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APPLICATION AND ENHANCEMENT OF LIFE CYCLE ASSESSMENT AND WATER FOOTPRINT APPROACHES TO AGRICULTURAL MACHINERY AND CULTIVATION

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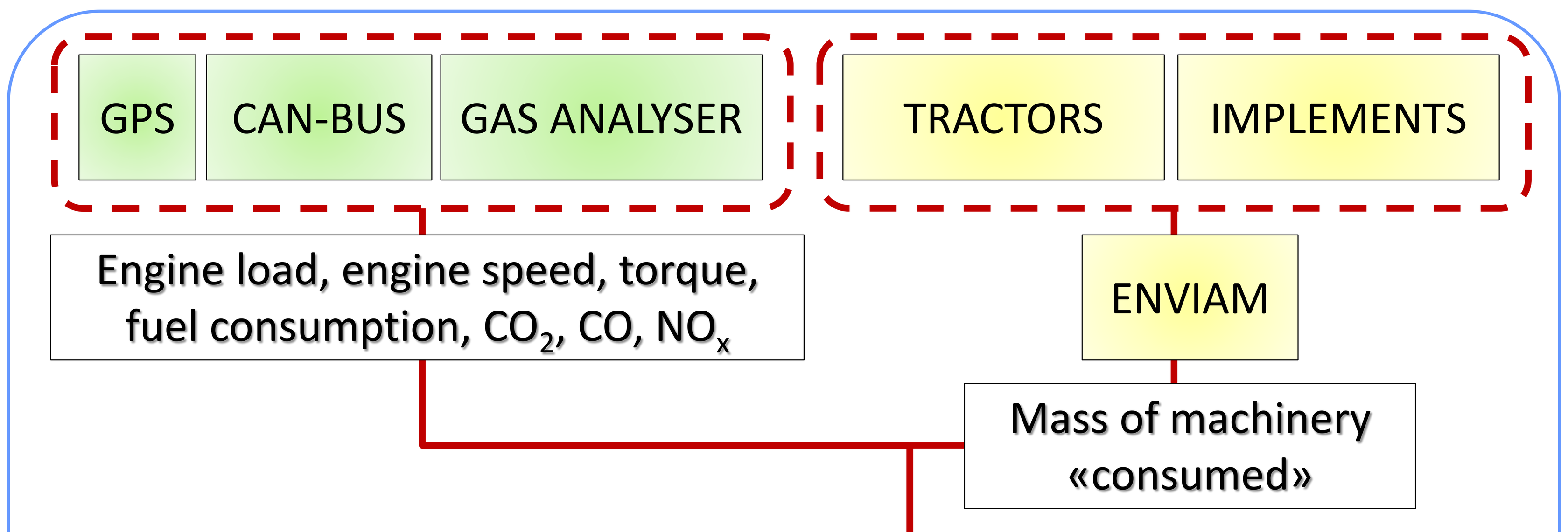
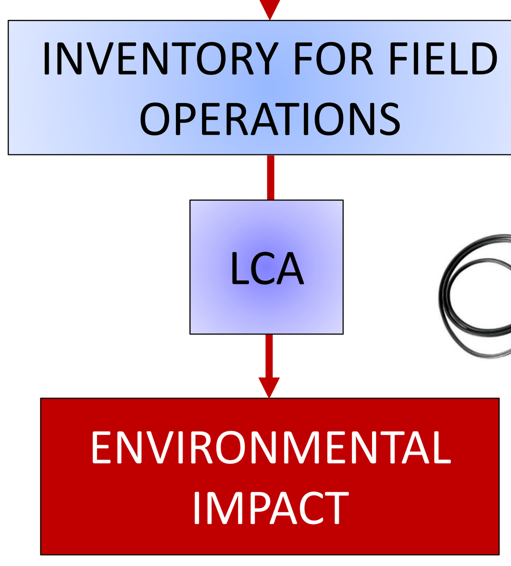
INTRODUCTION

For the environmental impact assessment of agricultural machinery operations, the collection of reliable inventory data (e.g., materials and fuel consumptions, pollutants emissions) is a prerequisite for the achievement of trustful results. The searched data cannot be always directly measured because of measurement difficulties and of the local variability linked to pedo-climatic, site-specific and work-specific and logistic variables.



Environmental impact category	Unit
Climate change	kg CO2 eq
Ozone depletion	kg CFC-11 eq
Particulate matter formation	kg PM2.5 eq
Photochemical oxidant formation	kg NMVOC eq
Acidification	kg H+ eq
Freshwater eutrophication	kg P eq
Marine eutrophication	kg N eq
Mineral, fossil and renew. resources depletion	kg Sb eq



AIM

To study how to make adequately reliable the life cycle inventories for performing trustworthy environmental sustainability assessments about agricultural machinery systems.

→ Study the environmental impact of crops production through LCA using local pedo-climatic variables and alternative machinery solutions. *(Papers 1-2-3-4).*

→ Understand the importance of local data (machinery mass, fuel consumption and exhaust gases emissions) respect to database average data for LCA results. *(Papers 1-2-3-4).*

→ Improve the methodological framework for reliable modelling and data collection about field operations in relation to efficiency improvements and technological innovation. *(Paper 5).*

MATERIALS AND METHODS

Life Cycle Assessment (LCA) is adopted for the environmental impact assessment. LCA is a standardised and widely recognised approach (ISO 14040-14044) that translates inputs (e.g., fuel, lubricants, fertilisers, water) and outputs (emissions of pollutants to air, soil and water) of a system into environmental impacts by means of characterisation factors.

LCA was used to quantify the environmental impact of field operations for seedbed preparation and organic fertilisers' spreading. Different machinery and work conditions were compared.

Field tests during ploughing, rotary harrowing, spring tine harrowing, sowing and rolling were carried out using a **tractor equipped with GPS, CAN-bus,** Dewesoft® **data logger and** Testo® **emissions analyser**.

This allowed: (1) collecting data directly during field operations, (2) mapping the operation with instantaneous data about engine, fuel and exhaust gases emissions and geographical position, and (3) processing data within the identified work states of effective work, turns at the headlands, and stops.

RESULTS AND CONCLUSIONS

→ Identify the **alternatives with a more restrained environmental impact** respect to others.

→ Machinery choice (with *vs* without equipment for exhaust gases emissions' reduction, implements with *vs* without PTO, type of ploughs, type of slurry tankers, etc.) greatly influences the environmental sustainability of agricultural productions: **farmers play a very important role** on these performances.

→ Importance of analysing carefully the case studies with **local variability** instead of secondary data.

→ Evaluations about the **best driving and turning schemes** were obtained, and LCA was performed with directly collected data.

→ The effective work resulted quite homogeneous in terms of **fuel consumption and exhausts emissions**, whereas turns at headlands and stops achieved the worst and unstable results.

→ The role of farmers is fundamental and they should be taught about the consequences of their choices.

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