IJESRT

INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

EVALUATION PERFORMANCE OF TRANSPORT VEHICLE ON DIFFERENT SURFACES

Hussein. A. Jebur*
* Dept. of Agric. Mach. and Equip. / Coll. of Agric. / Univ. of Baghdad/ Iraq.

ABSTRACT

This study was carried out at farm of El-Gemmaiza Agriculture Research Station, El-Garbia Governorate Egypt, to determine the performance characteristics of an agricultural transport. The performance of this transportation was compared between three surfaces (asphalt, dusty and field). The study was concentrated on the rate of drawbar pull, slip ratio, tractive efficiency and specific energy per unit area. The comparison was made under three different surfaces (asphalt, dusty and field), different traveling speeds from (3.38 to 6.55 km/h) and variable weights (0 and 300 kg). The results showed that the highest value of the tractive efficiency 60.20 % was obtained at traveling speed 4.00 km/h with weight on rear wheel on asphalt surface. The highest value of specific energy 1.93 kW.h/ton during use of ballast on rear tractor wheels at traveling speed 3.38 km/h on field surface.

KEYWORDS: Tractor, Energy, Transportation, Weight, Power.

INTRODUCTION

Farm transport is considered an important farm work that agricultural tractor work it because it required highest power and the conducting multiple transport in the field fertilizer, seed, labors and all service operations of the crop. Tractor is central to mechanization to reduce the drudgery of farm work, increase productivity of farm workers,**)** and improve timelines and quality of farm work and cultivation. **Fouad et al (2004)** indicated that the used tractor power is relatively much higher than that mentioned actually required which means a waste of power. Thus the tractor power used in transportation has to be reconsidered. Another alternative is to increase the load of the trailer with adapted new design. **Whitey and Cochran (1978)** concluded that a transport system depends upon several components, which are identified as follows: loader or chopper harvester rate, number of transport units, capacity of each transport unit, field to mill distance, average speed of transport units and mill waiting time. **Crossley et al (1983)** mentioned that the transportation is a vital part of many production systems, as products which remain at the site of production cannot normally be regarded as having entered the marketing system. The initial change of location from production site to the first stage of the marketing infrastructure is therefore a significant one. **Abdel Mawla (2011)** mentioned that the Agricultural transport is an important item that has to be mechanized because it requires intensive power. **Klatzel (2000)** farm transportation plays a key role in the agricultural and economic development of many nations as it provides access for extension agents to transfer new and improved agricultural technologies to the rural and farming communities, timely delivery of inputs to the farm and evacuation of harvests to the urban areas where they are mostly demanded. These ensure improvement in agricultural production, food availability in urban areas and improvements in the economy of the rural communities. **Kanali et al (1997)** the proportion of trailers carrying loads in excess of established safe axle loads was assessed. **Abdel Mawla (2000)** mentioned that the trailers pulled by tractors are often used to transport cane especially when field to store distance more than one kilometer. According to **Matete (1989)** the high demand for sugarcane as a raw material for the factory and the high cost per tone of sugarcane transported by the smaller trailers has necessitated the use of heavy trailers hauled by powerful tractors with a sugarcane payload of over 118 kN on a single axle trailer which is much more higher than recommended payload. Therefore, the general objectives of this research were to investigate the performance characteristics of a transport vehicle. To accomplish the objective of the study was survey and analysis comparison between three surfaces (asphalt, dusty and field) and their relationship to the performance of a transport process.

MATERIALS AND METHODS

The experimental work was carried at farm of El-Gemmaiza Agriculture Research Station, El-Garbia Governorate Egypt.

Tractors

Two tractors were used in the experiment, namely, New Holland 90 hp. The specifications of the used tractor:

Type	New Hollland
Engine HP at R.P.M	90 at 2500
Engine type	IVECO
Fuel type and No. of cylinders	Diesel, 6 cylinders
Bore and stroke (mm)	104 × 132
P.T.O. (rpm)	540-2200
Tire size front, rear	7.50-20, 16.9/14-38
Capacity (cm^3)	6728
Cooling system	Water
Weight (kg)	4930

Tractor trailer

The specification of the Trailer:

Make	Egypt
Capacity (m^3)	4
Length (m)	4
Width (m)	2
Height (m)	0.5
Weight (kg)	2750

Measuring instruments

1. Spring dynamometer
2. Stop watch.
3. Fuel consumption apparatus by volume.
4. Tape 50 m.

Parameters Measurements:

Fuel consumption determination

The fuel consumption was measured as follows: fuel tank is filled to full capacity before and after the test. Amount of refueling after the test is the fuel consumption for the test.

Determination of the tractive force

The spring dynamometer was fixed between a rubber wheel tractor and the agricultural working unit during transportation when recording the pull required for moving the unit of Newholand 110-90 tractor.
During the operation the following measurement were obtained:

A = rolling resistance for the working unit (tractor + trailer).
B = the recording pull by using trailer.
Net drawbar pull, kN = B - A

$$= \frac{60}{Total\ time\ consumed\ \ per\ \min ute} \ ...cycle\,.h^{-1}$$

***Wheel slip*:**

The slippage percentage was measured by using the following formula:

$$S = \frac{FS_1 - FS_2}{FS_1} \times 100$$

Where

S : wheel slip, %
FS_2 : traveling speed with load km/h, and
FS_1 : traveling speed without load km/h.

$$E.P.R = \left(F_C \times \frac{1}{3600}\right) \times \rho_f \times L.C.V \times 427 \times \eta_{th} \times \eta_m \times \frac{1}{75} \times \frac{1}{1.36}$$

***Tractor power balance*:**
a. Drawbar power (ND):
Drawbar Power (kW) = Drawbar pull (kN) × traveling speed (km/h)/3.6
*b- Power consumed by rolling resistance (NR)***:**
Rolling resistance (kW) = rolling resistance (kN) × traveling speed (km/h)/3.6
*c- Power consumed by slip (NS)***:**

$$NS = [ND + NR] \times \frac{S}{100 - S}$$ **[3]**

Where:
NS = Power consumed by slip (kW)
ND = Drawbar power (kW)
NR = rolling resistance power (kW)
S = Slip in percent (%).

***Tractive efficiency*:**
Tractive efficiency is defined as:

$$TE(ratio) = \frac{Output\ Power}{Input\ power} \Rightarrow \frac{Db.power}{Axle\ power}$$ **[9]**

***Field capacity determination and efficiency*:**
Actual field capacity of the transportation:
= full cycle time of the transportation

So, actual field capacity = full cycle time × capacity of trailer … ton.h^{-1}

***Engine Power Requirements*:**
Where:
$E.P.R$: Power Requirements from Fuel consumption; kW.
F_c : Fuel consumption rate; L/hr
ρ_f : Density of the fuel; Kg/L (for solar fuel = 0.85 Kg/L)
L.C.V : Lower calorific value of fuel Kcal/Kg; (average L.C.V of solar fuel is 10^4 Kcal/Kg)
427 : Thermo – Mechanical equivalent; Kg m/ Kcal;
η_{th} : Thermal efficiency of the engine (assumed to be 40% for diesel engine);
η_m : Mechanical efficiency of the engine (assumed to be 80% for diesel engine).

***Specific Energy*:**

$$SEA = \frac{E.P.F}{A_{f.c}}$$

Where:
SEA: specific energy, kW.h/ton.

E.P.F : Power required for a particular operation, kW,
$A_{f.c}$: Actual field capacity, ton.h^{-1}.

RESULTS AND DISCUSSION

Slip ratio and drawbar pull: Results presented in figs. (1 and 2) show the effect of traveling speed and the weight on the rear tractor wheels on the drawbar pull and wheel slip. It is obvious that both of the drawbar pull and wheel slip increased with the increase of the traveling speed. the drawbar pull and wheel slip increased by an average (31.89 and 37.81 %) on the field surface with increasing the traveling speed (from 3.38 to 5.80 km/hr) and weight (300 kg) on rear wheels. Figs. (1 and 2) also show that the increase in drawbar pull and the decrease in wheel slip with increasing the weight on the rear tractor wheels at the given speed.

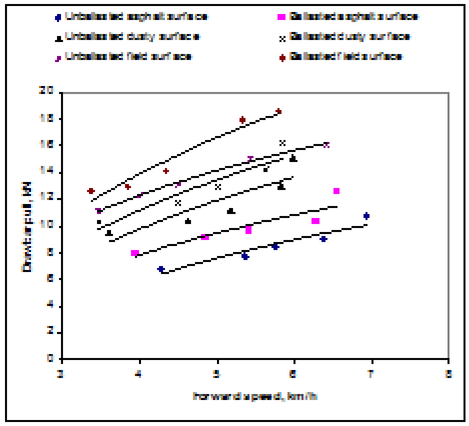

Fig. (1): Effect of traveling speed on drawbar pull in case of using trailer for three surface comparison (ballasted, Unballasted)

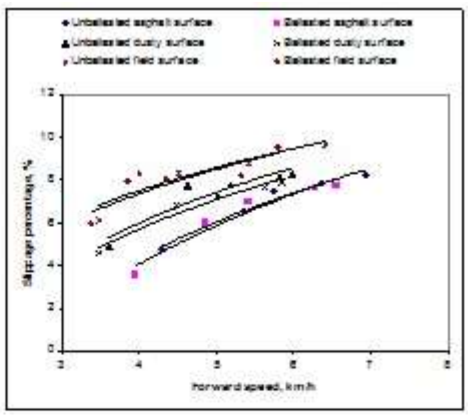

Fig. (2): Effect of traveling speed on slippage percentage with all traction surface types comparison (ballasted, Unballasted)

Tractive efficiency: Results illustrated in fig (3) show the effect of traveling speed and the weight on the rear tractor wheels on the tractive efficiency. It is clear that the tractive efficiency decreased by increasing the traveling speed. The maximum average of the tractive efficiency was (8.68 %) on the asphalt surface with ballasted 300 kg at the traveling speed (from 3.95 to 6.55 km/h). This may be due to the losses in output power that come from both travel reduction, which is also referred to slip or pull losses.

ISSN: 2277-9655
(I2OR), Publication Impact Factor: 3.785

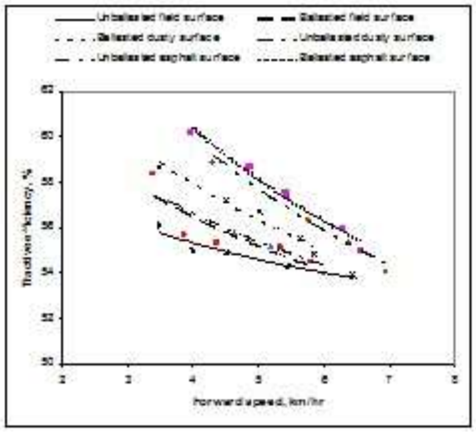

Fig. (3): Effect of traveling speed on tractive efficiency with all traction surface types comparison (ballasted, Unballasted)

Specific energy: Figure (4) show the effect of traveling speed and the weight on the rear tractor wheels on the specific energy (kW.h/ton). The specific energy effected by addition weight on rear tractor wheel, Fig. (4), it was noted that the specific energy decreased by an average 44.56 % with the increase of the traveling speed (from 3.38 to 5.80 km/h) during use ballast (300 kg) on rear tractor wheels on field surface. This is because the specific energy is expression of the required power per unit power.

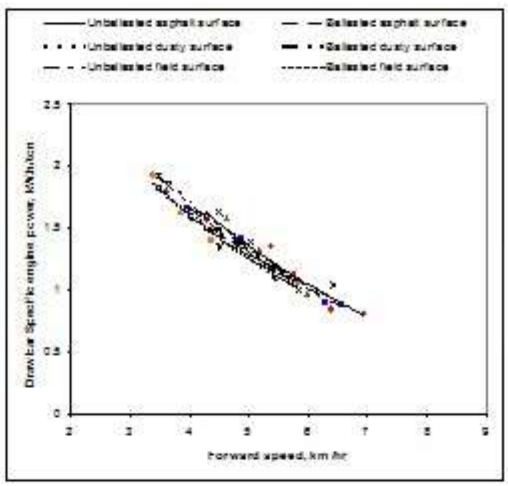

Fig. (4): Effect of traveling speed on specific energy with all traction surface types comparison (ballasted, Unballasted)

CONCLUSION

The main results in this study can be summarized as following:

1. The traveling speed and the weight on the rear tractor wheels were the most important factors that affecting the drawbar pull and the specific energy.
2. The wheel slip increased with the increase in the traveling speed, while decreased by increasing the weight on the rear tractor wheels.
3. The drawbar pull increased by increasing the traveling speed or the weight on the rear tractor wheels.
4. The drawbar specific fuel consumption decreased with the increase in the traveling speed, or the weight on the rear tractor wheels.
5. The highest value of the tractive efficiency 60.20 % was obtained at traveling speed 4.00 km/h with weight on rear wheel on asphalt surface. While, the highest value of specific energy 1.93 kW.h/ton during use of ballast on rear tractor wheels at traveling speed 3.38 km/h on field surface.

REFERENCES

[1] Abdel Mawla, H. A. "Analysis of cane delay of traditional delivery systems": Paper presented to the MSAE, Menofia Univ: 25-26 October 2000.
[2] Abdel Mawla, H. A, B. El-Din Hemeda and H. M. Hassan. "Performance of farm transport equipment in upper Egypt". The 18th. Annual Con of the Misr Soc. of Ag.Eng., (2011), 28(4):455-466.
[3] Al-Ashry, A.S,. "Proper size of tractor in local greenhouse". Ph.D. Thesis, Fac. Agric., Kafr El-Sheikh, Tanta Univ. Egypt, (1994).
[4] Crossley, P. , J. Kilgour and J. Morris. "Small mechanization for developing countries". John Wiley and Sons Ltd. New York, Brisbane, Toronto, Singapore, (1983).
[5] Fouad, H. A, H. Abdel-Mawla, A. S. Rasmy and M. M. Geasa. "Survey and analysis of mechanization of sugar-cane transport process (case study)". Misr.J. Ag.Eng. (2004), April 21(2):238-254.
[6] Kanali, C. L, P.G. Kaumbutho, C. M. Maende and J. Kamau. "The use of soil compaction levels in the selection of field-safe sugarcane transport vehicles". J. of terramechanics, (1997), 34(2): 127-140.
[7] Klatzel, F. "Green Surfaces: Building environmental friendly, low maintenance rural surfaces through local participation", (2000).
[8] Matete, J. Agricultural Service Annual Report. Mumias Sugar Company Ltd. (1989).
[9] Sharma D. N., and S.Mukesh. "Design of agricultural tractor" (principles and problems). Published by Shri Sunil Kumar Jain for Jain Brothers (New Delhi) 16/873, East Park Road, New Delhi – 110 005. First Edition, (2010), P.No: 199 – 213.
[10] Whitey, R. W and B. J. Cochran. Predicting sugar-cane mill delivery rates. Trans. Of ASAE.: (1978), 47-48.