Annals of the Academy of Romanian Scientists
Series on Agriculture, Silviculture and Veterinary Medicine
ISSN 2344-2085 Volume **15**, Number **1**/**2026**

ASSESSMENT OF THE CARBON FOOTPRINT OF DIETARY HABITS AMONG FOOD SCIENCE STUDENTS USING THE DIGITAL FOOD SUSTAINABILITY TOOL (FST): A PILOT STUDY ON A ROMANIAN COHORT

Liviu GACEU[1], Oana Bianca OPREA[2], Romulus GRUIA[3]

Abstract. *Food systems account for approximately 20–30% of global greenhouse gas (GHG) emissions, with animal-based foods representing the dominant share. The transition towards more sustainable diets is one of the most effective individual-level strategies for reducing the carbon footprint. The Food Sustainability Tool (FST), an open-access digital instrument developed within the European FoodCLIC project, calculates the GHG emissions of current dietary habits and simulates the effect of dietary change, food-waste reduction and short supply chains. This pilot study, conducted in March–April 2026 on 88 food-science students, used the FST Advanced Version as a self-assessment instrument. Of the 88 submissions, 43 (48.9%) contained machine-readable text, and the quantitative analysis covered 39 complete records. Results were strongly polarised: 56.4% of students (n = 22) made no dietary change (0% reduction), while 43.6% (n = 17) selected scenarios with a positive climate impact. The mean reduction across all records with data was 7.6%, and 17.4% among those who chose to change (range 1–75%). The advanced modules (waste, transport) were activated by 97.7% of participants. The study demonstrates the feasibility and pedagogical value of the FST while revealing an intention–behaviour gap in sustainable eating.*

Keywords: *food sustainability; carbon footprint; greenhouse gas emissions; dietary behaviour; nutrition education; FoodCLIC; Food Sustainability Tool; students.*

DOI [10.56082/annalsarsciagr.2026.1.115](https://doi.org/10.56082/annalsarsciagr.2026.1.115)

[1]Prof. PhD. Hab. Eng., Researcher, Transilvania University of Brașov, Faculty of Food and Tourism, Romania, Corresponding Member Academy of Romanian Scientists, E-mail: gaceul@untbv.ro
[2]Lecturer Ph.D. Transilvania University of Brașov, Faculty of Food and Tourism, Romania, E-mail: oprea.oana.bianca@unitbv.ro
[3] Prof. PhD. Eng. Transilvania University of Brașov, Faculty of Food and Tourism, Romania, CSCBAS&CE-MONT Centre/Ince-Romanian Academy, Full member of Academy of Romanian Scientists, Associate member of Academy of Agricultural and Forestry Sciences “Gheorghe Ionescu-Sisesti, Bucharest, Romania, E-mail: ecotec@unitbv.ro

1. Introduction

Climate change is one of the most pressing challenges of the 21st century, and the global food system lies at the heart of this debate, both as a causal factor and as a domain with major potential for solutions. The production, processing, distribution, consumption and waste management of food contribute, according to recent estimates, approximately 20–30% of total anthropogenic greenhouse gas (GHG) emissions [3, 24].

A comprehensive analysis of the EDGAR-FOOD database quantified the food system's share of global emissions at about 34% for 2015, highlighting that a significant proportion stems from agricultural production and land-use change [24]. Within this picture, animal-based foods – particularly ruminant meat and dairy products – generate a disproportionately large carbon footprint relative to their nutritional and caloric contribution [18].

Against this background, the individual diet has become a recognised point of leverage for reducing emissions. Landmark studies have shown that shifting towards predominantly plant-based dietary patterns can reduce the dietary carbon footprint by 30–70% while maintaining nutritional adequacy [18, 17, 11]. The EAT–Lancet Commission report proposed a "planetary health reference diet" capable of reconciling human-health goals with the biophysical limits of the planet [27]. Nevertheless, translating this scientific knowledge into concrete changes in eating behaviour remains difficult, a phenomenon documented in the literature as the "intention–behaviour gap" [1, 20].

An increasingly important role in narrowing this gap is played by digital carbon-footprint calculators and interactive dietary-simulation platforms. These transform complex scientific data into personalised, visual and actionable feedback, supporting both awareness and experiential learning [13, 26]. In the context of higher education for sustainability, such tools offer the opportunity to combine curricular content with reflection on one's own behaviour, contributing to the training of future professionals of the agri-food system.

The present work falls within this framework and draws on a specific digital instrument – the Food Sustainability Tool (FST) – developed within the European FoodCLIC project. The main objective of the study is to assess the carbon footprint of dietary habits and the readiness for change among students in food-science programmes at a Romanian university, using the FST as a self-assessment instrument. The secondary objectives are: (i) to characterise students' engagement in exploring the extended dimensions of sustainability (food waste, transport, local supply chain); (ii) to evaluate the technical feasibility of collecting and automatically processing the data generated by the tool; and (iii) to discuss the pedagogical value of integrating the FST into university curricula.

The relevance of the topic is amplified by the profile of the study participants. Food-science students represent a strategic category: as future specialists – product engineers, technologists, food-safety and quality experts, or nutritionists – they will influence, through their professional decisions, both the food supply and the messages conveyed to consumers. Assessing how this population relates to the sustainability of its own diet therefore provides valuable insight into the effectiveness of sustainability education and into the barriers that persist even in the presence of specialised knowledge.

State of the art

Carbon footprint of food systems and diets

The environmental impact of foods is quantified predominantly through Life Cycle Assessment (LCA), which aggregates the emissions generated along the "farm-to-fork" chain. The meta-analysis by Poore and Nemecek [18], synthesising data from around 38,000 farms in 119 countries, revealed enormous variability of impact within the same product category, but also systematic differences between food groups: producing one kilogram of beef generates, on average, tens of times more emissions than producing legumes or cereals. The central conclusion of this research is that the choice of food type often matters more than the production method of the same food.

At the aggregate level, the EDGAR-FOOD database [24] allowed, for the first time, a systematic decomposition of food-system emissions by stage, gas and region, confirming that in high-income countries the consumption and waste-management stages account for a growing share. This observation justifies the integrated approach of the FST, which is not limited to the emissions associated with consumption itself but also includes dedicated modules for food waste and transport.

In the European and national context, food-consumption data indicate a persistent gap relative to the patterns recommended by a sustainable diet: an intake of animal protein above physiological needs, an insufficient consumption of legumes, fruits and vegetables, and a high share of ultra-processed products. These patterns have dual implications, for both public health and the environment, since exactly the over-represented food groups are also those with a high carbon footprint [23, 10]. Garnett's synthesis [9] emphasises that the major opportunities for reducing emissions in the food system lie both in production and in consumption, and that acting on demand – by changing dietary structure – is complementary to technological efforts on the supply side. For a young, educated population at the beginning of its dietary autonomy, such as students, the window of opportunity for consolidating sustainable habits is particularly relevant, because preferences formed at this stage tend to persist throughout adult life.

Sustainable diets and co-benefits for health

The Food and Agriculture Organization (FAO) defined sustainable diets as “diets with low environmental impacts which contribute to food and nutrition security and to healthy life for present and future generations” [4]. Numerous European studies have demonstrated substantial co-benefits: more sustainable diets tend to be, at the same time, healthier and, in many cases, more economically affordable [17, 11, 21]. The comparative analysis by Irz and colleagues [11] across several European countries showed that the dietary changes needed to improve sustainability are not identical from one country to another, which underlines the importance of national contextualisation – a feature built into the FST through the selection of a reference country.

At the same time, research on reducing dietary emissions [17] draws attention to an important limit: beyond a certain threshold, further reductions in the carbon footprint may conflict with the nutritional adequacy, affordability and cultural acceptability of the diet. This fine balance is relevant for interpreting the results obtained through the FST, since scenarios with very large reductions must be critically evaluated from a nutritional perspective.

Food waste and short supply chains

Food waste is a major and avoidable source of emissions: it is estimated that approximately one third of the food produced globally is lost or wasted, with a considerable associated climate impact [5, 22]. At the level of the European Union, the FUSIONS study estimated waste of around 88 million tonnes per year, with households representing the main source [22]. Reducing waste at the individual and household level therefore constitutes a lever complementary to dietary change, which is why the FST includes a module dedicated to this dimension.

Regarding the transport and provenance of foods, the literature offers a nuanced picture. Although the concept of “food miles” popularised the idea of local consumption, life-cycle analyses show that transport represents, on average, a relatively small fraction of the total footprint of most foods, except for air-freighted products [18, 25]. Short supply chains remain valuable, however, through co-benefits such as supporting the local economy, freshness and reduced packaging, aspects that the FST can highlight through its transport module and local-supply-chain option.

Digital tools for sustainability education

Carbon-footprint calculators and dietary-simulation applications have proliferated over the past decade, both as public-awareness instruments and as educational resources. Critical evaluations of these tools [13, 26] emphasise that their effectiveness depends on methodological transparency, the quality of the underlying data, and the capacity to provide personalised and actionable feedback. Unlike the mere provision of information, interactive tools that allow the simulation of "what-if" scenarios draw on the principles of experiential learning, increasing the user's cognitive and emotional engagement [26].

Nevertheless, evidence on the long-term effect of these tools on actual behaviour remains limited. The awareness generated by digital feedback does not automatically translate into durable behavioural change, consistent with theoretical models of planned behaviour [1] and with the synthesis on the intention–behaviour gap [20]. The present study contributes to this literature by examining how students with specialised training in the food domain respond to such a tool.

A further distinction emphasised in the literature concerns the difference between feedback that is merely descriptive and feedback that is prescriptive and goal-oriented. Descriptive feedback informs the user about the magnitude of their impact, whereas goal-oriented feedback also suggests concrete pathways for improvement and allows progress to be tracked over time. Interactive simulation tools occupy an intermediate position: by enabling users to test alternative scenarios, they make the consequences of different choices visible and thus combine informational and motivational functions. The Food Sustainability Tool belongs to this latter category, since it not only reports current emissions but also quantifies the effect of user-defined changes, an architecture particularly suited to educational use.

The FoodCLIC project and the Food Sustainability Tool

FoodCLIC is a project funded by the European Union (Horizon Europe programme), running from September 2022 to February 2027, whose acronym summarises the objective of developing integrated urban food policies through sustainability Co-benefits, spatial Linkages (L), social Inclusion (I) and sectoral Connections (C). The project brings together eight European city-regions – including the Brașov municipal area in Romania – alongside universities, local authorities and civil-society organisations, aiming to transform urban food environments and systems towards healthier, fairer and more sustainable models [6, 7].

Within its decision-support activities, the FoodCLIC consortium developed the Food Sustainability Tool (FST), an interactive, open-access digital platform available at foodsustainabilitytool.eu. The instrument calculates the GHG emissions associated with the user's current dietary habits and allows the simulation of the impact of various changes – modifying the dietary structure by food group, reducing waste, and adopting a local supply chain – expressing the result as a percentage reduction relative to the baseline scenario [6, 8]. Through the intuitive equivalences it offers (for example, the number of trees needed to offset emissions or the kilometres avoided), the FST translates abstract sustainability concepts into accessible language, making it suitable for both the general public and educational contexts. This dual character – decision tool and pedagogical resource – underpins its use in the present study.

2. Materials and methods

2.1. Study design and participants

Saccharina Latissima is a valuable The study was designed as a cross-sectional, exploratory, pilot investigation, carried out in March–April 2026. The sample consisted of 88 students enrolled in undergraduate programmes in the field of food science and engineering (study groups IMIT, IMAPA, CEPA and DTI). Participation was of a didactic and voluntary nature, the activity being integrated into a seminar task on food sustainability. Since the study used exclusively aggregated and anonymised data generated by a publicly available instrument, and did not collect sensitive health data, the ethical risks were minimal; participants were informed of the didactic and research purpose of the activity.

2.2. Description of the FST instrument (Advanced Version)

The Advanced Version (Questionnaire 2) of the Food Sustainability Tool platform was used. Each student entered their own daily food consumption for seven food groups: (1) cereals and starchy products; (2) vegetables and fruits; (3) legumes and nuts; (4) animal proteins; (5) plant-based fats; (6) added sugars; and (7) beverages. The student selected Romania as the reference country, which adjusts the emission factors and calculation parameters to the national context. In addition, the tool requested the number of days per week on which the participant prepares meals and the number of persons for whom they cook, parameters that allow the impact to be extrapolated at household level.

The Advanced Version offers three optional extended-analysis modules: (i) the food-waste module, which estimates the emissions avoidable by reducing losses; (ii) the road-transport module, which assesses the impact of transport distance; and (iii) the local-supply-chain option (for example, “Brașov local” or “Local Europe”). Based on the data entered, the instrument automatically calculates the total annual GHG emissions (kg CO_2/year) for the current diet and for any alternative scenario selected by the user, expressing the final result as a percentage reduction, alongside illustrative equivalences.

2.3. Data-collection protocol

Each student completed the online questionnaire individually and saved the final result as a screenshot or PDF file, which was subsequently submitted to the coordinating teacher. The documents thus collected constituted the primary database of the study. This collection method, although flexible and easy to implement didactically, generated significant heterogeneity in file formats, with direct implications for the capacity for automatic processing, as detailed in the following section.

2.4. Data extraction and processing

The documents received were classified into three categories according to the possibility of automatic data extraction: (a) PDF files with machine-readable text, from which the values could be extracted algorithmically; (b) PDF files resulting from scanning or photographing the screen, which contained only images and would have required optical character recognition (OCR); and (c) actual images (.png, .jpg). For category (a), an automatic extraction procedure was applied for the indicators of interest (percentage reduction, days/week, number of persons, module activation, supply chain, current and post-change emissions). For categories (b) and (c), processing was limited to the descriptive level in the present study, with detailed data not being automatically extracted.

Of the total 88 submissions, 43 (48.9%) belonged to the machine-readable category, 42 (47.7%) were scanned PDF files, and 3 (3.4%) were images. The composition of the dataset by file type is presented in Figure 1. The quantitative analysis of the emission-reduction indicators covered the 39 records (out of the 43 with text) for which the percentage reduction value could be precisely determined.

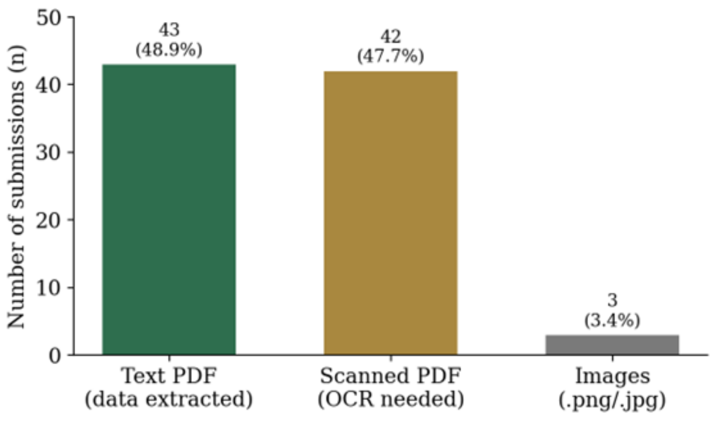

Fig. 1. Composition by file type of the 88 submissions collected via the Food Sustainability Tool, with the share of each category.

The extraction procedure followed the principles of reproducibility: for each machine-readable document, the indicators of interest were identified on the basis of the standardised labels generated by the instrument (percentage reduction, household parameters, module status and emission values), and the results were consolidated into a single table, manually spot-checked to detect any parsing errors. This semi-automatic approach combines the efficiency of algorithmic processing with the quality control specific to rigorous research. The main limitation of the method remains its dependence on the export format chosen by each participant, which led to the exclusion from quantitative analysis of documents available only as images and which underpins the standardisation recommendation formulated in the discussion section.

3. Results and discussions

3.1. General characteristics of the sample

A summary of the main indicators extracted from the FST questionnaires is presented in Table 1. Of the 88 submissions, 43 allowed data extraction, and 39 provided complete values for emission reduction. The high activation rate of the advanced modules – 42 out of 43 students with data (97.7%) for both waste and transport – indicates a substantial level of engagement in exploring the extended dimensions of sustainability.

Table 1. Summary of the indicators extracted from the FST questionnaires.

Indicator	**Value**
Total submissions collected	88
Submissions with machine-readable text (data extracted)	43 (48.9%)
Scanned PDF files	42 (47.7%)
Images (.png / .jpg)	3 (3.4%)
Records with a determined reduction value	39
Students with 0% reduction (no change)	22 (56.4%)
Students with >0% reduction	17 (43.6%)
Mean reduction – full sample with data (n = 39)	7.6%
Mean reduction – students who chose change (n = 17)	17.4%
Maximum reduction recorded	75%
Activation of the food-waste module	42 / 43 (97.7%)
Activation of the transport module	42 / 43 (97.7%)
Selection of the “Brașov local” supply chain	10

3.2. GHG emission reduction

The distribution of GHG emission reductions revealed a strongly polarised character (Figure 2). More than half of the students with quantifiable data – 56.4% (n = 22) – made no change relative to their current diet, recording a 0% reduction. The remaining 43.6% (n = 17) selected alternative scenarios with a positive climate impact. Across the whole sample of 39 records, the mean reduction was 7.6%, whereas among those who actually chose a change the mean reduction was 17.4%, with a median of 7% and a wide range, from 1% to 75% (standard deviation ≈ 22.2%). By interval, the distribution was as follows: reductions of 1–5% in 7 students (17.9% of the sample of 39); 6–15% in 5 students (12.8%); 16–30% in 2 students (5.1%); and above 30% in 3 students (7.7%). The maximum value, 75%, corresponded to a scenario modelled for 3 persons over 7 days/week, illustrating the amplified potential of dietary changes when applied at the level of the entire household. The high variability of the reductions reflects both the heterogeneity of the starting diets and individual differences in readiness for change.

Table 2. Distribution of GHG emission reductions by interval (n = 39).

Reduction interval	Students (n)	Share (%)
0% (no change)	22	56.4
1–5%	7	17.9
6–15%	5	12.8
16–30%	2	5.1
>30%	3	7.7
Total	39	100.0

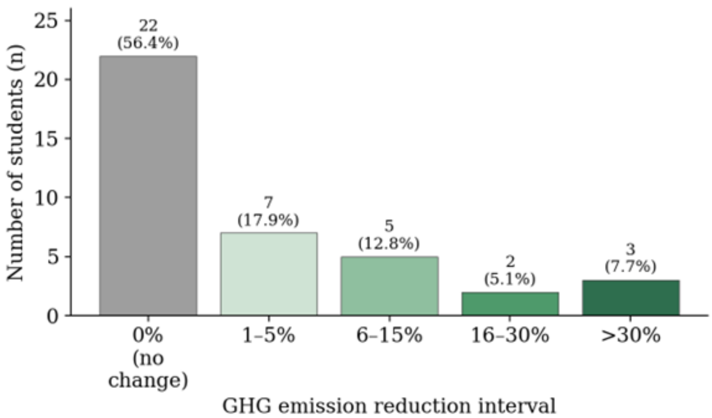

Fig. 2. Distribution of GHG emission reductions by interval among students with quantifiable data (n = 39).

3.3. Meal-preparation frequency and household size

Regarding food-preparation behaviour (n = 42 with data), 23 students (54.8%) reported cooking on all 7 days of the week, followed by those preparing meals 3 days/week (5 students) and 5 days/week (4 students); the full distribution is shown in Figure 3. As for the number of persons for whom meals are prepared, the relative majority – 22 students (52.4%) – cook for a single person, and 12 (28.6%) for two persons, reflecting typical student living conditions (living alone or as a couple). Only a small subgroup modelled diets for larger households (3–7 persons), and it was precisely these cases that were associated with the largest absolute emission reductions.

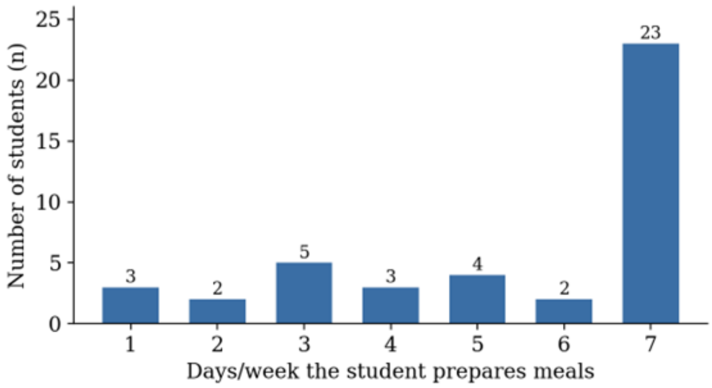

Fig. 3. Meal-preparation frequency (days/week) among students with available data (n = 42).

3.4. Advanced modules: waste, transport and supply chain

One of the most notable observations of the study is the near-universal activation rate of the advanced analysis modules. Both the food-waste module and the road-transport module were activated by 42 out of the 43 students with extracted data (97.7%). This behaviour suggests genuine interest in the holistic assessment of the environmental impact of diet, beyond the mere calculation of dietary emissions. Regarding the supply chain, 10 students selected the "Brașov local" option and 3 opted for "Local Europe", the remainder not specifying an explicit preference. The predominance of the local Brașov option is consistent with the membership of the Brașov municipal area in the network of FoodCLIC pilot city-regions and suggests a certain familiarity of the participants with the regional food context.

3.5. Absolute emissions and illustrative equivalences

In addition to the percentage reduction, the FST provides absolute values of annual emissions (kg CO_2/year) for the current diet and for the chosen scenario, together with intuitive equivalences such as the number of trees needed for offsetting or the equivalent road distance avoided. In the cases where these values were extracted, they confirmed the magnitude of the differences: for example, the scenario with the maximum reduction of 75% corresponded to a diet modelled for a three-person household, with an absolute reduction of the order of a few thousand kilograms of CO_2 per year. Such equivalences play an important pedagogical role, as they translate abstract values into tangible language that is easy to communicate and remember. It must be emphasised, however, that absolute values depend sensitively on the accuracy of self-reported consumption and on household parameters, which is why their quantitative interpretation must be made with caution in this pilot study.

3.6.Discussions

The results of this pilot study offer a nuanced picture of how students with specialised training in the food domain relate to the sustainability of their own diet when they have a digital self-assessment instrument at their disposal. The central observation – that more than half of the participants (56.4%) did not identify or did not opt for a scenario with a reduced carbon footprint – is, at first sight, surprising for a population that benefits from formal knowledge in nutrition and food science. This finding nevertheless aligns with the literature on the intention–behaviour gap [1, 20]: theoretical knowledge does not automatically translate into action, and barriers such as established habits, taste preferences, social context and the perceived effort required can inhibit change, even when the benefits are understood.

On the other hand, the subgroup that opted for change achieved substantial reductions, with a mean of 17.4% and a remarkable maximum of 75%. This contrast highlights a polarisation of the sample: an “inertial” majority and a “proactive” minority capable of significant modifications. From the perspective of designing educational interventions, this polarisation suggests that uniform strategies are probably ineffective; differentiated approaches, separately targeting the activation of the inertial group and the reinforcement of the already motivated one, might be more appropriate.

A second significant result is the near-universal (97.7%) activation rate of the advanced modules. Even in the absence of immediate behavioural changes, participants showed a willingness to explore the full picture of dietary impact, including waste and transport. This curiosity supports the hypothesis that interactive tools such as the FST have high pedagogical potential: they can serve as starting points for reflection and debate, even if their direct effect on behaviour is limited in the short term. Their educational value lies less in immediate “persuasion” and more in the concrete visualisation of abstract concepts and in stimulating critical thinking about one's own choices.

From a methodological standpoint, the study highlights an important practical challenge: almost half of the submissions (47.7%) were transmitted as scanned files or images, unavailable for automatic extraction. This finding has direct implications for future research and for the design of teaching activities based on the FST. Standardising the reporting method – for example, by explicitly requesting a machine-readable PDF export or by integrating a structured results-collection mechanism – would significantly improve data coverage and quality. Alternatively, the application of optical character recognition (OCR) techniques could recover the information from scanned documents.

It is also worth noting the contrast between the high engagement with the analytical features of the tool and the comparatively low rate of behavioural commitment. Participants readily activated the optional modules and explored the extended dimensions of their dietary impact, yet a majority ultimately retained their baseline diet. This pattern is consistent with a model in which curiosity and information-seeking precede, but do not guarantee, behavioural change. For educators, it suggests that the moment of engagement with such a tool is a valuable teachable opportunity that should be deliberately scaffolded with discussion, goal-setting and follow-up, rather than treated as a self-contained exercise expected to produce change on its own.

3.7. National context and relevance for the Brașov pilot region

The predominance of the selection of the “Brașov local” supply chain (10 students) among the participants is significant in relation to the positioning of the Brașov municipal area as a pilot region of the FoodCLIC project. Anchoring the instrument in the national context, through the selection of Romania as the reference country, and the availability of regional options give the results enhanced local relevance and open the possibility of integrating the FST into concrete urban food-policy initiatives. Connecting university teaching activities with the regional sustainable-food agenda can generate co-benefits: on the one hand, students acquire an applied understanding of food impact; on the other, authorities and local networks benefit from a better-informed and potentially more receptive young population. In this sense, the present pilot study can serve as a starting point for future collaborations between academia and regional actors within FoodCLIC.

3.8. Implications for education and public policy

The observed reluctance to change diet is consistent with results reported at the level of the general population, where reducing meat consumption is often perceived as a difficult concession despite awareness of the environmental impact

[12]. The fact that a similar pattern appears even among specialist students suggests that information, although necessary, is insufficient to trigger change. The literature on sustainable food consumption [19, 2] indicates that effective measures combine information with interventions on the choice context – availability, price, social norms and choice architecture (nudging). From this perspective, tools such as the FST are most useful when integrated into a broader educational framework that combines personalised feedback with debate, the setting of concrete goals and the monitoring of progress. At the policy level, partnerships between universities and local authorities – of the kind promoted by FoodCLIC – can turn such teaching exercises into levers for transforming urban food environments.

The results must be interpreted in the light of several limitations. First, the small size of the sample with quantifiable data (n = 39) and the exploratory nature of the study do not allow generalisations or inferential analyses. Second, the data come from self-reporting and are subject to errors in estimating one's own consumption and to possible social desirability. Third, the study captures a single point in time and does not evaluate actual behavioural change or its persistence. Finally, scenarios with very large reductions were not validated from the perspective of nutritional adequacy, an aspect essential to the literature on sustainable diets [17]. Nevertheless, by its nature as a pilot study, the research achieves its aim of demonstrating the feasibility of the method and generating hypotheses for subsequent investigations. [14, 15, 16]

A promising direction for future research is a longitudinal design, capable of capturing not only the intention expressed at a single moment but also actual behavioural change and its persistence over time. Combining the FST with elements of goal-setting, periodic monitoring and, possibly, gamification mechanisms could enhance the transformation of awareness into action. Extending data extraction to scanned documents through OCR techniques would allow full use of the cohort and increase statistical power, paving the way for inferential analyses and comparisons between subgroups. Finally, replicating the study on samples from other universities and pilot regions of the FoodCLIC project would allow the robustness of the results to be assessed and any regional particularities of sustainable dietary behaviour to be identified.

4.Conclusions

The study demonstrates the feasibility and pedagogical value of using the digital Food Sustainability Tool, developed within the European FoodCLIC project, as a self-assessment and sustainability-education resource in the university environment. The main conclusions are as follows:

(1) More than half of the students (56.4%) did not choose a dietary scenario with lower emissions than their current diet, indicating a persistent gap between knowledge and sustainable dietary behaviour, even among a population with specialised training.

(2) Students who adopted changes achieved a mean reduction of 17.4% in GHG emissions, with a maximum of 75% in household-level scenarios, confirming the real potential of dietary modifications.

(3) The near-universal activation rate of the advanced modules (97.7% for waste and transport) reflects genuine interest in the holistic assessment of food impact and supports the tool's pedagogical potential.

(4) Almost half of the submissions were transmitted in formats that could not be processed automatically, highlighting the need to standardise the collection protocol in future research and teaching activities.

(5) The integration of the FST into university curricula in the fields of food, nutrition, public health and the environment is recommended, accompanied by critical reflection on the nutritional adequacy of the scenarios and by longitudinal evaluation of behavioural change.

Acknowledgements

The authors thank the FoodCLIC project team for making the Food Sustainability Tool available as an open-access educational resource, and the participating students for their involvement in the research activity. The FoodCLIC project is funded by the European Union through the Horizon Europe programme. This work was elaborated within the FoodCLIC project, funded by the European Union under the Horizon Europe research and innovation programme (Grant Agreement No. 101000803). The views and opinions expressed are those of the authors alone and do not necessarily reflect those of the European Union or the European Research Executive Agency (REA). Neither the European Union nor the REA can be held responsible for them.

Notations and abbreviations

CO_2 – carbon dioxide; FAO – Food and Agriculture Organization; FST – Food Sustainability Tool; GHG – greenhouse gases; LCA – Life Cycle Assessment; OCR – Optical Character Recognition; PDF – Portable Document Format; SD – standard deviation.

R E F E R E N C E S

[1] Ajzen, I., The theory of planned behavior, *Organizational Behavior and Human Decision Processes*, vol. 50, no. 2, pp. 179–211, 1991.

[2] Aleksandrowicz, L., Green, R., Joy, E. J. M., Smith, P., Haines, A., The impacts of dietary change on greenhouse gas emissions, land use, water use, and health: A systematic review, *PLoS ONE*, vol. 11, no. 11, 2016.

[3] Crippa, M., Solazzo, E., Guizzardi, D. et al., Food systems are responsible for a third of global anthropogenic GHG emissions, *Nature Food*, vol. 2, pp. 198–209, 2021.

[4] FAO, *Sustainable Diets and Biodiversity: Directions and Solutions for Policy, Research and Action*, Food and Agriculture Organization of the United Nations, Rome, Italy, 2012.

[5] FAO, *Global Food Losses and Food Waste – Extent, Causes and Prevention*, Food and Agriculture Organization of the United Nations, Rome, Italy, 2011.

[6] FoodCLIC Consortium, FoodCLIC – Integrated urban FOOD policies: developing sustainability Co-benefits, spatial Linkages, social Inclusion and sectoral Connections, Horizon Europe Project (Grant Agreement No. 101060717), 2022–2027.

[7] FoodCLIC EU project, *https://foodclic.eu* (accessed June 2026).

[8] Food Sustainability Tool, CMCC / FoodCLIC, *https://www.foodsustainabilitytool.eu* (accessed June 2026).

[9] Garnett, T., Where are the best opportunities for reducing greenhouse gas emissions in the food system (including the food chain)? *Food Policy*, vol. 36, suppl. 1, pp. S23–S32, 2011.

[10] Hallström, E., Carlsson-Kanyama, A., Börjesson, P., Environmental impact of dietary change: a systematic review, *Journal of Cleaner Production*, vol. 91, pp. 1–11, 2015.

[11] Irz, X., Leroy, P., Réquillart, V., Soler, L. G., Welfare and sustainability effects of dietary recommendations, *European Journal of Nutrition*, vol. 57, pp. 1981–1998, 2018.

[12] Macdiarmid, J. I., Douglas, F., Campbell, J., Eating like there's no tomorrow: Public awareness of the environmental impact of food and reluctance to eat less meat as part of a sustainable diet, *Appetite*, vol. 96, pp. 487–493, 2016.

[13] Mulrow, J., Machaj, K., Deanes, J., Derrible, S., The state of carbon footprint calculators: An evaluation of calculator design and user interaction features, *Sustainable Production and Consumption*, vol. 18, pp. 33–40, 2019.

[14] Oprea, O.B., Gaceu, L., Application of multiple criteria decision making (mcdm) in bakery industry. Study case: wastes and by-products. Bulletin of the Transilvania University of Brasov. Series II: Forestry Wood Industry Agricultural Food Engineering, 89-94, 2016.

[15] Oprea, O. B., Gaceu, L., Gadei, G. Investigation methodology about labels information content of the meat products from Romania, in accordance with European Legislation. In Proceeding of the international conference Agri. Informatics, pp. 7-12, 2013

[16] Oprea, O. B., Gaceu, L., Consumer acceptance and sensorial analysis of bread with grape seed flour. In E3S Web of Conferences (Vol. 215, p. 01005). EDP Sciences, 2020.

[17] Perignon, M., Vieux, F., Soler, L. G. et al., How low can dietary greenhouse gas emissions be reduced without impairing nutritional adequacy, affordability and acceptability of the diet? *Public Health Nutrition*, vol. 19, no. 14, pp. 2662–2674, 2016.

[18] Poore, J., Nemecek, T., Reducing food's environmental impacts through producers and consumers, *Science*, vol. 360, no. 6392, pp. 987–992, 2018.

[19] Reisch, L., Eberle, U., Lorek, S., Sustainable food consumption: an overview of contemporary issues and policies, *Sustainability: Science, Practice and Policy*, vol. 9, no. 2, pp. 7–25, 2013.

[20] Sheeran, P., Webb, T. L., The intention–behavior gap, *Social and Personality Psychology Compass*, vol. 10, no. 9, pp. 503–518, 2016.

[21] Springmann, M., Clark, M., Mason-D'Croz, D. et al., Options for keeping the food system within environmental limits, *Nature*, vol. 562, pp. 519–525, 2018.

[22] Stenmarck, Å., Jensen, C., Quested, T., Moates, G., *Estimates of European Food Waste Levels*, FUSIONS project, Stockholm, Sweden, 2016.

[23] Tilman, D., Clark, M., Global diets link environmental sustainability and human health, *Nature*, vol. 515, pp. 518–522, 2014.

[24] Tubiello, F. N., Rosenzweig, C., Conchedda, G. et al., Greenhouse gas emissions from food systems: building the evidence base, *Environmental Research Letters*, vol. 16, no. 6, 065007, 2021.

[25] Weber, C. L., Matthews, H. S., Food-miles and the relative climate impacts of food choices in the United States, *Environmental Science & Technology*, vol. 42, no. 10, pp. 3508–3513, 2008.

[26] West, S. E., Owen, A., Axelsson, K., West, C. D., Evaluating the use of a carbon footprint calculator, *Journal of Industrial Ecology*, vol. 20, no. 3, pp. 396–409, 2016.

[27] Willett, W., Rockström, J., Loken, B. et al., Food in the Anthropocene: the EAT–Lancet Commission on healthy diets from sustainable food systems, *The Lancet*, vol. 393, no. 10170, pp. 447–492, 2019.