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SOCIO-ECONOMIC EVALUATION OF FOOD LOSS AND WASTE INTERVENTIONS: A STRUCTURED METHODOLOGICAL FRAMEWORK

Abstract

Food loss and waste (FLW) represent a major socio-economic and environmental challenge, generating significant economic losses, environmental externalities, and social inefficiencies across food systems. While numerous interventions targeting FLW prevention and valorisation have been implemented, their socio-economic impacts are assessed using heterogeneous methodological approaches, limiting comparability and policy relevance. This paper provides a structured overview and comparative assessment of socio-economic evaluation methods applied to FLW interventions. The analysis reviews cost-benefit analysis, full-cost accounting, life-cycle costing, input-output and economy-wide models, as well as hybrid and multi-criteria frameworks. For each method, the paper discusses analytical scope, data requirements, strengths and limitations, and suitability for different intervention types. The findings underline that no single method adequately captures the multidimensional impacts of FLW reduction, highlighting the need for integrated and context-sensitive evaluation frameworks. The paper concludes with methodological guidance for researchers and policymakers aimed at supporting evidence-based decision-making aligned with circular economy and sustainable development objectives.

Key words: *food loss and waste (FLW), socio-economic evaluation, cost-benefit analysis, sustainability assessment, policy analysis, circular economy*

JEL classification: *Q18, D61, Q53*

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СОЦИО-ЕКОНОМСКА ЕВАЛУАЦИЈА ИНТЕРВЕНЦИЈА ЗА СМАЊЕЊЕ ГУБИТАКА И ОТПАДА ОД ХРАНЕ: СТРУКТУРИСАНИ МЕТОДОЛОШКИ ОКВИР

Апстракт

Губици и отпад од хране (FLW) представљају један од кључних социо-економских и еколошких изазова савремених прехрамбених система, који генеришу значајне економске губитке, еколошке екстерналије и друштвене неефикасности дуж читавог ланца снабдевања храном. Иако су развијене и примењене бројне интервенције усмерене на превенцију и валоризацију FLW, њихови социо-економски ефекти се процењују применом хетерогених методолошких приступа, што ограничава упоредивост резултата и њихову релевантност за креирање јавних политика. Овај рад пружа структурирани преглед и компаративну анализу метода социо-економске евалуације примењених у процени FLW интервенција. Анализа обухвата анализу трошкова и користи, рачуноводство пуних трошкова, обрачун трошкова животног циклуса, инпут-аутпут моделе и моделе на нивоу привреде, као и хибридне и вишекритеријумске оквире. За сваку методу разматрају се аналитички обухват, захтеви у погледу података, предности и ограничења, као и погодност за различите типове интервенција. Резултати указују да ниједна појединачна метода не обухвата у потпуности мултидимензионалне ефекте смањења FLW, што наглашава потребу за интегрисаним и контекстуално прилагођеним евалуационим оквирима. Рад се завршава методолошким препорукама намењеним истраживачима и доносиоцима одлука, са циљем подршке доношењу одлука заснованих на доказима, у складу са принципима циркуларне економије и одрживог развоја.

Кључне речи: *губици и отпад од хране (FLW), социо-економска евалуација, анализа трошкова и користи, процена одрживости, анализа јавних политика, циркуларна економија*

Introduction

Food loss and waste (FLW) is a pressing global issue with profound economic, environmental, and social implications. Approximately one-third of all food produced for human consumption is lost or wasted worldwide, costing the global economy around $940 billion annually and contributing roughly 8% of greenhouse gas emissions (Champions 12.3, 2017). In the European Union (EU) alone, an estimated 59 million tonnes of food are wasted each year, representing an economic loss of about €143 billion (in product value and waste-management costs) (Eurostat, 2022). These losses exacerbate food insecurity and environmental degradation while indicating systemic inefficiencies in the food supply chain (e.g. unnecessary resource use and pollution) (Kitanovski et al., 2025). Reducing FLW is therefore recognized as a key strategy for improving food system sustainability and is reflected in policy goals such as United Nations SDG 12.3, which calls for halving per capita food waste by 2030, and the EU's Circular Economy Action Plan (De Laurentiis et al., 2020). Achieving these targets will

require not only effective interventions across the food supply chain, but also robust methods to evaluate the socio-economic outcomes of these interventions. Policymakers and stakeholders need evidence on the costs, benefits, and broader impacts of FLW prevention and valorisation initiatives in order to prioritize strategies and justify investments (De Laurentiis et al., 2020).

However, evaluating FLW interventions is challenging due to the diverse methodological approaches used in research and policy assessments. Studies have applied everything from basic financial cost-benefit analyses to complex systems models, each capturing different dimensions of impact. This variability makes it difficult to compare results across projects or to generalize best practices. Recent reviews highlight a lack of standardized frameworks: many interventions report on physical waste reductions, but few quantify broader economic, environmental, or social effects, limiting the ability to identify which measures truly offer the best value or overall benefit (De Laurentiis et al., 2020). For instance, Goossens et al. (2019) found that relatively few published studies on food waste initiatives evaluated outcomes like cost savings or social impacts, and that methodologies differed widely among those that did (Goossens et al., 2019). Stöckli et al. (2018) likewise called for more systematic and comparable evaluation of consumer-focused food waste interventions, noting inconsistent metrics and a need for common definitions and methods. Recognizing these gaps, the European Commission's Joint Research Centre (JRC) developed an evaluation framework and Food Waste Prevention Calculator to consistently assess both the environmental and economic performance of FLW prevention actions (De Laurentiis et al., 2020). This reflects a broader trend in the EU toward evidence-based policy: under the Better Regulation guidelines (European Commission, 2017), major policy proposals (including those on food waste) undergo impact assessments that examine expected economic, social, and environmental effects in tandem (De Laurentiis et al., 2020).

In this context, the present paper provides a structured overview of the main socio-economic evaluation methods used for FLW prevention and valorisation initiatives. It describes key methodologies, discusses how each has been applied (with examples from literature and policy), and compares their applicability, data requirements, strengths and limitations for different types of FLW interventions. The methods covered include: Cost-Benefit Analysis (CBA), Full-Cost Accounting (including environmental externalities), Input-Output (IO) and Economy-Wide (EW) Models, Life-Cycle Costing (LCC), and Hybrid frameworks that integrate economic, environmental, and social assessment. A comparative table is presented to summarize these approaches. Our aim is to guide researchers, practitioners, and decision-makers in selecting appropriate evaluation tools for various FLW strategies, and to highlight methodological and institutional gaps that must be addressed to improve the evidence base. Ultimately, more robust and comprehensive evaluations will help ensure that resources are directed to the most cost-effective and impactful FLW reduction measures, aligning with both economic incentives and broader sustainability goals (De Laurentiis et al., 2020).

Socio-Economic Assessment Methods for FLW Initiatives

Cost-Benefit Analysis (CBA)

Overview: Cost-Benefit Analysis is a well-established economic evaluation method that compares the monetary costs of an intervention to its monetary benefits

over time. A CBA yields metrics such as a benefit-cost ratio (BCR) or net present value (NPV), indicating whether the benefits of an action outweigh its costs. In the context of food waste, CBA typically counts direct financial costs (e.g. implementation expenses, operating costs) against direct financial benefits (e.g. reduced waste disposal fees, savings from purchasing less food, revenues from by-product sales). CBA appeals to both policymakers and businesses because it translates outcomes into the common language of money, facilitating comparisons and investment decisions (ReFED, 2016). However, conventional CBA often struggles to incorporate intangible or non-market impacts (like environmental improvements or social benefits) unless these are monetized. Thus, while CBA is excellent for evaluating private profitability or budgetary impacts of FLW interventions, it may undervalue external benefits unless adjusted (see *Full-Cost Accounting* below for approaches to address this).

Applications in FLW interventions: CBA has been widely used to demonstrate the economic rationale for reducing food waste. A landmark example is the report *"The Business Case for Reducing Food Loss and Waste"* by Champions 12.3, which analysed historical data from multiple countries, cities, and companies (Champions 12.3, 2017). Hanson and Mitchell (2017) found that the financial benefits of food waste reduction efforts often far exceed the costs: on average, companies achieved a 14:1 return on investment, and a UK nationwide campaign reduced household food waste by 21% with a benefit-cost ratio over 250:1 (Champions 12.3, 2017). These striking BCRs (e.g. £250 saved per £1 invested in the UK case) strengthen the argument that FLW reduction makes economic sense for both governments and businesses (Champions 12.3, 2017). Another influential analysis by ReFED (2016) evaluated 27 food waste solutions in the United States, ranking them by societal net economic value per ton of waste reduced. The ReFED Roadmap calculated how much each intervention would cost to implement versus the financial savings and revenues it would generate, using a 10-year NPV framework. This CBA-driven approach identified priorities like consumer education campaigns and packaging improvements as "low-hanging fruits" with high net benefits, while also highlighting interventions (e.g. certain recycling technologies) that might not pay off without policy support (ReFED, 2016). Both the Champions 12.3 and ReFED studies communicated results in clear economic terms that resonated with decision-makers, thereby spurring action.

Strengths: CBA's main strength is its clarity and decision-orientation. By summarising outcomes to a single monetary metric or ratio, CBA allows straightforward comparison of options: if an FLW project has a BCR > 1 (benefits greater than costs), it is economically justified. This makes CBA a powerful tool for advocacy and policy justification (Champions 12.3, 2017). It is also relatively intuitive and uses data (prices, quantities) that are familiar to businesses and governments. CBA works best for interventions with easily quantifiable direct impacts – for example, a change in packaging that costs *X* but reduces food spoilage by *Y* amount, saving *Z* euros. Indeed, many food waste reduction measures yield direct cost savings (less waste to haul, less purchasing of surplus food) that can be readily monetized (Kitanovski et al., 2025). CBA is thus well suited to assessing efficiency improvements or technologies from the standpoint of the investor or implementing entity (e.g. a company evaluating if a waste tracking system will pay off).

Limitations: The simplicity of CBA can also be a weakness. By focusing on monetized costs and benefits, a standard CBA may omit broader societal impacts that

are harder to price, such as reduced greenhouse gas emissions (GHG), improved food security, or job creation in redistribution programs. For example, the benefit of averting a tonne of CO_2 from avoided food production can be included if one applies a carbon price, but the choice of price (social cost of carbon, market price, etc.) significantly influences results (Hanes, 2014; Research Institute of Organic Agriculture, 2014). Social benefits like increased awareness or changes in consumer behaviour are even more difficult to monetize credibly. Therefore, a narrowly financial CBA might undervalue interventions that have big environmental or social paybacks but modest immediate financial returns. Another challenge is data availability, as performing a robust CBA for FLW initiatives requires data on costs (which may be dispersed across stakeholders) and on the economic value of food waste avoided. While direct cost data are often obtainable, estimating the monetary benefit of "a tonne of food waste prevented" can be complex since it involves upstream embedded costs (production, processing, etc.) and downstream waste management costs. Some studies address this by using average food prices for the edible portion and typical disposal costs per tonne (De Laurentiis et al., 2020). Nonetheless, uncertainties remain, and sensitivity analysis is important to test key assumptions (e.g. the longevity of an intervention's effects, discount rates, or future price changes).

Examples: Despite these limitations, CBA continues to be a foundational tool in FLW policy analysis. The European Commission often employs cost-benefit thinking in its impact assessments for waste legislation, weighing implementation costs against expected savings for consumers and businesses. For instance, the Impact Assessment accompanying the EU's proposed food waste reduction targets estimated both compliance costs (~€2 billion across the food chain) and the economic value of food saved (European Commission, 2023a). Even at the local level, municipalities have used CBA to decide on waste prevention programs, comparing the expense of running education campaigns to the avoided landfill costs and potential savings for households.

In sum, CBA provides an outcome-focused evaluation of FLW interventions in monetary terms. It excels at answering the question "Is this intervention worth it financially?" but may need to be complemented by other methods to capture the full spectrum of benefits and trade-offs. This sets the stage for more comprehensive approaches like full-cost accounting and integrated assessments presented below.

Full-Cost Accounting (FCA) and True Cost of Food Waste

Overview: Full-Cost Accounting extends traditional cost analysis by including externalities and hidden costs associated with an intervention or activity. In the context of food waste, FCA attempts to account for all costs and benefits to society, not just those that directly accrue to the implementer. This means assigning monetary values to environmental impacts (e.g. GHG, water use, biodiversity loss) and social impacts (e.g. health or employment effects) so that they can be considered alongside direct financial costs (Hanes, 2014; Research Institute of Organic Agriculture, 2014). FCA is sometimes termed "true cost accounting" when used to reveal the true societal cost of food waste itself. A seminal study by the FAO (2014) applied FCA to global food wastage: it estimated not only the market value of lost food (~$1 trillion) but also the hidden environmental costs (~$700 billion, from emissions, water, land degradation) and social costs (~$900 billion,

from livelihood impacts, hunger, etc.) of food waste. The conclusion was that food waste's *total* cost to society was about $2.6 trillion annually, far higher than the direct economic value of the wasted food (FAO, 2014). This kind of analysis underscores that decisions solely based on private costs (e.g. the grocery store's loss or disposal fee) vastly understate the harm of food waste when externalities are ignored (Schuler, 2017).

In evaluating FLW interventions, an FCA approach would incorporate both the standard financial results (like a CBA would) *and* the monetized value of external impacts. For example, consider an initiative to divert surplus food to bioenergy rather than landfilling it. Beyond the operational costs and revenue from energy, an FCA might include the climate benefit of methane emissions avoided at landfills and the societal value of energy generated. Similarly, a household food waste reduction program's full benefits would include not just household savings, but also the upstream resource savings (land, water, fuel) from producing less food, monetized via environmental economic estimates. The goal is to inform decision-makers of the comprehensive return on investment from society's perspective (Hanes, 2014). FCA is closely aligned with the "polluter pays" principle and is useful for policy design (e.g. setting the level of incentives or penalties that reflect true costs).

Applications in FLW interventions: At a macro level, the FAO's Food Wastage Footprint: Full-Cost Accounting project (2014) remains a touchstone, illustrating how to layer environmental and social cost factors onto food waste tonnages by region and commodity (TMG & WWF, 2021). On a project scale, FCA techniques have been employed in some municipal waste management analyses and corporate sustainability assessments. For instance, the U.S. EPA and various municipalities produced guides on FCA for solid waste in the 1990s, encouraging local governments to calculate the real cost of waste services by including capital depreciation, environmental compliance, etc., a concept now extending to food waste programs. In the FLW context, De Menna et al. (2018) conducted a review of life-cycle costing (LCC) approaches for food waste, which essentially falls under FCA when environmental costs are internalized. They note that methods range from simple add-on cost estimates (e.g. multiplying emissions by a carbon price) to more elaborate hybrid LCA-LCC models that integrate life-cycle environmental impacts with economic costing. An example from their review is a study where the "cost" of a food waste prevention measure included not only the program's expenses but also the social cost of carbon saved by avoiding waste, thus altering which option appeared most attractive when ranked by true cost (De Menna et al., 2018). Another example is the UK's Waste & Resources Action Programme (WRAP), which has at times highlighted the "true cost" of household food waste by factoring in the retail price of food wasted (£14 billion/year in the UK) plus disposal costs and environmental costs – framing FLW reduction as a win-win for consumers and the planet (WRAP, 2016).

Strengths: FCA provides a holistic evaluation, aligning financial analysis with sustainability goals. It helps capture the rationale for interventions that might be overlooked if only direct profits are considered. For policymakers, FCA can justify supportive measures (subsidies, regulations) for FLW reduction: if an intervention's private BCR is <1 but the societal BCR (including external benefits) is $\gg 1$, public intervention may be warranted to bridge that gap (U.S. Environmental Protection Agency, 2025a). FCA also aids in prioritizing actions by true effectiveness, for instance, it might show that preventing a tonne of food waste at the consumer level yields greater net social benefit than recycling two tonnes via composting, when all factors are weighed. By making

external costs explicit, FCA pushes stakeholders to recognize otherwise "invisible" savings like GHG reductions or reduced water pollution. It aligns with concepts like the food waste hierarchy by giving prevention a higher value (due to larger avoided externalities) than end-of-pipe solutions. In summary, FCA translates sustainability into the language of finance, broadening the scope of CBA to encompass public goods.

Limitations: The challenge, of course, lies in monetizing externalities credibly. Estimates of environmental costs can vary widely depending on methodologies (e.g. different carbon prices can dramatically change the valuation of emissions saved). There is also the ethical debate of putting a price label on certain social impacts (what is the monetary value of reducing hunger by redistributing food surplus, for example?). FCA results may be sensitive to contested assumptions, and presenting highly aggregated "single figure" outcomes (like € saved when including nature) can invite scrutiny. To mitigate this, analysts often present ranges or conduct sensitivity tests. Another limitation is data and complexity, as performing a rigorous FCA often requires life-cycle assessment data, environmental economic data (for damage costs), and socio-economic data, which can make it resource-intensive. Despite these hurdles, the trend is towards improving these valuations. For instance, the European Commission has developed methods like the Environmental Footprint 4.0, which quantifies several environmental impacts of products and can be linked to cost factors (Kitanovski et al., 2025). Indeed, the JRC Food Waste Prevention Calculator mentioned earlier incorporates default environmental coefficients to estimate CO_2 savings and other impacts for prevention actions (De Laurentiis et al., 2020), effectively building a simplified FCA into a user-friendly tool.

Examples: An illustration of FCA in practice is a city evaluating an organic waste prevention program versus building a new anaerobic digester. A pure financial analysis might favour the digester (if it generates revenue from energy and compost). But an FCA could reveal that the prevention program yields greater net benefit once the *social value* of food saved (e.g. if redistributed) and the *environmental value* of avoided emissions are counted, whereas the digester still results in some emissions and only addresses waste after it is created. Such insights guide more sustainable choices.

In conclusion, FCA complements traditional CBA by illuminating the *total* costs and benefits of FLW interventions. It provides a strong argument for preventative measures and can help align business cases with societal welfare. Many European policy analyses now embrace this approach, ensuring that evidence-based decisions on food waste are informed by the true costs and savings at stake (Eosta et al., 2017).

Input-Output Models and Economy-Wide Impact Assessment

Overview: Input-Output (IO) models and related economy-wide models (such as Social Accounting Matrices (SAM) or Computable General Equilibrium (CGE) models) are used to assess the broader macroeconomic and sectoral impacts of changes in the food system, including those from FLW reductions. Unlike project-level evaluations, IO models consider how an intervention's effects ripple through the economy, capturing indirect and induced impacts on output, employment, income, and even trade. For example, reducing food waste might lower demand for food production (affecting the agriculture and food manufacturing sectors), but increase economic activity elsewhere (as households spend

their saved money on other goods, or waste management companies see reduced business) (Lekavičius et al., 2023). IO analysis uses large tables of inter-industry transactions to estimate these cross-sector effects. In the context of FLW, IO and SAM models can help answer questions like: *What is the net effect on GDP and jobs if we halve food waste?* or *How do food waste reductions in households versus farms differ in their economic outcomes?* These models can also integrate environmental extensions, producing results on how economy-wide resource use or emissions change under different scenarios.

Applications in FLW research: A recent study by Lekavičius et al. (2023) provides a prime example of using an economy-wide model for FLW reduction analysis. They applied a SAM-based model (SAMmodEU) to simulate various food waste reduction scenarios across the EU supply chain, analysing impacts on GDP, employment, and pollution. The results showed that most scenarios led to slight increases in GDP and employment, essentially, a net positive socio-economic effect, though outcomes varied by sector (Lekavičius et al., 2023). Interestingly, the multicriteria analysis in this study identified reducing waste in food services (restaurants, catering) as yielding the best overall performance when considering both economic and environmental criteria (Lekavičius et al., 2023). Another important insight from economy-wide modelling is the identification of potential trade-offs: for instance, some general equilibrium analyses (such as those using the MAGNET model) have found that if household food waste is sharply reduced, the food production sector might contract, potentially affecting farmer incomes, a reminder that waste reduction, while socially beneficial, can redistribute economic activity (Philippidis et al., 2019). Such models underscore the importance of complementary measures (like redirecting surplus to bioeconomy uses) to mitigate any negative economic side-effects.

Beyond academic studies, IO approaches are also employed in policy. The European Commission's Impact Assessment for food waste targets considered indirect economic effects on upstream and downstream industries, using multiplier estimates (European Commission, 2023a). National and regional governments have commissioned IO-based analyses as well. For example, a Massachusetts (USA) study used an IMPLAN IO model to estimate the economic impact of a commercial food waste landfill ban – finding it would create jobs in recycling and composting sectors while minimally affecting the food industry overall (ICF, 2016; BioCycle, 2025). Similarly, a European study used a multi-regional IO scenario to evaluate energy and environmental savings if Europe meets SDG 12.3, highlighting significant reductions in energy use and GHG emissions at the continental scale (Osei-Owusu et al., 2023). These approaches help elevate the discussion from individual projects to the system-wide implications of tackling food waste.

Strengths: The chief strength of IO and SAM models is their comprehensiveness in scope. They capture the interconnected nature of the food system and economy, acknowledging, for example, that cutting food waste can free up resources (land, labour, capital) which then get used elsewhere, rather than simply "disappearing" from economic consideration. This allows for a balanced view of winners and losers. Policymakers gain insight into which sectors may need support (if demand for their output falls) and where new opportunities arise (e.g. in redistribution networks or valorisation industries) (Lekavičius et al., 2023). IO models are also particularly good at estimating employment impacts, which are a key policy concern. Reducing FLW might slightly reduce jobs in food production, but could create jobs in logistics, recycling, or IT (for waste tracking

apps), and IO analysis quantifies these net changes. Moreover, by adding environmental extensions (so-called EEIO models), analysts can link economic changes to changes in environmental outcomes (like carbon footprint or water footprint) on a broad scale (U.S. Environmental Protection Agency, 2025b). This is valuable for evaluating FLW strategies in terms of decoupling economic growth from environmental harm.

Limitations: One limitation is that IO models are typically linear and static, based on fixed coefficients of production and consumption. They generally do not account for price changes or behavioural responses (that is the realm of CGE models). Thus, an IO-based scenario might overestimate benefits by not considering, for example, that reduced food demand could lower food prices and induce some rebound consumption. More sophisticated CGE models can handle such market-mediated effects, but at the cost of greater complexity and data requirements. Another limitation is that IO models tend to work at an aggregate sector level. Food waste is not a single sector, it occurs in agriculture, manufacturing, retail, food service, households, hence analysts must introduce scenarios or shocks into multiple sectors. The resolution of what constitutes "food waste reduction" in IO terms can be tricky. For example, if households waste less, does the model reduce overall household expenditure on food? If so, the model reallocates that spending to other goods (perhaps increasing activity in other sectors). The assumptions behind these reallocations can influence results, and they should be made explicit (Lekavičius et al. (2023), for instance, assumed savings are spent on general goods, leading to modest positive GDP effects). Furthermore, IO models rely on accurate baseline data, which, for food waste flows specifically, is still improving in accuracy. As the EU and countries gather better FLW statistics (e.g. via Eurostat's new reporting), these models will become more reliable.

When to use: Economy-wide modelling is most useful for high-level policy analysis and for interventions expected to have significant upstream or macroeconomic impacts. For example, a national strategy to halve food waste will affect many sectors and stakeholders; an IO/CGE approach is warranted to capture all implications. On the other hand, a small-scale pilot at a single company would not need this treatment. In EU policy circles, these models complement micro-level CBAs: the micro analysis might show, for instance, a €1 investment yields €10 savings in a supermarket (private view), while the macro analysis shows negligible GDP impact but a potential small increase in employment (societal view). Both perspectives together provide a richer understanding. In summary, IO and related models broaden the lens of evaluation to include indirect economic effects and system dynamics. They remind us that FLW reduction is not just an environmental or ethical issue, but also an economic transition, one that can be managed to maximize co-benefits (like green jobs) and minimize disruptions if we plan using sound evidence.

Life-Cycle Costing (LCC) and Life-Cycle Assessment (LCA) Integration

Overview: Life-Cycle Costing (LCC) is an evaluation method that counts all costs associated with a product, service, or intervention over its entire life cycle. It is often used alongside Life-Cycle Assessment (LCA), which assesses environmental impacts over the life cycle. In the context of FLW interventions, LCC asks: *What are the costs incurred*

at each stage from implementation through end-of-life? and *How do they compare to the baseline scenario costs?* Unlike a basic CBA, which might focus on net benefits to one actor, LCC can be structured to include costs borne by different actors across the supply chain or lifecycle (it can even be expanded to societal LCC, including externalities in monetary terms, which overlaps with FCA). For example, consider an intervention like improved inventory management to reduce decomposition at a retailer. An LCC would include the retailer's upfront system costs, training costs, ongoing operational costs, and any cost shifts upstream (perhaps suppliers face different order patterns) and downstream (less waste disposal cost). If combined with LCA, one could also measure how environmental impacts (carbon, water, etc.) per functional unit change, providing a full sustainability profile. Essentially, LCC is a way to systematically account for costs across the same system boundaries that an LCA would use for impacts (Albizzati et al., 2021).

Applications: LCC has been applied to various food waste management and prevention options, frequently in research that aims to identify the optimal waste handling strategy. For instance, a study by Albizzati et al. (2021) performed a quantitative sustainability assessment of different food waste pathways in the EU, using a combination of LCA and societal LCC (SLCC). They evaluated 21 scenarios ranging from prevention and redistribution to composting and bioenergy, calculating environmental impacts and life-cycle costs (including external costs) for each. Their findings reinforced the waste hierarchy: prevention yielded the highest sustainability benefits, and after prevention, reuse (for human or animal feed) was the next best option, whereas some valorisation routes like biochemical production were less favourable when all impacts and costs were considered. Life-cycle costing in this study captured not only direct financial costs but also things like indirect subsidy costs or societal costs of emissions (hence "SLCC") (Albizzati et al., 2021). De Menna et al. (2018)'s review of LCC methods highlighted case studies where LCC was used to compare, say, the cost per tonne of food waste managed via anaerobic digestion vs. composting vs. landfill, often revealing that prevention has a much lower cost per tonne avoided when the avoided production costs are accounted for. Another example: a municipality might use LCC to justify investing in food waste prevention campaigns by showing that, over a 5-year period, the avoided collection and disposal costs (savings) exceed the program costs, even if the program itself does not generate revenue.

When integrated with LCA, this becomes a form of Life-Cycle Sustainability Assessment (LCSA), covering the triple bottom line. For example, the JRC's Food Waste Prevention Calculator effectively implements a simplified LCA+LCC: it asks users for inputs like the amount of food saved (so environmental savings can be calculated via LCA data) and the cost of implementing the action, then outputs both net environmental savings and net economic benefits (De Laurentiis et al., 2020). Such tools illustrate the practical use of life-cycle thinking in everyday decision-making, for example, a project manager can see if an initiative is not only reducing emissions but also saving money over its life cycle, or if there are trade-offs (e.g. an action might reduce waste but require a lot of energy, leading to costs or emissions that offset some benefits).

Strengths: Life-cycle approaches are excellent for avoiding the drawback of problem shifting. By looking at the whole system, LCC/LCA ensures an intervention is not simply pushing costs or impacts to another stage or stakeholder. For example, a packaging change might reduce consumer waste but increase production costs and environmental impacts from packaging materials, only a life-cycle approach would catch that and allow a balanced

decision (maybe the net effect is still positive, but it needs to be quantified) (De Laurentiis et al., 2020). LCC also helps in capturing long-term costs: some interventions might have higher upfront costs but lead to significant savings downstream. A straightforward annual budget analysis could miss this, whereas a life-cycle view (often using discounted cash flow) will show the intervention's true cost-effectiveness over time (De Menna et al., 2018). This is particularly relevant for infrastructure or technology investments in FLW reduction (like automated monitoring systems or new processing facilities) that have multi-year lifespans. Additionally, when combined with LCA, it provides a multi-criteria perspective, stakeholders can see both cost and environmental impact per unit of food waste reduced. This supports informed decision-making where trade-offs are explicit. For instance, one option might be cheaper but less climate-friendly, while another is costlier but yields big emissions reductions; decision-makers can then weigh budget vs. climate priorities transparently (Roy et al., 2023).

Limitations: One challenge with LCC is defining the scope and boundaries. If two alternatives have different functionality (e.g. prevention versus recycling yield different co-products or services), making them comparable requires careful functional unit definition. In FLW interventions, the functional unit often chosen is "per tonne of food waste avoided or treated," which works for many cases but can overlook qualitative differences (like nutritional value saved, or whether people were fed). Moreover, LCC results can be sensitive to the assumptions about future costs (energy prices, labour, etc.) and discount rates. A societal perspective might use a low discount rate for long-term effects, while a private company might use a higher rate, thus leading to different views of, for example, the value of future savings from prevention. It is important to clarify the perspective (private vs. public) in any LCC. Data intensity is another issue, as LCC requires cost data across the lifecycle, which might be proprietary or hard to get (e.g. farmers' costs, transport costs, etc., in different scenarios). Often studies have to use proxies or averages, which introduce uncertainty (Kitanovski et al., 2025). Lastly, while LCC captures costs, it does not inherently capture benefits unless those are framed as "negative costs" (savings). It also does not monetize externalities unless one deliberately includes them, which then essentially merges it with FCA. So, LCC by itself is often one component of a larger analysis.

Examples: LCC is particularly useful when evaluating alternative end-of-life or recycling options for food waste, or comparing prevention with downstream solutions. It is been used by city planners and waste companies to determine the cheapest and most sustainable way to handle unavoidable food waste (e.g. compare the LCC of building an anaerobic digester versus expanding composting facilities, including the capital and operating costs and the byproduct revenues) (Roy et al., 2023). It is also used in project proposals for funding, an EU project might be required to present an LCC showing that a new valorisation process for food waste is economically viable over its lifetime, not just environmentally beneficial. By combining LCC and LCA, one can produce a single integrated report that speaks to economists, engineers, and environmental scientists alike. This integration is evident in tools like the REFRESH project's *FORKLIFT* valuation tool, which allowed users to explore environmental and economic outcomes of different valorisation strategies (REFRESH, 2018).

In conclusion, LCC adds a dynamic, temporally and spatially broad viewpoint to socio-economic evaluation. When leveraged together with environmental assessment, it

helps ensure FLW interventions are truly sustainable, delivering net benefits over their full lifespan and avoiding unintended consequences at other stages of the food system.

Hybrid Frameworks and Multi-Criteria Decision Analysis

Many complex decisions on FLW interventions cannot be made on a single metric alone. Hybrid evaluation frameworks combine multiple methods or criteria to provide a more nuanced assessment. This can include Multi-Criteria Decision Analysis (MCDA) where a set of economic, environmental, and social indicators are evaluated together (sometimes with weighting), or adapted frameworks that integrate qualitative and quantitative evaluation. In the European policy context, there has been a move towards such integrated assessments. The EU Platform on Food Losses and Food Waste, for example, developed recommendations for evaluating food waste prevention initiatives that include criteria like effectiveness (amount reduced), efficiency (cost per amount), environmental benefit, social benefit, scalability, and sustainability over time (Caldeira et al., 2019). Garcia-Herrero et al. (2023) proposed a comprehensive framework for consumer food waste intervention evaluation that considers: intervention design quality, effectiveness (waste reduction achieved), efficiency (including cost-effectiveness), wider systemic effects, sustainability over time, and transferability. Such frameworks go beyond pure economics to capture behavioural and institutional factors (e.g. is the intervention easy to replicate elsewhere? Does it have lasting effects or only short-term?). While these criteria are sometimes scored qualitatively, they can incorporate quantitative measures like cost per kg avoided (efficiency) or tons waste reduced (effectiveness) alongside softer measures.

MCDA specifically has been used in FLW strategy selection. For instance, the study by Lekavičius et al. (2023) mentioned earlier not only modelled scenarios but also performed a multicriteria analysis ranking scenarios on both economic (GDP, employment) and environmental outcomes. This showed that reducing waste in food service was most balanced in delivering economic gains and pollution reduction, guiding policymakers to perhaps focus efforts there. Another example of MCDA in practice: A city considering various FLW initiatives (public awareness campaign, food donation program, waste-to-energy facility) might evaluate each against criteria such as cost, waste reduction potential, public acceptance, regulatory feasibility, and environmental impact. Each criterion can be given a weight (reflecting priorities, e.g. perhaps environmental impact and waste reduction are rated highest). The options are then scored and a composite score calculated to identify which option best meets the city's objectives. This approach was reflected in some local waste management plans in Europe, where stakeholders engaged in ranking exercises to decide on interventions with the help of MCDA software.

Hybrid economic-environmental models are another form of integration. One such approach is combining Economic Input-Output models with LCA (EIO-LCA) to estimate upstream environmental impacts of economic changes. While not specific to FLW, an EIO-LCA tool could, for example, estimate how a reduction in food sector output (due to waste cuts) translates into environmental savings economy-wide. Another hybrid is the use of Social Return on Investment (SROI) analysis for food waste projects, which assigns monetary values to social and environmental outcomes (much like FCA) and computes a

ratio of total value to investment. SROI has been applied to food redistribution programs: by monetizing social outcomes (meals for people in need, volunteer skill development) and environmental outcomes (emissions avoided via redistribution), one can claim a societal return like "€X of social value created per €1 spent." This is compelling for charities and funders. For example, an SROI analysis of a UK surplus food redistribution network found a return on investment of approximately 5:1 when considering the social value of nutrition provided and emissions averted (Nicholas et al., 2025). Such analyses, while requiring many assumptions, help communicate the full impact of an intervention to stakeholders who care about more than just financial gains.

Strengths: They provide a balanced evaluation that acknowledges multiple goals. FLW reduction is not purely an economic exercise; it is about environmental sustainability, food security, and social well-being too. Hybrid frameworks ensure that a narrow focus (e.g. cost per ton) does not lead to perverse choices (like ignoring an option that slightly costs more but yields huge social benefits). They are especially useful in participatory decision-making, allowing different stakeholders (government, industry, NGOs, community) to see their concerns addressed in the criteria and to find common ground. Moreover, integrated approaches can identify win-win solutions or acceptable trade-offs. For instance, MCDA might reveal that an option is second-best on both cost and environmental impact, but by far the best on social acceptance, perhaps making it the overall preferred compromise.

Limitations: The more criteria and methods one combines the more complex the analysis and the more expertise and data required. MCDA outcomes can be sensitive to the weighting scheme, which might be subjective, transparency and stakeholder input in setting weights is critical to maintain legitimacy. There is also a risk of information overload, since presenting too many indicators can confuse decision-makers. Thus, often a hybrid framework will convert findings into an easy format (like a dashboard or a single index) at the end, but that in itself requires careful normalization and can obscure detail. Ensuring consistency is another issue, as economic and environmental models might not align perfectly (e.g. system boundaries or assumptions differ). A lot of effort in integrated assessment goes into harmonizing these pieces. The JRC's framework, for example, had to align data collection templates so that reported outcomes from interventions could feed into both cost analysis and environmental analysis uniformly (De Laurentiis et al., 2020). Finally, not all outcomes are quantifiable, some might be qualitative (like "improved stakeholder collaboration" as a systemic effect). These must be evaluated in a narrative or ordinal way, which can feel less rigorous. Nonetheless, including them is important for a full picture.

Examples: Europe has been moving toward such integrated evaluations. The Better Regulation Toolbox explicitly encourages assessments of economic, social, and environmental impacts in unison for any major policy proposal (European Commission, 2023b). In the FLW realm, this means that when the European Commission proposed binding food waste reduction targets in 2023, the impact assessment considered not just compliance costs to businesses but also social impacts (e.g. potential job shifts, effects on food donation) and environmental gains (emissions, water) (European Commission, 2023a). Likewise, national strategies often use a suite of indicators to track progress, economic savings, tonnage reductions, hunger alleviation, etc., reflecting a hybrid mindset.

Comparative Analysis of Evaluation Methods

The summary of comparative insights of the discussed methods is presented in Table 1. Each method offers a distinct lens on FLW interventions, and they are often complementary. Using multiple methods in tandem can yield a robust evaluation: for example, performing a CBA to get financial metrics, an LCA to get environmental metrics, then using MCDA to weigh them along with social considerations. The ultimate aim is to ensure that decisions on how to reduce food waste are evidence-based, context-appropriate, and aligned with broader sustainability values (De Laurentiis et al., 2020). There is no one-size-fits-all method, the choice depends on the question being asked (micro or macro? financial or multi-faceted?) and the audience for the results (investors, policymakers, public). The European research and policy community, through efforts like the REFRESH and FUSIONS projects and the EU FLW Platform, has made significant strides in mapping these methods and developing guidance on their use (REFRESH, 2018; United Nations DESA, 2025). The following table synthesizes key characteristics to aid in method selection for future FLW evaluation needs.

Each method has a distinct focus, from purely financial metrics to integrated sustainability criteria. Often, multiple methods are used in combination – for example, a project might undergo a CBA for financial feasibility, an LCA for environmental impact, and then an MCDA that includes both results plus social considerations. Selecting the right tool (or mix of tools) depends on the decision context, scale of intervention, and stakeholder needs. Policy frameworks increasingly call for combining these approaches to ensure that no important impact is overlooked (De Laurentiis et al., 2020; Garcia-Herrero et al., 2023).

To illustrate conceptually how multiple evaluation methods may be combined in practice, consider a supermarket intervention based on improved inventory management and surplus food redistribution. In a first step, CBA can be used to assess direct financial effects, including implementation costs, savings from reduced disposal, and the value of avoided product losses. In a second step, LCA/LCC may be applied to estimate life-cycle environmental savings and longer-term cost implications, including avoided greenhouse gas emissions, water use, and resource depletion associated with food production that no longer becomes waste. In a third step, MCDA can integrate these economic and environmental results with additional social and operational criteria, such as food donation outcomes, stakeholder acceptability, and implementation feasibility. In this way, the intervention can be assessed not only in terms of private financial efficiency, but also in relation to broader sustainability performance and decision-making relevance.

Table 1. Comparison of Evaluation Methods for FLW Interventions

Method	**Scope & Focus**	**Key Metrics/ Outputs**	**Data Requirements**	**Strengths**	**Limitations**
Cost-Benefit Analysis (CBA)	• Project or program level • Economic (financial) focus • Single-actor perspective (firm or public agency).	• BCR • NPV • Internal Rate of Return (IRR) (monetary terms)	• Costs of intervention • Monetary value of benefits (e.g. waste disposal cost saved, food saved * price) • Discount rate for NPV	• Clear yes/ no financial viability criterion (BCR>1) • Easy to communicate • Widely understood by decision-makers • Uses familiar monetary units, facilitating comparison across different options	• Does not automatically include externalities (unless monetized separately) • Can undervalue interventions with big environmental/ social benefits but modest financial returns. • Results sensitive to assumptions (e.g. benefit valuation, time horizon). • Usually static, and single-figure outcome may mask distributional effects.
Full-Cost Accounting (FCA)	• Broad societal perspective • accounts for external environmental and social costs/ benefits as well as direct financial ones • Can be applied at project or system level.	• "True cost" or net societal benefit in monetary terms (includes e.g. monetized carbon emissions, pollution, health impacts) • Sometimes expressed as expanded BCR including external value	• All data from CBA + estimates of external impacts (emission quantities, environmental damage costs per unit, social impact valuations) • Often requires LCA data and economic valuation coefficients.	• Holistic: captures the full societal value of an intervention, aligning with sustainability goals • Reveals hidden costs of inaction (food waste) or hidden benefits of action, strengthening the case for preventive measures • Can justify policy support if private and social returns diverge	• Monetization of externalities can be controversial or uncertain (results depend on carbon price chosen, etc.) • Data- and analysis-intensive; requires interdisciplinary inputs • May be less intuitive to stakeholders if not familiar with environmental economics • Risk of double-counting or inconsistency if not carefully done (boundary issues)

Input-Output / Economy-Wide Models (e.g. IO, SAM, CGE models)	• Macro or sectoral level • Captures indirect and induced effects across the economy • Looks at inter-sector linkages and possibly price/market adjustments (in CGE) • Can be national or multi-regional.	• Changes in GDP, employment, sector outputs, trade balances, etc. • Possibly changes in aggregate environmental indicators if linked (e.g. total emissions). • Often scenario-based ("with vs without intervention").	• Baseline IO or SAM tables • Data on how the FLW intervention translates into shocks (e.g. reduced final demand for food, increased spending elsewhere). • For CGE: elasticities, behavioural parameters.	• System-wide perspective: identifies economy-wide gains or losses and distribution across sectors • Can uncover trade-offs (e.g. reduced production in one sector vs. growth in another) • Captures employment effects and other policy-relevant macro indicators • With extensions, integrates environmental footprint analysis on a large scale.	• Aggregate: less detail on specific projects, more on overall trends. Not suitable for micro evaluation. • IO assumes fixed coefficients (CGE relaxes this but is complex). • Data may be outdated or coarse (food waste not always explicitly modelled, it is an implicit reduction in demand). • Requires expertise to run and interpret • Results can be abstract for untrained stakeholders.
Life-Cycle Costing (LCC) (often alongside LCA)	• Life-cycle system perspective (cradle-to-grave for a product, or end-to-end for a process) • Focus on costs incurred by all processes/stages in the system, over time • In societal LCC, includes external costs • In conventional LCC, just costs to defined actors	• Total cost over life cycle (often expressed per functional unit, e.g. per tonne of food waste managed or prevented) • Breakdown of costs by life-cycle stage. • If paired with LCA: environmental impact indicators (CO_2 eq, water use, etc.) for the same functional unit.	• Detailed process data: capital costs, operating & maintenance costs at each stage • Depreciation periods • Disposal costs or residual values • If dynamic, need discount rate • LCA data for environmental impacts per stage (if integrated assessment).	• Prevents problem-shifting: ensures an intervention's impacts/ costs aren't simply moved elsewhere unseen • Long-term view: captures full lifespan costs, supporting sustainable financial planning • When combined with LCA, provides a robust multi-dimensional picture (both cost and environmental impact per unit outcome) • Useful for comparing waste management alternatives on equal footing (e.g. cost per tonne for landfill vs. AD vs. composting vs. prevention).	• Data intensive: requires granular data which may be hard to get (especially for new processes or informal processes like donation) • Can be complex to communicate, especially if both cost and multiple impact results are presented • Results may vary with system boundary choices (e.g. whether to credit avoided product production in prevention scenarios) • Does not inherently prioritize, multiple indicators need interpretation (hence often fed into MCDA).

Hybrid / Integrated Frameworks (e.g. MCDA, custom scoring frameworks, SROI)	• Combination of dimensions: economic, environmental, social, technical feasibility, etc. • Can be at project, program, or policy level. • Often involves stakeholder input for criteria weighting.	• Depends on framework: could be a composite index or ranking • In MCDA, a score for each option against each criterion and an overall weighted score. • In SROI, a monetized "social return" ratio (e.g. € value created per € invested). • In qualitative frameworks, narrative evaluations for each criterion.	• Requires a broad set of data: economic (costs, savings), environmental (emissions, etc.), social (e.g. number of people reached or qualitative ratings of acceptance), plus expert/ stakeholder judgments for scoring or weighting. • SROI needs outcomes and proxies to monetize them.	• Comprehensive and flexible: can incorporate any factor of importance, thus reflecting real-world decision criteria (not just financial efficiency) • Encourages stakeholder engagement, making the basis of decisions transparent and inclusive (especially with MCDA workshops) • Can reveal balanced solutions and facilitate trade-off discussions (e.g. option that is moderate on all criteria vs. one great economically but poor socially). • SROI and similar approaches communicate social impact in monetary terms, resonating with funders and policymakers by speaking in ROI language albeit social.	• Subjectivity in weighting and scoring, hence results can be contested if stakeholders disagree on importance of criteria. • Requires careful design to avoid bias (e.g. double-counting a benefit in multiple criteria). • May be complex to execute and interpret if many criteria. • Can lead to oversimplification (index) or overwhelm (too many numbers). • SROI monetization faces similar challenges to FCA (assigning € to volunteer time, carbon, etc.) and can be sensitive to those proxy values.

Source: Authors

Conclusions and Recommendations

The FLW challenge demands not only innovative solutions on the ground, but also rigorous ways to measure and compare the outcomes of those solutions. This paper has surveyed the main socio-economic evaluation methods currently used to assess FLW prevention and valorisation initiatives, highlighting their relevance in research and European policy contexts. A clear finding is that no single method can provide a full picture. Instead, a toolkit of approaches is needed, and their judicious application will yield the most credible and useful insights. Encouragingly, a convergence is observed in recent years: economists, environmental scientists, and social experts are working together more closely to evaluate FLW interventions, resulting in more holistic studies

and policy assessments (De Laurentiis et al., 2020). For example, European projects like REFRESH and national programs in France, Italy, and elsewhere have developed evaluation guidelines that blend cost-effectiveness analysis with environmental assessment and social impact criteria (REFRESH, 2018; Garcia-Herrero et al., 2023). The European Commission's own analyses for new waste legislation exemplify integrated assessment, ensuring that proposed measures (like setting EU-wide food waste reduction targets) are backed by evidence on economic feasibility, social acceptability, and environmental benefit (Lekavičius et al., 2023; United Nations DESA, 2025).

Key recommendations are as follows:

First, match the method to the question. If the primary concern is financial viability for an investor or company, CBA (possibly extended to ROI or payback period calculations) will be the central tool. If the question is societal value, then FCA or SROI frameworks should be applied, to account for external benefits. For policy choices involving trade-offs, MCDA or hybrid scoring can be invaluable. One size does not fit all, thus evaluators should be clear on whose perspective is being analysed (private vs public, micro vs macro) and choose methods accordingly. It is often useful to perform both a private CBA and a societal CBA (i.e. FCA) to highlight differences, as Champions 12.3 (2017) did by noting private ROI alongside broader benefits.

Second, leverage life-cycle and systems thinking. FLW interventions often have cross-cutting impacts (e.g. upstream production resources, downstream waste). LCA and costing approaches should be more widely adopted so that we do not unintentionally shift burdens. For instance, a policy to convert food waste to animal feed might seem great in a simple analysis (divert waste from landfill), but an LCA/LCC might show high energy use or costs in processing that negate some benefits. European research institutions (like JRC) have provided tools and data to facilitate this – the Environmental Footprint method and the Food Waste prevention calculator are readily available resources to incorporate life-cycle data into evaluations (De Laurentiis et al., 2020). Practitioners are encouraged to use these tools, as they simplify complex LCA/LCC calculations into user-friendly formats, ensuring even smaller organizations can do a simple integrated analysis.

Third, improve data and fill methodological gaps. One recurring challenge noted is data quality, especially on the amounts of FLW prevented and the costs associated with interventions (many of which are not published due to commercial sensitivity). Continued efforts to build databases of intervention outcomes (perhaps through the EU FLW Platform or academic repositories) would aid future evaluations. Methodologically, standardizing certain assumptions can improve comparability, for example, having a common assumed social cost of carbon for European analyses, or using a standard set of commodity prices for food waste economic value (as done in some studies using FAO or Eurostat data). The EU FUSIONS project's work in estimating EU food waste levels with a consistent approach (De Laurentiis et al., 2020) and the more recent EU Consumer Food Waste Forum outcomes on evaluation frameworks (Garcia-Herrero et al., 2023) are steps in this direction. Yet, gaps remain, for instance, how to evaluate behavioural interventions that do not lend themselves to simple tonnage or cost metrics. Developing proxies for "behaviour change benefit" or longitudinal study designs to capture lasting impact are areas needing attention (as highlighted by Stöckli et al. (2018), and Reynolds et al. (2019)). Methodological innovation should continue, perhaps learning from public health and education sectors on evaluating awareness campaigns and habit changes.

Fourth, focus on European context and policy integration. For European stakeholders, it is crucial that evaluation methods align with EU policy frameworks. This means incorporating social and environmental dimensions in addition to economics, reflecting EU priorities like the Green Deal and Climate Law. It also means providing evidence in a form useful for Better Regulation processes, i.e. clear, quantified impacts on key indicators. European research can lead by tailoring general methods to food waste specifics: for example, updating input-output models to include a food waste sector or parameter, or enhancing CGE models to simulate food waste reduction explicitly (some CGE models like MAGNET have started exploring this (Garcia-Herrero et al., 2023)). Additionally, the EU and national governments should continue funding studies that demonstrate the co-benefits of FLW reduction (like how it contributes to climate targets, resource efficiency, and even economic resilience, as less waste can mean less dependence on imports, etc.). The systemic nature of FLW means it links to agriculture, environment, social policy, and beyond, so evaluation approaches should ideally capture these linkages to inform cross-cutting policy development.

Although this review is situated primarily within the European policy and research context, the methodological insights are transferable beyond Europe. The core evaluation challenges associated with FLW interventions, including the need to balance financial feasibility, environmental externalities, social outcomes, and system-wide effects, are also highly relevant in low- and middle-income countries as well as in other developed economies. However, transferability requires sensitivity to contextual differences in data availability, institutional capacity, supply-chain structure, informal food distribution systems, and policy priorities. In high-income settings, integrated approaches may be applied through advanced datasets and formal policy appraisal frameworks, whereas in resource-constrained contexts, simplified combinations of CBA, basic environmental indicators, and qualitative multi-criteria assessment may provide a more feasible evaluation pathway. Therefore, the framework proposed in this paper should be understood as adaptable rather than region-specific.

Fifth, communicate findings effectively. Even the best analysis is only as good as how its insights are communicated to decision-makers. The narrative around FLW interventions should emphasize the multiple wins documented by comprehensive evaluation. Namely, investments in food waste prevention programs yield direct savings for businesses and households, avoid tonnes of CO_2 emissions contributing to climate benefits, increase jobs in the local economy, and strengthen food security. The EU statistics on 88 million tonnes waste, which is equal to €143 billion cost, are often cited in policy debates (Champions 12.3, 2017), ensuring these figures are up-to-date and grounded in sound evaluation reinforces the urgency to act and guides where action is most needed.

In conclusion, advancing the fight against FLW will require parallel advances in how we evaluate progress. By using the full arsenal of socio-economic methods, from CBA to LCA to multi-criteria frameworks, a 360-degree view of interventions' impacts can be obtained. This structured, evidence-based approach will help identify the most effective strategies for different contexts (be it a household education campaign in a city or a supply-chain optimization by a major food company) and ensure that resources are directed toward solutions that offer the greatest overall benefit for Europe's economy, society, and environment. The findings of this paper underscore that many FLW initiatives are not just good for the planet, but sound investments with paybacks on multiple levels (Champions

12.3, 2017; ReFED, 2016). As EU member states and businesses rise efforts to meet SDG 12.3 and forthcoming EU targets, rigorous evaluation will be an indispensable tool, one that transforms unreliable success stories into quantifiable, comparable results and thereby accelerates the adoption of best practices across Europe. By institutionalizing the use of these evaluation methods in project and policy cycles, we can move towards a future where preventing food waste is not only seen as the right thing to do, but also the economically and socially prudent thing to do. In sum, better evaluation will enable better decision-making, which in turn will drive better outcomes in our collective efforts to reduce FLW.

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