GOBIERNO DE ESPAÑA

MINISTERIO DE AGRICULTURA, PESCA Y ALIMENTACIÓN

ESTACION DE MECANICA AGRICOLA

Measuring Energy Efficiency (Test and Methodologies)

Bologna, 8th November 2018

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Terms

- Tractor → Self-propelled wheeled tractors, having at least two axles, or with tracks, designed to carry out the following operations:
  1. to pull trailers;
  2. to carry, pull or propel agricultural and forestry tools or machinery and, where necessary, supply power to operate them with the tractor in motion or stationary.

- Efficiency → the ratio of the useful work performed by a machine or in a process to the total energy expended or heat taken in.

Background

- In 2004, an energy-saving strategy was developed by Spain government.
- A working-group was created in order to achieve this goal.

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Methodology

- Due to the renowned prestige of OECD tractor tests, data from code 2 (OECD STANDARD CODE FOR THE OFFICIAL TESTING OF TRACTOR PERFORMANCE) were taken into account in this purpose.
  1. Power Take-Off and Engine Tests (3.1)
  2. Drawbar Power and Fuel Consumption (3.3)

OECD
BETTER POLICIES FOR BETTER LIVES

Methodology

- Power Take-Off and Engine Tests
  - 3.1.1 maximum power - one-hour test
  - 3.1.2 power at rated engine speed
  - 3.1.3 power at standard pto speed [1000 ± 25 or 540 ± 10 min-1 (rev/min)]
  - 3.1.6 part loads at different engine speeds

Methodology

- Drawbar Power and Fuel Consumption
  - 3.3.1 maximum power in tested gears/speed settings
  - 3.3.2.1 Fuel consumption in selected gear/speed setting nearest 7.5 km/h, at maximum power at rated engine speed
  - 3.3.2.2 Fuel consumption in selected gear/speed setting nearest between 7 km/h and 10 km/h at rated engine speed

Methodology

- Drawbar Power and Fuel Consumption
- On tractors with automatic mode next partial loads points are used:
  - From 3.3.2.1.1 to 3.3.2.1.4 (7,5 km/h)
  - From 3.3.2.2.1 to 3.3.2.2.4 (7 to 10 km/h)

- **Efficiency index** (C_{kt})is a global evaluation of the specific fuel consumption (l/kWh) which estimate the yield of:

Engine	Transmission
	

Methodology

- Engine

3.1.6 part loads at different engine speeds

3.1.6.1 Maximum power at rated engine speed

3.1.6.2 80% of power obtained in 3.1.6.1 at maximum speed setting

3.1.6.3 80% of power obtained in 3.1.6.1 with governor control set to 90% of rated engine speed

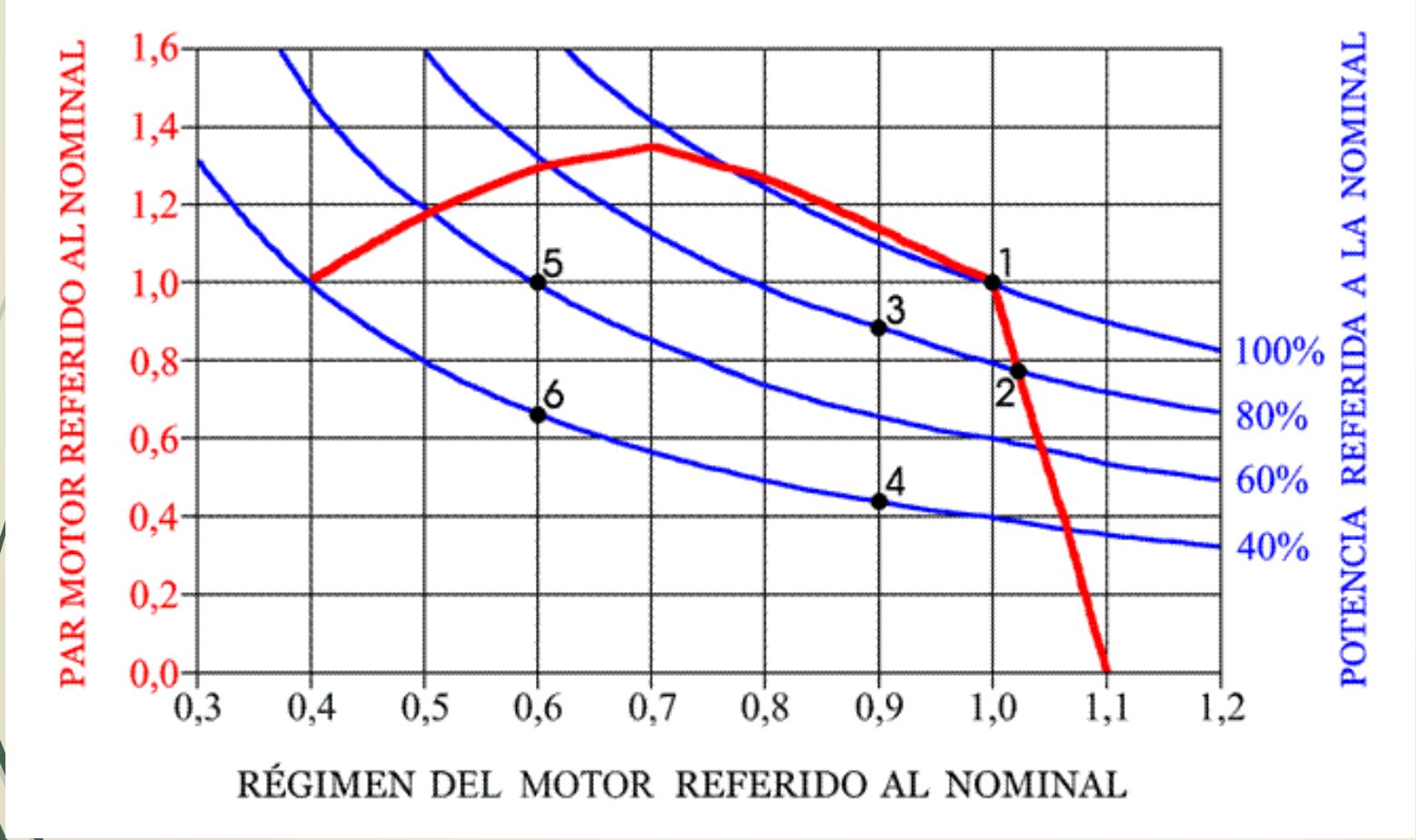
3.1.6.4 40% of power obtained in 3.1.6.1 with governor control set to 90% of rated engine speed

3.1.6.5 60% of power obtained in 3.1.6.1 with governor control set to 60% of rated engine speed

3.1.6.6 40% of power obtained in 3.1.6.1 with governor control set to 60% of rated engine speed

Methodology

- Engine



$$C_k = \frac{\sum_{i=1}^{6} SVFC_i}{6}$$

SVFC= Specific volumetric fuel consumptiom (l/kWh)

Methodology

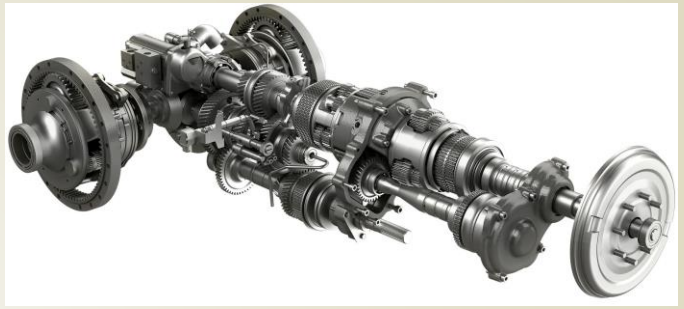
- Tractors with automatic mode

$$RSVFC = \frac{1}{4} \times \left(\frac{SVFC_{75auto7,5}}{SVFC_{75manual7,5}} + \frac{SVFC_{50auto7,5}}{SVFC_{50manual7,5}} + \frac{SVFC_{75auto7\ a\ 10}}{SVFC_{75manual7\ a\ 10}} + \frac{SVFC_{50auto7\ a\ 10}}{SVFC_{50manual7\ a\ 10}} \right)$$

$RSVFC$ is a reduction coefficient that will modify the C_k index

$$C_k = \frac{RSVFC \sum_{i=1}^{2} SVFC_i + \sum_{i=3}^{6} SVFC_i}{6}$$

Methodology



- transmission

$$\eta = \frac{\mathrm{P}_{\mathrm{drawbar}}}{\mathrm{P}_{pto}}$$

$$P_{drawbar} = \frac{P_{recorded}}{1-\sigma}$$

Only some values are taken into account. The engine speed has to be between rated engine speed and a close value to máximum power engine speed

Methodology

- C_{Kt} Index

$$C_{Kt} = \frac{C_K}{3} \times \left(1 + \frac{1}{\eta_{ls}} + \frac{1}{\eta_{hs}}\right)$$

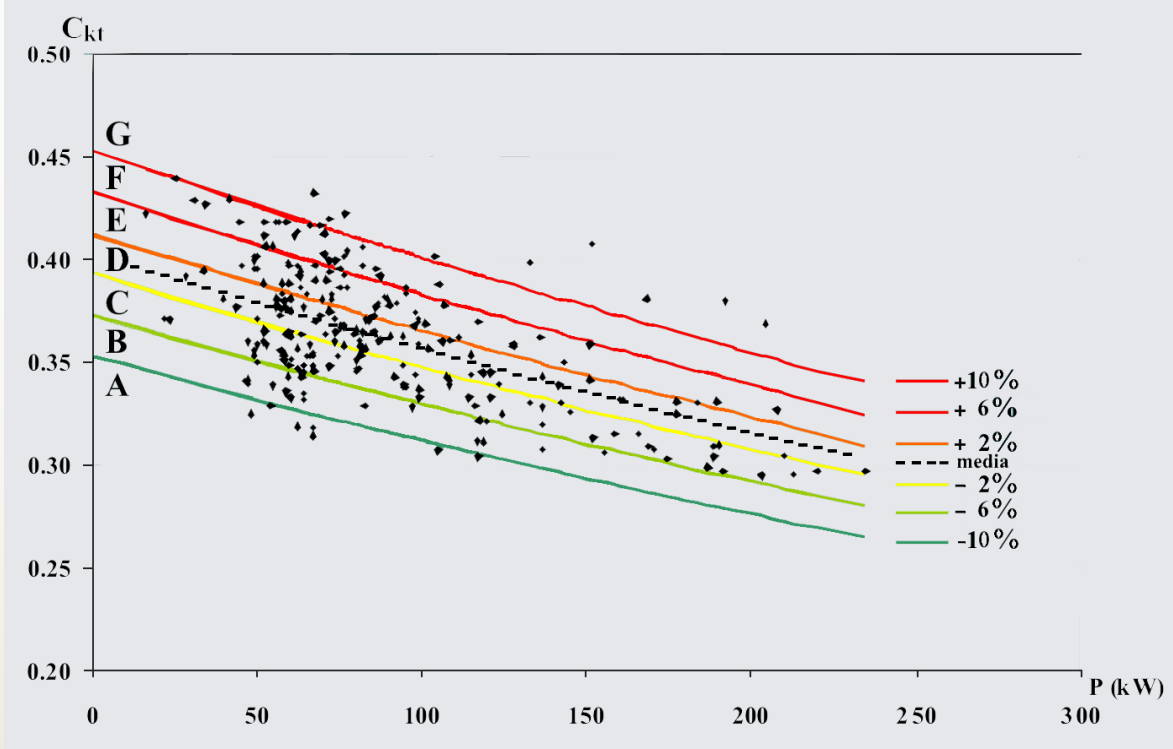
  - η_{ls} performance for low speed (< 8 km/h)
  - η_{hs} performance for high speed (> 8 km/h)

Class tractor

- Class tractor is the national software of tractor classification according to its energy efficiency.

Class tractor

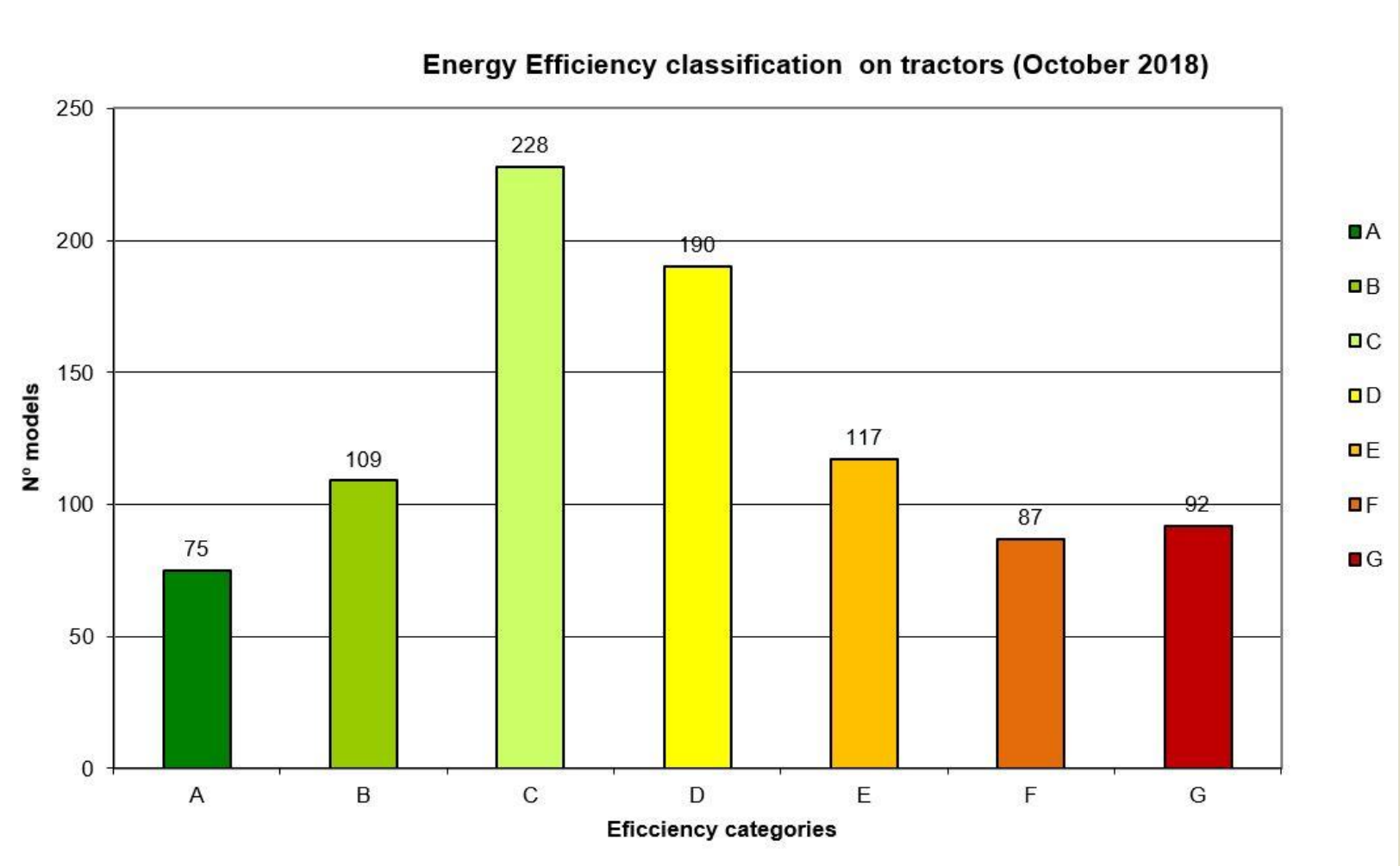
- Class tractor was updated on 2016 for last time. A new mid line with a sample of 579 tractors was established.



Class tractor

- 898 tractors have been classified
  - 92 tractors tested by EMA
  - 806 tractors tested by other OECD stations

Class tractor



Application

- Since the begining until today, the application of this energy efficient classification has been used by the Spanish Ministry of Agriculture to give financial support for the adquisition of new tractors of the most efficient categories (A and B until 2016 and from then A, B y C).
- In the same way, this methodology is also used by autonomous communities for rural development aids.

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Thank you for your attention