |
|---|---|---|---|---|
| | 3.77 | 5.19 | 6.45 | |
| 15 | 513.11 | 584.50 | 638.21 | 578.607 |
| 20 | 654.42 | 718.27 | 773.53 | 715.405 |
| 24 | 822.63 | 896.34 | 938.82 | 885.93 |
| L.S.D | | 16.37 | | 10.25 |
| Means | 663.387 | 733.037 | 783.52 | |
| L.S.D | | 11.14 | | |

Table 4 shows the Effect of practical speeds of tractor and tillage depths on the practical productivity. 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 15 cm achieved the high practical productivity amounted 0.256 ha/hr., also practical speed of tractor 6.45 km·hr$^{-1}$ achieved high practical productivity 0.303 ha/hr. As shown in table 4 that tillage depth 15 cm and 6.45 km·hr$^{-1}$ registered high practical productivity amounted 0.337 ha/hr., while tillage depth 24 cm and practical speed of tractor 3.77 km·hr$^{-1}$ registered less practical productivity amounted 0.127 ha/hr. The reason due to the practical speed of tractor that considered main element to determine the practical productivity, also practical speed of tractor is directly proportion to the practical productivity this is consistent with the results indicated by the researchers (6, 19).

**Table 4. Effect of practical speeds of tractor and tillage depths on the practical productivity (ha/hr.)**

| Tillage depths (cm) | Practical speeds of tractor (km·hr$^{-1}$) | | | Means |
|---|---|---|---|---|
| | 3.77 | 5.19 | 6.45 | |
| 15 | 0.183 | 0.249 | 0.337 | 0.256 |
| 20 | 0.151 | 0.226 | 0.294 | 0.224 |
| 24 | 0.127 | 0.185 | 0.278 | 0.197 |
| L.S.D | | 0.028 | | 0.013 |
| Means | 0.154 | 0.220 | 0.303 | |
| L.S.D | | 0.019 | | |

The use of the combined plow led to the flipping and harrowing of the soil at the one passage. The use of the combined plow led to the shortcut in time, as well as the speed of completion the required tillage operation. Less economic cost in terms of working hours required for the tillage and reducing the fuel consumed from tractor.

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