Studying the power losses of two and four wheel drive tractors (2WD and 4WD) of Massy Ferguson (2680)

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ABSTRACT

Massy-Ferguson (2680) tractor was used as 2WD and 4WD tractor to study the power losses at the traction wheels . The experiments were conducted using subsoiler to load the tractor .The experiments parameters are the subsoiler operating depths 20,30,40,50,and 60 cm four forward speeds were used G1= 0.39 , G2 = 0.51 , G3 = 0.72 and G4 = 1.20 m / sec for 2WD and 4WD . The experiments were conducted in silty clay soil under hard, semi hard and fragile soil conditions . The results showed that the power losses increased as the draft force increased for 2WD and 4WD tractors and it was higher for 2WD than 4WD by 43 % . The power losses also increased with tractor forward speed from G1 to G4 and they were 9.38 kW and 5.4 kW for 2WD and 4WD tractors respectively . The power losses increased as the slipping increase for both tractors , and they decreased by 30 % as the mobility number increased from 25 to 58 for 2WD and 4WD tractors.

Key words: power losses , slipping , draft force , forward speed , mobility number

INTRODUCTION

The tractor is considered the main energy source for agricultural machinery in the field, where various agricultural machinery derives most of its energy in the tractor whether energy used in the withdrawal of machines is used in the preparation of soil cultivation and field crops or rotation energy used to pumps and machines to cut grass and other such energy must be provided by the tractor in most circumstances must be preserved from the loss within acceptable limits, so that it does not lead to further loss of operating costs and, consequently, low productivity. The research indicates that 20 to 55% of the power of the tractor available lost during the interaction of the tire with the surface soil because of a slipping and rolling resistance, which are the major factors in power losses as well as the corrosion of the tractor tires and compaction soil which was causing a drop in crop productivity [3;8] and used [6] The tractive efficiency for measuring the performance of tractor and which reflects the ratio between the drawbar pull power to the engine power of this means that efficiency includes the efficiency of internal transport for the instruments of the transfer of power and the loss by the slipping and rolling resistance. In a study conducted by [1] in which he explained that when adding weight to the wheels of the tractor this leads to a decrease in the power losses by slipping. Also [10 ;11] referred to the decreasing in the efficiency of the work of the tractor returns to the power losses because of a slipping caused traction wheels, and rolling resistance. While each explained from [5;9] to the loss of a large part of the tractor power with increasing the forward speed for the tractor to overcome rolling resistance and slipping. Also many researchers [4;12;7;13] explained the best value slips and where the work of the tractor with high efficiency is at 10% which then less power losses. They also indicated a decrease in the value of slipping into the soil solid, at high mobility number and heightened in to the soil fragile, at low mobility number. Also [14] explained when increasing power lost between the tractor tires and surface soil by slipping This leads to increased power

losses for tractor until up the proportion of slipping to 65% and then be a very clear and significant power losses. He also pointed to the need to reduce slipping and rolling resistance, to the least that could be to get the efficiency of the work of high for tractor and the exploitation of optimum capacity. In a study conducted by [2] In which he explained when to increase the proportion of slipping this leads to increasing the power losses because of the slipping and this loss is increasingly whenever decreased soil force.

The aim of the research is to study the power losses caused for tractor because of a slipping and rolling resistance, and compared to this loss for tractor between four wheel drive (4WD) and rear two wheel drive (2WD).

MATERIAIS AND METHODS

THE MATERIALS USED IN THE EXPERIMENT

1 - Tractor Massy Ferguson (2680) : the tractor, which was conducted by research, It is of the type, which gives four wheel drive (4WD) and rear two wheel drive (2WD) by the arm to the fund in gearbox. The tractor diesel-engine provider consists of six cylinders and operates four strokes, the power of the engine 130 hP, Equipped with gearbox gives eight forward speeds, four heavy and four lights. The size of rear tires is (16.9 R38) and the size of the front tires is (12.4 R28).

2 - Tractor Massy Ferguson (285S) : this was used the tractor for attaching the plough and to raise and Land it in the soil by the hydraulic system ,also in the experiments ,the gearbox for this tractor was uneffective.

3 - Subsoiler plough: was testing the use by subsoiler which consists of one leg , length and rake angle 100 cm , 67 degree respectively and rake angle to penetrate the foot 30 degree . used plough in five of the working depth 20, 30, 40, 50 and 60 cm for the purpose of loading the engine of the tractor Massy Ferguson (2680) of the different draft force .

METHODS OF WORK

measured the forward speed (theoretical speed) for tractor Massy Ferguson (2680) by measuring the time required to distance 20 m on the straight asphalt street after 1500 rpm to stabilize the engine speed and repeated the operation three times of each forward speed using, G1= 0.39 , G2= 0.51,G3= 0.72 and G4= 1.20 m/sec for 2WD and 4WD .

Calculate the theoretical speed by using the following equation :

$$V_t = D / t \qquad (1)$$

where:

V_t = theoretical speed (m/sec)

D = traveled distance (20 m)

t = The spent time in the distance of 20 m, (sec)

measured the actual forward speed for tractor Massy Ferguson (2680) In the field, Where used with pull of the tractor Massy Ferguson (285S) and subsoiler plough. The engine speed for tractor Massy Ferguson (2680) was stabilize on 1500 rpm, Also , stabilized all the working depths and forward speed. In addition, the time was measured for distance 20 m , and repeated the operation three times for all the working depths and all the forward speed and for both the situations 2WD and 4WD.

The draft f

orce has been measured at the same time as the measurement of actual forward speed using the Dynamometer as a link between the two tractors. It was the process of measuring the draft force for all the working depths and all the forward speed and for both the situations 2WD and 4WD.

Calculate the draft force from the following equation :

$$F = 0.8 + 0.44165\ X \qquad (2)$$

Where:

F = draft force (kN)

X = reading Dynamometer (bar)

According to a slipping of the equation become :

$$S = (V_t - V_a) / V_t \qquad (3)$$

Where:

S = slipping (%)

V_t = theoretical speed (m/sec)

V_a = actual forward speed (m/sec)

Calculate the drawbar pull power from the following equation :

$$PF = F \times Va \quad (4)$$

Where:
PF = drawbar pull power (kW)
F = draft force (kN)
V_a = actual forward speed (m/sec)

Calculate the power at driving wheels from the following equation :

$$Pd = H \times V_t \quad (5)$$

Where:
Pd = power at driving wheels (kW)
H = Thrust .
The Thrust has been calculated as following:

$$H = F + R \quad (6)$$

Where
R = Rolling resistance (kN)

According to the power losses of the equation become :

$$PL = Pd - PF \quad (7)$$

Where:
PL = power losses (kW)
It was the expense of mobility number dependent on the method adopted by [14] and using the following equation:

$$M = Cbd / w \quad (8)$$

Where:
M = mobility number
C = cone Index (kN/m^2)
b = width of the rear tire (m)
d = diameter of the rear tire (m)
w = dynamic weight to rear tire (kN)

Calculate the Resistance to penetrate the soil by using the penetrometer hydraulic during different work depths and three different sites hard , semi-hard and fragile soil as following :

$$P = 0.07065x \quad (9)$$

Where:
P = the penetrating force (kN)
X = pressure force measured by the penetrometer (bar)
0.07065 = constant calibration
Where calculated to resist penetration of the dividing by the penetrating force on an area of the base of the cone depending on of the following equation:

$$\text{Cone Index} = p / a \quad (10)$$

RESULTS AND DISCUSSION

The Results indicated that an increase in power losses with increasing draft force for tractor Massy Ferguson (2680) and for both the situations 2WD and 4WD. as shown in figure (1). This is due to increase the thrust of tires in the soil with an increase in the draft force, This leads to increased displacement of soil and, consequently, increasing slipping traction tires for tractor This is causing an increase in the power losses, as well as for the lost power because of rolling resistance which means the lost power to overcome the obstacles to the movement of the tractor tires. The results showed that the value of power losses various for tractor between both situations 2WD and 4WD. where in the situation 2WD it was observed when increasing the draft force from 10 kN to 30 kN was the value of the power losses 10.5 kW, while in the situation 4WD at the same increase the draft force has been the value of the power losses 5.5 kW. Due to decrease in the value of slipping for tractor in the situation 4WD compared with the situation 2WD which led to lower lost power .

The results show from the figure (2) that the power losses is increased for tractor with increasing forward speed with both situations 2WD and 4WD.This is due to increase the displacement of soil with an increase in forward speed, consequently, increasing slipping traction tires this leads to increase the power losses by slipping. In addition, the rolling resistance an increase with increasing the forward speed ,this is causing an increase in the power losses. Also the value of the power losses with an increase the forward speed was the largest for tractor in the situation 2WD compared with the situation 4WD because of reducing of the slipping in the tractor tires at the situation 4WD compared with the tractor at the situation 2WD.

Results of the current study as shown in figure (3) which explain the relationship between slipping and power losses for tractor, increase in power losses for tractor with an increase in the slipping with both situations 2WD and 4WD due to a lower forward speed for tractor with an increase in the slipping, which leads to a decrease in the drawbar pull power and, consequently, increasing the power losses. It also notes that power losses were the largest for tractor in the situation 2WD of the situation 4WD for the same value of the slipping. Where it was noted at the value of a slipping in the value of 30 % the power losses in the situation 2WD was 12.3 kW while in the situation 4WD for the same value slipping was the value of the power losses 7 kW because the power available draw in the situation 4WD the largest of the situation 2WD thus, the decrease rate of forward speed be the largest in the situation 2WD than in the situation 4WD.

According to the results of figure (4) to a decrease the power losses with increase the mobility number for tractor in the both situations 2WD and 4WD. This is due to increase the strength of soil, which leads to decrease the proportion of slipping on tires and rolling resistance, due to a decrease in the value of immersing tires in the soil. While results showed that the power losses were less in the situation 4WD compared with the situation 2WD. Where it was noted at the mobility number (40) was the power losses in the situation 2WD 9 kW, while at the situation 4WD was the power losses 5.2 kW due to the reducing of the slipping for tractor when the situation 4WD compared with the situation 2WD, which caused a decrease in the value of the power losses.

CONCLUSIONS

The conclusion of this study as follows:

1 - The power losses increase with increasing the draft force for tractor MF (2680) and for situations 2WD and 4WD.

2 - The power losses increase with increasing the forward speed for tractor MF (2680) and for situations 2WD and 4WD.

3 - The power losses increase with increasing the slipping for tractor MF (2680) and for situations 2WD and 4WD.

4 - The power losses decrease with increasing the mobility number .

5 - The power losses for tractor MF (2680) in the situation 4WD was much less compared with the situation 2WD.

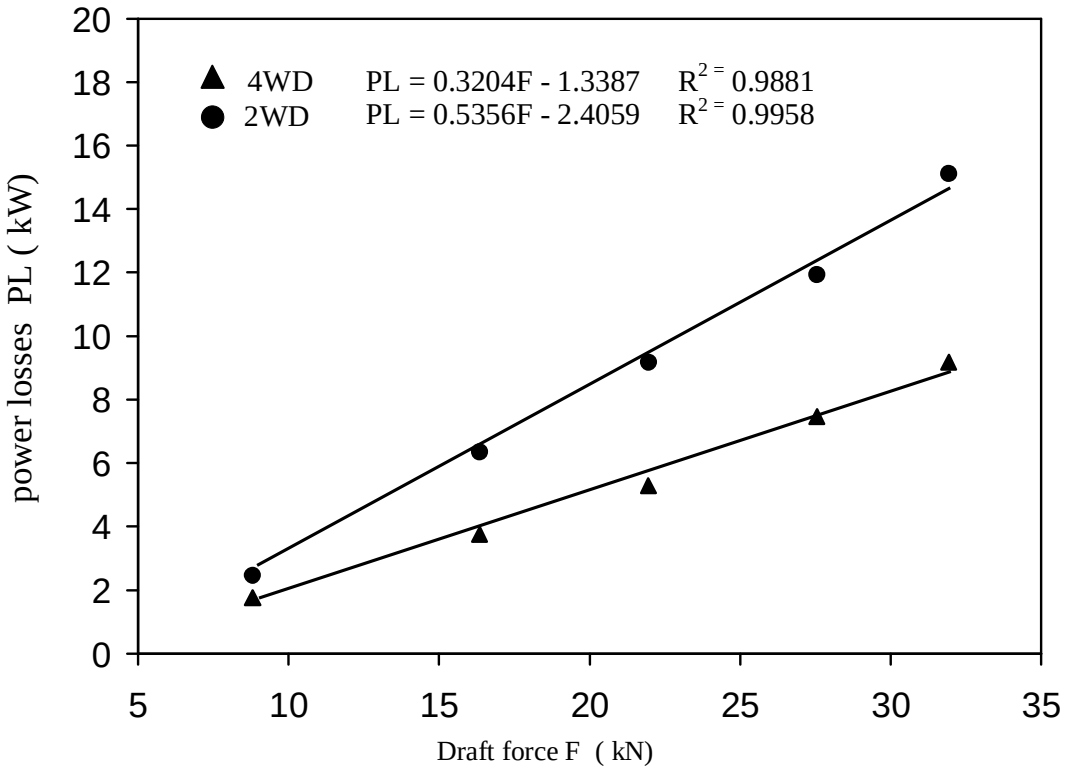

Figure (1) : The relationship between the draft force and the power losses for tractor MF(2680)

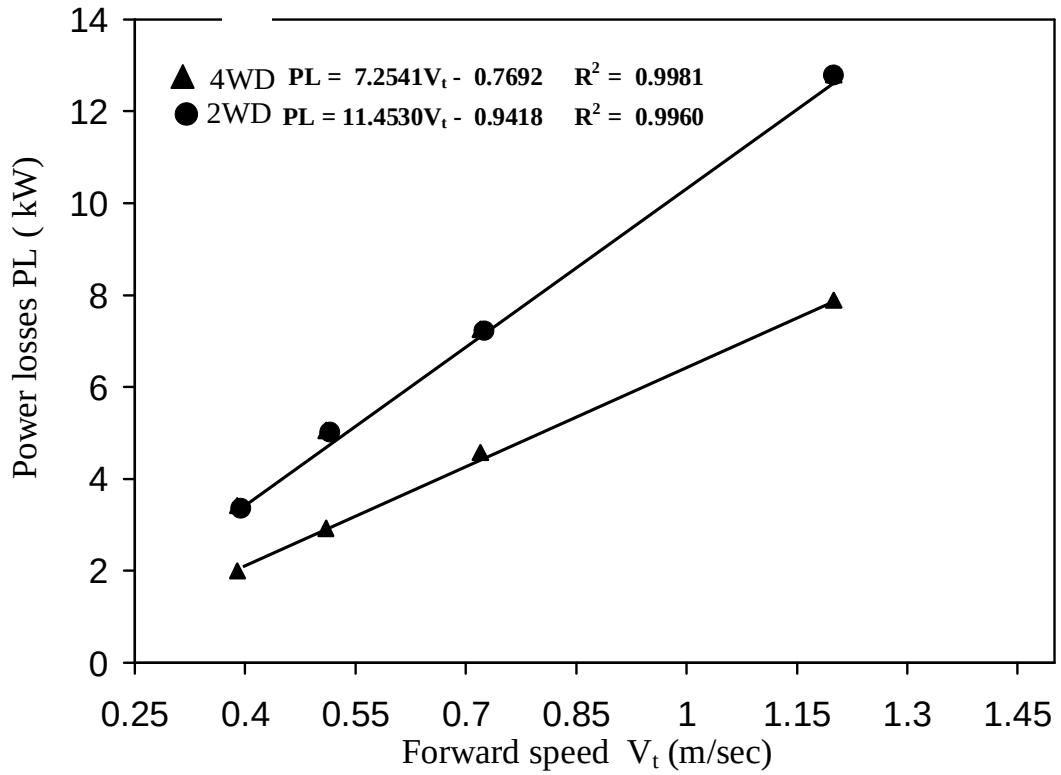

Figure (2) : The relationship between the forward speed and the power losses for tractor MF(2680)

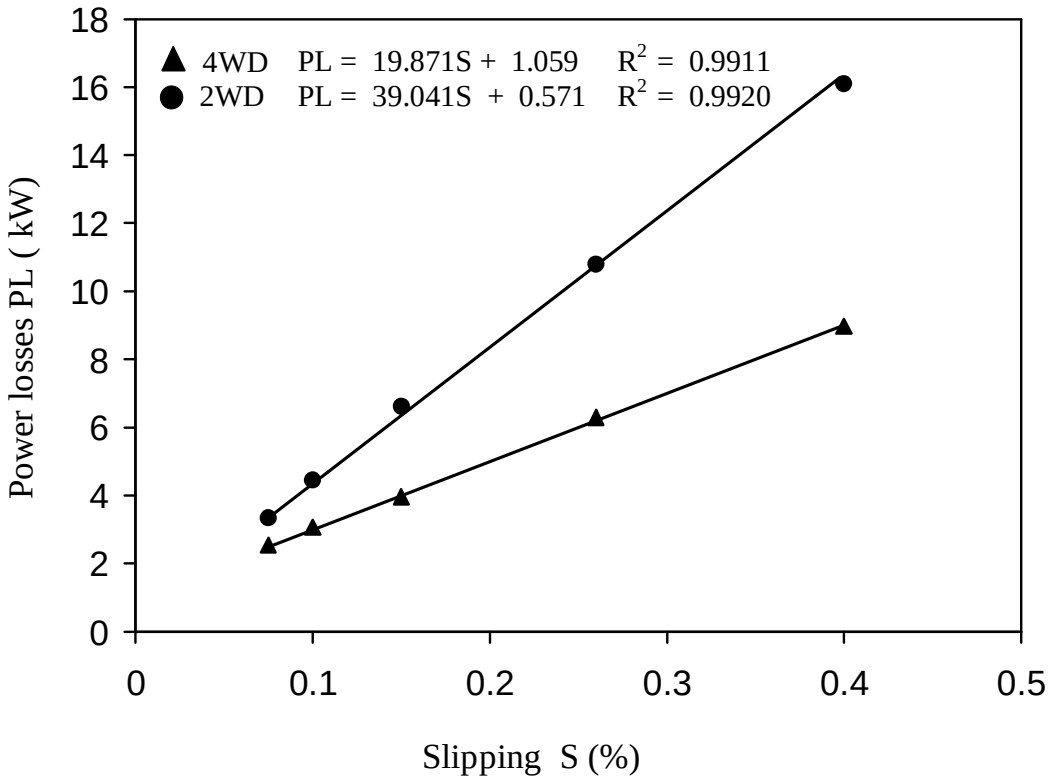

Figure (3) : The relationship between the slipping and the power losses for tractor MF(2680)

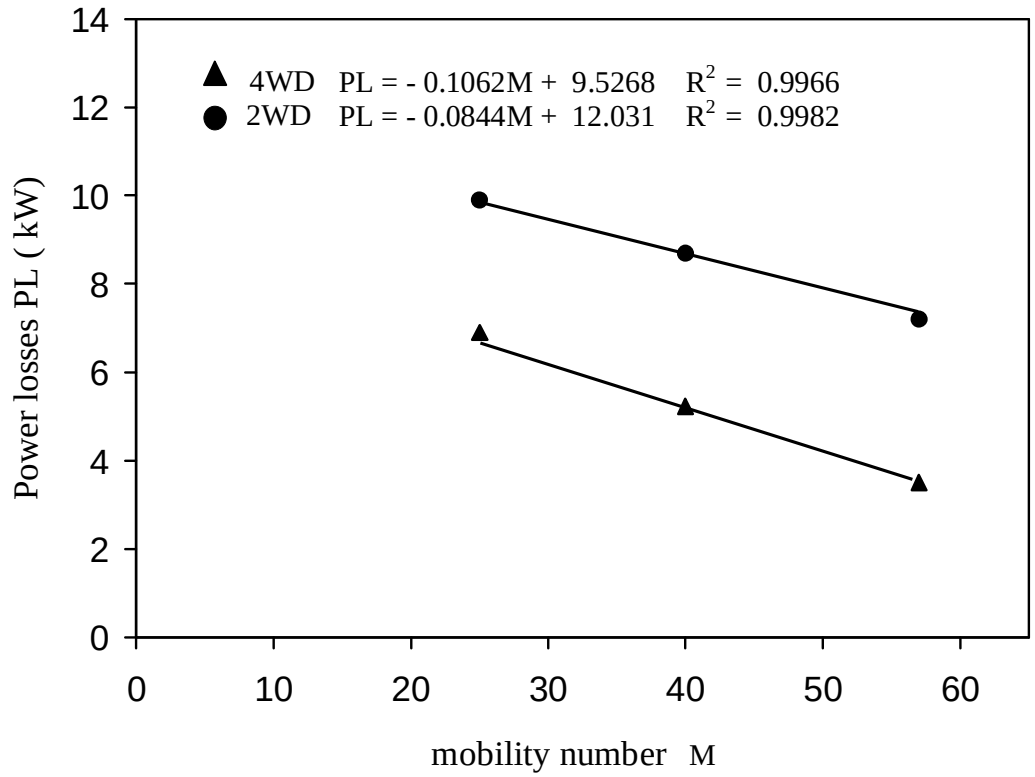

Figure (4) : The relationship between the mobility number and the power losses for tractor MF(2680)

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دراسة الفقد بالقدرة في الساحبة (2680) Massy Ferguson ذات الدفع الرباعي (4WD) ومقارنته مع الدفع الثنائي الخلفي (2WD)

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الخلاصة

استخدمت في هذه الدراسة ساحبة (2680) Massy Ferguson تولد دفعا" ثنائيا" بعجلاتها الخلفية (2WD) ودفعا" رباعيا" بعجلاتها الخلفية والأمامية (4WD) لغرض دراسة الفقد الحاصل في القدرة ولكلا الوضعين (2WD) و (4WD) . كما استخدم محراث تحت التربة احادي السلاح لغرض تحميل محرك الساحبة حيث تم استخدامه على اعماق حراثة مختلفة وهي cm (20 ، 30 ، 40 ، 50 ، 60) . كما استخدمت اربع سرع أمامية للساحبة وهي m / sec (G1= 0.39 , G2= 0.51 , G3= 0.72 , G4 = 1.20) لكلا الوضعين (2WD) و (4WD). واجريت التجارب في تربة طينية غرينية وفي ثلاثة مواقع (تربة صلبة وشبة صلبة وهشة) .

أظهرت الدراسة زيادة الفقد بالقدرة مع زيادة قوة السحب وللوضعين (2WD) و (4WD) وكانت نسبة الفقد بالقدرة للساحبة في الوضع (2WD) أكبر منها في الوضع (4WD) وبحدود % 43 . كما بينت النتائج زيادة الفقد بالقدرة مع زيادة السرعة الامامية حيث عند زيادة السرعة الامامية من السرعة الاولى (G1) الى السرعة الرابعة (G4) زاد الفقد بالقدرة ليصل الى (9.38 kW) عند الوضع (2WD) بينما بلغت الزيادة في القدرة المفقودة (5.4 kW) عند الوضع (4WD). كما اشارت النتائج الى زيادة الفقد بالقدرة مع زيادة الأنزلاق للساحبة ولكلا الوضعين(2WD) و(4WD). كما اوضحت النتائج الى انخفاض الفقد بالقدرة مع زيادة رقم قابلية الحركة حيث قل الفقد بالقدرة بحدود 30% عند زيادة رقم قابلية الحركة من (25) الى (58) وللوضعين (2WD) و (4WD) .