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# *Biosystem Engineering for sustainable agriculture, forestry and food production*

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**Matera, 12-13 September 2019**

**Organization**

**SAFE - School of Agriculture, Forestry, Food and Environmental Sciences - University of Basilicata, with the technical support of Ninetek Innovazioni per l'Agro-industria s.r.l., spin-off company of the University of Basilicata**

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# Presentation

Sustainable development of agriculture, forestry, and food production sectors is closely related to the research developments in the field of biosystems engineering. On one side, biosystems research is oriented to efficiently produce and process biological resources to satisfy the demand of consumers and a wide range of industries for food, feed, bio-energy and bio-based products. At the same time, it provides and develops engineering-based methodologies and decision support tools for management and protection of soil, water and environmental resources; design of structures, facilities, equipment and infrastructures; planning and design of rural areas and landscape; mechanization and technologies for agricultural production; agricultural electrification and energy usage; ergonomics and work organization and safety; computer and communication technologies.

Matera, 12 September 2019

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# 1 Foreword

The aim of this Conference is to stimulate contributions related to the engineering technological applications to the agriculture, forestry, and agro-food sectors. Researchers involved in activities related to Biosystems and Agricultural Engineering, as well as Agricultural, Forestry and Food Engineers, farm and food company managers are warmly invited to attend the Conference.

The Conference will deal with the following major topic

## Innovative biosystems engineering for sustainable agriculture, forestry and food production

The specific subjects will include (but not will be limited to)

- Agricultural hydraulics
- Water resources management in agriculture and forestry ecosystem
- Design and management of Farm and District-Scale Irrigation Systems
- Remote Sensing in agricultural and forestry systems
- Monitoring and modeling of the interactions among soil hydrological, plant and atmosphere processes, and agricultural management practices
- Soil and contaminant hydrology
- Forestry hydraulics and hydraulics protection of agricultural and forestry systems
- Bioengineering Techniques for soil protection and slope stabilization
- Rural buildings, facilities and territory
- Spatial and landscape analysis
- Planning and design of rural areas
- Mechanization and technologies for agricultural production
- Agricultural electrification and energy usage
- Ergonomics and work organization
- Computer and communication technologies
- Machines and facilities for agricultural products and food processing

*CODE: 109*

*Reference Topic: Mechanization and technologies for agricultural production.*
*AIIA Section: 3a. Proposal for Oral presentation or Poster: Oral presentation.*

# 10.10 HIGH ACCURACY SITE-SPECIFIC SECONDARY DATA FOR MECHANICAL FIELD OPERATIONS TO SUPPORT LCA STUDIES

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## 1. Introduction

Methodologies to quantify the environmental impacts of mechanical field operations are widely applied, but, usually, system inputs and outputs come from international databases or literature and rarely represent the studied situation. The aim of the study was to quantify site-specific secondary data related to mechanical field operations in EU cereal cropping (from soil tillage to grain and straw transportation), paying particular attention to barley crop.

## 2. Material and methods

The model ENVIAM v1 ("ENVironmental Inventory of Agricultural Machinery operations"), developed some years ago, has been implemented into ENVIAM v2. Through this second version, each mechanical field operation is subdivided into 13 working times. For each of them, according to tractor power and engine load, (i) direct consumptions (fuel, lubricants, AdBlue®) and (ii) emissions into the air (i.e. engine exhausted gases of $CO_2$, CO, HC, $NO_x$ and PM) are calculated. Indirect consumptions of materials composing the mass of tractors and implements are also computed, taking into account: (i) physical lifetime of the machine, (ii) duration of the operation and (iii) a specific repair factor. Finally, the model allows the calculation of the mass of heavy metals (Cd, Pb and Zn) released into the soil due to tire abrasion. Three scenarios (S) of barley cultivation were identified (AAU: S1 = 50 ha, S2 = 100 ha, S3 = 200 ha); these scenarios have the same: (i) percentage of barley area (60% of AAU), (ii) soil texture (medium) and slope (flat conditions), (iii) barley field distance from the farm (2 km) and shape (rectangular), (iv) mechanical operations sequence (10 in total) and type of machine, (v) cropping inputs (seeds and herbicide rates). For each scenario, two barley varieties were taken into account: (i) currently in use (BarNow) and (ii) future (BarPlus). The latter is characterized by: (i) higher grain and straw yields (+25% and +14.5% $t \cdot ha^{-1}$ DM, respectively), (ii) greater N-fertilization (+20% $kg \cdot ha^{-1}$ of N), (iii) use of TIER 5 tractors' engines (-90% of $NO_x$ emissions using SCR system and AdBlue®), (iv) lower minimum specific fuel consumption (-10% $g \cdot kWh^{-1}$), and (v) greater Effective Field Capacity (+10% and +15% $ha \cdot h^{-1}$ for low and high technological level of machines, respectively). These accurate inventories provided by ENVIAM v2 were then used to carry out an LCA analysis related to barley cultivation in EU.

## 3. Results

For operations performed by an implement coupled with a tractor (9/10 in barley cropping), the environmental performances strongly depend on the correct tractor power choice; moreover, the assumption of carrying out the operation at a constant engine load, leads to large underestimations of emissions into the air. Inputs used for BarNow cropping amount to: fuel FC = 67÷74 $kg \cdot ha^{-1}$, lubricants LC = 560÷725 $g \cdot ha^{-1}$, mass MC = 7.9-8.8 $kg \cdot ha^{-1}$. Inputs used for BarPlus cropping amount to: fuel FC = 55÷60 $kg \cdot ha^{-1}$, lubricants LC = 535÷690 $g \cdot ha^{-1}$, mass MC = 7.2-8.0 $kg \cdot ha^{-1}$, AdBlue® AdB = 2.8-3.0 $kg \cdot ha^{-1}$. The highest fuel and mass consumptions are, in any scenario, related to tillage operation.