

CIRCULAR FOOD SYSTEM LAB

A new Living Lab for the Twin
Transition of Food Systems at the
Politecnico di Milano



Circular Food System Lab (CFS Lab) is a research laboratory at the Politecnico di Milano, multidisciplinary and modular, focused on the circular transition and digital transformation of Food Systems in metropolitan, urban, and peri-urban contexts. CFS Lab develops competitive research and consultancy activities for businesses and institutions. Created by the Department of Design in collaboration with the Departments of Mechanical Engineering and Electronics, Information, and Bioengineering, CFS Lab is structured as a **Living Lab** that collaborates with various external contexts and their circularity initiatives.

CFS Lab researches and develops product-service and process solutions for the **circular innovation of Food Systems**, with the main reference being the Farm to Fork Strategy (EU Green Deal 2020) and its objectives: the ecological transition of agri-food systems, the consumption of sustainable foods, the reduction of food waste, the adoption of healthy eating behaviors, and the enhancement of biodiversity in Agri-Food Systems.

The laboratory, active since the beginning of 2025, is funded through PNRR funds via MUSA (*Multilayered Urban Sustainability Action*), an innovation ecosystem for urban regeneration, born from the collaboration between the University of Milano-Bicocca, Politecnico di Milano, Bocconi University, and the University of Milan.

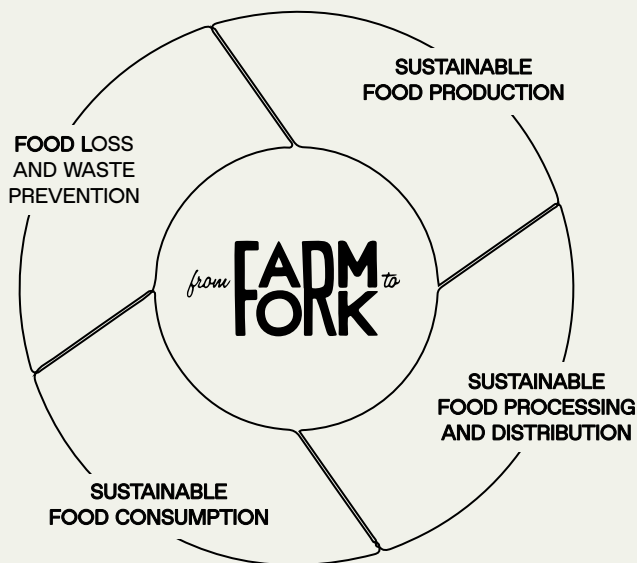


WHAT DO WE DO



CFS Lab focuses on **competitive research** on Circular Food Systems, providing **consultancy** for circular innovation to businesses and organizations, developing **patents and start-ups** dedicated to food systems, and **public engagement** to promote circularity within agri-food systems.

CFS Lab adopts an action-research approach and practical experimentation, developing **pilot projects** and **proof of-concept** for Food Systems at the territorial scale. It combines design-driven and technological innovation, including open-source solutions, in the fields of mechanical engineering, computer science, electronics, and bioengineering, to create solutions applicable to products and services dedicated to Circular Food Systems.





WHAT WE EXPLORE AND EXPERIMENT

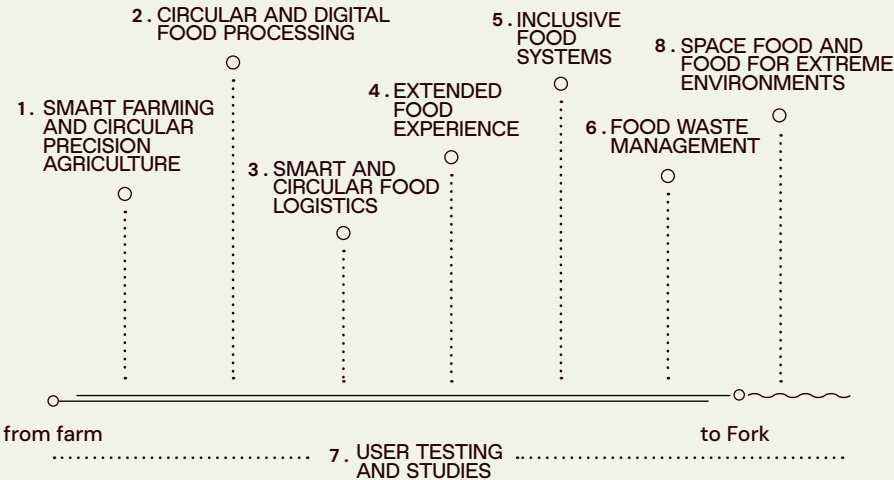
Eight research areas to innovate from Farm to Fork.

- 1. SMART FARMING AND CIRCULAR PRECISION AGRICULTURE**
Solutions for vertical and urban farming, crop monitoring, biodiversity traceability, and waste valorization.
- 2. CIRCULAR AND DIGITAL FOOD PROCESSING**
Systems for alternative food processing, conservation, and tracking of material and energy flows.
- 3. CIRCULAR AND SMART FOOD LOGISTICS**
Solutions for transport, packaging, and tracking of goods, using circular materials and Digital Product Passport (DPP) for agri-food products.
- 4. EXTENDED FOOD EXPERIENCE**
Devices for extended reality (AR/VR) to enhance analysis and sensory experiences of Food Systems.
- 5. INCLUSIVE FOOD SYSTEMS**
Solutions for food redistribution, education, and access to Food Systems for vulnerable and disadvantaged communities.
- 6. FOOD WASTE MANAGEMENT**
Innovative systems for the collection, sorting, and recycling of food waste and post-consumer materials.
- 7. USER TESTING AND STUDIES**
Innovative tools to test new product and service solutions with users in research and consultancy projects.
- 8. SPACE FOOD AND FOOD FOR EXTREME ENVIRONMENTS**
Solutions for producing and consuming food in space and in environments made extreme by climate change.



CFS Lab operates across the entire agri-food supply chain, following the objectives of the Farm to Fork Strategy. The area of user testing and studies is transversal to the research areas and vertical specializations, as CFS Lab operates as a Living Lab, adopting a user-centered and open innovation approach.

THEMATIC AREAS OF INTEREST OF CFS LAB





CFS LAB: MODULES AND COMPETENCES

A Living Lab with three physical spaces across the Bovisa campuses of the Politecnico di Milano.

CIRCULAR DESIGN FOR FOOD SYSTEMS is the module that coordinates CFS Lab. It is managed by **Polifactory**, the makerspace of the Politecnico di Milano active in the Department of Design. Physically integrated into the Fab Lab, this module specializes in research, circular design, and prototyping of interactive product-service systems for Food Systems. il modulo che coordina il CFS Lab.

CIRCULAR LOGISTICS FOR FOOD SYSTEMS is the module managed by the **IoT Lab** of the DEIB Department. It is physically located in **MADE**, the Competence Centre for Industry 4.0 at the Politecnico di Milano. This module specializes in the development of tech solutions (IoT and ICT) for logistics, traceability, monitoring, and control of circular agri-food supply chains.

RECOVERY AND RECYCLING FOR FOOD SYSTEMS is the module managed by **The Manufacturing Lab** of the Department of Mechanical Engineering. Physically located in the Bovisa La Masa Campus, it develops high-tech solutions (mechanics-automation) for the recovery, recognition, sorting, and treatment of waste and post-consumer materials related to Food Systems.



CFS Lab across the Bovisa campuses



POLITECNICO | DIPARTIMENTO
MILANO 1863 | DI DESIGN



POLITECNICO | DIPARTIMENTO DI ELETTRONICA,
MILANO 1863 | INFORMAZIONE E BIOINGEGNERIA



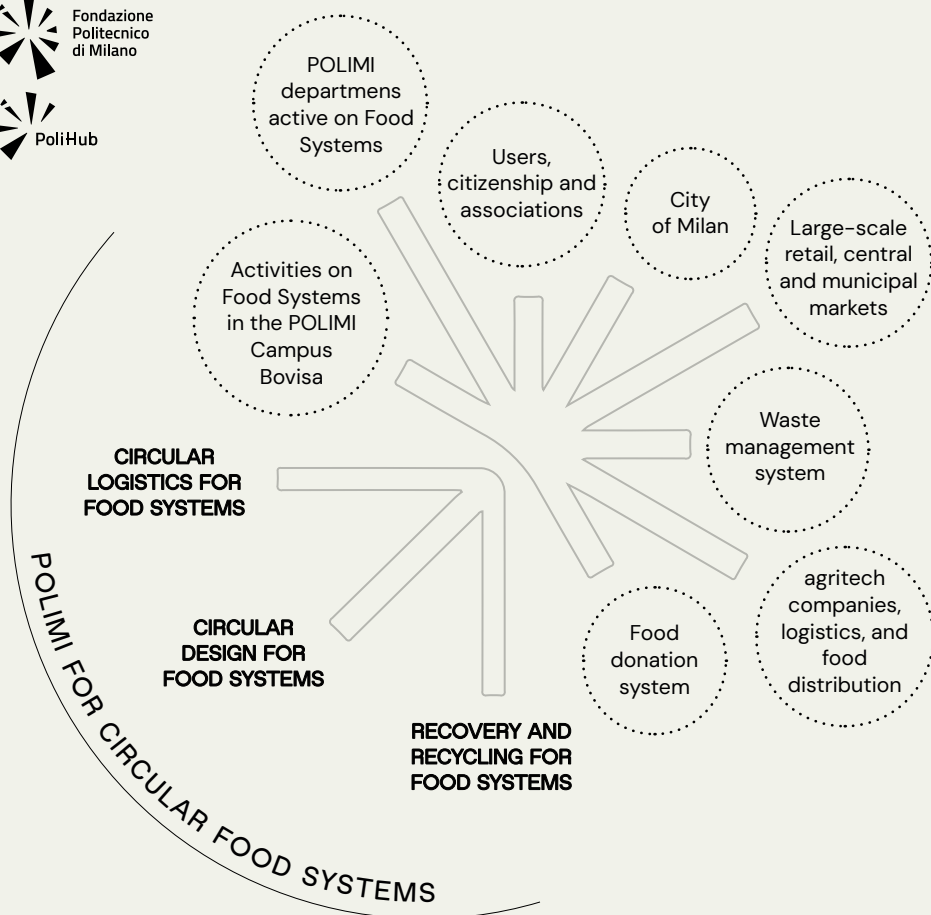
POLITECNICO | DIPARTIMENTO
MILANO 1863 | DI MECCANICA



Fondazione
Politecnico
di Milano



PoliHub



The three modules of CFS Lab create a Living Lab for Food Systems that experiments with design and technologies in real-world contexts and conditions, with actors from the production world, public and private entities and institutions, citizens, and their associations. The Lab promotes synergies with social innovation initiatives on Food Systems active at the Politecnico di Milano, with the city of Milan and its Food Policy, with agritech companies and food distribution, and with food waste management and food donation networks.



MODULE 1

CIRCULAR

DESIGN FOR

FOOD SYSTEMS

Design solutions – strategies,
product-service systems,
processes, and tools for the
circularity of Food Systems.



c/o Polifactory,
Via Candiani 72, Politecnico di Milano,
Campus Bovisa-Durando,
Building B3, Milano, 20158

<https://www.polifactory.polimi.it/>

STAFF

Coordinator

Stefano Maffei

Full Professor, Department of Design,
Scientific Director Polifactory

Team

Massimo Bianchini

Associate Professor, Department of Design
Lab Manager Polifactory

Laura Cipriani

PhD Candidate, Department of Design

Luca Grosso

Research Fellow, Department of Design

Lorenzo Silvestri

Research Fellow, Department of Design

Matteo Mojoli

Research Fellow, Department of Design

Valentino Stella

Research Fellow, Department of Design

Francesca Zeccara

Research Fellow, Department of Design

Barbara Parini

Coordinator of the Specializing Master in Design for
Food Systems, POLI.design



SPECIALIZED EQUIPMENT AND TOOLS

Smart Farming e
Circular Precision
Agriculture

System for vertical and indoor farming with aeroponic systems and growing boxes.

IoT devices and drones for precision agriculture.

Extended Food
Experience

Instruments for the analysis of the chemical and organoleptic properties of food (spectrophotometer, colorimeter, hygrometer, pH meter, refractometer, probe thermometer, electronic nose, dynamometer)

Smart & circular
food logistics,
inclusive food
systems e circular
food waste

Set of readers and terminals for traceability and identification (RFID systems, antennas, and smart gates)

Circular food
processing

Catering equipment:

- Professional kitchen furniture system
- Smart refrigerator with AI food recognition
- Combination convection and steam oven
- Softcooker for low-temperature cooking
- Set of professional appliances (microwave oven, blast chiller-freezer, proofing chamber, multifunction kitchen robot, slow-speed juicer, dehydrator)

Food processing equipment:

- Electric grain mill and flaker
- Freeze dryer (lyophilizer)
- Rotovapor (rotary evaporator)
- Essential oil distiller
- Molecular gastronomy kit

Laboratory and Precision Instruments:

- Ultrasonic food treatment tank
- Bench and laboratory weighing instruments
- Food incubator



MULTIPURPOSE EQUIPMENT AND TOOLS

Digital Fabrication

3D Printers:

- FELIX Switch Head Food 3D Printer
- MSLA Formlabs Form 4B compatible with medical-grade materials
- LDM Wasp 40100 for high-viscosity materials
- FDM Original Prusa XL with 5 extruders
- FDM Bambu Lab X1 Carbon with AMS

Physical Computing

Workstation equipped with tools for electronics, microcontrollers, microprocessors, and sensors for IoT prototypes

Robotics and automation

Universal Robot UR5e Cobot with a 5 kg payload, Robotiq 2F-140 grippers, and a Cobot Station Mini workstation

Extended Reality

Workstation for interactive simulations in virtual reality with Meta Quest Pro headsets and standalone 3D scanner





MODULO 2

CIRCULAR LOGISTICS FOR FOOD SYSTEMS

Tech solutions (IoT and ICT) for logistics, traceability, monitoring, and control of agri-food supply chains



c/o IoT Lab / Centro MADE,
Via Candiani 72, Politecnico di Milano,
Campus Bovisa-Durando,
Building B8, Milan, 20158

www.iotlab.polimi.it

STAFF

Coordinator

Antonio Capone

Full Professor, Department of DEIB,
Scientific Director ANTLab

Team

Mattia Cerutti

Researcher, Department of DIG,
Operative Director IoT Lab

Sanders Batista

Research Fellow, Department of DEIB



SPECIALIZED EQUIPMENT AND TOOLS

Smart Farming Sensoristics

Sensors:

- Acidity sensors (pH)
- Nitrogen, Phosphorus, Potassium (NPK) sensors
- Water hardness sensors (TDS)
- Wind speed sensors

General Sensoristics

Sensors:

- Thermal camera (infrared)
- Camera
- Temperature, Pressure, Humidity, Presence sensors
- Volumetric sensors

MULTIPURPOSE EQUIPMENT AND TOOLS

Hardware Platforms

- Raspberry PI 5 8GB
- Jetson Orin Nano Dev. Kit
- Impinj IPJ R700 RFID Reader
- Kathrein WRA 3070 Antenna

Connectivity

- Development boards for Wireless Short-Range
- Development boards for Wireless Long-Range



MODULE 3

RECOVERY AND RECYCLING FOR FOOD SYSTEMS

Tech solutions (mechanical and automation) for the recovery, sorting, and treatment of post-consumption materials from Food Systems

c/o The Virtual Prototyping Lab,
Via Giuseppe La Masa 1, Politecnico
di Milano, Campus Bovisa – La Masa,
Building B23, Milan, 20158

https://tecnologie.mecc.polimi.it/laboratory_en.htm

STAFF

Coordinator

Giorgio Colombo

Full Professor, Department of Mechanical Engineering, Scientific Director The Manufacturing Lab

Team

Marco Rossoni

Researcher, Department of Mechanical Engineering



SPECIALIZED EQUIPMENT AND TOOLS

Food Waste Depackaging	Station for the study and simulation of (de-)packaging of food packaging, consisting of a collaborative robot and a tracking system integrated with immersive visualization solutions
Artificial Olfactory System	AI-based system for recognizing and classifying odors in a controlled environment

MULTIPURPOSE EQUIPMENT AND TOOLS

Robotics and automation	Universal Robot UR5e Cobot with a 5 kg payload, equipped with end-effectors such as grippers and vision systems
Extended Reality	Workstation for interactive simulations in virtual reality equipped with Meta Quest headset
Physical Computing	• Nvidia Jetson Nano • Raspberry Pi 4 8 GB • Sensori Bosch BME688
Tracking System	8-camera Vicon tracking system



www.circularfoodsystemlab.polimi.it/en/
circularfoodsystemlab-design@polimi.it



CIRCULAR FOOD
SYSTEM LAB

POLITECNICO MILANO 1863