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# ROJECT ECOFOODCYCLE

# Output 2.2 – Small-Scale pilots

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Italy – Croatia

ECOFOODCYCLE

# ECOFOODCYCLE

Reducing Food Waste and its Environmental Footprint through Sustainable Food Systems

# Output 2.2 – Small-Scale Pilots

# WP 2

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# Index


**1. EXECUTIVE OVERVIEW: THE COLLABORATIVE EXPERIMENTATION PLATFORM** ..... 5

1.1. SCOPE OF OUTPUT 2.2 AND INDICATOR ACHIEVEMENT ..... 5

1.2. THE "LIVING LAB" APPROACH: MULTI-ORGANIZATIONAL TESTING OF NEW IDEAS & APPROACHES - n.8 small scale pilot actions ..... 8

1.3. CROSS-BORDER PORTFOLIO OVERVIEW ACROSS THE FOOD SUPPLY CHAIN (AGRICULTURE, FOOD SERVICES, RETAIL, CONSUMERS) ..... 11

**2. COMMON EXPERIMENTAL & MONITORING FRAMEWORK** ..... 16

2.1. THE 3-PHASE "LIVING LAB" LIFECYCLE ..... 16

2.2. HARDWARE, SOFTWARE & DIGITAL TOOLS DEPLOYED IN REAL-WORLD ENVIRONMENTS ..... 19

2.3. LOCAL ECOSYSTEMS & STAKEHOLDER COLLABORATION DYNAMICS ..... 23

2.4. CO-DESIGN & LIVING LAB OUTPUTS ..... 24

**3. SECTORAL PORTFOLIO OF THE 8 SMALL-SCALE PILOT ACTIONS** ..... 28

3.1. PRIMARY AGRICULTURE & PROCESSING SECTOR ..... 28

3.2. FOOD SERVICES & EDUCATIONAL CANTEENS SECTOR ..... 30

3.3. RETAIL & COMMERCIAL DISTRIBUTION SECTOR ..... 33

3.4. HOUSEHOLD CONSUMERS & DYNAMIC EVENTS LOGISTICS SECTOR ..... 35

**4. PRACTICAL ASSETS & OPEN-ACCESS TOOLKITS CREATED** ..... 38

4.1. PHYSICAL INFRASTRUCTURES & CYBER-PHYSICAL TESTING ASSETS ESTABLISHED ..... 38

4.2. COMMUNICATION REACH & PUBLIC AWARENESS IMPACT ..... 39

**5. FIELD REPLICABILITY GUIDE: HOW OTHER ORGANIZATIONS CAN EXPERIMENT** ..... 41

5.1. OPERATIONAL SETUP CHECKLISTS FOR EXTERNAL LOCAL ADOPTERS ..... 41

5.2. PRACTICAL FIELD LESSONS LEARNED & QUICK FIXES FROM LIVING LAB DEPLOYMENTS ..... 42

**6. CONCLUSIONS & NEXT STEPS FOR REGIONAL SCALING** ..... 45

**7. REFERENCES DOCUMENTS** ..... 47






# 1. EXECUTIVE OVERVIEW: THE COLLABORATIVE EXPERIMENTATION PLATFORM

## 1.1. SCOPE OF OUTPUT 2.2 AND INDICATOR ACHIEVEMENT

The ECOFOODCYCLE project "Reducing Food Waste and its Environmental Footprint through Sustainable Food Systems", co-funded by the European Union under the Interreg Italy–Croatia Programme 2021–2027, addresses one of the most pressing socio-economic and environmental challenges across the Adriatic basin: systemic food loss and waste across the entire value chain. Food waste represents a severe structural inefficiency that unnecessarily depletes critical natural resources—such as land, water, soil, and energy—while generating substantial greenhouse gas emissions that accelerate climate change. Across the Cooperation Area, significant quantities of edible food and agricultural residues are systematically discarded at every stage, from unharvested seasonal surpluses in primary agriculture, to preparation and plate leftovers in school and hospitality canteens, unsold close-to-date items in retail distribution, and unstructured meal management within domestic households and dynamic events.

To directly counter this issue, ECOFOODCYCLE established an integrated, cross-border operational model designed to transition from isolated, static awareness campaigns toward hands-on, multi-sectoral circular economy interventions.

Output 2.2 captures the physical and operational manifestation of Work Package 2 within the ECOFOODCYCLE project. While Output 2.1 establishes the overarching, transferable

"Joint Solution" blueprint and Deliverable D2.3.1 delivers the post-hoc scientific and analytical impact evaluation, Output 2.2 serves as the executive catalogue and demonstrative platform of the 8 Small-Scale Pilot Actions (SSPAs) executed across the Interreg Italy–Croatia Cooperation Area.

Within this document, readers and external stakeholders are guided through a practical, real-world portfolio of interventions. It details the operational setup, deployed hardware and digital tools, local ecosystem collaborations, and immediate field results achieved across four key nodes of the food value chain: Primary Agriculture, Food Services, Retail and Consumers.

This output formally verifies and documents the total fulfillment of the project's target indicator (*Small-scale pilot actions established/implemented*), demonstrating the successful activation of **8 fully operational Living Lab pilots.** Under the overall technical coordination of **EcamRicert S.r.l. (PP6) as WP2 Leader**, and with the general governance of the Lead Partner (LIRA), the project partnership brought together diverse expertise across seven key territories in Italy and Croatia:

- **Lika-Senj County (Croatia):** Led by LIRA (LP), focusing on agricultural surplus stabilization and circular by-product transformation in Gospić.
- **Karlovac County (Croatia):** Spearheaded by the Regional Development Agency of Karlovac County – JURRA (PP2), testing kitchen compaction systems in vocational culinary education.





- **Zadar County (Croatia):** Managed by the Zadar County Development Agency – ZADRA NOVA (PP3), operationalizing split-phase weighing and zero-waste culinary modules.
- **Rijeka (Croatia):** Coordinated by the University of Rijeka, Faculty of Economics and Business – EFRI (PP4), implementing canteen behavioral nudges and surplus fruit upcycling in primary education.
- **Veneto Region (Italy):** Executed by EcamRicert S.r.l. (PP6) in Padua through two distinct actions: implementing interactive educational workshops (the "EcoFood Waste Truck" program) to actively engage primary school pupils in food waste reduction—using automated AI image-recognition smart bins as an objective tracking tool to measure behavioral improvements in the canteen—alongside structured domestic family training pathways.
- **Apulia Region (Italy):** Led by the University of Foggia – UNIFG (PP7), introducing dynamic "AI Smart Boxes" and interactive AI recipe tools in commercial supermarket chains.
- **Abruzzo Region (Italy):** Operationalized by the National Confederation of the Craft Sector and SMEs Abruzzo – CNA Abruzzo (PP8), testing digital pre-booking green protocols for catering logistics on dynamic film sets.

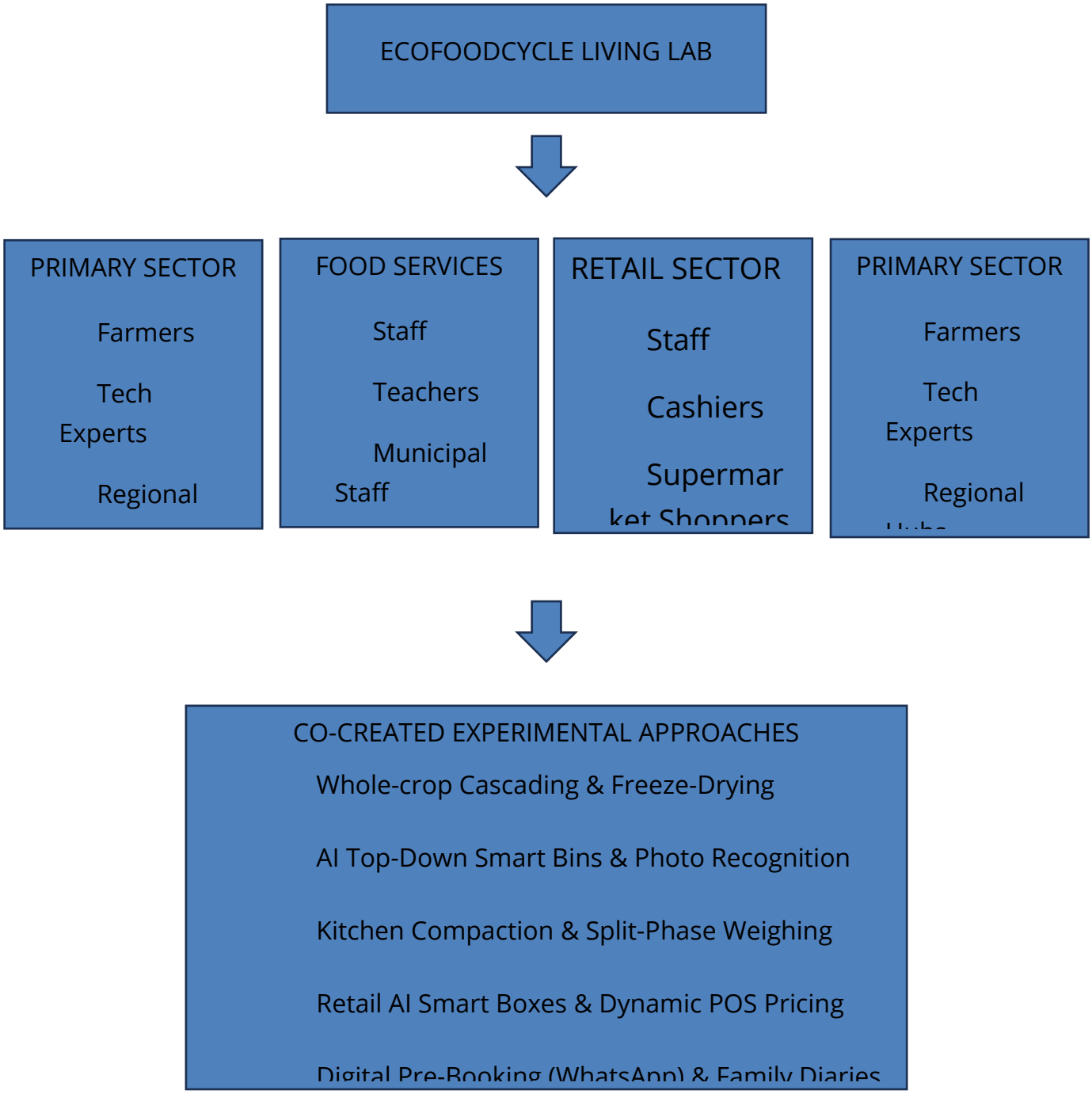
Together, these eight pilot actions established an active cross-border testing ground that directly bridges strategic sustainability policy objectives with real-world food value chain operations.

### 1.2. THE "LIVING LAB" APPROACH: MULTI-ORGANIZATIONAL TESTING OF NEW IDEAS & APPROACHES - n.8 small scale pilot actions

The fundamental core of Output 2.2 lies in operationalizing the central mandate of the Application Form: **providing a platform for different organizations to come together and experiment with new ideas and approaches**. Rather than conducting isolated academic trials or static equipment demonstrations, the project deployed an open **Living Lab methodology**.

Within this framework, real-world operational environments—such as working primary school canteens, active commercial supermarkets, vocational hospitality kitchens, family home environments, agricultural processing centers, and dynamic film sets—were transformed into collaborative ecosystems.

Graph 1:


ECOFOODCYCLE LIVING LAB
PRIMARY SECTOR
Farmers
Tech Experts
Regional
FOOD SERVICES
Staff
Teachers
Municipal Staff
RETAIL SECTOR
Staff
Cashiers
Supermar
ket Shoppers
PRIMARY SECTOR
Farmers
Tech Experts
Regional
CO-CREATED EXPERIMENTAL APPROACHES
Whole-crop Cascading & Freeze-Drying
AI Top-Down Smart Bins & Photo Recognition
Kitchen Compaction & Split-Phase Weighing
Retail AI Smart Boxes & Dynamic POS Pricing
Digital Pre-Booking (WhatsApp) & Family Diaries

- **Public Authorities & Municipalities** collaborated with academic researchers, Project Partners, and school boards—such as the *"Luigi Luzzatti"* Primary School in Italy (PP6) alongside Croatian institutions including *"Vladimir Gortan"* Elementary School in Rijeka (PP4), the Commerce and Catering School in Karlovac (PP2), and the Hotel, Tourism and Catering School in Zadar (PP3)—to test automated AI image-recognition waste-tracking hardware within daily canteen routines, as well as to implement structured manual monitoring protocols to assess changes in dietary habits and plate waste.

- **Commercial Retailers** partnered with university scientists to test dynamic pricing models and AI-driven consumer engagement at the point of sale.

- **Agricultural Cooperatives and Local Farmers** worked alongside regional development agencies to process unexploited harvest surpluses and secondary residues using advanced dehydration and oil-extraction technologies.

- **Cultural Associations, Film Commissions and Household Communities** joined forces with cinema academies, catering logistics providers, and local citizen networks to test both paperless, zero-waste digital pre-booking protocols on fast-paced movie sets and structured domestic family training programs focused on household food management, meal planning, and creative leftover upcycling.

This multi-organizational testing approach guaranteed that every tool, hardware configuration, and digital workflow was rigorously stress-tested against real-world operational friction, proving that circular economy solutions can be seamlessly integrated into daily business and institutional practices.

### 1.3. CROSS-BORDER PORTFOLIO OVERVIEW ACROSS THE FOOD SUPPLY CHAIN (AGRICULTURE, FOOD SERVICES, RETAIL, CONSUMERS)

To systematically tackle systemic food loss and waste across the Italy–Croatia Cooperation Area, the ECOFOODCYCLE project designed a targeted cross-border experimental portfolio covering four primary stages of the food supply chain: **Primary Agriculture**, **Food Services & Canteens**, **Retail & Commercial Distribution** and **Consumers**.

Rather than treating these sectors as isolated silos, the 8 Small-Scale Pilot Actions were conceptualized as an integrated circular ecosystem. Each pilot was explicitly tailored to address key sectoral barriers using a specific combination of **raising awareness & behavioral engagement**, **vocational & operational process optimization**, or **cyber-physical technology deployment**.

The table below presents the comprehensive Cross-Border Portfolio Map of the ECOFOODCYCLE Living Labs.

Table 1.

| **Value Chain Sector** | **Pilot ID** | **Living Lab Environment** | **Core Innovation / Experimental Approach Tested** |
|---|---|---|---|
| Primary Agriculture & Processing | **Pilot 1** (LP - LIRA) *Gospić, Lika-Senj County (HR)* | Development Centre of Lika-Senj County / Zero Waste Innovation Lab | Whole-crop cascading of seasonal surpluses (plums) into cold-pressed kernel oil, press-cake feed, and biofuel pellets; fruit freeze-drying. |
| Food Services & Educational Canteens | **Pilot 2** (PP2 - JURRA) *Karlovac (HR)* | Commerce and Catering School Karlovac | Operational integration of commercial organic waste volume-compaction hardware paired with kitchen prep-waste tracking. |
| Food Services & Educational Canteens | **Pilot 3** (PP3 - ZADRA NOVA) *Zadar (HR)* | Hotel, Tourism and Catering School Zadar | Split-phase input-output weighing matrices during professional chef training, farm-to-fork study visits, and zero-waste recipe co-creation. |
| Food Services & Educational Canteens | **Pilot 4** (PP4 - EFRI) *Rijeka (HR)* | "Vladimir Gortan" Elementary School | Canteen behavioral nudges, fruit-surplus smoothie upcycling stations, and municipal drain-grinder waste-diversion integration. |
| Food Services & Educational Canteens | **Pilot 5** (PP6 - EcamRicert) *Padua (IT)* | Institute "Luigi Luzzatti" Primary School | Automated top-down image-recognition smart disposal bins (QR/tablet), interactive SDG gamification, and farm field trips. |

| | | | |
|---|---|---|---|
| Retail & Commercial Distribution | **Pilot 7** (PP7 - UNIFG) *Foggia (IT)* | Mercati di Città "La Prima" Supermarket | Fixed-price near-expiry bundled Kraft boxes ("Smart Boxes") linked via dynamic QR codes to an AI "Virtual Chef" recipe engine at POS. |
| Consumers | **Pilot 6** (PP6 - EcamRicert) *Padua (IT)* | Villa Vanna / Domestic Family Kitchens | Guided 3-phase family training: kitchen logging diaries and chef-led show cooking. |
| Consumers | **Pilot 8** (PP8 - CNA Abruzzo) *Farindola & Montebello di Bertona (IT)* | Active Film Production Sets & IFA Cinema School | Operational Green Protocol for film set catering: WhatsApp digital meal pre-booking, portion-controlled compostable meals, and controlled coffee-breaks. |

**Detailed Sectoral & Operational Focus of the 8 Pilots:**

1. **Primary Agriculture & Processing Sector (LP - LIRA):**
    - **Focus: Bio-Economy Infrastructure & Surplus Upcycling.** Pilot 1 (Gospić, HR) established a physical processing hub testing whole-crop cascading and freeze-drying techniques to convert unharvested fruit surpluses and agricultural by-products into high-value feed, oils, and pellets.
2. **Food Services & Educational Canteens Sector (PP2, PP3, PP4, PP6):**
    - **Focus on Raising Awareness & Student Engagement (Pilots 4 & 5):**

- **Pilot 4 (PP4 - EFRI / Primary School "V. Gortan", Rijeka, HR):** Concentrated heavily on **student awareness, educational nudging, and behavioral change** (e.g., interactive mascot campaigns, "smoothie upcycling" workshops) combined with canteen drain-grinder waste reduction.
- **Pilot 5 (PP6 - EcamRicert / Primary School "Luzzatti", Padua, IT):** Centered on **pupil engagement, SDG interactive gamification, and the "EcoFood Waste Truck" mobile lab**, utilizing automated AI image-recognition smart bins as an objective diagnostic tool to track how increased student awareness directly reduced plate waste over time.

- **Focus on Vocational Kitchen Operations & Professional Training (Pilots 2 & 3):**
  - **Pilot 2 (PP2 - JURRA / Commerce & Catering School, Karlovac, HR):** Focused on operational waste management in vocational hospitality education through kitchen compaction hardware and waste-stream sorting.
  - **Pilot 3 (PP3 - ZADRA NOVA / Hotel & Tourism School, Zadar, HR):** Focused on capacity building for future chefs, introducing split-phase input/output weighing matrices and co-creating zero-waste culinary recipes.

3. **Retail & Commercial Distribution Sector (PP7 - UNIFG):**
    - **Focus: Consumer Nudging & AI POS Engagement.** Pilot 7 (Foggia, IT) introduced fixed-price near-expiry bundled "Smart Boxes" in supermarket chains, using dynamic POS pricing and an AI "Virtual Chef" recipe engine to raise shopper awareness about food rescue at the point of sale.
4. **Household Consumers & Dynamic Events Logistics Sector (PP6, PP8):**
    - **Focus on Household Raising Awareness (Pilot 6 - PP6 EcamRicert / Padua, IT):** Directly engaged family nuclei through structured domestic waste-logging diaries, intergenerational workshops, and chef-led show cooking ("Famiglie Insieme") to boost home kitchen food management awareness.
    - **Focus on Dynamic Event Logistics & Demand Matching (Pilot 8 - PP8 CNA Abruzzo / Movie Sets, IT):** Tested a digital Green Protocol for movie set caterings, deploying WhatsApp-based digital meal pre-booking to align catering prep with real crew demand and prevent overproduction.

This multi-sectoral coverage ensures that the ECOFOODCYCLE Living Lab portfolio provides tested, real-world solutions for every stage of the European food supply chain, offering an open platform for regional scaling and institutional replication.





# 2. COMMON EXPERIMENTAL & MONITORING FRAMEWORK

To guarantee coherence, comparability, and scientific validity across the 8 Small-Scale Pilot Actions, the ECOFOODCYCLE project established a shared experimental architecture under the technical steering of EcamRicert S.r.l. (PP6) as WP2 Leader.

This framework provided a structured operational bridge between local field activities and overall project objectives. It ensured that every pilot, regardless of whether its primary focus was on raising awareness, vocational training, or logistical optimization, operated within a standardized yet flexible lifecycle supported by appropriate cyber-physical tools and local ecosystem dynamics.

## 2.1. THE 3-PHASE "LIVING LAB" LIFECYCLE

Every Small-Scale Pilot Action followed a uniform three-phase operational methodology, designed to guide the Living Lab platforms from initial diagnosis through real-world execution to final collaborative evaluation:

**PHASE 1: BASELINE ASSESSMENT & SETUP**

- Initial quantitative & qualitative diagnostics (pre-intervention waste audits & surveys)
- Hardware installation, digital tool configuration & local stakeholder onboarding

During this foundational phase, the Living Labs focused on establishing a solid pre-intervention baseline while preparing both physical and digital testing environments across the seven target territories. Project partners conducted initial quantitative waste audits,





historical data gathering, and stakeholder perception surveys to accurately capture the status quo before deploying any experimental action. Concurrently, technical setups were completed according to specific sectoral needs: physical hardware—such as processing machinery in agricultural hubs, organic volume compactors in vocational kitchens, and AI smart bins in primary school canteens—was installed and calibrated. On the digital side, custom workflows, including WhatsApp pre-booking systems for dynamic catering and AI-driven point-of-sale interfaces for retail, were fully configured alongside the active onboarding of local stakeholders, teachers, canteen staff, and commercial operators.

**PHASE 2: FIELD INTERVENTION & MONITORING**

- Deployment of core action (awareness workshops, nudging, training, pre-booking, upcycling)
- Continuous tracking via digital tools (AI smart bins, POS logs) & manual plate waste audits

Once the operational frameworks were established, the second phase marked the active deployment of the core experimental interventions in real-world environments. Field activities were tailored to each sectoral Living Lab: interactive awareness workshops and nudging campaigns were carried out with primary school pupils, specialized zero-waste modules were integrated into vocational chef training, near-expiry surplus items were bundled for retail shoppers, and digital pre-booking protocols were operationalized on movie sets. Throughout this execution phase, operational progress and behavioral shifts were tracked continuously. Partners implemented a dual monitoring approach, combining





automated cyber-physical tools—such as top-down AI image recognition and digital POS sales logs—with hands-on, qualitative methodologies, including split-phase weighing registers and visual plate-waste audits.

**PHASE 3: JOINT EVALUATION & REPLICABILITY**

- Post-intervention data collection & comparative analysis against baseline
- Co-creation of open-access toolkits, guidelines, cookbooks, and field replicability checklists

In the final phase, the experimental findings were consolidated, evaluated, and packaged to ensure long-term regional scaling and cross-border transferability. Partners executed comprehensive post-intervention assessments, comparing field data against initial Phase 1 baselines to measure tangible achievements in waste reduction, operational efficiency, and community awareness. Rather than leaving these results as purely academic data, the Living Lab platforms actively distilled their field learnings into practical, open-access assets. This included the co-creation of step-by-step operational guidebooks, zero-waste cookbooks, educational games, and practical setup checklists, equipping external public authorities, catering operators, retailers, and agricultural actors across the Interreg Italy–Croatia area with immediate tools for replication.





## 2.2. HARDWARE, SOFTWARE & DIGITAL TOOLS DEPLOYED IN REAL-WORLD ENVIRONMENTS

The ECOFOODCYCLE small-scale pilot actions integrated a combination of cutting-edge cyber-physical hardware, customized software applications, and practical analog tools. It is important to emphasize that while advanced technologies were deployed, in several pilots—such as primary school canteens—they served primarily as **diagnostic and measurement instruments** to evaluate the direct impact of educational and awareness-raising activities.

The matrix below summarizes the technology and operational tool deployment across the partnership.





Table 2.

| **Purpose of Technology** | **Deployed Hardware Assets** | **Deployed Software & Tools** |
|---|---|---|
| Physical stabilization and upcycling of raw plum surpluses into secondary market products. | Industrial freeze-dryer, hydraulic oil press, pelletizer, cold storage unit. | Processing log software, yield tracking spreadsheets. |
| Waste volume reduction and pre-consumer preparation waste monitoring in vocational training. | Commercial organic waste compactor unit, precision kitchen scales. | Digital weight logging sheets, kitchen inventory tracking. |
| Operational skill-building for future chefs in tracking ingredient yield and trimming waste. | Dual split-phase input/output kitchen scales, professional culinary station assets. | Standardized digital recipe costing & waste ratio calculation templates. |

| | | |
|---|---|---|
| Supporting student awareness campaigns and diverting residual food waste from municipal waste streams. | Commercial canteen drain-grinder unit, smoothie preparation stations | Manual plate-waste audit logging frameworks, nudging visual campaign assets. |
| **Purpose of Technology** | **Deployed Hardware Assets** | **Deployed Software & Tools** |
| Diagnostic measurement tool to objectively track and verify plate-waste reduction resulting from pupil awareness workshops. | Automated top-down AI image-recognition smart bins | AI waste tracking dashboard, interactive SDG educational gamification apps. |
| In-store shopper engagement, incentivizing the purchase of near-expiry goods through culinary AI suggestions | Dedicated in-store "Smart Box" display stands, branded eco-Kraft bundling boxes. | AI-powered "Virtual Chef" recipe recommendation web app, dynamic QR code engine. |

| | | |
|---|---|---|
| Empowering domestic households to track waste habits, plan meals, and practice surplus preservation. | Kitchen vacuum-sealing units, batch-cooking equipment, household weighing scales. | Family kitchen logging templates, interactive meal planning tools. |
| Demand-matching logistics to eliminate overproduction in mobile film set catering. | Portion-controlled thermal delivery containers, compostable serving materials. | Instant messaging (WhatsApp) pre-booking workflow, digital meal selection forms. |





## 2.3. LOCAL ECOSYSTEMS & STAKEHOLDER COLLABORATION DYNAMICS

A core strength of the ECOFOODCYCLE experimental approach was the creation of active local ecosystems surrounding each Living Lab. Rather than operating in institutional isolation, project partners actively engaged local actors, ensuring that the solutions were co-created, practical, and grounded in community reality.

The collaboration dynamics brought together four primary stakeholder groups:

- **Educational Communities & Youth (Schools & Universities):** In primary education environments—such as the *"Luigi Luzzatti"* Primary School in Padua (PP6) and the *"Vladimir Gortan"* Elementary School in Rijeka (PP4)—teachers, pupils, canteen staff, and municipal staff (dietitians) actively co-created educational routines. Pupils were transformed into active "food saving champions" through gamification, field trips, and hands-on workshops. In vocational hospitality institutes—such as the Commerce and Catering School in Karlovac (PP2), the Hotel, Tourism and Catering School in Zadar (PP3), and the IFA Cinema School (PP8)—students and instructors embedded circular practices directly into their professional curricula.

- **Primary Producers & Agricultural Networks:** In Lika-Senj County, LIRA (LP) collaborated directly with local family farms (*OPGs - Obiteljska Poljoprivredna Gospodarstva*) and agricultural cooperatives. Farmers provided raw seasonal surpluses (plums) and unmarketable secondary crops, actively participating in testing decentralized dehydration and processing techniques that offer new revenue streams for rural communities.

- **Commercial & Business Operators (Retailers & SMEs):** In Foggia, UNIFG (PP7) partnered with the supermarket chain *Mercati di Città "La Prima"*, working side-by-side with store managers, department heads, and cashiers to test the "AI Smart Box" setup without disrupting daily commercial operations. Similarly, in Abruzzo, CNA Abruzzo (PP8) worked with local catering SMEs, independent film producers, and movie crew managers to adapt catering logistics to fast-paced production schedules.

- **Citizens, Families & Regional Public Authorities:** Through household-focused actions led by EcamRicert (PP6), local families in the Veneto region engaged in multi-generational food management activities, sharing practical experiences to develop between parents and children. Furthermore, regional development agencies (JURRA, ZADRA NOVA, LIRA) and public institutions ensured that field learnings were continuously communicated to local decision-makers to support long-term regional scaling.

This multi-stakeholder ecosystem approach proved that effective food waste reduction relies on combining appropriate technical tools with deep, human-centered community engagement.

### 2.4. CO-DESIGN & LIVING LAB OUTPUTS

The practical assets, publications, and operational toolkits generated across the 8 Small-Scale Pilot Actions are not static theoretical manuals, but the direct output of a structured, multi-stakeholder co-design methodology. Rather than applying a top-down academic approach, project partners established an iterative, cross-professional feedback loop across





all four supply chain sectors—connecting frontline workers, local producers, technical operators, students, families, and scientific experts.

**Step 1: Field Intervention & Operational Bottleneck Diagnosis**

In each pilot environment, activities began with empirical baseline audits to identify specific structural bottlenecks:

- *Primary Agriculture (LP - LIRA):* Local family farms (OPGs) and processing technicians mapped raw surplus perishability and the unexploited volume of secondary fruit residues (plum pits).
- *Vocational Culinary & Institutional Kitchens (PP2 - JURRA & PP3 - ZADRA NOVA):* Instructors, kitchen staff, and culinary students logged the exact ratio of edible ingredient trimmings discarded during bulk food preparation versus plate waste.
- *Primary School Canteens (PP4 - EFRI & PP6 - EcamRicert):* Teachers, canteen staff, and pupils monitored daily meal rejection patterns, unconsumed whole fruit items, and plate leftovers.
- *Commercial Supermarkets (PP7 - UNIFG):* Store managers, department heads, and cashiers tracked the timing and volume of write-off losses for products nearing their minimum durability date.
- *Domestic Kitchens & Mobile Film Sets (PP6 - EcamRicert & PP8 - CNA Abruzzo):* Participating families logged daily household discarding habits via kitchen diaries, while film crews and catering providers audited unserved buffet meals caused by schedule volatility.

**Step 2: Bottom-Up Co-Creation & Prototyping**

Armed with diagnostic evidence, operational actors actively co-created tailored circular workflows rather than relying on abstract guidelines:

- *Bio-Economy Cascading (Pilot 1):* Agronomists and machine operators tested real-time mechanical cracking and cold-pressing parameters to optimize kernel oil extraction and fuel pellet density.
- *Culinary Upcycling & Kitchen Routines (Pilots 2 & 3):* Vocational students and chefs drafted creative recipes that repurpose vegetable peelings and secondary meat cuts, pairing them with daily compaction routines.
- *School Nudging & Smoothies (Pilots 4 & 5):* Pupils co-designed awareness mascots and smoothie-making stations using surplus fruit, while teachers integrated SDG educational games into the classroom.
- *Dynamic Retail Packaging (Pilot 7):* Supermarket floor operators designed the physical assembly of fixed-price Kraft "Smart Boxes" and tested dynamic QR-code interfaces linked to an AI recipe engine.
- *Household Meal-Prep & Green Catering (Pilots 6 & 8):* Families drafted leftover upcycling meals alongside professional chefs during live show-cooking workshops, while movie directors, actors, and caterers co-designed an agile, 24-hour WhatsApp meal pre-booking routine.





**Step 3: Cross-Professional, Technical & Regulatory Validation**

To ensure that all co-created solutions were technically feasible, legally sound, and safe for wide-scale adoption, drafted protocols underwent a comprehensive multi-disciplinary cross-check:

- *Nutritional & Health Standards:* Municipal dietitians and nutritionists validated school recipes and family meal plans to guarantee strict adherence to age-appropriate macronutrient targets, allergen standards, and HACCP rules.
- *Retail & Logistics Feasibility:* Supermarket management verified that "Smart Box" assembly workflows did not disrupt morning shelf restocking or create checkout delays, while movie production coordinators ensured meal pre-booking aligned smoothly with daily evening call sheets.

**Step 4: Formal Deliverable Packaging & Open-Access Capitalization**

The final validated outputs were codified into official project deliverables, formal publications, and practical toolkits:

- **Formal Publications & Cookbooks (Annexes to D2.2.1):** The *"Zero Waste Cook Book"* (Annex I - PP3), the *"Ogni Boccone Conta – Recipe Book"* (Annex II - PP6), and the *"Famiglie Insieme Contro lo Spreco Alimentare – GuideBook"* (Annex III - PP6).
- **Operational Guidelines & Playbooks:** The *Primary Agriculture Surplus Upcycling Manual* (LP), the *Vocational Kitchen Organic Waste Management Guidebook* (PP2), the *Canteen Nudging Playbook* (PP4), the *Retail Surplus Bundling Playbook* (PP7), and the *Green Catering Protocol for Movie Sets* (PP8).

# 3. SECTORAL PORTFOLIO OF THE 8 SMALL-SCALE PILOT ACTIONS

This chapter forms the executive core of Output 2.2, presenting the practical portfolio of the 8 Small-Scale Pilot Actions deployed across the Interreg Italy–Croatia Cooperation Area. Each field sheet outlines the operational setup, local ecosystem collaboration, specific technological or educational tools deployed, and the immediate practical outputs generated.

The portfolio is structured according to the four strategic nodes of the food supply chain:

1. Primary Agriculture & Processing Sector
2. Food Services
3. Retail & Commercial Distribution Sector
4. Consumers

## 3.1. PRIMARY AGRICULTURE & PROCESSING SECTOR

In primary agriculture, significant food loss occurs prior to distribution due to seasonal harvest spikes, cosmetic imperfections, and lack of immediate processing infrastructure. Pilot 1 established a physical **Zero Waste Innovation Lab** within the Development Centre of Lika-Senj County. The operational goal was to demonstrate how regional development agencies and agricultural cooperatives can deploy whole-crop cascading techniques to convert unexploited seasonal fruit surpluses—specifically plums—and processing by-products into high-value market goods.

The pilot created an active collaborative platform bringing together local family farms (*OPGs*), agricultural technical experts, and regional food processors. LIRA coordinated the testing of specialized processing machinery:

- **Freeze-Drying Unit:** Tested batch preservation of fresh fruit slices, extending shelf life while retaining nutritional properties for retail snack markets.
- **Hydraulic Oil Press:** Processed plum kernels recovered from fruit pits, extracting high-grade cosmetic/culinary oil and press-cake feed.
- **Pelletizer System:** Crushed discarded fruit stones to manufacture biomass biofuel pellets for local heating.

**Practical Asset & Technical Protocols:**

- **Operational Bio-Processing Line:** Fully equipped pilot processing facility at the Development Centre of Lika-Senj County available for demonstration and regional producer testing.
- **Surplus Valorization Protocols & Parameter Sheets:** Standardized processing guidelines and operational parameters (freeze-drying cycles, plum kernel cold-pressing yields, and biomass pelletization workflows) documented in Deliverable D2.2.1.

## 3.2. FOOD SERVICES & EDUCATIONAL CANTEENS SECTOR

Educational and institutional food services present two distinct operational challenges across the food supply chain: managing high volumes of organic kitchen waste during large-scale preparation, and addressing behavioral plate waste generated by consumers.

In primary education canteens, waste is predominantly driven by pupil dietary preferences, selective eating, and whole unconsumed fruit items. To address this, the setup in primary school Living Labs ("Vladimir Gortan" in Rijeka and "Luigi Luzzatti" in Padua) targeted early-age behavioral change through interactive learning and nudging setups, utilizing physical tools—such as fruit smoothie upcycling stations, organic drain-grinders, and top-down AI image-recognition smart bins—as diagnostic instruments to measure the impact of educational campaigns.

Conversely, in vocational hospitality environments (the Commerce and Catering School in Karlovac and the Hotel, Tourism and Catering School in Zadar), the operational focus shifted to professional skill-building and back-of-house kitchen efficiency. Here, the setups established structured monitoring procedures to address high volumes of wet organic preparation scrap and trimming waste, integrating commercial compaction hardware and split-phase weighing systems directly into daily culinary training routines.

Across all four locations, project partners established active collaborative ecosystems bringing together municipal dietitians, school boards, culinary instructors, kitchen staff, pupils, and vocational students:





- **Vocational Operational Optimization (Pilots 2 & 3):**
    - **In Karlovac (JURRA - PP2):** The Living Lab deployed a commercial organic waste compactor capable of reducing organic waste volume through mechanical liquid extraction. Culinary students and kitchen staff were trained to weigh, log, and compact prep-waste, embedding waste reduction discipline into daily kitchen management.
    - **In Zadar (ZADRA NOVA - PP3):** Culinary instructors and students implemented a split-phase weighing matrix (tracking raw input, yield, inedible trim, and plate waste) combined with farm-to-fork study visits, co-creating circular recipes that utilize ingredient trimmings and peelings.
- **Primary Education Awareness & Diagnostic Tracking (Pilots 4 & 5):**
    - **In Rijeka (EFRI - PP4):** The team introduced canteen visual nudges, mascot-led campaigns, and "Fruit Upcycling Stations" that transformed unpeeled fruit into fresh smoothies for pupils, while deploying a commercial drain-grinder unit to divert organic scraps from municipal streams.
    - **In Padua (EcamRicert - PP6):** As WP2 Leader, EcamRicert deployed the mobile "EcoFood Waste Truck" to deliver interactive SDG workshops and gamified activities. Top-down AI image-recognition smart bins were integrated into the canteen to automatically log plate waste volumes, serving as an objective

diagnostic tool to measure how pupil awareness campaigns directly reduced waste over time.

**Practical Assets & Replicability Toolkits by Pilot**

- **Pilot 2 (PP2 - JURRA - Karlovac):**
    - **Physical Asset:** Commercial organic waste compaction unit integrated into the working kitchen of the Commerce and Catering School Karlovac.
    - **Practical Toolkit:** *Standardized kitchen waste sorting and compaction protocols, including daily weight-per-meal tracking sheets and volume compaction efficiency benchmarks documented in D2.2.1*
- **Pilot 3 (PP3 - ZADRA NOVA - Zadar):**
    - **Practical Asset / Publication:** *Zero Waste Cook Book*, featuring co-created recipes utilizing ingredient trimmings, peelings, and secondary cuts.
    - **Practical Toolkit:** *Split-phase input-output weighing matrices and educational culinary modules for vocational hospitality students, integrated into Deliverable D2.2.1*
- **Pilot 4 (PP4 - EFRI - Rijeka):**
    - **Physical Asset:** Canteen fruit smoothie upcycling station and heavy-duty drain-grinder system.

- **Practical Toolkit & Nudging Framework:** Visual nudging campaign templates, mascot engagement materials, and smoothie station workflows documented in Deliverable D2.2.1

- **Pilot 5 (PP6 - EcamRicert - Padua):**
  - **Physical Asset / Mobile Lab:** "EcoFood Waste Truck" mobile educational setup, canteen top-down AI image-recognition smart bins, and standardized dietary habit monitoring protocols.
  - **Practical Toolkit:** *"Ogni Boccone Conta – Recipe Book"* (official project publication registered as Annex II to Deliverable D2.2.1), alongside the canteen awareness slide deck and monitoring forms.

### 3.3. RETAIL & COMMERCIAL DISTRIBUTION SECTOR

The retail and commercial distribution sector acts as a critical bridge between bulk food logistics and end-consumer purchasing decisions. A major source of loss at this stage stems from products approaching their minimum durability date (shelf-life expiration), which are frequently discarded despite remaining perfectly safe and nutritious for consumption.

Pilot 7 targeted this commercial bottleneck by introducing a dedicated **"AI Smart Box" retail framework** directly within active supermarket environments in Foggia. The operational setup was designed to intervene before items reached waste streams, creating a high-visibility, fixed-price bundling system supported by dynamic pricing and digital culinary suggestions at the point of sale.





Under the guidance of the University of Foggia (UNIFG - PP7), the Living Lab established an operational partnership with supermarket operators, department managers, cashiers, and daily retail shoppers:

- **In-Store Operations & Inventory Sorting:** Supermarket staff were trained to identify eligible near-expiry goods during routine morning inventory scans, assembling them into standardized, branded Kraft "Smart Boxes" sold at accessible, fixed discounted prices.
- **Point-of-Sale (POS) & AI Digital Integration:** UNIFG deployed a dynamic QR code system integrated into the packaging. When scanned by shoppers using their smartphones, the dynamic code activated an **AI-powered "Virtual Chef" web app**. The AI instantly analyzed the specific combination of items inside the box and generated customized, creative recipes, empowering consumers to transform near-expiry products into immediate home meals.

**Practical Assets & Replicability Toolkits by Pilot**

**Physical & Digital Assets:** Dedicated in-store "Smart Box" display modules in *Mercati di Città "La Prima"* supermarkets and the AI-powered "Virtual Chef" dynamic recipe web tool accessed via on-pack QR codes.

**Practical Toolkit:** Standardized inventory sorting routines, point-of-sale (POS) bundling guidelines, and customer engagement feedback protocols documented in Deliverable D2.2.1





### 3.4. HOUSEHOLD CONSUMERS & DYNAMIC EVENTS LOGISTICS SECTOR

Final consumption represents the end of the food value chain, split between static domestic environments (households) and highly flexible, fast-paced commercial activities (mobile event catering and film sets).

In domestic households, waste is largely driven by a lack of awareness regarding meal planning, improper food storage, and poor utilization of leftovers. To tackle this, Pilot 6 focused directly on **raising household awareness** through an intensive, multi-step family engagement program in the Veneto region, utilizing waste-logging diaries and chef-led workshops to reshape domestic food management habits.

In contrast, dynamic event environments—such as movie sets—face severe overproduction waste due to unpredictable crew numbers and fluctuating daily schedules. Pilot 8 addressed this operational friction by setting up a paperless **"Green Catering Protocol"** across film sets in Abruzzo, introducing digital real-time meal pre-booking to align kitchen preparation directly with actual daily demand.

Both Living Labs actively engaged end-users and local operators in co-creating circular habits tailored to their specific operational environments:

- **Household Raising Awareness & Family Engagement (Pilot 6 - PP6 EcamRicert):**

EcamRicert brought together local families and professional chef. Participating households completed multi-week kitchen logging diaries (Phase 1 Baseline vs. Phase 2 Post-

Intervention) to track domestic waste patterns. EcamRicert organized practical intergenerational workshops (*"Famiglie Insieme contro lo spreco alimentare"*) and live show-cooking events led by professional chef, teaching families food preservation techniques, batch cooking, and creative leftover upcycling recipes.

- **Dynamic Movie Set Logistics & Digital Pre-Booking (Pilot 8 - PP8 CNA Abruzzo):**

CNA Abruzzo united film commissions, cinema academies (IFA Cinema School), catering logistics providers, and film crews. The Living Lab tested an agile, paperless meal pre-booking system utilizing instant messaging workflows (WhatsApp messaging groups and digital forms). Film crew members pre-selected their daily menus 24 hours in advance, allowing catering providers to prepare exact portion quantities, utilize reusable/compostable packaging, and eliminate systemic overproduction on set.

**Practical Assets & Replicability Toolkits by Pilot**

- **Pilot 6 (PP6 - EcamRicert - Padua/Veneto):**
    - **Practical Asset / Publication:** *Famiglie Insieme Contro lo Spreco Alimentare – GuideBook*" (official project publication registered as Annex III to Deliverable D2.2.1)
    - **Practical Toolkit:** Household kitchen logging diary templates, food storage guides, and intergenerational workshop modules documented in Deliverable D2.2.1

- **Pilot 8 (PP8 - CNA Abruzzo - Abruzzo Movie Sets):**
    - **Digital Asset:** Instant-messaging (WhatsApp) paperless meal pre-booking workflow and digital headcount form protocols tested on live film production sets.
    - **Practical Toolkit:** *Green Catering Protocol for Dynamic Events & Movie Sets*, detailing demand-matching catering procedures, compostable packaging standards, and mobile event logistics checklists documented in Deliverable D2.2.1

# 4. PRACTICAL ASSETS & OPEN-ACCESS TOOLKITS CREATED

The tangible value of Output 2.2 lies in the concrete, open-access deliverables generated across the 8 Small-Scale Pilot Actions. Rather than producing abstract academic literature, the ECOFOODCYCLE Living Labs focused on establishing permanent physical infrastructure, cyber-physical testing assets, and practical operational toolkits that remain available for continuous regional use.

## 4.1. PHYSICAL INFRASTRUCTURES & CYBER-PHYSICAL TESTING ASSETS ESTABLISHED

Throughout the project execution, physical and digital infrastructure was deployed across the seven target regions. These assets form the physical backbone of the ECOFOODCYCLE Small-Scale Pilots network, remaining operational for long-term regional experimentation:

- **Agricultural Processing Hub (Gospić, HR - LP LIRA):** A fully operational pilot processing line equipped with an industrial freeze-dryer, hydraulic kernel oil press, biomass pelletizer, and cold storage units at the Development Centre of Lika-Senj County.
- **Vocational Kitchen Compaction Hardware (Karlovac, HR - PP2 JURRA):** Commercial organic waste compaction equipment integrated into the daily kitchen prep routine at the Commerce and Catering School in Karlovac.
- **Split-Phase Kitchen Measurement Stations (Zadar, HR - PP3 ZADRA NOVA):** Dual-scale input/output kitchen weighing stations operational within the training kitchens of the Hotel, Tourism and Catering School in Zadar.

- **Canteen Upcycling & Drain-Grinder Station (Rijeka, HR - PP4 EFRI):** A dedicated smoothie upcycling counter and commercial drain-grinder unit installed at the "Vladimir Gortan" Elementary School.
- **Educational Lab (Padua, IT - PP6 EcamRicert):** Educational materials designed for children aged 8–11; hands-on activities to carry out with pupils (tailored for teachers). Canteen data collection methodology (monitoring users' dietary habits).
- **Supermarket "Smart Box" In-Store Modules & AI POS Interface (Foggia, IT - PP7 UNIFG):** Branded physical display stands and dynamic QR-code dynamic packaging setups connected to the AI *"Virtual Chef"* web application across the *Mercati di Città "La Prima"* supermarket chain.
- **Paperless Movie Set Pre-Booking Digital Workflow (Abruzzo, IT - PP8 CNA Abruzzo):** Instant-messaging pre-booking digital architecture and portion-controlled thermal delivery systems deployed across active film sets in Abruzzo.
- **Domestic Household Digital & Practical Testing Kits (Padua, IT - PP6 EcamRicert):** Multi-week family food-logging tools and simplified monitoring protocols deployed across domestic household environments in the Veneto region.

### 4.2. COMMUNICATION REACH & PUBLIC AWARENESS IMPACT

The small-scale pilots served as high-visibility communication hubs, raising public awareness across the Italy–Croatia area through direct community involvement:





- **Direct Educational Engagement: primary school pupils** and **vocational culinary students** actively participated in hands-on waste monitoring, SDG workshops, and smoothie upcycling sessions.
- **Citizen & Household Activation: domestic family nuclei** attended intergenerational chef workshops in the Veneto region.
- **Retail & Event Visibility:** supermarket shoppers were reached via in-store "Smart Box" displays and AI recipe dynamic QR codes in Apulia, while mobile film crews across Abruzzo were exposed to zero-waste paperless catering routines.
- **Media & Digital Dissemination:** Pilot activities were featured across local press, and the official Interreg project communication channels, driving widespread recognition of circular food solutions.

# 5. FIELD REPLICABILITY GUIDE: HOW OTHER ORGANIZATIONS CAN EXPERIMENT

To bridge the gap between pilot testing and regional rollout, this chapter provides a practical roadmap for external organizations (municipalities, school boards, supermarket managers, and caterers) wishing to replicate the ECOFOODCYCLE Small-Scale Pilot actions models in their own operational contexts.

## 5.1. OPERATIONAL SETUP CHECKLISTS FOR EXTERNAL LOCAL ADOPTERS

Before launching a local food waste trial, external adopters should follow this standardized operational checklist derived from WP2 field testing:

1. **Define Operational Boundaries & Scope:** Identify the target facility (e.g., school canteen, retail store, catering service) and specify whether the intervention focuses on *awareness*, *vocational process*, or *technological optimization*.

2. **Establish Pre-Intervention Baseline (Phase 1):** Conduct a mandatory 1-to-2 week baseline assessment using visual plate audits, manual weight logs, or inventory scans before introducing any new equipment or campaign.

3. **Onboard Key Stakeholders & Human Operators:** Run brief orientation sessions with frontline staff (canteen workers, cashiers, chefs, teachers) to explain *why* the trial is happening and how it benefits daily routines.

4. **Select Low-Barrier Tools:** Prioritize simple, low-cost or intuitive digital/physical tools (e.g., instant-messaging pre-booking, dynamic QR codes, basic digital scales) to minimize operational friction.

5. **Deploy & Track Continuously (Phase 2):** Launch the intervention while keeping weekly tracking logs to monitor progress and identify sudden operational bottlenecks.

6. **Evaluate & Package Results (Phase 3):** Compare post-intervention metrics against the initial baseline and share success metrics with organizational leadership to justify permanent policy adoption.

## 5.2. PRACTICAL FIELD LESSONS LEARNED & QUICK FIXES FROM LIVING LAB DEPLOYMENTS

Real-world testing across the 8 pilots revealed practical operational hurdles. The table below outlines these field lessons and the quick fixes developed by partners.

*Table 3.*

| **Living Lab Context** | **Field Challenge / Bottleneck Identified** | **Operational "Quick Fix" Implemented** |
|---|---|---|
| Primary School Canteens | Pupil hesitation or confusion when using canteen waste disposal areas during busy lunch hours. | Introduced visual color-coded bin labels, canteen mascot nudges, and pupil "food waste monitors" to guide classmates. |
| Vocational Kitchens | Kitchen staff viewing additional split-phase weighing steps as a time-consuming administrative burden. | Integrated weighing scales directly into prep counters and replaced complex logs with simplified 1-click digital tally sheets. |
| Retail | Consumers unaware of what products were inside near-expiry bundled boxes before purchasing. | Added transparent window packaging and clear thematic labels (e.g., "Breakfast Box", "Pasta Meal Box") alongside the QR code. |
| Movie Sets & Catering | Film crew members forgetting to pre-book meals 24 hours in advance via digital forms. | Switched from complex web forms to simple WhatsApp group polls sent automatically with evening daily call sheets. |





| | | |
|---|---|---|
| Domestic Households | Families abandoning manual paper logging diaries after the first week due to lack of time. | Replaced paper logs with mobile-friendly digital surveys and incentivized participation through live show-cooking event. |

# 6. CONCLUSIONS & NEXT STEPS FOR REGIONAL SCALING

Output 2.2 demostrates that circular food economy solutions are not only theoretically viable, but operationally efficient and economically beneficial across the Italy–Croatia Cooperation Area. By testing 8 Small-Scale Pilot Actions across Primary Agriculture, Food Services, Retail, and Consumers/Events, the project established a robust matrix of physical infrastructure, cyber-physical tools, and behavioral methodologies.

Far from being isolated trials, these field interventions have proven that multi-sectoral collaboration—connecting public authorities, educational communities, private enterprises, and citizens—can effectively overcome systemic barriers to food waste reduction in real-world environments.

To ensure that the results of the Living Labs extend beyond the project's immediate duration and geographic footprint, all operational assets, diagnostic models, and educational toolkits have been integrated into the **ECOFOODCYCLE Cross-Border Platform**.

Serving as a centralized digital knowledge hub, the CB Platform provides public institutions, catering operators, retailers, and agricultural cooperatives with immediate open-access to (https://ecofoodcycle.eu/hospitality/):

- **Interactive Evaluation & Planning Tools:** Dedicated digital applications, such as the *Hospitality ROI Calculator* and cross-border food waste tracking engines, designed to quantify financial savings and environmental benefits (avoided $CO_2$ and resource loss) across commercial kitchens and canteens.

- **Downloadable Practical Kitchen Assets & Worksheets:** Ready-to-use operational templates directly tested in food services, including standardized *Waste Audit Sheets*, daily *Inventory Trackers* with smart FIFO controls, and *Daily Prep Guides* to minimize over-preparation.
- **Sustainable Culinary Arts & Kitchen Systems Guides:** Specialized publications and operational briefs (such as *Zero-Waste Kitchen Systems*, commercial *Composting Blueprints*, and *Root-to-Stalk / Nose-to-Tail* recipe strategies) empowering chefs to repurpose trimmings into high-value menu items.
- **Sectoral Living Lab Manuals & Curricula:** Complete zero-waste cookbooks (including the *Zero Waste Cook Book*, *Ogni Boccone Conta*, and *Famiglie Insieme*), split-phase weighing frameworks, primary school nudging toolkits, and dynamic event green catering protocols.
- **Peer-to-Peer Technical Guidance:** Direct connection channels with project partners and Living Lab pilots to provide technical assistance, training materials, and support for external local adopters.

By bridging real-world Living Lab evidence with regional policy design, the ECOFOODCYCLE framework ensures that local success stories are transformed into long-term institutional procurement rules, regional development strategies, and permanent circular economy investments across the Adriatic region. Specifically, the field results support three main areas of strategic scaling:





- **Green Public Procurement (GPP):** Translating canteen and educational pilot outcomes into standardized criteria for municipal school and hospital catering tenders.
- **Rural Development & Bio-Economy Funding:** Utilizing primary agriculture processing benchmarks to guide regional development funds toward shared, decentralized harvest stabilization infrastructure.
- **Commercial Incentivization Frameworks:** Demonstrating the economic viability of dynamic retail pricing and digital event pre-booking to encourage broader commercial adoption across the Cooperation Area.

Through this integrated architecture, combining field-tested toolkits, open-access digital platforms, and policy-oriented evaluation; Output 2.2 provides a concrete, replicable blueprint for building a resilient, zero-waste food system across Italy and Croatia.

## 7. REFERENCES DOCUMENTS

ECOFOODCYCLE Project Deliverables & Core Reference Framework:

- Output 2.1: Joint Solutions for Tackling Food Waste – The overarching transferable operational blueprint and multi-tier solution architecture.

- Deliverable D2.1.1: ECOFOODCYCLE Cross-Border Interactive Platform & Digital Tools – Online knowledge repository, digital savings calculator, and food redistribution module.

- Deliverable D2.2.1: Report on n.8 Small-Scale Pilot Actions – Detailed technical documentation, baseline-versus-intervention logs, and comprehensive field data sheets (325 pages).
- Deliverable D2.3.1: Joint Assessment Report – Post-hoc transnational impact evaluation, comprehensive SWOT matrix, indicator validation, and environmental benefits assessment.
- Output 1.1: Joint Cross-Border Strategy for Food Waste Awareness, Reduction, and Management.
- Official Cross-Border Platform: www.ecofoodcycle.eu