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Comparison of Constant and Adjustable Drawbar for a Domestic Horticulture Tractor

Yilmaz G[1], Çakırlar U[1], Anapa H[2] and Akdemir B[1]*

[1]Department of Biosystems Engineering Faculty of Agriculture, Namik Kemal University, Turkey

[2]Taral Agricultural Machinery and Equipment Company, Istanbul, Turkey

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***Corresponding author:** Akdemir B, Department of Biosystems Engineering Faculty of Agriculture, Namik Kemal University, Turkey, E-mail: bakdemir@nku.edu.tr

Abstract

In this study, adoption study of drawbar pull from constant height to adjustable height was investigated for improving mechanical structure, increasing efficiency of fuel consumption, decreasing slippage of domestic horticulture tractors. Materials were a horticulture tractor, an orchard sprayer, speed measurement sensor, load cell and fuel consumption. New drawbar which connection height of implements can be adjustable was designed and manufactured for horticulture tractor. Constant height drawbar and adjustable height drawbar were compared for pulling force, forward speed and fuel consumption by using orchard sprayer. Tests were carried out for 2 km, 1 hour, 3rd gear at 2500 rpm of engine. Forward speed was determined as 15 km/h for drawbar pull test and fuel consumption tests. According to the fuel consumption results; the adjustable drawbar was better than constant drawbar 0.29 l/h on soil and 0.34 l/h on concrete surface. Forward speed with adjustable drawbar was faster than constant drawbar as 1.7 km/h for field and 2.0 km/h for concrete surface. Drawbar pull of the adjustable drawbar was less than constant drawbar 36.58 N on concrete road and 74.29 N in soil surface even there wasn't any problem for pulling sprayer. Work was performed with less drawbar pull and less fuel consumption. Adjustable drawbar suggested to manufacturer for investigated horticultural tractor because of its advantages due to constant drawbar.

Keywords: Adjustable drawbar; Orchard tractor; Drawbar force; Fuel consumption; Forward speed

Introduction

Trailed equipment is connected to the tractor via drawbar. Machines such as trailers that are drawn by the tractor are connected to the tractor using a drawbar that can rotate around its own axis. In some cases, drawbar is used which is a lama with holes that is connected to the lower arms of the three point linkage system [1]. Horticulture tractors are the smallest tractors that are used in vegetable gardens that cultivate vegetables for the market, nursery gardens, small gardens, chicken farms etc. as well as many other small agricultural establishments. The location of the drawbar affects tractor control as well as its ability to draw along with the ability of trailers to follow the trail. Only the drawbar should be able to rotate around the longitudinal axis of the tractor and the hole of the trailer beam should remain constant. Thus, the trailer and the tractor can turn against each other. This ability to turn prevents the tractor from additional strain when the dumper trailer topples over. The height of the drawbar grasp from the ground should be the same with that of the drawbar beam. If the drawbar is lower, the load of the rear wheels of the tractor decreases whereas the load on the front wheels increases. This makes it more difficult for the tractor to apply the required draft. Many problems arise such as accidents with severe injuries (trailer cut-off etc.), loss of draft and control difficulties. It is important to pass from the fixed rear traction system to the adjustable height rear traction system for horticulture tractors. In this study, the transformation from fixed drawbar to adjustable height drawing has been carried out for a locally manufactured horticulture tractor. The objective of the study was to enhance the mechanical structure of locally manufactured tractors, to increase efficiency in fuel consumption while decreasing loss of speed. In addition, it is also thought that this study will also eliminate the additional workload resulting from the connection of the trailer to the tractor thereby eliminating the additional loss of time.

Materials and Methods

A horticulture tractor, pulverisator, speedometer, load cell and fuel meter were used in the study as material.

Tractor: Taral VST 818 horticulture tractor was used in the study (Figure 1). Technical properties have been given in Table 1 [2].

Figure 1: Taral VST 818 Orchard Tractor (http://taral.com/).

Model	Taral VST 818
Max. power (ISO) HP	18.0@2700 (DIN 70020)
Max. Engine speed(min^{-1})	2900
Number of the cylinder	3
Number of the gear	6 forward, 2 back gears
Hydraulic system capacity(kg)	700

Table 1: Technical specifications of Taral VST 818 tractor ((http://taral.com/).

Tractor drawn tools and equipment are usually connected to the tractor via fixed drawbar (Figure 2).

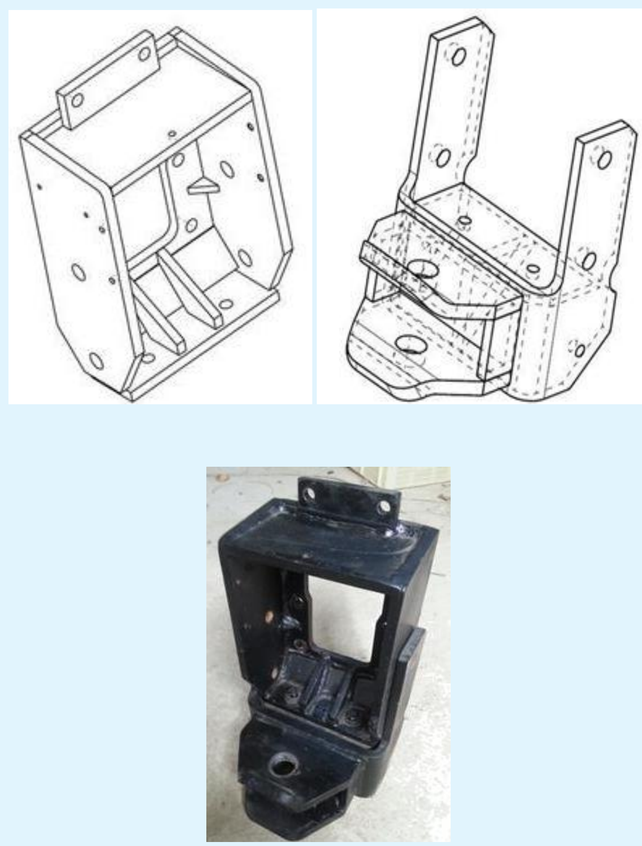

Figure 2: Drawbar case, Taral VST818 drawbar.

Pulverisator: Taral 1200 horticulture pulverisator was used in the study (Figure 3). Taral 1200 horticulture pulverizator technical properties have been given in Table 2.

Figure 3: Orchard pulverisator (http://taral.com/).

Model	TP 1200 milenyum
Depot capacity (litre)	1200
Material	Polyester
Pump type	Tar 125
Flow rate (l/min)	125
Speed (min^{-1})	540
Pressure (kg/cm^2)	0-50

Table 2: Taral 1200 orchard pulverisator technical specifications

Fuel Meter: Aqua Metro Contoil VZD 4 brand flow meter with a digital screen and digital data output was used in the study (Figure 4). The technical properties of Aqua Metro Contoil VZD 4 fuel meter have been given in Table 3.

Figure 4: Aquametro Contoil Vzd Fuel meter.

Measurement step	0.01 l
Measurement interval	1 – 135 l/h
Connection	M14 x 1.5

Table 3: Aquametro Contoil Vzd Fuel meter technical specifications [3]

Load Meter: ESİT SC load cell with the technical properties given in Table 4 with a capacity of 10 tons was used in order to measure draft (Figure 7) Sabancı A (1997) [4].

Figure 5: 10 ton ESIT SC load cell in measuring capacity.

Max. capacity (emax)	Kg	10000
Total error	%	<=+-0.05<=+-0.02<=+-0.015
Min. load	%Emax	0
Overload capacity	%Emax	150
Breaking capacity	%Emax	300

Table 4: ESİT SC yükhücresiteknikötzellikleri [5]

Indicator: Baykon Bx1 T the technical properties of which have been given in Table 5 was used in order to read the load values in the load cell [6].

Linearity &Temperature coefficient	% 0.0015 FS ; ≥ 2 ppm/°C
Measurement speed	Max. 100 measurement/s
Energy requirement	5 VDC, max. 100 mA
Data output	Standard RS 232C

Table 5: Baykon Bx1 T Indicator Technical Specifications.

Inverter: Black & Decker 500 W inverter was used in the study to generate the 220 V AC electrical power required in the study. 12 V DC power acquired from the tractor battery was transformed into 220 V current via the inverter and was used in the study.

Speedometer: MEFA magnetic detector the technical properties of which have been given in Table 6 was used in the study (Figure 6).

Figure 6: Magnetic sensor.

Current	10-60 Volt DC
Radius	M12x1 metal
Length	50 mm
Output	NPN
Sensing distances	4mm
Connection type	2m, 3 cable

Table 6: Magnetic sensor technical specifications

Interface: Spider 8 HBM brand interface was used in the study to analyze and red the values obtained via the magnetic detector. The technical properties of the Spider 8 HBM interface have been given in Table 7 [7].

Connections	RS-232 Kablo
Software	Catman professional
Frequency	50 – 60 Hertz

Table 7: Spider 8 HBM Interface Technical Specifications.

Design and Production of the Adjustable Traction System

Dimensioning of the bearing elements of the adjustable traction system was made in accordance with the dimensions allowed by the space around the tail shaft of the tractor. The technical drawings and dimensions of the adjustable traction system have been shown in Figure 7. The diameter of the lift holes on the cover was 18.5 cm, with 5 cm intervals in the vertical axis and 5.5 cm between two holes in the horizontal axis (Figure 7)

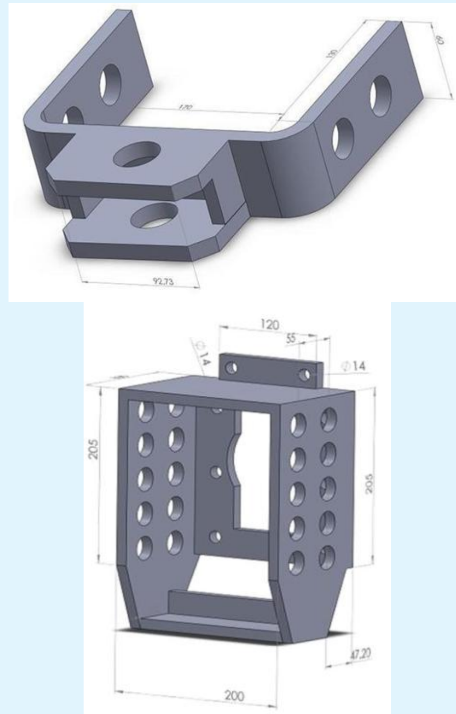

Figure 7: New designed drawbar and case technical drawings.

12 mm black sheet metal was used for the production of the adjustable traction system. Cutting, bending, weld bonding and hole boring operations were carried out in accordance with the pre-determined dimensions (Figure 8).

Figure 8: Cutting, forming, welding and drilling of steel plate.

The technical drawings of the adjustable drawbar along with the manufactured product as a result of the works carried out in the workshop have been given in Figure 9.

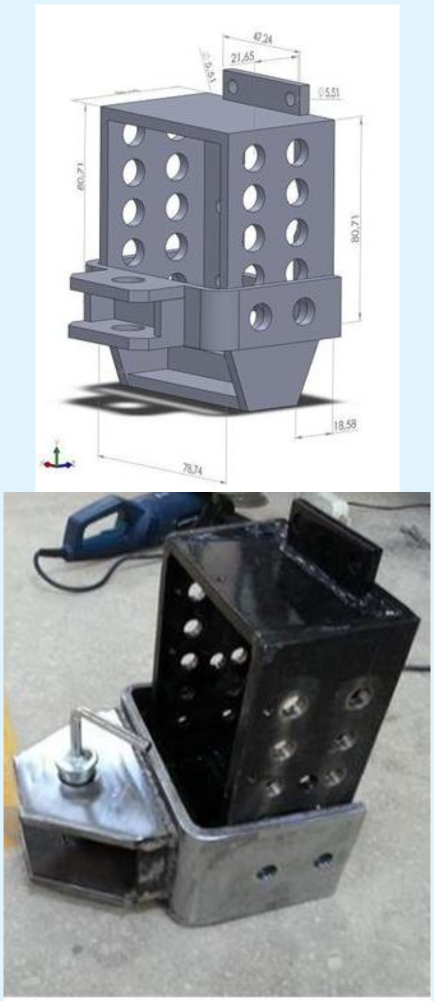

Figure 9: Adjustable drawbar.

Grinding and sanding operations were carried out in order to cleanse the adjustable traction system from any possible roughness, coating was carried out afterwards to prevent rusting in the system and to provide an aesthetically pleasing appearance. The completed adjustable traction system ready for use was then mounted on the tractor to carry out the trials (Figure 10).

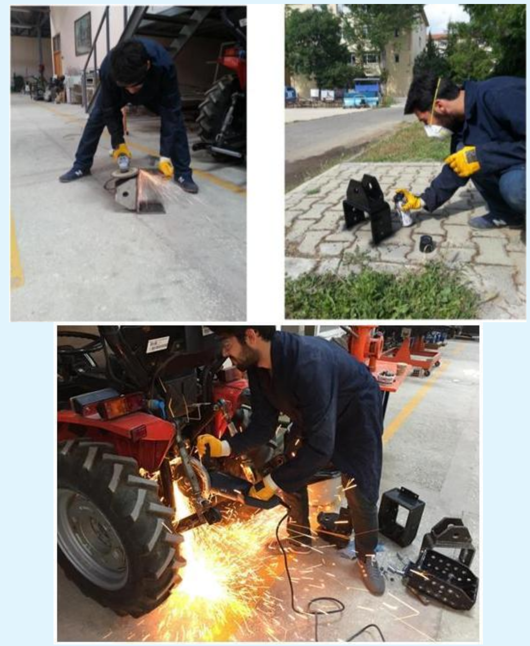

Figure 10: Grinding, painting and montage.

Measuring Fuel Consumption

Pulverisator used with the horticulture tractor was connected to the fixed position drawbar on the tractor and the produced adjustable traction system after which fuel consumptions were determined and compared for a distance of 2000 m, 1 h work time and 2500 r/m operating speed. The trials were carried out at fixed speed, fixed revolution and fixed working time in road and terrain conditions for fixed and adjustable drawbar (Figure 11).

Figure 11: Fuel consumption.

Draft Measurement

Draft was tested during the trials for fixed drawbar and adjustable traction system on the soil and concrete surface; data were measured via the load cell connected between the drawbar and the pulverisator. Data were read from Baykon Bx1 T indicator (Figure 12).

Figure 12: Pulling force measurement.

Speed Measurement

The trials were carried out for the fixed drawbar and height adjustable traction system for the road position at 3rd gear, 2500 r/m for the Figure to which pulverizator connected to the fixed drawbar is connected. Results for the concrete surface and the field conditions were compared (Figure 13).

Figure 13: Forward speed measurement on soil surface.

Results and Discussion

Fuel consumption tests were carried out at 2500 rev/min for 15 km/h fixed speed for a period of 1 hour. Fuel consumption values obtained during the tests for a length of 15.000 meters have been shown in Table 8. Fuel consumptions were measured as 2.41 l/h for field conditions and as 2.23 l/h for concrete surface with fixed drawbar. Whereas the values were 2.12 l/h and 1.89 litres for field and concrete surface conditions respectively with adjustable traction system.

	Exist drawbar (l/h)	Adjustable (l/h)	Differences (l/h)	Differences (%)
Concrete surface	2.23	1.89	0.34	15
Soil surface	2.41	2.12	0.29	12
Differences	0.18	0.23		

Table 8: Fuel consumption

Speed measurement tests were carried out in 3rd gear for 1 hour at 2500 r/m under road conditions. The values obtained with fixed drawbar were 13 km/h at field conditions and 14 km/h on concrete surface, whereas the values obtained with the adjustable traction system were 14.7 km/h under field conditions and 16 km/h on concrete surface (Table 9).

	Exist drawbar (km/h)	Adjustable (km/h)	Differences (km/h)	Differences (%)
Concrete surface	14	16	2	14
Soil surface	13	14.7	1.7	13
Differences	1	1.3		

Table 9: Forward speed (km/h)

Draft measurement results were obtained with 3 repetitions during trials carried out with Taral horticulture a for the fixed and adjustable traction system. When the average results were examined for fixed traction the minimum value in field conditions was 187.23 N, whereas the maximum value was 1328.0 N; for the concrete surface the minimum value obtained was 168.09 N whereas the maximum value obtained was 1219.58 N. When the average results for the adjustable traction system were examined, it was observed that the minimum value obtained under field conditions was 172.0 N, whereas the maximum value was 1253.71 N; the minimum value obtained for the concrete surface was 161.20 N, whereas the maximum value was 1183.0 N (Table 10).

	Exist drawbar (N)	Adjustable (N)	Differences (N)	Differences (%)
Concrete surface	1219.58	1183	36.58	3
Soil surface	1328	1253.71	74.29	5
Differences				

Table 10: Pulling force.

Conclusions

Problems and disadvantages related with fixed traction for the Taral 818 horticulture tractor were determined as a result of the trials and calculations carried out. Design and prototype production for the adjustable traction system was carried out. Tractor travel speed, traction force, hourly fuel consumption values were measured to compare the developed adjustable traction system and the fixed drawbar. When the fuel consumption values were examined, it was observed that 0.29 l/h and 0.34 l/h less amount of fuel was consumed with the designed adjustable traction system in comparison with the fixed traction system under field and road conditions respectively. When the speed measurement results were examined, it was observed that the designed adjustable traction system can go 1.7 km/h and 2.0 km/h faster in comparison with the fixed traction system under the same in field and road conditions respectively with the same load. When the draft results were examined, it was observed that the maximum values for the adjustable traction system were lower by 36.58 N on concrete surface and by 74.29 N under field conditions in comparison with fixed traction and thus it was determined that the newly designed adjustable traction system decreases the load on the tractor. It has been put forth that the adjustable traction system adjusts the most suitable position for drawbar thus resulting in lower traction force and lower fuel consumption and therefore it is suggested to use it in all locally manufactured horticulture tractors.

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