

John Deere Werke Mannheim

Agricultural Tractor John Deere 6820 AutoQuad Plus EcoShift

Fuel Consumption during Transport Work

DLG Test Report 5435 F



*The tractor
during the test
drive*



Registering company

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Content of the Test

A model 6820 tractor was available for the test.

In order to guarantee that all components of the tractor were identical for the comparative measurements and with regard to engine power, both transmissions AutoQuad Plus as well as the AutoQuad Plus EcoShift were mounted into the same tractor for the respective test series. At the beginning of the test, pto power and fuel consumption were measured according to the regulations of the OECD Standard Code, using the common procedure of the DLG Test Center.

The goal of the test was to determine whether fuel consumption with the EcoShift version of the transmission is lower under realistic conditions without the transport speed being reduced.

Further criteria were not tested.

Short Description

The agricultural tractor 6820 AutoQuad Plus from John Deere is a four wheel drive standard tractor featuring a chassis-frame design. The six-cylinder engine has a displacement of 6.78 l, with electronically controlled common rail injection, and four valves per cylinder. The tractor is available with four transmission options (PowrQuad Plus; AutoQuad Plus; AutoQuad Plus EcoShift and AutoPowr). The AutoQuad Plus transmission offers a total of 20 gears (four power-shiftable gears within five synchronized ranges), which are also available for reverse operation, thanks to a separate reverser lever. Besides other programmable functions, it features a disengageable automatic system that shifts the power-shift

gears automatically depending on engine speed. When shifting between the ranges, the appropriate power-shift gear is engaged automatically. The shifting points are set with a rotary control knob. At the position „Eco /1“, gears are shifted down at 1,220 rpm and up at 1,700 rpm. At position 5 on the rotary control knob, the shifting points are 1,600 and 2,050 rpm. Any intermediate position can be selected as an application requires. However, the distance between the engine speeds at which gears are shifted up or down cannot be changed. The transmission is available as a 40 km/h and a 50 km/h version.

The version AutoQuad Plus EcoShift is basically a transmission

for a maximum speed of 50 km/h. In highest gear, however, the engine speed is reduced so that the resulting maximum speed is approximately 43 km/h (depending on tyre size).

The same fuel saving effect could be achieved on a tractor with a maximum design speed of 50 km/h by manually reducing the engine speed in the top gear using the „cruise control“ knob. However, the actual costs for a 50 km/h tractor are higher due to annual general safety inspection checks and half-yearly safety inspection on the brake system (at a permissible vehicle gross weight of more than 7.5 t) (Germany only).

Evaluation – Short Version

Tested criterion	Test result	Evaluation
Fuel savings	Very high (depending on conditions)	++
Operation of the AutoQuad Plus transmission	Good because operation is largely automatic	+
Operation EcoShift	Very good, automatic	++

Evaluation scale: ++ / + / o / - / -- (o = standard)

Measuring Method

The test drives were carried out on public roads. A trailer had to be pulled over a 19.6 km long even road (Main river valley) and a 5.35 km long sloped road in the hills of the Odenwald (difference in altitude: approximately 185 m; average gradient: 3.5%).

Both tracks were driven three times each with an empty and a loaded trailer as well as with both transmission variants. The time required and fuel consumption for the entire distance were determined. Within the test course, short time measure-

ments were carried out at six identical spots (four during rides on sloped roads) where engine speed, fuel consumption, fuel temperature, and the driving speed were recorded. These tests over a distance of approximately 200 m were not influenced by road traffic.

The transmission was always in the automatic mode. The shifting-point selector was set on „Eco“ during rides with an unloaded trailer and on position „4“ during rides with a loaded trailer. The driver always drove at full throttle.

Fuel consumption was measured with a PLU 116 Pierburg fuel measuring device. The return flow from the injection pump was fed back into the fuel supply line behind the measuring instrument. To avoid power losses due to higher fuel temperatures, the returning fuel flow ran through a cooler. To measure the distance covered during the individual tests, a Peiseler distance metering wheel was used.

Specifications

Total weight of tractor	6440 kg
Trailer empty/combined weight tractor/trailer	4625/11065 kg
Loaded trailer/combined weight tractor/trailer	17650/24090 kg
Front tyres	MICHELIN XM 108 - 540/65R28
Rear tyres	MICHELIN XM 108 - 650/65R38
Pto power at rated speed (2,100 rpm)	92.1 kW
Specific fuel consumption at rated speed	244 g/kWh
Absolute fuel consumption	22.44 kg/h
Pto power at maximum power speed (1,900 rpm)	101.5 kW
Specific fuel consumption at maximum power speed	230 g/kWh
Absolute fuel consumption	23.39 kg/h
Torque rise	42 %

Test Results and Individual Evaluations

Diagram 1 shows the engine characteristics. The ranges of the engine speed during transportation are marked. At reduced engine speed (1,690 rpm at 43 km/h) in the Eco mode of the EcoShift transmission (right border of the green area), torque reserve is still available. The engine works near the speed where it delivers its maximum power. Normally when the engine speed in the gears 1 to 19 is not automatically reduced, the governor curve is inclined (in the range between rated speed at 2,100 rpm and high idling speed at 2,250 rpm). If the engine speed is limited in the EcoShift mode, however, the governor curve is vertical (isochronic). This means that the engine speed remains the same even if the load changes.

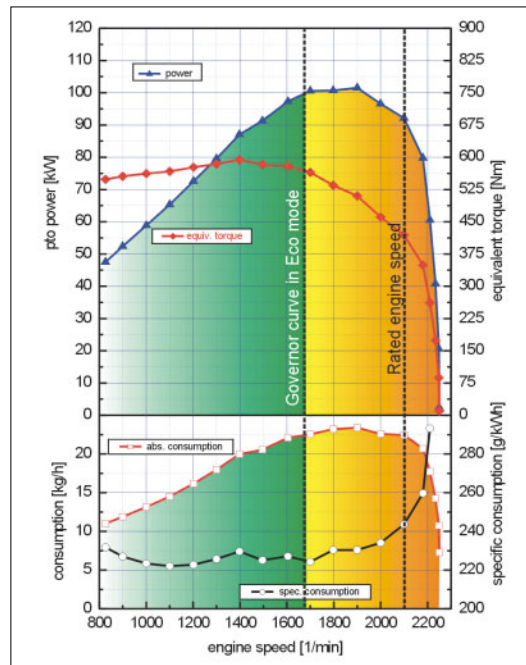


Diagram 1:
Results of the
Pto measurement



Figure 2:
Range lever with two
push buttons to power-
shift gears (above)
and the resume switch to
activate the automatic
shifting system (below,
middle)

Results of the Test Drives

Measurements on even roads

Long-term measurement in road traffic, Table 1

The table shows clearly that at virtually identical average speeds over the entire distance, fuel consumption is about 23% lower while towing an empty trailer if the distance is driven with EcoShift compared to an AutoQuad Plus transmission. When the trailer is loaded, the consumption of the EcoShift version increases as well, but with approximately 20% less, it is still considerably below the consumption of an AutoQuad Plus. The differences in fuel consumption between towing

an empty and a loaded trailer for the same transmission show the increased power required for towing and accelerating with the trailer loaded. Other random differences result from the individual traffic situation (red traffic lights, etc.).

Short-term measurement, constant operation, Table 2

The comparison of the average values of 3 individual measurements taken at the same location clearly shows the reduction of engine speed and, hence, also of consumption in both transmission ver-

sions. During an empty ride, the speed of the engine in the tractor with an EcoShift transmission is 540 rpm below that of the tractor with AutoQuad transmission. Due to different gear ratios, the driving speed is about the same. Even during loaded rides, the engine with EcoShift runs at the same speed due to the vertical governor curve. The operating point of an engine with an AutoQuad transmission, however, has slightly shifted on the inclined governor curve. Consequently, driving speed is lower as well.

Table 1:

Results of the measuring rides on even roads, long-term measurement in road traffic

Long-term measurement in road traffic	Even road, empty trailer, 19.6 km, mean values of 3 rides		Difference 6820AQ+ =100% %	Even road, loaded trailer, 19.6 km, mean values of 3 rides		Difference 6820AQ+ =100% %
	John Deere 6820 AQ+ EcoShift	John Deere 6820 AQ+		John Deere 6820 AQ+ EcoShift	John Deere 6820 AQ+	
Total travel time (h)	0.4821	0.4869	99.0	0.4922	0.5092	96.7
Average speed (km/h)	40.66	40.25	101.0	39.83	38.78	102.7
Total consumption (l/19.6 km)	6.63	8.60	77.1	7.71	9.71	79.4
Consumption ¹⁾ (l/h)	13.68	17.67	77.4	15.66	19.08	82.1
Consumption (l/100 km)	33.84	43.90	77.1	39.34	49.54	79.4
Consumption ²⁾ (ml/t km)	73.18	94.91	77.1	22.29	27.70	80.4

¹⁾ Consumption in l/h is also depending on the travel time.

²⁾ Consumption in ml/t km is a measure of fuel economy during transport rides. The less load is transported, the more uneconomical the ride becomes.

Table 2:

Short-term measurement on level roads, constant operation

Short-term measurement, constant operation	Even road, empty trailer, mean values of 3 rides		Difference 6820AQ+ =100% %	Even road, loaded trailer, mean values of 3 rides		Difference 6820AQ+ =100% %
	John Deere 6820 AQ+ EcoShift	John Deere 6820 AQ+		John Deere 6820 AQ+ EcoShift	John Deere 6820 AQ+	
Engine speed (1/min)	1686	2226	75.7	1686	2207	76.4
Consumption (l/h)	13.56	18.25	74.3	14.70	20.46	71.8
Consumption (kg/h)	11.27	15.17	74.3	12.20	17.00	71.8
Speed (km/h)	42.68	43.41	98.3	42.68	42.92	99.4

Measurements on sloped roads

Long-term measurement on sloped roads, Table 3

As expected, greater power requirements result in smaller differences between the transmission versions during rides on sloped roads. During rides with a loaded trailer, no more noticeable differences occur. The EcoShift transmission shifts to a lower gear. The governor curve inclines again.

Short-term measurement, constant operation, Table 4

During this exemplary individual measurement on a sloped road (gradient approximately 6%), it was shown that the EcoShift variant only provided noticeably lower consumption during rides with an empty trailer.

Table 3: Results of the measuring rides on sloped roads, long-term measurement

Long-term measurement in road traffic	Sloped road, empty trailer, 5.35 km, mean values of 3 rides		Difference 6820AQ+ =100%	Sloped road, loaded trailer, 5.35 km, mean values of 3 rides		Difference 6820AQ+ =100%
	John Deere 6820 AQ+ EcoShift	John Deere 6820 AQ+	%	John Deere 6820 AQ+ EcoShift	John Deere 6820 AQ+	%
Total travel time (h)	0.1366	0.1374	99.4	0.1929	0.1960	98.4
Average speed (km/h)	39.18	38.94	100.6	27.74	27.29	101.6
Total consumption (l/5.35 km)	3.02	3.24	93.0	4.94	5.06	97.6
Consumption ¹⁾ (l/h)	22.08	23.67	93.3	25.61	25.83	99.2
Consumption (l/100 km)	56.36	60.80	92.7	92.34	94.64	97.6
Consumption ²⁾ (ml/t km)	121.95	131.07	93.0	51.98	52.58	98.9

¹⁾ Consumption in l/h is also depending on the travel time.

²⁾ Consumption in ml/t km is a measure of fuel economy during transport rides. The less load is transported, the more uneconomical the ride becomes.

Table 4: Short-term measurement on sloped roads, constant operation

Short-term measurement, constant operation	Sloped road, empty trailer, mean values of 3 rides		Difference 6820AQ+ =100%	Sloped road, loaded trailer, mean value of 3 rides		Difference 6820AQ+ =100%
	John Deere 6820 AQ+ EcoShift	John Deere 6820 AQ+	%	John Deere 6820 AQ+ EcoShift	John Deere 6820 AQ+	%
Engine speed (1/min)	1690	1772	95.4	1710	1773	96.4
Consumption (l/h)	27.26	27.68	98.4	27.47	27.59	99.6
Consumption (kg/h)	22.64	23.02	98.4	22.82	22.91	99.6
Speed (km/h)	34.51	34.18	101.0	18.18	19.08	95.3

Summary and Evaluation

The EcoShift variant of the Auto-Quad Plus transmission is a useful possibility to save fuel during transport rides. The more even the roads are and the longer the fastest gears can be used, the greater the fuel saving effect becomes. Since the

engine speed is only reduced in the highest gear in order to maintain the maximum design speed of 40 km/h, the saving effect diminishes the more often the tractor is operated in lower gears due to uphill roads.

A subjectively determined positive side effect is less noise exposure during rides in the fastest gear, since the noise is reduced due to lower engine speed.

Test

Realization of the tests

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January 2005

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