Tractor tests in Douro Demarcated Region vineyards

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Abstract

The increase level mechanisation in last years, in Douro Demarcated Region, hasn't being followed by the necessary performance check. So, in the scope of the project AGRO 163 "Vineyard mechanisation in Douro Demarcated Region", we have done several tractor tests to get the main engine characteristics.

The equipment used in these tests was a electronic dynamometer, mark Froment, model XT - 200, that measure the power and torque at different engine regimes; the data measured are the maximum power, the maximum torque, the power corresponding to the normalised PTO regime, the torque reserve and gain factor and a graphic with the power and torque evolution, according the regime, is displayed. This information is compared with the new tractors data to detect any problems, such as the power losses, the irregularity response to the charge increase, etc.

A report with the tractor tests results and the malfunctions found are sent to the farmer with the indications that must be taken to solve the performance lack and avoid future troubles.

Introduction

The vineyard mechanisation is more than the right chose of equipments to the farmer, because it is also necessary to keep its best functionality. So, with this purpose, we had been doing, in the project "Vineyard mechanisation in RDD", some engine performance tests, namely some power and torque data and the characteristics curves determination, with are compared with the new engines data.

Material and methods

In this tests it was used a electronic dynamometer, mark Froment, model XT - 200, connected by a acquisition board data to a computer, that allow saving several information namely the power and torque developed by the engine in each power take off regime, the engine characteristic engine curves, etc., which are saved in a file that can be imported by a worksheet to make a detailed study of the engine performance. This equipment is trailer mounted which makes its displacement easier.

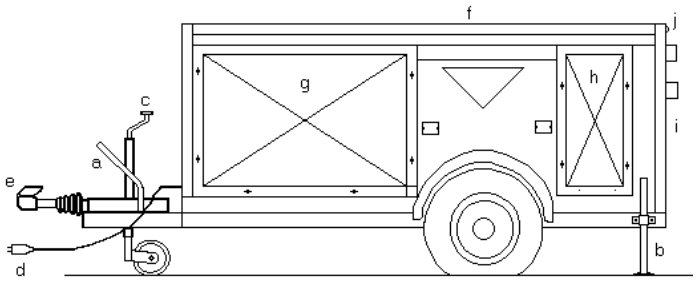
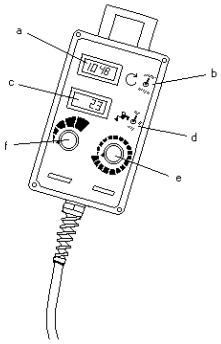


Figure 1- Electronic dynamometer used in tests
a- parking brake b- prop stands or corner steadies c- jockey wheel with level adjuster d- seven pin trailer plug for highway lighting e- coupling to suit 50 mm ball f- canopy g- side curtains large h- side curtains small i- end curtain j- speedlite lamp.
Source: Instruction manual of "Froment Tractor Test Center". (1991).

The test methodology used consisted, basically, in the connection between tractor and the dynamometer and, after the tractor engine warm up, put it running to the maximum speed, after which the engine charge is gradually increase; the charge increase is done using a hand held control unit (figure 2) that show the developed power and the engine regime.

Figure 2- Hand held control unit
a- digital readout speed b- digital read out speed selector switch 540 or 1000 rpm c- digital read out power d- digital readout selector switch hp, cv, or kW e- fine load control f- coarse load control.
Source: Instruction manual of "Froment Tractor Test Center". (1991).



The power and torque related data, according the engine regime, as its graphic representation, are saved in a portable computer, in which screen, besides the tractor information (mark, model, etc,) and the introduced program variables, that will be used by the dynamometer (dynamometer setup), presents a resume of the measured data and the settled one (summary of tests).

The data are saved in a "dat" extension file, which makes easier to import it by a worksheet for later detailed analysis; the power take off regime (rpm) is converted in engine regime. The graphics data are used to estimate a polynomial equation which allows the intermediate values determination. The dynamometer data are presented during the tests, to allow the operator following the power, regime and torque developed at each moment to gradually increase the engine charge to get well defined torque and power curves.

Results

The data power and torque used for tractor comparison are corresponding to the maximum engine regime (necessaries to overcome the transmission friction), to the nominal regime (used to the continuous tractor work), the regime corresponding to the maximum power and the regime corresponding to the normalised power take off speed.

Besides the presented data the software allow to determine the torque backup ratio (RB) and the gain factor (GF); using some data determined by the software the speed decrease ratio (SDR) and the irregularity regulator degree (GIR) are taken.
The formulas to get these data are as follow:

Torque Backup Ratio (%) = (Max. Torque - Torque @ Max. Power) / Torque @ Max. Power

The Speed Decrease Ratio (%) = (Max. RPM - RPM @ Max Torque) / Max. RPM * 100

The Gain Factor = Torque Reserve / Speed Decrease Ratio

The Irregularity Regulator Degree (%) = (Max. Regime - Nominal Regime) / (Nominal Regime+ (Max. Regime - Nominal regime)) * 100

The worksheet, where each line represents a tractor and the columns the variables, the data are compare among them (tractors of same mark and model) and with the new tractors which, together with the characteristics curves, allow the engine performance diagnosis.

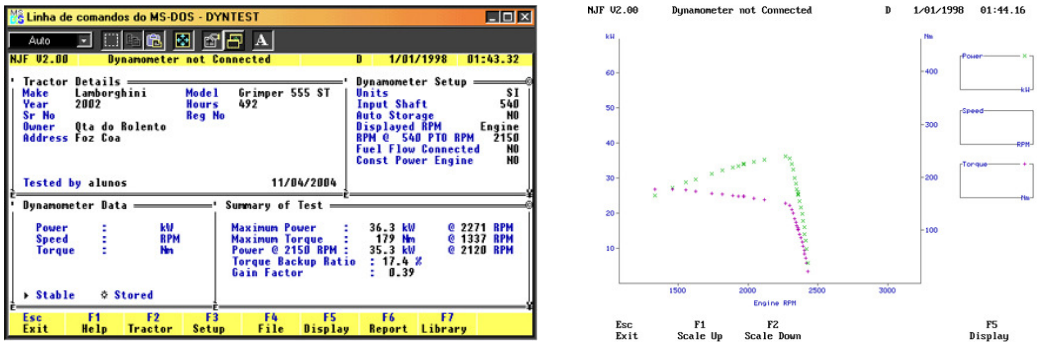


Figure 3- Display with data measured and graphic with power and torque curves.

In annex 1 and 2 are presented some of the data that had result from these tests.

Conclusions

The large area of the DDR vineyards to be mechanised justify continuing with the mechanisations projects and keep them with the purpose of increasing the equipments performance.

The studies and projects done in the last twenty years allowed the definition of mechanisation strategies for the different installations types but, for specific situations, it is necessary to make a strictly analyse, which presuppose a technical attendance and financial resources.

Technical and economical best fit equipments for each situation needs a good equipment maintenance, why high performance must be kept. So, with this purpose, studies similar to these one must continue to determine the tractors anomalies and those ones that are becoming obsolete and must be substitute.

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Annex 1

Marca	Modelo		rgM	Ano	Horas	Mt (novo)			Mt (reg.max.)			Mt (reg.nom.)			Mt (bin.max.)			Mt (TDF-540)			R.B.	SDR	GF	GIR
		SL	(540)			(kw)	(cv)	(rpm)	(rpm)	(kW)	(mN)	(rpm)	(kW)	(Nm)	(rpm)	(kW)	(Nm)	(rpm)	(kW)	(Nm)	(%)	(%)		(%)
David Brown	885	2RM	1100	1973	12000				1429	5.6	37.4	1276	27.9	208.9	878	21.4	233.0	1078	24.6	218.0	11.5	31.2	0.37	10.7
Ebro	155 E	2RM	2050	1978	6990				2122	3.0	13.5	1608	29.6	175.9	1244	24.9	191.0	2044	6.1	28.5	8.6	22.6	0.38	24.2
Ferrari	System50AR	4RM	1520	2002	1253	??	???	???	1979	5.1	26.0	1570	23.2	141.2	1118	20.0	171.0	1537	23.1	143.6	21.1	28.8	0.73	20.7
Fiat	45-66	2RM	2150	1992	2771				2200	2.9	12.6	1935	23.3	115.0	1348	19.3	137.0	2150	7.7	34.2	19.1	30.3	0.63	12.0
Fiat	55-65	RT	2160	1987	5008?	37.5	51.0	2199	2743	5.3	19.0	2477	27.4	105.7	1281	20.4	152.0	2201	26.6	115.5	43.8	48.3	0.91	9.7
Fiat	55-76	4RM	2150	1991	2806?	37.5	51.0	2199	2434	4.0	17.0	2232	27.6	118.1	1430	23.6	158.0	2232	27.6	118.1	33.7	35.9	0.94	8.3
Fiat	55-85	RT	1960	1998	3900	37.5	51.0	2199	2434	5.0	19.6	2235	33.0	141.1	1250	22.2	170.0	1942	30.8	151.5	20.5	44.1	0.47	8.2
Fiat	55-86	4RM	1900	1994	3571	37.5	51.0	2199	2324	4.4	18.7	1955	34.7	169.6	1159	23.8	196.0	1955	34.7	169.6	15.6	40.7	0.38	15.9
Fiat	FD 72-85	RT	2150	1995	3047		78 ??		2538	4.3	20.0	2323	47.1	193.7	1367	33.3	233.0	2208	46.2	199.9	20.3	41.2	0.49	8.5
Ford	3930	4RM	1760	1990	???	40.4	55.0		2161	4.9	22.0	2036	34.0	159.5	1038	19.3	178.0	1790	32.2	171.9	11.6	49.0	0.24	5.8
Ford	4610	4RM	1800		5383	36.8	50.0	1800	2324	5.6	23.0	2103	42.0	190.8	1175	26.4	215.0	1804	37.8	200.2	12.7	44.1	0.29	9.5
Goldoni	U 238	4RM	1800	1986	>10000	23.6	32.0	2806	1444	14.8	97.8	1444	14.8	97.9	1444	14.8	98.0					0.0		
Goldoni	Compac 604 D	4RM	2100	1997	1828				2231	3.2	13.7	1887	31.4	159.0	1354	23.7	167.0	2100	11.2	51.0	5.0	28.2	0.18	15.4
Goldoni	U 238	4RM		1984	4400?	23.6	32.0	2806	1843	2.5	13.0	1627	17.5	102.8	1313	15.0	109.0				6.1	19.3	0.31	11.7
Goldoni	U 238	4RM		1985	5400	23.6	32.0	2806	1880	2.6	13.0	1561	16.8	102.8	1275	14.7	110.0				7.0	18.3	0.38	17.0
JD	1140	2RM	2100	1982	8900	44	60		2690	5.4	20	2528	34.0	128.5	1380	23.3	161.0	2115	31.7	143.2	25.3	45.4	0.6	6.0
JD	1550	2RM	2120	1988	5858				2460	4.1	15.9	2241	36.3	154.8	1210	22.4	177.0	2163	35.7	157.7	14.4	46.0	0.31	8.9
JD	1445 FA	4RM	2150	1990	2899				2424	3.8	20.0	2213	27.1	117.0	1197	18.5	148.0	2213	27.1	117.0	26.5	45.9	0.58	8.7
JD	1745 F	4RM	2150	1989	7000				2454	3.9	15.2	1982	31.3	150.9	1395	26.4	181.0	2131	30.7	137.6	20.0	29.6	0.67	19.2
JD	1846 F	4RM	2200	1999	1916				2392	20.9	83.4	2247	35.9	152.6	1366	24.0	168.0	2247	35.9	152.6	10.1	39.2	0.26	6.1
JD	5400 S	4RM		2000	842	44.6	60.7	2400	2441	4.2	16.0	1803	39.8	210.9	1563	38.9	238.0	2102	37.9	172.3	12.8	13.3	0.97	26.1
Lamborghini	555ST	RT	2020	1998	1541	40.4	55.0		2440	9.2	36.0	2367	34.7	140.1	1420	25.1	169.0	2063	32.4	150.1	20.7	40.0	0.52	3.0
Lamborghini	613DTV	4RM	1980	1985	4931	41.2	56.1	2000	2232	3.8	16.3	2030	34.4	161.9	1460	27.0	177.0	1942	33.5	164.8	9.3	28.1	0.33	9.1
Lamborghini	660 F plus	4RM	2050	1999	3656				2373	4.1	20.0	2196	35.4	154.0	1207	23.4	185.0	2040	34.2	160.2	20.1	45.0	0.45	7.5
Lamborghini	C533	RT	1500	1985	5000?	39.7	54.1	1969	1754	3.7	21.0	1520	26.3	165.3	1085	20.6	181.0	1520	26.3	165.3	9.5	28.6	0.33	13.3
Lamborghini	C554	RT	1500	1990	>10000	39.7	54.1	1969	1563	3.1	19.0	1389	33.1	227.7	1315	31.4	228.0	1502	16.2	103.0	0.1	5.3	0.03	11.1
Lamborghini	C554	RT	1960	1985	>10000	39.7	54.1	1969	2210	3.8	16.4	2027	29.9	140.9	1298	21.1	155.0	1958	29.6	144.4	10.0	36.0	0.28	8.3
Lamborghini	C583S	RT	1960	1990	>10000	39.7	54.1	1968	2316	4.4	18.1	1996	23.4	112.0	1160	17.7	146.0	1996	23.4	112.0	30.3	41.9	0.72	13.8
Lamborghini	Grimper 555 ST	RT	2050	2000	362	40.4	55.0	2350	2494	4.7	18.0	2354	33.5	136.0	1254	23.5	179.0	2034	32.3	151.7	31.7	46.7	0.68	5.6
Lamborghini	Grimper 555 ST	RT	2050	2001	247	40.4	55.0	2350	2515	4.9	19.0	2375	32.0	128.7	1252	22.7	173.0	2050	31.1	144.9	34.4	47.3	0.73	5.6
Lamborghini	Grimper 555 ST	RT	2050	2000	524	40.4	55.0	2350	2490	4.7	18.0	2324	32.5	133.6	1298	23.6	174.0	2065	31.5	145.7	30.2	44.1	0.68	6.7
Lamborghini	Grimper 555 ST	RT	2050	2002	492	40.4	55.0	2350	2320	5.9	20.0	2271	36.3	152.7	1337	25.0	179.0	2120	35.3	159.1	17.2	41.1	0.42	2.1
Lamborghini	Grimper 570 ST	RT	2050	1990	1077	52.0	70.0	2350	2505	7.0	30.0	2313	41.3	170.6	1139	26.9	226.0	2060	40.7	188.8	32.5	50.8	0.64	7.7
Lamborghini	Runner 450	4RM	2650	2003	319	30.9	42.0	3000	3198	4.6	14.0	2964	27.0	87.0	2052	20.4	95.0	2618	25.0	91.2	9.2	30.8	0.30	7.3
Lamborghini	Runner 450	4RM	2650	2003	126	30.9	42.0	3000	3203	4.6	10.0	3067	25.9	80.7	2336	21.3	87.0	2772	24.5	84.4	7.8	23.8	0.33	4.2
Landini	7860	4RM	1980	1988	8000	55.0	75.0		2267	4.2	17.4	2203	46.2	200.4	1168	30.2	247.0	19996	44.7	21.4	23.3	47.0	0.50	2.8
Landini	Mistral 50	4RM	1950	2000	2000?	34.6	46.0		2461	5.3	21.0	2271	26.0	109.4	1406	17.4	118.0	1895	22.8	115.0	7.9	38.1	0.21	7.7
Landini	Trecker 60 F	RT	2000	2002	804				2341	4.2	17.0	2163	32.5	143.6	1683	28.4	161.0	2024	31.9	150.6	12.2	22.2	0.55	7.6
Landini	Trekker 55 F	RT	1950	2000	2000?				2201	3.8	17.0	1968	30.1	146.1	1383	23.2	160.0	1968	30.1	146.1	9.5	29.7	0.32	10.6
MF	234 CF	RT		1989	7000				1236	2.7	21.0	1169	27.8	227.2	834	22.7	260.0	1236	2.7	20.9	14.4	28.7	0.50	5.4

Annex 2

Marca	Modelo	SL	MtPm (rpm)	MtPm (kW)	MtPm (cv)	rM-sc (rpm)	rM-n (rpm)	Pt/rM-n (kW)	Bn/rM-n (Nm)	Cs (g/kWh)	rM-540 (rpm)	PtrM-540 (kW)	brM-540 (Nm)	rM-bm (rpm)	PtrM-bm (kW)	brM-bm (Nm)	R.B. (%)	SDR (%)	GF	GIR (%)
BCS Variant	500 AR	4RM=		23.5	32.0	2935	2800	23.5	80.2	248	2577	23.1	85.4	1800	19.1	101.0	26.0	35.7	0.7	4.6
BCS Vithar	800 RS	4RM=		36.7	49.9	2835	2600	36.7	134.9	206	2266	35.1	147.5	1700	30.2	169.0	25.3	34.6	0.7	8.3
BCS Vithar	900 MT	4RM=		50.1	68.1	2880	2600	50.1	184.1	254	2266	47.9	201.3	1400	37.3	254.0	38.0	46.2	0.8	9.7
BCS Vivid	400 DT	4RM		21.5	29.2	3550	3400	21.5	60.4	277	2742	18.8	65.3	2100	15.0	68.0	12.6	38.2	0.3	4.2
Case IH	CS 48 a	4RM	2250	34.5	46.9	2250	2250	34.5	146.5	260	2044	33.0	153.8	1400	27.0	183.5	25.3	37.8	0.7	0.0
Case IH	CS 94a M2	4RM	2102	66.6	90.6	2489	2300	63.8	265.0	249	2132	66.6	297.5	1205	46.8	370.0	39.6	47.6	0.8	7.6
Case IH	CX 100	4RM	2000	65.0	88.4		2200	64.3	279.2	279	2000	65.0	309.5	1404	53.7	364.0	30.4	36.2		
Case IH	CX 50	4RM	2248	31.7	43.1		2248	31.7	134.7	277	2006	30.5	144.8	1200	20.7	164.0	21.7	46.6		
Case IH	CX 60	4RM	2200	42.1	57.3		2250	41.9	177.9	258	2006	41.0	194.7	1293	29.6	218.0	22.5	42.5		
Case IH	CX 70	4RM	2000	46.3	63.0		2200	44.5	193.3	282	2000	46.3	220.5	1200	33.4	265.0	37.1	45.5		
Case IH	CX 80	4RM	2000	54.4	74.0		2200	53.2	231.0	282	2000	54.4	259.0	1406	45.0	305.0	32.0	36.1		
Case IH	CX 90	4RM	2000	60.5	82.3		2000	59.4	283.8	267	1998	60.5	288.4	1400	46.9	319.0	12.4	30.0		
Case IH	JX 55	2RM	2500	33.6	45.7		2500	33.6	128.4	263	2200	31.6	136.8	1500	24.6	156.3	21.7	40.0		
Case IH	JX 65	4RM	2500	37.8	51.4		2500	37.8	144.5	249	2200	35.6	154.1	1300	24.0	175.8	21.7	48.0		
Case IH	JX 75	2RM	2550	45.7	62.2		2500	45.2	172.7	248	2200	42.0	181.8	1200	26.2	207.8	20.3	52.0		
Case IH	JX 85	4RM	2525	53.4	72.6		2500	53.0	202.5	250	2200	49.1	212.6	1500	36.2	230.1	13.6	40.0		
Case IH	JX 95	2RM	2350	62.1	84.5		2500	60.9	232.7	248	2200	60.9	263.6	1300	38.2	279.8	20.2	48.0		
Case IH	MX 100 C	4RM	2200	61.4	83.5		2200	61.4	266.6	294	2200	61.4	265.8	1398	51.7	352.0	32.0	36.5		
Case IH	MX 80 C	4RM	2100	50.6	68.8		2200	50.0	217.1	297	2200	50.0	216.5	1305	40.6	296.0	36.3	40.7		
Case IH	MX 90 C	4RM	2100	56.3	76.6		2200	56.2	244.1	291	2200	56.2	243.3	1394	46.8	319.5	30.9	36.6		
Case IH	STX 375	4RMa	1600	288.3	392.1	2134	2000	252.0	1203.8	210	2000	252.0	1200.0	1198	226.0	1797.0	49.3	40.1	1.2	6.3
Case IH	STX 440	4RMa	1700	338.7	460.6	2154	2000	298.8	1427.4	214	2000	298.8	1422.9	1100	250.2	2166.0	51.7	45.0	1.1	7.1
Case IH	STX 440 Q	RT	1599	335.8	456.7	2160	1999	297.6	1422.4	211	1999	297.6	1417.9	1099	247.6	2146.0	50.9	45.0	1.1	7.5
Daedong	DK 45	4RM	2600	27.0	36.7	2800	2600	27.0	99.2	302	2503	27.0	102.7	1700	21.7	121.4	22.4	34.6	0.6	7.1
Daedong	DK 50	4RM	2600	30.3	41.2	2846	2600	30.3	111.3	291	2503	29.8	113.4	1900	25.0	125.3	12.5	26.9	0.5	8.6
Daedong	DK 80	4RM	2300	49.7	67.6		2300	49.7	206.5	282	2205	49.3	212.9	1400	37.0	251.7	21.9	39.1		
Daedong	DK 90	4RM	1950	55.6	75.6		2205	50.8	220.1	276	2205	50.8	219.4	1400	44.0	299.4	36.0	36.5		
Daedong	L3503 D	4RM		21.2	28.8	2948	2600	21.2	77.9		2431	20.1	78.7	1500	15.2	96.8	24.3	42.3	0.6	11.8
Daedong	LB1914	4RM		12.8	17.4	2952	2800	12.8	43.7		2648	12.8	46.0	2200	11.8	51.2	17.2	21.4	0.8	5.1
Daedong	LF 80-90	4RM	2402	56.8	77.2	2593	2402	56.8	225.9	263	2198	55.2	239.2	1556	46.4	284.2	25.8	35.2	0.7	7.4
Daedong	LK 2554	4RM		14.3	19.4	2808	2600	14.3	52.5		2429	13.7	53.7	1500	11.2	71.3	35.7	42.3	0.8	7.4
Daedong	LK 3504	4RM	2700	19.1	26.0		2700	19.1	67.6	317	2610	18.9	69.0	1800	15.6	82.4	21.9	33.3		
Deutz-Fahr	Agrolux 60	4RM		40.9	55.5	2600	2400	40.9	162.8	221	2044	38.4	178.9	1400	29.0	197.0	21.0	41.7	0.5	7.7
Deutz-Fahr	Agroplus 60	4RM	2399	38.4	52.2	2494	2399	38.4	152.9	299	2304	37.9	156.7	1571	29.1	176.6	15.5	34.5	0.4	3.8
Deutz-Fahr	Agroplus70	4RM	2300	49.6	67.5	2452	2300	49.6	206.0	267	2300	49.6	205.4	1498	38.9	247.1	19.9	34.9	0.6	6.2
Fendt	410 Vario			63.7	85.4		2100	63.7	289.8	252	1937	70.6	347.1					100.0		
Fendt	411 Vario			71.6	96.0		2100	71.6	325.8	255	1937	79.2	389.4					100.0		
Fendt	412 Vario			80.0	107.3		2100	80.0	364.0	249	1937	85.5	420.4					100.0		
Fendt	Farmer 411 Vario	4RM	1805	82.7	112.5	2294	2102	75.3	342.3	238	1939	80.7	396.4	1251	67.1	511.0	49.3	40.5	1.2	8.4
Fiat	55-56	2RM	2500	36.1	49.1	2500	2500	36.1	138.0	278	1966	30.3	146.8	1200	20.0	158.8	15.1	52.0	0.3	0.0
Fiat	L85	RM		56.7	77.1	2741	2495	56.7	217.1		2383	56.4	225.4	1364	40.1	280.1	29.0	45.3	0.6	9.0
Fiatagri	L60	RM		38.9	52.9	2745	2502	38.9	148.5		2383	37.5	149.9	1493	29.3	186.6	25.6	40.3	0.6	8.9