LCA OF DIFFERENT DEVICES FOR POLLUTANTS EMISSION REDUCTION ON AGRICULTURAL TRACTORS

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INTRODUCTION

The **aim** of this study is to quantify the potential environmental impacts of ploughing carried out with 3 tractors belonging to different emission Stages for the control of pollutant emissions produced during engine combustion.

METHODS

A **cradle to- farm gate perspective** was applied: the system boundary includes the production of inputs consumed during ploughing and the related emissions.

The **Functional Unit** is 1 ha of soil properly tilled.

Inventory data were measured for fuel consumption during the three ploughing trials and for urea solution consumption in tractor B. Engine exhaust gases emissions were quantified by referring to the emission limits of the Stage of belonging as defined by EU Directives.

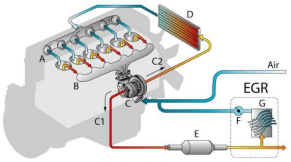
Variables		Unit	Tractor A, Stage 3A with EGR	Tractor B, Stage 3B with SCR	Tractor C, with no emission control
Fuel consumption		kg ha^{-1}	40.3	38.4	39.4
Urea solution consumption		dm^3 h^{-1}	--	1.08	--
Mass of tractor		kg	7200	8140	6665
Mass of plough		kg	1280	1280	1280
Working time per year	Tractor	h y^{-1}	500	500	500
	Plough	h y^{-1}	130	130	160(*)
Consumed mass	Tractor	kg ha^{-1}	1.53	1.74	1.01
	Plough	kg ha^{-1}	1.04	1.04	1.16

Ploughing was performed with a 4-furrows mouldboard plough on a medium texture-clayey soil coupled with the three tractors compared:

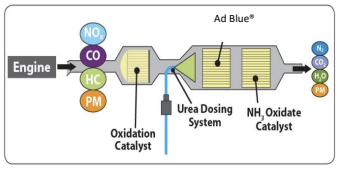
- tractor A, 179 kW, minimum specific fuel consumption 213 g/kWh, emission Stage 3A, equipped with EGR (Exhaust Gas Recirculation),
- tractor B, 191 kW, minimum specific fuel consumption 196 g/kWh, emission Stage 3B, equipped with SCR (Selective Catalytic Reduction) in which a urea solution is used at 3.4% volume of the fuel consumed,
- tractor C, 135 kW, minimum specific fuel consumption 235 g/kWh, previous to emission Stage limits, therefore no equipment for pollutants reduction is included. At that time more powerful tractors were not available on the market, therefore this less powerful tractor in respect to A and B was used.

COMPARED TECHNOLOGIES

EGR consists of a valve to recirculate part of the exhaust gases as intake air in the engine. Advantages: Oxygen per unit volume of intake air is lowered and this intake air has already high temperatures, hence NOx formation is lowered. Disadvantages: increase in fuel consumption (4-10%).

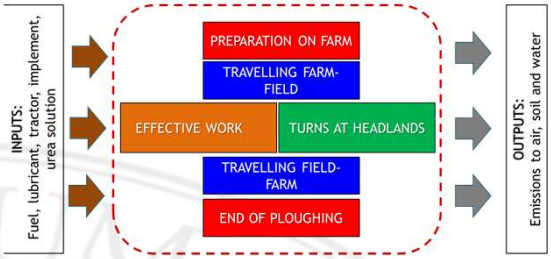


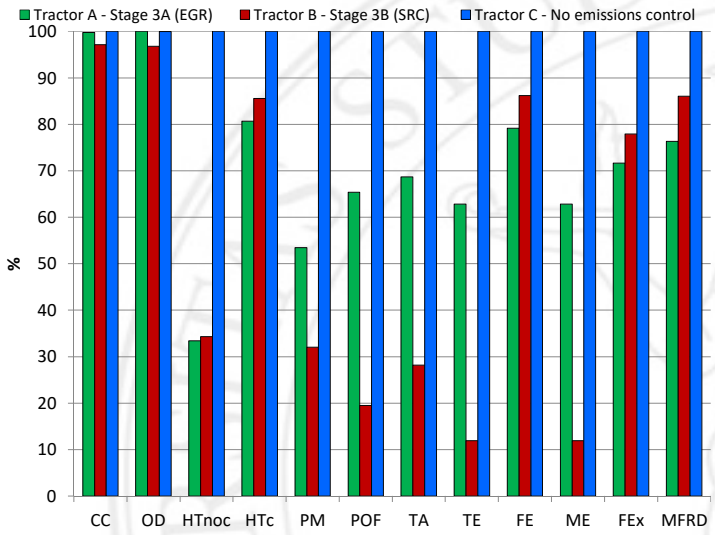
SCR removes NOx using ammonia as reducing agent. Ammonia is formed through thermolysis and hydrolysis of the urea solution. Advantages: higher specific power output, improved engine life and lower fuel consumption due to an increase in fuel efficiency (4-5%). Disadvantages: consumption of urea solution.



The no-emissions control tractor, instead, is a common one, outdated but still present on farms, without emissions control strategies because limits were still not introduced for agricultural tractors.

SYSTEM BOUNDARY





RESULTS

Tractor C has the worst environmental performance on all impact categories.

Regarding the best solution, instead, not univocal results are obtained, mainly because of engine and operative characteristics of the tractors.

The worst results for tractor C are related to the categories mainly affected by pollutants emissions. For CC and OD the impact is very close for all the 3 cases due to the similar fuel consumption, especially of tractors A and C.

The best outcomes are achieved for 7 of 12 impact categories by tractor B. On HTnoc, HTc, FE, FEx and MFRD tractor B behaves worse than tractor A because the SCR consists of a more complex system that involves a substantial increase in the tractor mass.

CONCLUSIONS Urea solution has a negligible impact but its use involves important and efficient environmental benefits for pollutants emissions.

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