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AN ENGENERING STUDY ON THE PERFORMANCE OF A DEVELOPED HIGH CLEARANCE TRACTOR PROTOTYPE

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ABSTRACT

The modified high clearance power unit prototype was locally constructed, fabricated in a local workshop and tested at the Rice Mechanization Center (RMC), Agric. Eng. Res. Institute at Meet EL Deepa Kafr EL Sheikh Governorate during the season of 2007

Special tests and evaluation experiments were carried out to measure the locations of center of gravity to evaluate work stability and traction performance of the modified high clearance tractor prototype under different types of traction surfaces, different levels of tires inflation pressure and different levels of forward speed.

The obtained results indicated that the longitudinal location gravity center of the modified tractor without and with mounting cultivator load from the center of the rear wheel were 776 mm and 772 mm, respectively. Meanwhile, the vertical location gravity center of the modified tractor without and with mounting cultivator load were 370 mm and 364 mm, respectively. The rolling resistance of rear wheel for the modified tractor with and without mounting cultivator load are 0.245 and 0.270 kN, respectively for the traction surface of cultivated field. The tire inflation pressure of 275.79 kP for the modified tractor gave minimum contact area and maximum contact pressure for any given soil surface comparing with 137.9 kP tire inflation pressure. Increasing tire inflation pressure and increasing forward speed increased the wheel slippage percentage for the tractor wheels at any given contact surface. The traction surface of cultivated field gave the highest values of pulling resistance at all given tire inflation pressure and forward speed.

INTRODUCTION

Dwyer (1978) correlated an optimum ratio between the weight carried on the driving wheels and the power available at the driving axles at a given speed of operation and tractive efficiency to the required weight on the wheels. Based on this, he suggested a method of tire selection for agricultural tractors taking into account the relevant maximum load carrying capacity of the tires at minimum inflation pressure.

The tractive effort exertable at the periphery of a traction device (driving wheels or tracks) is limited by the traction force that develops at the contact between this device and the supporting surface. As is well known,1 the traction force depends in turn on the tractive coefficient between surface and traction device (a function of slip) and on the normal load on the traction device. On a plane, the drawbar pull is equal to the tractive effort exertable at the periphery of the traction device, less the resistance to motion (Wong 1978 and ASAE Standard 1991).

Liljedahl *et al.*, (1979) mentioned that the primary measure of a tractor's effectiveness is the ability of the tractor to pull various types of implements at a desired value of slip. Of the three principal ways of transmitting tractor-engine power into useful work - power take off, hydraulic and drawbar - the drawbar is the most commonly used and least efficient power outlet of agricultural tractors.

Burt *et al* (1982) stated that tractive efficiency was experimentally optimized for a radial-ply tractor tire. results showed that the tractive efficiency can be significantly improved by selecting appropriate levels of inflation pressure and dynamic load for a particular soil condition. The potential gains in tractive efficiency which could result from the application of automatic controls of field traction situations are explored.

Godbole *et al.*,(1993) reported that drive tires for agricultural tractors are required to provide traction on agricultural soils, to support the vehicle and to provide a minimum resistance to movement over the surface in the intended direction of travel.

EL-Shaikha (1995) studied the factors affecting coefficient traction of tractors in Egypt and found that the best results of Nasr tractor on the asphalt road, the standard drawbar at 65 cm high from ground and tires are water or calcium chloride ballasted and tire inflation pressure equal 101.4 kpa. It was found that the local drawbar hook (90 cm height) gave the best traction coefficient but increased the risk of jumping with critical loading. It was obvious that the front additional weights are important, the hook must be higher than the trailer hitch point and has to be as far as at least 90 cm from the rear wheel axle to guarantee the stability. On other hand , the best result of Kubota tractor were reached on asphalt with the low standard hitch ,four wheel driving , low tire inflation pressure and trailer hitch than tractor's one.

Sharma and Pandey (2001) made a comparison between the desired and actual weight on a single traction wheel and suitable tire and tire normally limited in Indian two wheel drive tractors up to 35 kW. Their results concluded that:

1. Optimum P/W ratio is a useful parameter in determining weight on driving wheels to power ratio (kg/kW) for agricultural tractors at maximum pulling ability and preselected slip.
2. For maximum utilization of available power weight on driving wheels to power ratio should be 347, and 248 kg/kW when operated at 2.5 and 3.5 km/h forward speed at 30% slip and 53% tractive efficiency, respectively, in sandy clay loam soils.
3. Indian two-wheel drive tractors are not adequately loaded and fitted with proper size tires to fully utilize the available power at these low travel speeds.

Transportation Research Board (2006) reported that a way to determine the energy loss of a rolling tire is to measure the rolling resistance force. This rolling resistance force has low values compared to other forces applied on tires. Therefore it can be difficult to achieve god accuracy. The rolling resistance can be measured in the laboratory using different kinds of test machines like drums or flat belts. The rolling resistance can also be measured on the actual roads using an instrumented vehicle or a trailer. An indirect method is to measure the energy consumption for driving a certain distance on different pavements with the same tires on the car.

Schreiber et al. (2007) mentioned that the traction properties of agricultural tires are of special importance because the tractive efficiency varies in a wide range to a maximum in the order of 75%. Different single wheel testing equipment is used to investigate tire performance and different mathematical methods are used to process the measured data. The different zero-slip definitions complicate a comparison between the measured data.

Hibbeler (2oo7) defined the rolling resistance, sometimes called rolling friction or rolling drag, is the resistance that occurs when a round object such as a ball or tire rolls on a surface. It is caused by the deformation of the object, the deformation of the surface, or both. Additional contributing sources include surface adhesion and relative micro-sliding between the surface of contact. It depends very much on the material of the wheel or tire and the sort of ground. Additional factors include wheel radius, and forward speed.

Peck (2007) indicated that rubber will give a bigger rolling resistance than steel. Also, sand on the ground will give more rolling resistance than concrete. A vehicle rolling will gradually slow down due to rolling resistance, but a train with steel wheels running on steel rails will roll much farther than a car or truck with rubber tires running on pavement. The coefficient of rolling resistance is generally much smaller for tires or balls than the coefficient of sliding friction. The rolling resistance force is increased as the speed increases. The coefficient of rolling resistance is nearly constant over the practical range of loads, meaning that the rolling resistance force is proportional to the load applied to the tire. The rolling resistance force decreases when the inflation pressure is raised. The rolling resistance is the force required to push a vehicle over the surface it is rolling over.

MATERIAL AND METHODS

The main objective of the present investigation was to develop, local construct, and fabricate of a high clearance tractor prototype for more usage and improvement its performance, to meet the different demands of post growing operation for small and medium farms in Egypt. Meanwhile, the specific objective is to evaluate work stability and traction performance of the modified high clearance tractor prototype under different types of traction surfaces, different levels of tires inflation pressure and different levels of forward speed. The modified high clearance tractor prototype was locally, constructed, fabricated and tested in workshop of Rice Mechanization Center (RMC), Agric. Eng. Res. Institute, at Meet EL Deyba Kafr EL-Sheikh Governorate, during season 2007.

1-Machinery used:

1-1 The prototype of modified high clearance tractor

The prototype of modified high clearance tractor was constructed and fabricated to suit row crop cultivator mounting or other post growing service machine in addition to use it as well as a self propelled sprayer in separation operation or in combination with cultivation operation. The main components of modified high clearance tractor are shown in Fig. (1) and summarized in the following items:

1-1-1 main frame

It's main frame was made from steel beam with vertical clearance of 910 mm from the ground surface to allow the grown plants passing smoothly during the movement of the high clearance tractor above it with a minimum level of damaged plants. The main frame also carry other components of high clearance tractor. The distance between the wheel tracks is adjustable to allow running in a different spaced rows and different stages of grown plants. The overall width, length and height of main frame is 225, 150 and 150 cm, respectively. Balancing and stability state was taken under consideration during fixing and distributing the main components of modified high clearance tractor on the main frame.

1-1-2 Power unit:-

A Yanmar diesel engine, Japan made, water cooled, 4-cycle, 3 cylinder diesel engine of 29 hp / 3000 rpm (21.36 kW) was used as a source of power. The engine was connected with HST (hydro-static transmission system) by v-belt throw the pulleys of engine and HST.

1-1-3 Power transmission system:-

HST system was used for transmitting power from engine to tractor wheels and PTO using. It consists of five main units as the follows:

1- HST pump, 2- gear box
3- Differential 4- Sprockets and chain
5- Final reduction 6- traction device (rear wheels).

The main advantages of this transmission system HST is giving a wide range of forward speeds ranged from 1to10 km/h for front and rear speeds also for PTO speeds ranged from 480 to 880 rpm, It was able to be increased using another pair of pulleys.

1-1-4 Steering unit:

A mechanical steering unit was used in the two front wheels of the high clearance tractor prototype. It consists of a steering wheel and scatra of a 128 FIAT car in close proximity of the constructed machine. These are jointed together by steel bar. They were connected with the front wheel by means of spring loaded chock absorber to reduce vibration at the front of the main frame of the prototype.

1-1-5 Hitching unit:

The prototype of high clearance unit was equipped with a modified hydraulic three-point lift system to hitch the sweep row crop cultivator and any other machines may be joined with it. This unit consists of hydraulic gear pump pressured oil at 160 kg /cm^2 and its discharge 4 cc/rev., directional control valve to control oil direction, single acting piston fixed with upper link for raising and lowering arms to hitching unit mount the cultivator or other tool.

1	Front wheel	12	Sprocket chain
2	Spring load	13	Rear wheel
3	Steering wheel	14	Tablo
4	Speed arm	15	Starting motor
5	Engine	16	Engine flywheel
6	Hydraulic valve	17	Tow v belts
7	Driver seat	18	HST
8	Fuel tank	19	Differential gearbox (Corona)
9	Upper link	20	Transmission gearbox
10	Hydraulic piston	21	Hydraulic oil tank
11	Lower link		

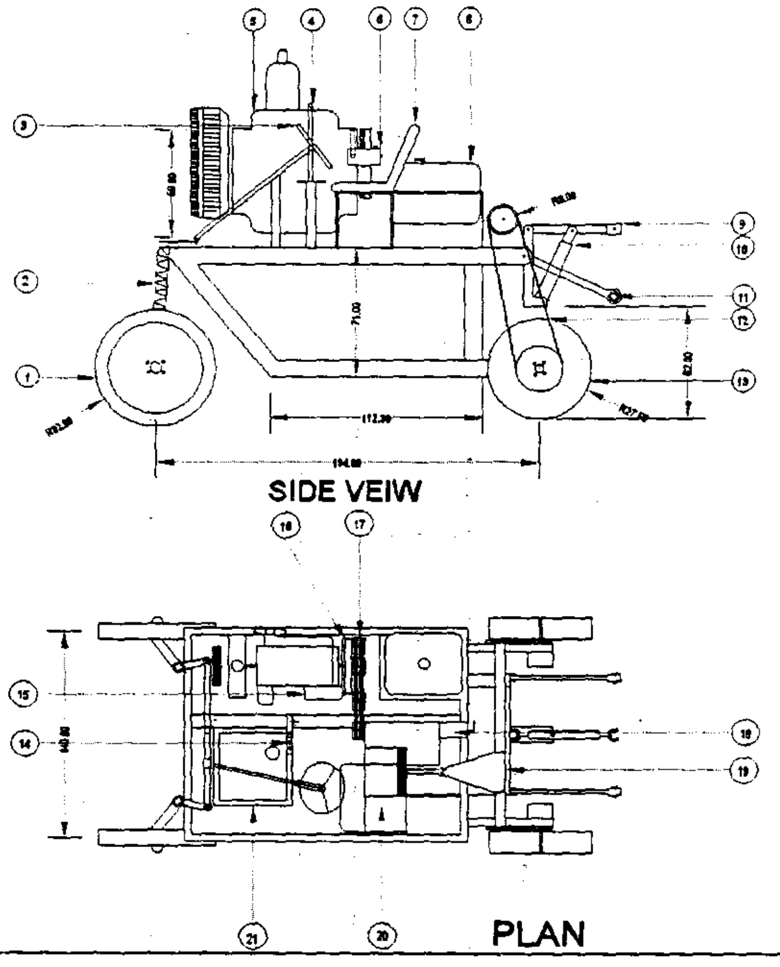

Fig. (1): Side and plan views of the modified high clearance tractor prototype.

1-2 Row crop cultivator

The sweep inter row cultivator used in the present study consists of the following parts as shown in Fig. (2):-

1.2.1 Frame

The frame of the cultivator was fabricated from square (6×6)cm steel beam with 240 cm length to carry out three sweeps . It was equipped with hitching triangle with distance between tow lower points was 68 cm and its heights 41cm.

1.2.2 Shanks

Three spring shanks steel with square cross section 2.5×2.5 cm and 130 cm length were fixed with frame by iron clamp using two bolts. The spacing between shanks can be easily adjusted according to crop row width.

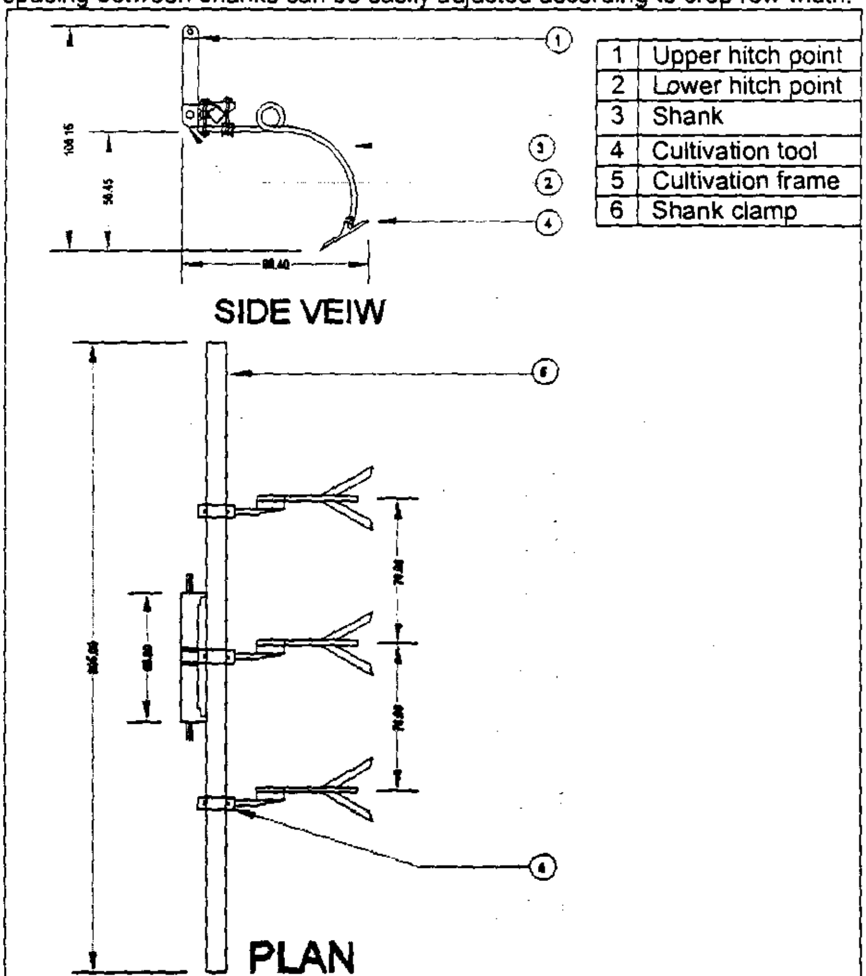

Fig. (2): Side and plan views of the row cultivator.

2- Study factors and measurements procedure.

Special tests and evaluation experiments were carried out to measure the locations of center of gravity to evaluate work stability and traction performance of the modified high clearance tractor prototype under the following study factors:

1- Four different traction surfaces, namely; asphalt road, farm road, stubble soil and cultivated soil.
2- Three different levels of forward speed for the modified tractor (5.11, 6.23 and 7.09 km/h).
3- Five different inflation pressure for front and rear wheels of the modified tractor (137.9, 172.37, 206.84, 241.32 and 275.79 kPa).
4- Using the modified tractor with and without cultivator loaded.

2-1 Centre of gravity locations

The centre of gravity mean the point where the whole influence of the mass or the weight of the tractor may be concentrated in it. Its location depends on the disposition of the various masses that comprise the tractor. Any analysis of the tractor chassis requires the location of the centre of gravity to be known. It is usually specified in relation to the rear axle as shown by point C_g in Figure (3):

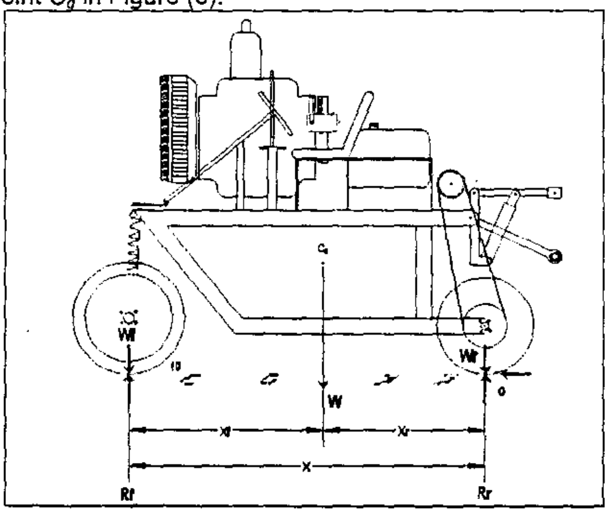

Fig. (3): Horizontal location of center of gravity of the modified high clearance tractor and distribution of soil reaction on the front/rear wheels.

2-1-1 Longitudinal location

The location of the centre of gravity in the longitudinal (x) direction may be found by measuring the weight on the front (W_f) and rear (W_r) wheels. Application of the force equilibrium condition gives the tractor weight, W:

$$W = W_f + W_r$$

Application of the moment equilibrium condition gives the required longitudinal location, x_r as shown in Fig. (3)
For the tractor take moments about ***O***:

$$W \cdot x_r = W_f \cdot x$$

$$X_r = \frac{W_f}{W} x$$

Pascal balance was used to determin the total weight and the reaction on the front wheels (W_f) and rear wheels (W_r) of modified tractor prototype. Consequently, the location of center of gravity point (C_g) was determined using weighting each of front and rear wheels alone.

1-2 Vertical location

The location of the centre of gravity in the vertical (y_g) direction is more difficult. The common method is to lift the front (or rear) of the tractor (as shown in Figures 4- a,b) and measure the weight on the front wheels (W'_f) in the raised condition. The following is similar to ***Macmillan, (2002)***.

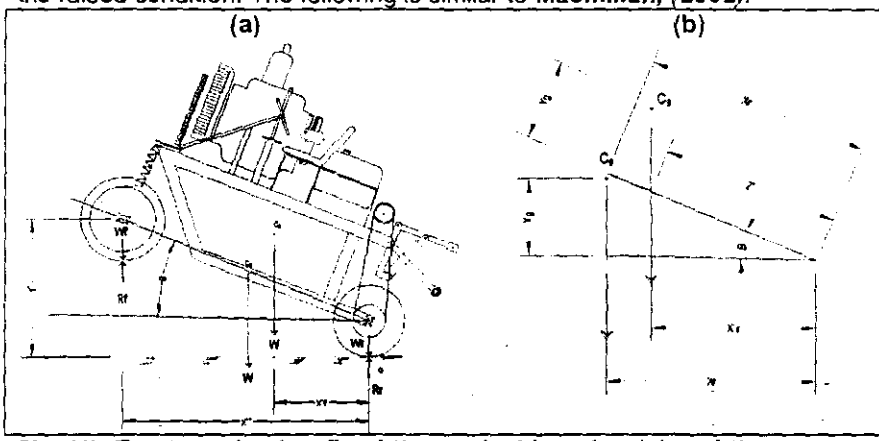

Fig. (4): Tractor raised to fined the vertical location (a) and the geometry position of center of gravity (b).

Application of the moment equilibrium condition gives the required vertical location, y_g. For the tractor take moments about ***O***:

$$x'_r = \frac{W'_f}{W} x''$$

$$z = \frac{x_r}{\cos \beta}$$

$$y_g = \frac{x'_r - z}{\tan \beta}$$

Substituting for ***z*** gives.

$$y_g = \frac{x'_r - \frac{x_r}{\cos \beta}}{\tan \beta}$$

where x'_r is as calculated from Equation .... above.

Using the pervious equations, measuring dimensions and data required for calculating the vertical location of gravity center by rising the front wheel of modified high clearance tractor at $\beta =$ [illegible] as shown in Fig. (4).

2-2 Turn back tractor conditions

The procedure followed to determine the turn back conditions of the modified tractor could be explained as follows:
The rear wheels of tractor were braked and raising the front wheel up to the tractor starting to turn it back. At this point the turn back angle (β), the height of the front wheel center and the reaction force on the rear wheels were determined.

2-3 Contact area(C.A) and pressure(C.P)

The contact area (C.A) of the front and rear wheels of the modified tractor was measured under four tire inflation pressures (137.90, 172.37, 206.84, 241.32 and 275.79 KPa) using the traditional method by raising up the tractor and painting the lower part of the tractor wheels tires which contact with ground surface, after that putting four parts of measuring square paper (0.5× 0.5 cm) under the four wheel tires, then lowering the tractor down to make a stamp for each contact area. The contact area was measured for front and rear wheels of the modified tractor with cultivator and without cultivator. The contact pressure (C.P) of the front / rear wheels tires were calculated according to the obtained data of the weight on the front/rear wheel and its contact area using the following formula:

$$\textit{Contact pressure(C.P)} = \frac{\text{vertical weight}}{\text{contact area}}$$

2-4 Rolling resistance

The force of rolling resistance can be calculated by:

$$F = C_{rr}.N_f$$

where: F = the resistant force,

C_{rr} = the dimensionless rolling resistance coefficient, and

N_f = the normal force.

The force of rolling resistance can also be calculated by:

$$F = \frac{Wa}{r}$$

where : F = the resistant force, r = radius

a = the rolling resistance coefficient or coefficient of rolling friction with dimension of length,

W = the weight, and

In usual cases, the normal force on a single tire will be the mass of the object which the tires are supporting divided by the number of wheels, plus the mass of the wheel, times the gravitational acceleration (9.81 $m{\cdot}s^{-2}$ on Earth). In other words, the normal force is equal to the weight of the object being supported, according to Transportation research Board (2006). Taken into consideration the coefficient of rolling resistance as 0.030, 0.037, 0.043 and 0.051 for traction surfaces of asphalt road, farm road , stubble field and cultivated field, respectively.

2-5 Pulling force

In the present study the net pulling force (T.F.) for the modified tractor with row cultivator was obtained by the method recommend by ASAE (1993). Therefore its required pulling force under the studied traction surfaces, were carried out at three forward speeds. Whereas, in each traction surface, the modified tractor was mounted and pulled (as a dummy machine) by a 38.5

kW auxiliary Yanmar tractor. Then the draught force was then measured. The average dynamometer readings were recorded when the combination of auxiliary tractor and the modified one between rows in cultivated field traction as well as on stubble field, farm road and asphalt road surfaces under study. The spring dynamometer was used to determine the traction force for the modified high clearance tractor on different surfaces under four tire inflation pressures. It was made to suit measuring the horizontal component of force between the driving tractor and the modified tractor under different test conditions.

2-6 Wheel slippage

The slippage of the modified tractor with row cultivator was determined using standard method, by measuring the distance of 10 revolution of the traction wheel of high clearance tractor on road and the same procedure repeated again in the field. The slip ratio was calculated using the following equation:

$$Slip\ \% = \frac{L_1 - L_2}{L_1} \times 100$$

Where: L_1 = The traveling distance for 10 rev. of a wheel on the road, under no load (m).

L_2 = The traveling distance for 10 rev. of a wheel on the field, under load (m).

RESULT AND DISCUSSION

1- Center of gravity locations(CG)

1-1 Longitudinal location

The obtained results from measuring total weight of the modified high clearance tractor and its distribution on front and rear wheels in addition to the calculation of longitudinal location of tractor gravity center are summarized as follows:

A-Without mounting cultivator:

Total weight of modified of high clearance tractor (***W***) = 8 kN.

The reaction force on the front wheels (W_f)= 3.2 kN.

The reaction force on the rear wheels(W_r) = 4.8 kN.

The longitudinal location gravity center of the modified high clearance tractor from the center of the rear wheel (X_r) = 776 mm.

B-With mounting cultivator:

Total weight of modified tractor (***W***) = 8.8 kN.

The reaction force on the front wheels (W_f)= 3.5 kN.

The reaction force on its rear wheels(W_r) = 5.3 kN.

The longitudinal location gravity center of the modified tractor prototype from the center of the rear wheel (X_r) = 772 mm.

From these results it could be concluded that the longitudinal location CG of the tractor prototype is approximately 40 % of wheel base (*X*) due to increasing the weight on the front wheels. Also the location distance was slightly changed to 39.8 % of wheel base (*X*) by applying the cultivator load.

1-2 Vertical location

From the obtained results and calculation during determining the vertical location of tractor gravity center, it could be concluded that :

A-Without mounting cultivator

The height of the front wheel center (y') from ground = 600 mm

The angle of $\beta = 17^o$

Total weight of the modified tractor (W) = 8 kN.

The reaction force on the front wheels (W_f) = 2.72 kN.

Vertical location of center gravity (y_g) = 370 mm

B-With mounting cultivator:

The height of the front wheel center (y') from ground surface = 600 mm

The angle of $\beta = 17^o$

Total weight of the modified tractor (W) = 8 kN.

The reaction force on the front wheels (W_f) = 2.98 kN.

Vertical location of center gravity (y_g) = 364 mm

From these results it could be concluded that the vertical location of the modified tractor was highly affected by the distributed weight on the front and rear wheels, also by applying the load of cultivator in addition to this location distance gave a wide range of tractor stability.

1-3 Turn back conditions of tractor prototype

A-Without mounting cultivator

The height of the front wheel center (y') from ground surface = 1015 mm

The starting point resulting in modified tractor turn back at angle $\beta = 31.5^o$

The reaction force on the rear wheels (W_r) = 8 kN.

The distance between the front and rear wheel centers ($\ddot{X}$) =1940 mm

B-With mounting cultivator

The height of the front wheel center (y') from ground surface =1013 mm

The starting point resulting in tractor turn back at angle $\beta = 30^o$

The reaction force on the rear wheels (W_r) =8.8 kN.

The distance between front and rear wheel centers ($\ddot{X}$) =1940 mm

From these results it could be concluded that the turn back angle is satisfy to maintain the stability and mechanical ability of the tractor to do its work on different traction and field conditions in a wide range of safety factors.

2- Rolling resistance

Effect of different types of traction surfaces on the rolling resistance of front and rear wheel of the modified tractor prototype with and without mounting cultivator load are summarized in Table (1). From this table it could be noticed that the rolling resistance force were highly affected with traction surface type and by applying cultivator load. The highest values of rolling resistance (0.245 and 0.270 kN) were obtained on the rear wheel of the tractor on traction surface of cultivated field without and with cultivator load, respectively.

Table (1): Mean values of rolling resistance for front and rear wheels of the modified tractor under different traction surfaces.

Traction surfaces	Without cultivator load		With cultivator load	
	Front wheel	Rear wheel	Front wheel	Rear wheel
Asphalt road	0.096	0.144	0.105	0.159
Farm road	0.118	0.178	0.130	0.196
Stubble field	0.138	0.206	0.151	0.228
Cultivated field	0.163	0.245	0.179	0.270

3-Contact area(C.A.) and pressure(C.P.)

Fig. (5) shows the effect of tire inflation pressure on the contact area and pressure for the front and rear wheels of the modified tractor with and without mounting cultivator load. The Figure cleared that increasing the tire inflation pressure decreased its contact area and increased tire contact pressure for the front and rear wheels of the modified tractor. However, the effect rate on the rear wheel was slightly different than that obtained for front wheel due to the differences in the tire dimensions and shapes. The front wheel tire gave the highest values of contact area and the lowest contact pressure at any given tire inflation pressure compared with rear wheel tire.

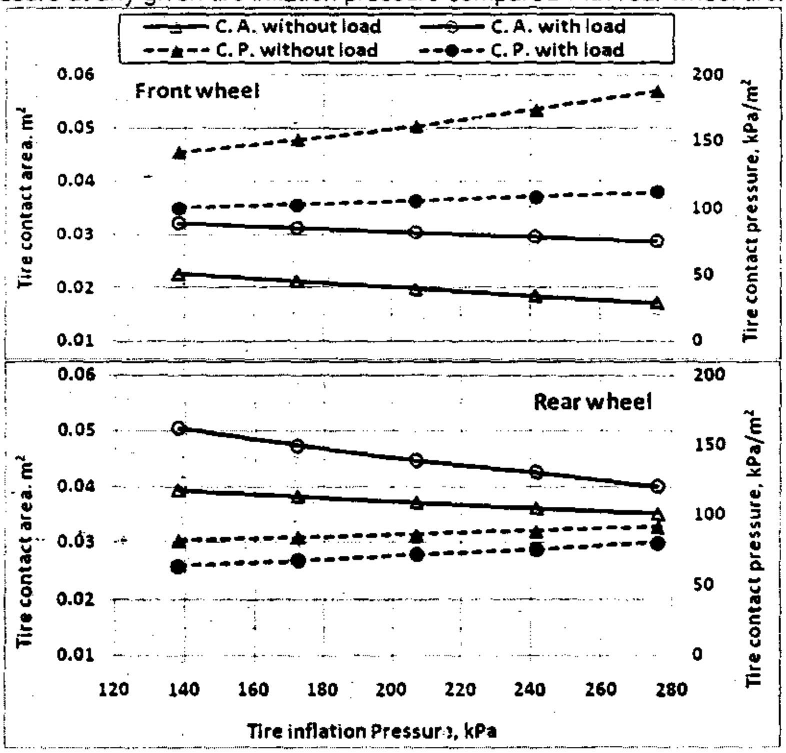

Fig. (5): The relationship between tire inflation pressure, tire contact area and pressure under different traction surfaces and forward speeds.

4-Wheel slip

The effect of tire inflation pressure of the modified tractor prototype on wheel slip under different forward speeds and traction surfaces of asphalt, farm road, stubble field, and cultivated field is illustrated in Fig. (6). From this Figure it could be noted that increasing the tire inflation pressure increased the wheel slippage at any given study parameters. The lower tire inflation pressure increase the contact area between the tire and the traction surface, this increased the grip force and decreases wheel slippage. It could be noted that the large slip percentages were resulted when using the higher tire inflation pressure.

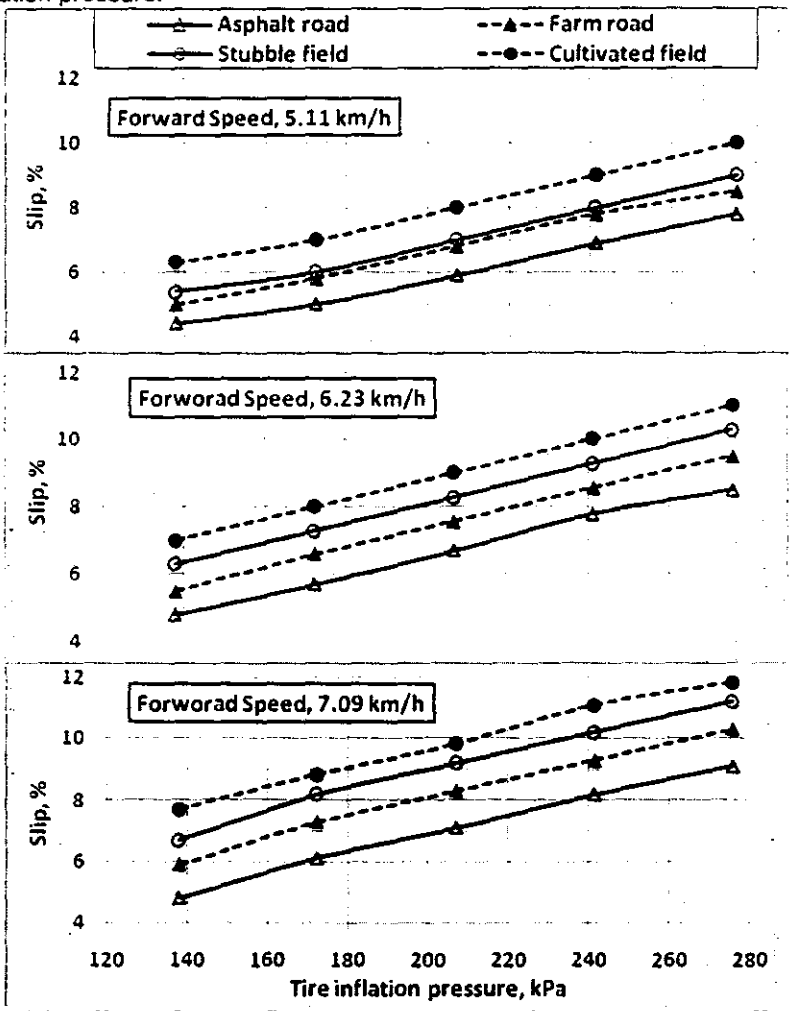

Fig. (6): Effect of tire inflation pressure on wheel slip under different forward speeds and different traction surfaces.

Also, the wheel slip was really affected by the type of traction surface at any given inflation pressure and forward speed. The highest levels of slippage were obtained on the cultivated field especially with higher tire inflation pressure followed by the stubble field , farm road and asphalted road.

An increment percentages of 28.2%, 29.8% and 30% were obtained in slippage values by changing the traction surface of asphalted road to cultivated field at forward speed 5.11, 6.23 and 7.09 km/h respectively, and highest tire inflation pressure values

5- Pulling force

The relationship between tire inflation pressure of the modified tractor under different traction surfaces and forward speeds is illustrated in Fig. (7). It could be concluded that the pulling force was highly affected by traction surface type and tire inflation pressure at any given operating speeds. Increasing tire inflation pressure decreased pulling force at any given traction surface and different forward speeds. It is well known that the lower the tire inflation pressure the larger will be contact surface area of the tire with ground, and consequently, the more will be the tire-ground grip, & vice versa so that the producers recommended lowering the tire inflation pressure, especially when tractor is moving on the field and not on asphalt or compacted roads. The traction coefficient gave the maximum values of the lower tire inflation pressures.

The obtained results indicated that the hard traction surfaces of asphalt and farm roads gave lower values of pulling force than that obtained with traction surface of stubble field and cultivated field. In other words, the minimum values of pulling force obtained with asphalt road flowed by farm road , stubble field and cultivated field which gave the highest values of pulling force at any given tire inflation pressure and forward speeds under study. The asphalt gave better results by about 75.65% more than the cultivated field. It is logic that the best results were reached with lower tire inflation pressures.

With respect of the effect of forward speed on the pulling force, it could be indicated that increasing forward speed increased the pulling force at any given tire inflation pressure. The results also, cleared that increasing the load (mounting cultivator unit on the tractor prototype) increased pulling force at any given tire inflation pressure, traction surface and operation forward speed under study.

The best results were reached with low tire inflation pressure on asphalt road at operating forward speed of 6 km/h for the modified high clearance tractor prototype with cultivator load and without cultivator load. While the highest values of pulling force was obtained with traction surface of cultivated field under the tire inflation pressure of 275.79 KPa and 8 km/h forward speed for the tractor prototype with and without cultivator.

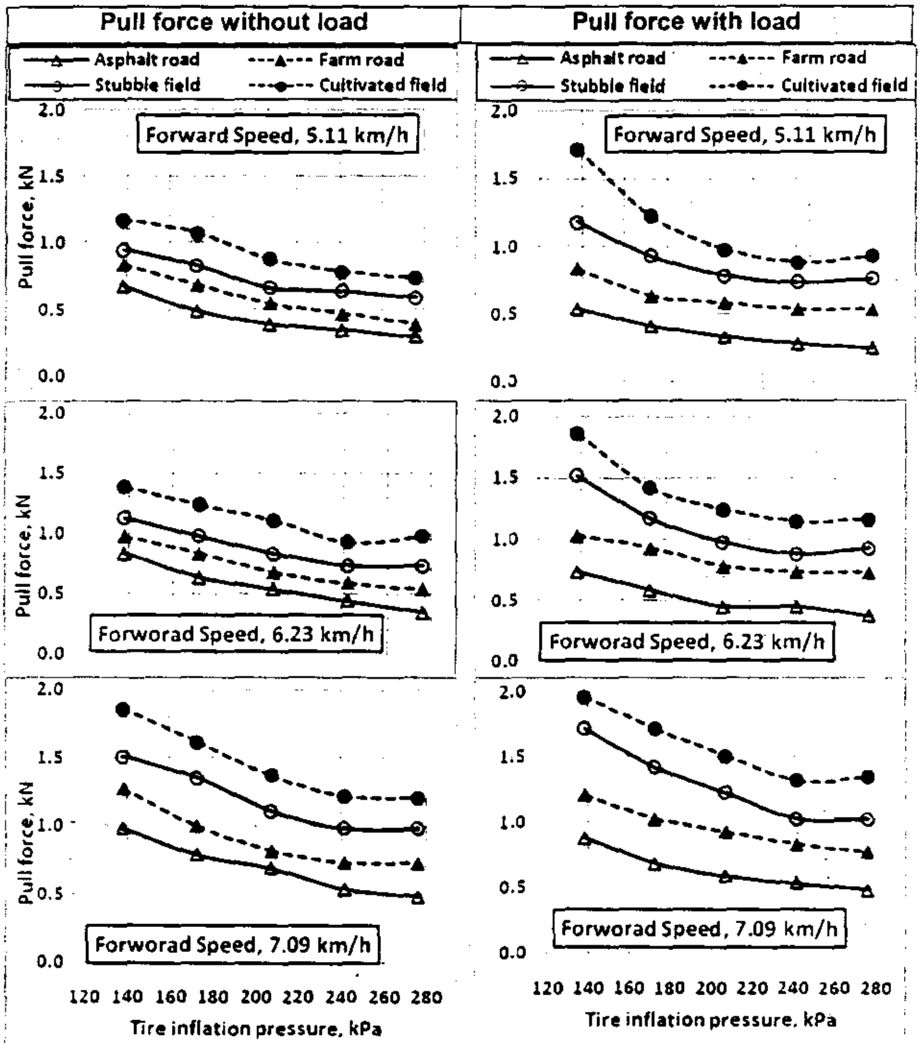

Fig. (7): Effect of tire inflation pressures, traction surfaces and forward speed on pulling force of the modified high clearance tractor.

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دراسة هندسية على الأداء المطور لنموذج الجرار ذو الخلوص الأرضي العالي

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٢- قسم الميكنة زراعية – مركز ميكنة الأرز بميت الديبة - معهد بحوث الهندسة الزراعية

أجريت هذه الدراسة لتطوير و تصنيع نموذج بحثي لجرار ذو خلوص أرضى عالي محليا يناسب احتياجات المزارع المصري في خدمة المحصول النامي من عزيق ورش وتسميد..........الخ
وقد كان هدف هذا البحث هو تقيم واختبار الأداء للجرار تحت سطوح جر مختلفة و ضغوط عجل مختلفة وسرعات أمامية مختلفة لدراسة الاتزان و الانزلاق و قوى الجر ومقاومة الدوران تحت هذه الظرف . وقد تم تصنيع الجرار بورش خاصة بمدينة سمنود – محافظة الغربية ثم تطويره وتزويده بوحدة عزيق بين الخطوط بورش مركز ميكنة الأرز بميت الديبة – فرع معهد بحوث الهندسة الزراعية بكفر الشيخ خلال موسم ٢٠٠٧ بينما تمت التجارب والاختبارات بالمركز والمزرعة البحثية الملحقة به :-

متغيرات الدراسة :

١- خمسة ضغوط انتفاخ للعجل الأمامي والخلفي للنموذج البحثي للجرار وهى ١٣٧،٩٠؛ ١٧٢،٣٧؛ ٢٠٦،٨٤؛ ٢٤١،٣٢ و ٢٧٥،٧٩ كيلو باسكال.
٢- أربع سطوح تلامس مختلفة وهى طريق أسفلت – طريق مزرعة – أرض محصودة من المحصول السابق' وأرض منزرعة عند مرحلة العزيق.
٣- ثلاث مستويات مختلفة للسرعة الأمامية للجرار وهى ٥،١١ ؛ ٦،٢٣ ؛ ٧،٠٩ كم / ساعة.
٤- الجرار بدون تعليق العزاقة وبعد تعليق العزاقة.

وقد كانت أهم النتائج المتحصل عليها كما يلي:

١- البعد الافقى لمركز ثقل الجرار ذو الخلوص الأرضي العالي عن محور العجل الخلفي هو ٧٧٦ مليمتر بدون تعليق للعزاقة و ٧٧٢ مليمتر عند تعليق العزاقة. بينما كان البعد الرأسي لمركز الثقل للجرار هو٥٤٢ مليمتر بدون تعليق للعزاقة و٥٤٠ مليمتر عند تعليق العزاقة.
٢- كانت أكبر مقاومه دوران للعجل الخلفى لنموذج الجرار ذو الخلوص الأرضي العالي ٠،٢٤٥و ٠،٢٧٠ كيلو نيوتن لأرض العزيق بدون تعليق العزاقة وعند تعليق العزاقة على التوالى.
٣- حقق ضغط النفخ لعجل نموذج الجرار ذو الخلوص الأرضي العالي ٢٧٥،٧٩كيلو باسكال أقل مساحة تلامس و أعلى ضغط تلامس على سطح الأرض وذلك بالمقارنة بضغط النفخ ١٣٧،٩٠ كيلو باسكال.
٤- تزداد نسبة الانزلاق بزيادة ضغط نفخ العجل من ١٣٧،٩٠ إلى ٢٧٥،٧٩كيلو باسكال و كذلك بزيادة السرعة من ٥،١١ إلى ٧،٠٩ كم / ساعة لأى سطح تلامس تحت الدراسة.
٥- كانت أقل قيم لقوى الجر على الطريق الأسفلتى بينما كانت أعلى قيم على سطح التلامس للأرض المعدة للعزيق.