

Lessons learnt and the way forward: civic engagement and advocacy for sustainable waste valorisation at European HEIs



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Abstract	This report presents the results, opportunities, and challenges of integrating citizen science in sustainable agri-food waste valorization, as applied by AGRIMA HE partner institutions in the framework of WP4A3.
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Partnership



The consortium governing the project adequately represents a wide range of expertise, as four Higher Education Institutions (Aix-Marseille University, the University of the Aegean, Instituto Politécnico do Porto, and the University of Novi Sad) join forces with a regional viticulture association (AVIPE) and a digital education specialist (Web2Learn). This mix of knowledge, skills, experiences, and networks ensures a comprehensive approach to agri-food waste valorisation, combining scientific research, technological innovation, territorial knowledge, and educational practices. Together, the partners bring the capacity to engage diverse stakeholders, including farmers, citizens, students, local authorities, and bio-based industries, supporting AGRIMA's goal of fostering circular and community-driven solutions in agri-food systems.

Name	Short Name	Country
Universite d'Aix-Marseille	AMU	France
University of the Aegean	UoA	Greece
Instituto Politécnico do Porto	IPP	Portugal
Univerzitet u Novom Sadu	UNS	Serbia
Associação de Viticultores do Concelho de Palmela	AVIPE	Portugal
Web2Learn	W2L	Greece



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Executive Summary

This report presents the lessons learned and the way forward from the citizen science strand of the AGRIMA project, developed under Work Package 4 (WP4): “Civic engagement and advocacy for sustainable waste valorization.” It focuses on the experience generated through Work Package 4 Activity 3, where higher education students and academic staff engaged in citizen science mini-projects on waste valorization.

Thus, AGRIMA approaches agri-food waste valorisation not only as a technical or environmental issue but also as an educational and social one. In this context, WP4 highlighted the social value of sustainable waste valorisation practices by encouraging participation and civic engagement both within and beyond higher education. The report examines how citizen science can support more open, participatory, and socially relevant forms of agri-food waste learning and knowledge building in European HEIs.

This Deliverable 7 (D7) is the result of WP4A4 (Lessons learnt and the way forward: civic engagement and advocacy for sustainable waste valorisation) of the EU-funded project AGRIMA (Agri-food Waste Management for Sustainable Bio-economy through Higher Education Curricula and Upskilling).



Background

Agri-food systems generate significant quantities of waste and residues at every stage, from primary production and processing to distribution and consumption. Globally, food loss and waste account for 8 to 10 percent of total greenhouse gas emissions, making their reduction a priority for climate action (IPCC, 2022). Beyond the environmental cost, these losses represent a substantial missed opportunity, as many agri-food residues carry real potential for valorisation as compost, animal feed, bio-based ingredients, or inputs to circular production processes (Parfitt, Barthel & Macnaughton, 2010; Kummu et al., 2012).

The shift from waste disposal to waste valorisation sits at the heart of circular bioeconomy strategies. However, scientific monitoring alone does not capture the full picture of how, where, and why waste occurs. Researchers increasingly argue that engaging citizens in data collection, observation, and local-level action improves both the accuracy of waste assessments and the effectiveness of mitigation strategies (Ammendolia & Walker, 2022; Pierini et al., 2021). In this context, citizen science, understood as the active participation of citizens in processes of observation, data gathering, and analysis (Shirk et al., 2012), offers a practical mechanism for this. Moreover, as food intersects with people's everyday practices, culture, and economy, it provides an inclusive entry point for broad public participation regardless of prior scientific background (Varga et al., 2023).

In higher education, evidence shows that participatory approaches, such as citizen science, increase students' interest in science, strengthen their sense of efficacy for environmental action, and make learning more relevant by connecting coursework to real sustainability challenges (Smith et al., 2021; Alfaro-Ponce et al., 2024). When embedded in the context of agri-food waste, these benefits extend to building environmental literacy, promoting circular economy awareness, and developing skills relevant to the green transition (Varga et al., 2023).

In this context, the AGRIMA project (Agri-food Waste Management for Sustainable Bioeconomy through Higher Education Curricula and Upskilling) aims to promote social innovation and entrepreneurship in agri-food systems by strengthening higher education capacity for the green transition through participatory and innovative learning approaches. The following sections of the report include a description of the methodology, an overview and detailed presentation of the eight citizen science projects, an analysis of challenges and opportunities, the results of the post-implementation survey, and a set of conclusions.



Methodology

The AGRIMA citizen science projects were implemented following a series of activities carried out across Work Package 4 (WP4). Specifically, this report draws on the outputs and knowledge generated through WP4A1, WP4A2, and WP4A3, moving from mapping existing practice to institutional preparation and project design, to implementation, and finally to synthesis and reflection.

Step 1 consisted of the collection and analysis of existing citizen science initiatives in waste valorization under WP4A1. Through a structured desk research process, AGRIMA partners identified and documented relevant initiatives using a common classification framework. This mapping exercise provided the consortium with an initial evidence base on existing approaches, levels of citizen participation, technologies used, waste streams addressed, and fields of application. It also offered concrete examples and methodological references that informed the subsequent design of AGRIMA's own citizen science actions.

Step 2 involved the consultation process carried out under WP4A2. Building on the findings of WP4A1, Web2Learn organised four structured consultation sessions, one per higher education partner, to support academic staff in the design and preparation of their citizen science projects. These consultations aimed to strengthen institutional understanding of citizen science, align project ideas with AGRIMA's objectives, and support partners in identifying feasible implementation pathways within their own academic contexts. In this sense, WP4A2 functioned as a preparatory and capacity-building stage that connected the mapping of existing practices with the design of context-specific citizen science interventions.

Step 3 included the implementation of the citizen science projects under WP4A3. In this phase, each higher education partner carried out two citizen science projects involving students, academic staff, and citizens, with a minimum target of 15 participants per project. These projects generated the primary implementation experience on which the present report is based. Partners documented their projects using a common template that covered elements such as:

- research design,
- participant profiles,
- type of waste,
- field of application,
- level of citizen participation,
- foreseen and actual results, and
- the challenges and opportunities that emerged during implementation.



Step 4 consists of the present report that synthesises the knowledge generated throughout the previous stages. Hence, the report represents the analytical and reflective culmination of the WP4 process, bringing together the evidence base established in WP4A1, the institutional preparation carried out in WP4A2, and the implementation experience produced through WP4A3.

Overview of citizen science projects

WP4A3 positioned participants as active contributors rather than passive recipients of information, as students and staff did not simply learn about sustainable waste valorization from a distance but they engaged with it through participation, observation, and contribution to knowledge-building processes. This reflects the wider rationale of AGRIMA, which aims to strengthen higher education capacity for the green transition through innovative educational practices and stronger links between knowledge, action, and societal relevance.





Citizen Science Projects





University of Novi Sad

CS1: Participatory estimation of methane production in municipal waste systems

Short description

Residents collected and reported household waste data, conducted simple waste audits, and applied methane modeling to estimate greenhouse gas generation potential at a community scale, based on the IPCC (Intergovernmental Panel on Climate Change).

[UNSCS1](#)

Key features

Institution	University of Novi Sad
Geographic area	Serbia
Level of citizen participation	Contributory
Technology used	Fermentation (IPCC-based stoichiometric mass balance approach)
Type of waste	Organic waste
Field of application	Environmental conservation
Data category	Primary quantitative environmental activity data; participatory monitoring data; bottom-up greenhouse gas inventory inputs

Results

Citizens, in collaboration with university staff and students, collected and classified household bio-waste daily over a defined period, measuring it by mass or volume and reporting usual disposal routes. Using a degradable organic carbon approach adapted from IPCC guidelines, participants estimated methane and carbon dioxide generation potential. The project produced *per capita* waste inventories with greenhouse gas calculations, available as open data for repository deposit.

Participant awareness and feedback showed early signs of positive shifts in waste sorting and composting behavior. The replicable methodology can be adopted by other municipalities at minimal cost, leveraging citizen networks and open-source tools.



University of Novi Sad

CS2: Cognitive bias in sensory evaluation of food products with biowaste-derived ingredients

Short description

The project measured cognitive bias in the sensory perception of foods containing biowaste-derived ingredients. Quantitative hedonic scores and qualitative feedback were analysed to assess perception shifts, supporting evidence-based communication strategies for sustainable food innovation and circular economy acceptance.

 [UNS CS2](#)

Key features

Institution	University of Novi Sad
Geographic area	Serbia
Level of citizen participation	Contributory
Technology used	GRAS (Generally Recognized As Safe) extraction method
Type of waste	Agricultural waste
Field of application	Functional ingredients
Data category	Experimental behavioural and psychometric data within a citizen-science framework

Results

The project demonstrated that food products with upcycled ingredients may receive significantly different sensory ratings depending on labeling, producing measurable evidence of cognitive bias in sensory perception. Negative framing, such as “biowaste derived,” may reduce liking and purchase intention, whereas positive sustainability framing (“antioxidant plant extracts”) may increase acceptance relative to neutral disclosure. Statistically significant differences are expected in overall liking, perceived safety, perceived quality, and willingness to purchase, stressing the importance of education, literacy, and positive framing.



University of the Aegean

CS1: From Lab to real life

Short description

Over the course of a one-week laboratory experimentation, citizen scientists worked alongside university staff and students in a real laboratory environment, applying fermentation-based biotechnological techniques to transform agricultural waste into value-added products. Specifically, they produced microbial lipids and microbial biomass, and contributed qualitative data through questionnaires completed at the end of the project.

[!\[\]\(8942d28dc4da2a769efbb41dc37c5a1c_img.jpg\) UoA CS1](#)

Key features

Institution	University of Aegean
Geographic area	Greece
Level of citizen participation	Contributory
Technology used	Fermentation
Type of waste	Agricultural waste
Field of application	Biomaterials
Data category	Qualitative

Results

Post-project questionnaires showed that most participants expressed interest in seeing the produced microbial lipids and biomass applied in the energy sector. A significant share also indicated willingness to consume food or cosmetics enriched with biotechnology-derived ingredients similar to those they had produced. Hands-on participation influenced not just knowledge but also openness to bio-based products.



University of the Aegean

CS2: FoodLoop - Closing the food waste cycle

Short description

Over the course of a one-day event, citizens worked alongside university staff and students in a hands-on composting demonstration that combined QR codes displaying food waste reuse pathways, step-by-step composting instructions, and augmented reality tools to show how household food waste can be redirected from landfill to resource. Through this process, citizens contributed observations and reflections that helped build a shared understanding of practical waste reduction strategies.

[UoA CS2](#)

Key features

Institution	University of Aegean
Geographic area	Greece
Level of citizen participation	Contributory
Technology used	Composting
Type of waste	Organic waste (household food waste)
Field of application	Environmental conservation
Data category	Qualitative

Results

Most participants had little prior familiarity with composting. More than 40% reported regularly forgetting food in the refrigerator, and just over a third said food often expired before they had a chance to use it. Food waste was not an abstract issue for them, it was part of their daily routine. The project also revealed a genuine readiness to act. When asked whether they would consider composting at home, nearly 60% said they would, if the process was simple enough, and 32% said they would definitely do so. The limiting factor was not motivation but access to practical, easy-to-follow guidance. The project demonstrated that once that barrier was lowered, willingness to change behavior followed.



University of Aix-Marseille

CS1: Evaluation of the amount of food waste produced at home and how soil conditions affect food waste composting

Short description

Participants measured and recorded their household food waste at home over two weeks and then set up a controlled composting experiment at the university to test how temperature, moisture, and substrate conditions affected the efficiency of food waste degradation.

[🔗 AMU CS1](#)

Key features

Institution	University of Aix-Marseille
Geographic area	France
Level of citizen participation	Contributory
Technology used	Composting
Type of waste	Food waste
Field of application	Composting
Data category	Experimental data (quantitative and observational)

Results

Participants became more aware of their own food waste production and gained an evidence-based understanding of the conditions that affect composting efficiency. Different food waste types, including pasta, bread, cheese, and apple pieces, were placed in containers under varying substrates, moisture levels, and temperatures and monitored over 32 days. Citizens were consistently engaged throughout the project, and discussions between citizens and academic staff proved particularly effective in translating scientific



University of Aix-Marseille

CS2: Comparing coffee grounds from different origins on plant growth

Short description

Citizens and students used coffee grounds from different origins as organic soil amendments to grow succulent cuttings in a community garden, observing and measuring plant growth over several weeks to determine which grounds produced the strongest growth response.

[AMU CS2](#)

Key features

Institution	University of Aix-Marseille
Geographic area	France
Level of citizen participation	Collaborative
Technology used	Composting
Type of waste	Organic waste (coffee grounds)
Field of application	Environmental conservation
Data category	Qualitative and quantitative

Results

Participants developed a stronger understanding of soil composition and its role in plant growth. Citizens engaged not just as data collectors but as participants in the interpretation of findings. Discussions within the group were collaborative and substantive. The outdoor, garden-based setting made the project accessible and concrete in a way that laboratory environments cannot always replicate, and participants left with a practical skill directly applicable to home or community gardening.



Instituto Politécnico do Porto

CS1: ReAct! Give value to waste! Science in action to transform what's left over into resources

Short description

Participants received a set of simple, safe, and detailed protocols for the reuse of domestic agri-food waste, including coffee grounds, fruit and vegetable peels, and used cooking oils, to produce cosmetic products, candles, hygiene products, and food. They documented their work through photographs and short reports. Through this process, citizens contributed directly to building an open knowledge base on agri-food waste valorisation, demonstrating that meaningful scientific participation does not require a laboratory or specialist training.

 [IPP CS1](#)

Key features

Institution	Instituto Politécnico do Porto
Geographic area	Portugal
Level of citizen participation	Collegial
Technology used	Sustainable extraction and fabrication methods
Type of waste	Domestic agri-food waste (coffee grounds, fruit and vegetable peels, used cooking oils)
Field of application	Functional ingredients
Data category	Qualitative (nominal, ordinal)

Results

The project involved 268 participants from 9 schools, including 245 students in grades 7 to 12, 12 teachers, and staff from the IPP and Portuguese Chemical Society. They utilized 12 protocols for valorizing coffee grounds, fruits, and vegetables, and used cooking oils, producing items like lip balm, facial masks, soaps, and food products like chocolate truffles. Some students created their own protocols, while an adapted approach called the "Mural of the Senses" catered to a student with special needs, promoting sensory environmental literacy. Teacher satisfaction averaged 4.7 out of 5, and student feedback revealed a positive shift in perspective regarding agri-food waste, highlighting its potential as a resource rather than just waste.



Instituto Politécnico do Porto

CS2: Bags that Gain Wings, Fly: Art, Science, and Mathematics from Waste

Short description

Primary school students, in collaboration with their teachers and IPP staff and students from IPP, took part in a series of activities centered on bioplastic production from agri-food waste. The bioplastics produced were then used as materials for artistic creations, integrating circular bioeconomy principles with creative practice.

[IPP CS2](#)

Key features

Institution	Instituto Politécnico do Porto
Geographic area	Portugal
Level of citizen participation	Collegial
Technology used	Sustainable extraction and production methods (bioplastic production)
Type of waste	Agri-food waste
Field of application	Arts
Data category	Qualitative (nominal, ordinal)

Results

The project at Escola Básica de 1.º CEB / JI do Paço in Águas Santas included 57 participants: 44 primary students aged 9 to 10, 3 teachers, and 10 staff and students from IPP. It comprised three phases: initial presentations on food waste, composting, and bioplastics; creative drawing of chosen winged decomposers on postcards, complemented by wings made from IPP-produced bioplastics; and an exploration of reflection and symmetry using a GeoReflector. This initiative effectively integrated science and art, receiving a post-session satisfaction average of 4.8 out of 5 from students.



Challenges and Opportunities

Challenges

The implementation of citizen science activities within WP4A3 highlights several factors that can influence the effectiveness of participatory approaches in higher education settings. According to the partners, these are the challenges that they identified through the implementation of their citizen science projects:

Limited research experience: Many participants had little or no previous experience with scientific research or laboratory environments. As a result, facilitators needed to dedicate additional time to explaining scientific concepts, guiding participants through the activities, and ensuring that everyone could participate confidently. In laboratory-based activities, participants sometimes found it difficult to relate scientific procedures to everyday life, particularly when the projects did not produce a tangible end product. This highlighted the importance of clearly demonstrating the real-world applications of research outcomes.

Limited prior knowledge of sustainability topics, such as composting, required project teams to introduce basic concepts before participants could fully engage with the scientific activities. This reduced the time available for more advanced discussion and reflection.

Participant engagement throughout projects implemented over several weeks proved challenging, as personal and professional commitments occasionally affected attendance and continuity.

Language differences occasionally **limited participation** in discussions and scientific activities, particularly when projects were delivered in English to participants with varying levels of language proficiency.

Projects that combined different disciplines, such as science, mathematics, and art, required careful **planning** to ensure that complex concepts remained understandable and engaging for participants of different ages and educational backgrounds.

Organisational demands: Coordinating citizen science activities across multiple schools or implementation sites increased, and made the consistent collection and reporting of data more difficult.



The long-term impact of citizen science remains a challenge. Although several projects reported positive changes in participants' awareness, attitudes, and willingness to adopt sustainable practices, these outcomes are not always easy to capture through simple evaluation methods.

Opportunities

Beyond the challenges, AGRIMA partners also identified key opportunities in applying citizen science for agri-food waste valorisation purposes. More precisely:

Better understanding of sustainable waste valorisation: Hands-on participation enabled citizens to actively engage with scientific research, making scientific concepts more accessible.

Positive attitudes: Direct involvement in laboratory and field activities encouraged more towards bio-based products and circular economy solutions, demonstrating the value of experiential learning. The implementation demonstrated that citizen science activities based on clear, accessible protocols can be successfully replicated across different educational and community settings without requiring specialized equipment.

A strong willingness among participants to adopt more sustainable behaviours, particularly when practical guidance and simple solutions were provided for issues such as household food waste and composting.

Collaboration between academic staff, students, citizens, schools, and local communities created opportunities for mutual learning, strengthening both scientific communication and community engagement. Also, the experience gained through WP4A3 established a strong foundation for future collaboration between higher education institutions, primary and secondary schools, local authorities, and community organizations.

Accessibility: Activities organised in community-based settings, such as primary and secondary schools and public gardens, increased accessibility and attracted participants who might not otherwise engage with HEI-led research activities.

Inclusive design approaches supported the meaningful participation of individuals with diverse educational backgrounds and learning needs, demonstrating the importance of considering accessibility from the earliest stages of project planning.



Post-Implementation Survey

A post-implementation survey was distributed to all participants after completing their citizen science activities. A total of 122 responses were collected across the eight projects.

The survey measured six dimensions: a) practical skills development, b) ability to work with open data, c) awareness of sustainable agri-food waste management, d) motivation for environmental action, e) overall satisfaction, and f) perceived inclusiveness of the projects.

Respondent profile

Of the 122 respondents, 72 identified as citizens not affiliated with a higher education institution. The remaining 50 were students or staff from AMU (13), UoA (17), UNS (16), and IPP (4). The IPP ReAge! project attracted the largest number of responses (34), followed by the UNS methane estimation project (23) and the two UoA projects (14 and 15, respectively). The AMU composting experiment generated 15 responses, and the AMU coffee grounds project received 6.

Prior knowledge of citizen science

Participants rated their prior knowledge of citizen science on a scale from 1 (no knowledge) to 5 (expert level). The average score was 3.47 out of 5, indicating a moderate starting level. This confirms that the projects reached a broad audience rather than a specialist one, in line with the inclusive design intentions of WP4A3.

Self-reported understanding after participation

After completing their projects, 43 respondents (35%) reported that they understand citizen science well enough to explain it to others. Another 43 (35%) said they understand the concept fairly well. Fifteen respondents (12%) described themselves as very confident in applying citizen science methods. Only 5 respondents (4%) said they still did not understand the concept after participation. Taken together, 82% of participants reached a functional or confident level of understanding by the end of their project.



Key findings

Overall satisfaction was the highest-rated indicator by response share, with 91% of respondents agreeing or strongly agreeing and an average score of 4.32. Inclusiveness and accessibility received the highest average score across all indicators (4.40), rated positively by 86% of respondents. This confirms that the accessibility measures integrated into WP4A3 from the start produced real results for participants.

Awareness of sustainable agri-food waste management and motivation for environmental action both reached 81% positive response rates, with averages of 4.13 and 4.07, respectively. These results show that participation produced attitudinal shifts, not just knowledge gains. Practical skills development scored 80% positive (average 4.02), reflecting the hands-on nature of the activities across all four institutions. The open data competency indicator received the lowest positive response rate at 67% (average 3.78), pointing to an area where future projects can invest more deliberately.

Outcome Indicators

Indicator	Agree (%)	Average
Practical skills development	80%	4.02
Ability to work with open data	67%	3.78
Awareness of sustainable agri-food waste management	81%	4.13
Motivation for environmental action	81%	4.07
Overall satisfaction	91%	4.32
Inclusiveness and accessibility	86%	4.40



Testimonials from citizen scientists

"I found this project very rewarding. It was very useful to learn how to reuse and valorize materials that I had previously considered rubbish. It changed the way I think about waste and showed me how it can be transformed into valuable resources."

"Before this work, I saw waste as garbage and useless. After the project, I realized that many of these products can be used in other ways. I became more aware of the importance of reducing waste and opting for more sustainable practices."

"I used spent coffee grounds to make a natural face mask. I found it interesting to realize that something so simple can still be useful. This project made me look at waste differently and think more about wastefulness."

"This experiment made me realize that we can take advantage of many food waste materials and reinvent new recipes with them. Excessive waste production increases soil, water, and air pollution, and when not properly treated, causes environmental damage."

"Before, I thought coffee grounds were just trash that we throw away. Now I realize that we throw away many things that can be used for other things. I took the coffee grounds, mixed in more ingredients, and made a moisturizing mask - the trash became useful again."

Conclusions

This report set out to show that citizen science is a practical and effective way for higher education institutions to engage with citizens regarding sustainable agri-food waste valorisation, and the eight projects implemented across four countries did exactly that. Students, academic staff, and citizens worked with common waste streams, generated real data, and left with stronger awareness, skills, and motivation for environmental action. What stood out was not only what participants learned but also who they were. Citizens made up the majority of respondents, not researchers or specialists, which speaks to how genuinely inclusive these projects were from the start.

The challenges encountered along the way were real, but none proved insurmountable. Keeping participants engaged across multiple sessions, bridging language differences, and connecting abstract science to something tangible all required careful thought and adaptation. The solutions, however, were already visible within the projects themselves. Simple protocols, visible results, and activities rooted in things participants already cared about made the difference. Where these elements came together, the science worked, and so did the learning.

What AGRIMA demonstrated, above all, is that Higher Education Institutions (HEI) do not have to wait for the right conditions to open their doors to citizens. The methodologies developed under WP4A3 are low-cost, replicable, and ready to be taken further by other institutions across Europe and beyond. When higher education brings its methods, its spaces, and its questions to the communities around it, both science and society become stronger. That is perhaps the most important finding of all.

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