Ergonomics and sustainability in agriculture

The **social** component of **sustainability** in agriculture deals with:

- preventive occupational health and safety
- human-centered design of work
- empowerment
- individual and collective learning
- employee participation

To promote system efficiency

To reduce social and health costs

The **anthropocentric perspective** leads to joint objectives between **ergonomics/human factors and sustainable development in agriculture**.
The research activity aims at identifying critical issues that may benefit from user-oriented interventions, in terms of:

- user-centered (re)design of tasks, machinery and technology, and
- targeted information campaigns and training actions

to lead to a better fit between the user and the work environment

Study of the physical and cognitive aspects of the human-task/machine/environment interaction, with particular attention to physical and demographic variability (aging, migrations) and technological development, aimed at improving systems’ usability

“INTRAC” (Integrazione tra gli aspetti ergonomici e di sicurezza nei trattori agricoli), (MiPAAF), 2016

“IMT ” Interactive Maintenance Training”, Regione Piemonte POR-F.E.S.R. 2007-2013
OBJECTIVES:
• Monitoring ammonia and GHG emissions derived from livestock sector;
• Improving livestock waste treatment technologies focused on ammonia and GHG reduction;
• Agronomical valorization of livestock waste

SCIENTIFIC RESULTS:
• N. Pampuro, F. Caffaro, E. Cavallo. 2018. Reuse of animal manure: a case study on stakeholders’ perceptions about pelletized compost in Northwestern Italy. Sustainability. 10, 2028.
OBJECTIVES:
• Optimization of biomass densification processes and characterization of densified products;
• Pelletized organic fertilizers production

SCIENTIFIC RESULTS:
Software for pest control

- Software to assist the farmer in phytosanitary treatment of crop
- The software is based on stage-structured population dynamics models
- The model is described by a system of forward Kolmogorov equations where the biodemographic functions (development, mortality and reproduction) are temperature-dependent
Two different models:

- **phenological**
  (percentage of insect in each stage)

- **demographic**
  (abundance of insect in each stage)
Software for pest control

MATHEMATICAL MODEL

Weather station

Biology of the pest

Monitoring crop

Monitoring pest

Expert opinion

Population dynamics

Weather forecast

DECISION
You have to select
- a location in which you want to know the dynamics
- the insect of interest
- the n. of days of weather forecast
- a set of temperature of the location chosen

Example of phenological model
The software produces
• the dynamics of each stage and each generation of the population
• a weather forecast useful to decide if or not make a treatment on the basis of a risk threshold on the level of the population
Next step: integrate in the software the production of invasion maps

Example of an invasion map produced for a Scientific Opinion of the European Food Safety Authority

Average number of adults per plant. Yellow dots: place of detection
An in vivo integrated biosensor for plant physiology monitoring and water management

Agriculture withdraw 70% of the fresh water available in the world.

The possibility to have an early warning for drought stress in plant cultivation, thus reducing the water consumption, is mandatory in the next decades.

The developed sensor being directly integrated in the plant stem, monitors, in vivo, in realtime the dynamic changes occurring in the plant sap, during the plant growth, development and during abiotic stresses events.

The in vivo OECT based sensor, enable

- an early warning (within the first 30 hours post stress)
- The possibility to fine tuning the crop water supply
- Have a closer look on the mechanisms that take place in the plant during the stress

(Coppedè et al., Sci Rep 2017)
Multy energy x-ray scanner for food control

Nowadays, in-line food control has become an important issue to ensure food safety. Existing X-ray scanners have no energy discrimination. IMEM-CNR is developing spectroscopic CdZnTe detectors, and, is collaborating with national industries to realize multi-energy x-ray scanners that ensure a high capability to reveal physical and chemical alterations in the inspected food.
Objective:
development of sensors and sensor processing methods to provide an autonomous agricultural vehicle with ambient awareness. The obstacle detection problem is specifically addressed, considering different obstacle types such as positive obstacles, negative obstacles, moving obstacles (people/animal) and difficult terrain. The potential of four sensor technologies i.e., (stereo) vision, radar, LiDAR and thermography is investigated.

Impact:
• to increase safety
• to allow for more optimal farming
• to reduce the demands for labor and increase competitiveness
• to reduce negative impacts on the environment (e.g. more fuel-friendly operation and reduction of fertilizers, herbicides, pesticides)
Multi-baseline stereo for scene segmentation in natural environments

Self-supervised scene segmentation:
- Stereo 3D information are used to segment the scene into ground and non-ground regions
- Self-learning framework: the ground model is automatically built during an initial bootstrapping stage, and is continuously updated to incorporate changes in the ground appearance

Simultaneous Safety and Surveying for Collaborative Agricultural Vehicles

- Multi-sensor obstacle detection
- Multi-modal 3D maps
- Situation awareness
- Crop assessment and recognition of condition
- Trafficability
- Traversability

Partners
- Danish Technological Institute (Denmark)
- University of Salento (Italy)
- Fraunhofer Institute for Intelligent Analysis and Information Systems IAIS (Germany)
- CNR - Institute of Intelligent Systems for Automation (Italy)
- AgriCircle AG (Switzerland)
Objective: multi-sensor terrain mapping and classification to support autonomous operations by an agricultural vehicle.

Contribution: terrain identification based not only on classical appearance features, such as color and geometric properties, but also on contact features, which measure the dynamic effects related to vehicle-terrain interaction that affect vehicle’s mobility.