Mainstreaming Integrated Assessment Models by embedding behavioural change and actor heterogeneity, and increasing their outreach to citizens, communities and industrial actors

CHOICE D4.1 Review of digital tools for promoting food mitigation measures

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Table of contents

Glossary of terms 7
List of abbreviations and acronyms 8
1. Executive Summary ix
2. Introduction 10
3. Methodology 11
3.1 Selection Criteria 11
3.2 Search Strategy 11
3.3 Data Analysis 11
3.4 Synthesis of Findings 13
3.5 Quality Assessment 13
3.6 Ethical Considerations 14
4. Overview of Digital Tools in Food Mitigation Measures 15
4.1 Mobile Applications 15
4.2 Online Platforms and Websites 15
4.3 Games and Gamification 15
4.4 Social media and Influencers 16
4.5 Data Visualization and Storytelling Tools 16
4.6 Audio-visual Tools 16
4.7 Virtual and Augmented Reality 16
4.8 Online Learning Platforms 16
4.9 AI and Machine Learning Online Learning Platforms 16
5. Analysis 17
5.1 Online Platforms & Websites 17
Analysis of Engagement Methodologies 21
Technical Insights and User Experience 31
Reward schemes and motivational factors 32
Key Artefacts of Success and Lessons Learned 33
Recommendations for Future Tool Development 34
Conclusions 34
5.2 Games 34
Analysis of Engagement Methodologies 35

Technical Insights and User Experience 36
Reward Schemes and Motivational Factors 37
Key Artefacts of Success and Lessons Learned 37
Recommendations for Future Tool Development 38
Conclusions 39
5.3 Data Storytelling 39
Analysis of Engagement Methodologies 43
Technical Insights and User Experience 48
Reward Schemes and Motivational Factors 48
Key Artefacts of Success and Lessons Learned 50
Conclusions 52
6. Discussion 53
6.1 Effectiveness of Digital Tools 53
6.2 Challenges and Limitations 54
6.3 Recommendations for Practitioners 55
6.4 Future Directions 55
7. Conclusions 57
References 59
Annex 1: List of Digital tools for food mitigation 62

Index of figures

Figure 1 Illustration of how cognitive, emotional, and behavioural reception of video games support behavioural change. 36
Figure 2 Beef: It's What's Contributing to climate change 40
Figure 3 Where does food waste occur? 41
Figure 4 The huge flow of animal waste 42
Figure 5 Food Carbon Foot-print Index 2018 42
Figure 6 Food Carbon Foot-print Index 2018 part 2 43
Figure 7 observation-chart title 44

Index of tables

Table 1: DM Austria - Engagement Analysis 24
Table 2: Albert Heijn engagement analysis 27
Table 3: Migros engagement analysis 30
Table 4: Game selection 34
Table 5: Evaluation of selected games and presence of attributes (Yes, No) defined by a study (Ouariachi et al., 2019). 38

Index of Images

Image 1 DM Austria - Category Page 17
Image 2 DM Austria - Product Page 18
Image 3 DM - Recommendations and promotions 18
Image 4 Albert Heijn - Category Page 19
Image 5 Albert Heijn - Product Page 19
Image 6 Migros - Category Page 20
Image 7 Migros - Product Page 20
Image 8 DM Austria - Category Page 21
Image 9 DM Austria - Product Page 22
Image 10 DM - Recommendations and promotions 23
Image 11 Albert Heijn - Category Page 25
Image 12 Albert Heijn - Product Page 26

Image 13 Albert Heijn - Recommendations and promotions 27
Image 14 Migros - Category Page.....28
Image 15 Migros - Product Page 29
Image 16 contextual information 30
Image 17 Migros - Recommendations and promotions.....30
Image 18 Swiss Retail Migros Negative Feedback 32

Glossary of terms

Term	Description
Mitigation	Actions taken to reduce or prevent negative impacts, such as reducing food waste to help the environment.
Gamification	Using game-like elements in non-game contexts to make activities more engaging and fun, like turning sustainable habits into a game.
Visualization	Creating visual representations of data or information to make it easier to understand, such as charts or graphs showing food waste levels.
Storytelling Tools	Tools used to tell stories with data, making complex information more relatable and engaging through visuals and narratives.
AI (Artificial Intelligence)	Technology that enables machines to perform tasks that typically require human intelligence, like predicting food demand to reduce waste.
Machine Learning	A type of AI where computers learn from data to improve their performance on tasks over time, such as identifying patterns in food consumption.
Virtual Reality	A technology that creates a simulated environment you can explore and interact with, often using special goggles, making you feel like you're there.
Augmented Reality	A technology that overlays digital information on the real world, like seeing virtual plants growing in your garden through your phone's camera.
Mixed Reality	A blend of virtual reality and augmented reality, where digital and real-world elements interact, like virtual characters moving around in your real living room.
Digital Divide	The gap between people who have access to digital technologies, like the internet and computers, and those who do not, which can limit the effectiveness of online tools for everyone.

List of abbreviations and acronyms

Abbreviation	Meaning
AI	Artificial Intelligence
AR	Augmented Reality
ML	Machine Learning
MR	Mixed Reality
VR	Virtual Reality
IoT	Internet of Things
ICT	Information and Communication Technology
GHG	Greenhouse Gas
CO2e	Carbon Dioxide Emissions
CO2	Carbon Dioxide
FAO	Food and Agriculture Organization
EU	European Union
UN	United Nations
NGO	Non-Governmental Organisation
SDG	Sustainable Development Goal
GIS	Geographic Information System
API	Application Programming Interface

1. Executive Summary

The development of digital tools has revolutionised the approach to managing food systems, offering innovative solutions to mitigate food waste and enhance food security. This review examines the current landscape of digital tools and their application in promoting food mitigation measures. We explore a range of digital solutions, from consumer-focused apps that encourage sustainable eating habits to industry-level systems that optimize food supply management. The effectiveness of these tools in reducing food loss and waste is critically assessed, drawing on recent studies that highlight the potential of artificial intelligence, machine learning, and Industry 4.0 technologies in the food sector (Principato et al., 2023; Tancredi, Vignali, & Bottani, 2022). Additionally, we consider the role of digital tools in dietary assessment and monitoring, which are essential for informing public health strategies (Chen, Grech, & Allman-Farinelli, 2022; Manners et al., 2022). The review also discusses the challenges and opportunities presented by digital tools, including the need for tailored solutions that address the unique requirements of different populations and sectors (Marra, 2022; Pan, Ren, Vos, & Brombacher, 2021). By synthesizing current research and case studies, this review provides insights into the interconnections between digital innovations and food mitigation, offering a comprehensive understanding of how these tools can contribute to more sustainable food systems. This study was implemented as part of Task 4.1 of the CHOICE project to review the most impactful digital tools linked to food mitigation measures and to understand their impact on food system sustainability.

2. Introduction

The exigencies of modern food systems necessitate innovative approaches to ensure sustainability and security. As the global population burgeons, the demand for food surges, placing immense pressure on food production, supply chains, and waste management practices. The Food and Agriculture Organization of the United Nations (FAO) has highlighted food waste as a critical issue, with approximately one third of all food produced for human consumption lost or wasted globally (FAO, 2019). This not only represents a significant economic loss but also contributes to environmental problems, including greenhouse gas emissions and unnecessary resource utilization (Gustavsson, Cederberg, Sonesson, Van Otterdijk, & Meybeck, 2011). In this intricate backdrop, food mitigation measures are imperative to address these multifaceted challenges, promoting more efficient, equitable, and environmentally conscious food systems. This study is part of Task 4.1 of the CHOICE project, aimed at reviewing the most impactful digital tools for food mitigation and their role in promoting sustainable food systems.

Integrating digital tools into food mitigation strategies presents a transformative opportunity. These tools, which span from consumer-oriented applications to complex industrial systems, harness the power of data and connectivity to foster informed decision-making and optimize food system operations (Principato et al., 2023). The potential of digital technologies to mitigate food issues is vast, encompassing the reduction of food waste, enhancement of food distribution efficiencies, and facilitation of sustainable consumption behaviours (Tancredi et al., 2022).

At the consumer level, digital applications aim to influence individual behaviours, which are a significant contributor to food waste. By leveraging digital tools for dietary assessment and monitoring, there is an opportunity to promote awareness and encourage more sustainable food choices among consumers (Chen et al., 2022). These tools can provide personalized feedback, nudging users towards reducing their food waste footprint.

In parallel, at the supply chain and industry level, digital tools offer sophisticated solutions for tracking, managing, and optimizing food production and distribution. From farm to fork, digital technologies such as AI and ML can predict demand, streamline logistics, and reduce overproduction and spoilage, which are key factors in food waste (Principato et al., 2023). Moreover, the advent of the digital twin technology and Industry 4.0 has opened new avenues for real-time monitoring and anomaly detection in food plants, ensuring product quality and safety (Tancredi et al., 2022).

However, the deployment of digital tools in food mitigation is not without its challenges. The digital divide, which refers to the gap between demographics and regions that have access to modern information and communications technology and those that do not, can limit the reach and effectiveness of these solutions (Pan et al., 2021). Additionally, concerns around data privacy, security, and the need for robust infrastructure to support these technologies are pertinent. There is also the need for interdisciplinary collaboration, bringing together technologists, food scientists, policymakers, and stakeholders to ensure that digital tools are designed and implemented in a manner that is contextually relevant and sustainable.

This review seeks to explore the wide range of digital tools available for food mitigation, critically examining their impact, scalability, and the barriers to their widespread adoption. This document provides an in-depth analysis of digital technologies in food mitigation, offering valuable insights for researchers, practitioners, and policymakers. In doing so, it aims to chart a course for future research

and action that not only leverages the potential of digital innovations but also addresses the pressing food challenges of our time.

3. Methodology

This section delineates the systematic approach adopted for identifying, assessing, and synthesizing digital tools that contribute to food mitigation measures. The methodology is meticulously crafted to encompass a broad spectrum of sources, ensuring a comprehensive review that captures the multifaceted nature of digital interventions in the food sector.

3.1 Selection Criteria

Digital tools included in this review were required to meet specific criteria. They must serve a clear purpose in food mitigation, whether through reducing waste, enhancing supply chain efficiencies, promoting sustainable consumption, or contributing to the overall sustainability of food systems. Eligible tools were those that had undergone empirical evaluation or were reviewed by users in reviewing platforms or had been the subject of detailed case studies in peer-reviewed academic journals or substantial industry reports. The selection of these tools includes also the digital tools that will be created by the CHOICE project. Tools that lacked empirical backing, were purely theoretical, or were in preliminary stages of development were excluded to maintain the focus on proven solutions.

3.2 Search Strategy

We used a multi-pronged search strategy to thoroughly identify relevant tools and literature. Electronic databases such as Web of Science, Scopus, and Google Scholar were searched for academic articles published in English from January 2010. The search terms included combinations of "digital tools," "food mitigation," "food waste reduction," "supply chain efficiency," "sustainable consumption," and "food system sustainability."

To capture the breadth of available digital tools beyond academic publications, the search was extended to include practical marketplaces where such tools are commonly available. This included searches through the Apple App Store and Google Play Store, which are rich repositories of consumer-facing applications. Additionally, direct online searches were conducted to locate digital tools hosted on web platforms or those that function as standalone software solutions.

3.3 Data Analysis

The data analysis phase of this review involved a comprehensive and systematic approach to gather, assess, and interpret data related to various digital tools employed in food mitigation measures. This phase was meticulously designed to ensure a thorough understanding of each tool's impact, effectiveness, and the challenges encountered (Goedde, McCullough, Ooko-Ombaka, & Pais, 2021; Stankovic, Neftenov, & Gupta, n.d.).

Data extraction was crucial. We gathered detailed information about each digital tool, including its name, type, description, manufacturer, primary purpose, functionalities, usage scenarios, availability, user reviews, impact, and noted barriers such as technical issues or user engagement problems (Balasundram, Shamshiri, Sridhara, & Rizan, 2023; Chauhan, Dhir, Akram, & Salo, 2021). This information was systematically organised into a matrix to facilitate cross-comparison and thematic analysis (Galanakis, Rizou, Aldawoud, Ucak, & Rowan, 2021).

To gain deeper insights into digital tools used for promoting sustainable food practices, we conducted an in-depth analysis of the online platforms of three European retail chains: Albert Heijn (Netherlands), Migros (Switzerland), and DM (Austria). These retailers were selected because they incorporate sustainability-related information into their online shopping experiences. Our analysis focused on how these websites communicate sustainability information to consumers, including product pages, category pages, and promotional content. We also evaluated the design and usability of these websites, focusing on how they encourage sustainable choices, and examined how these platforms measure and report the sustainability impact of their products.

We also explored the role of games and gamification tools in promoting food mitigation measures as these measures have shown potential to support educational and behavioural change efforts (Fernández Galeote & Hamari, 2021; Fernández Galeote et al., 2021; Ouariachi, Olvera-Lobo, Gutiérrez-Pérez, & Maibach, 2019). This involved analysing a selection of games featuring environmental and food system themes. Specifically, we reviewed the core mechanics of each game, including how they incorporate sustainability themes, the techniques used to engage players, such as narrative elements, rewards, and challenges, and assessed how these games may influence players' understanding, and actions related to food sustainability.

Data storytelling is a powerful tool for communicating complex information in an accessible and engaging way. We analysed fifty data stories related to the food chain and its environmental impact, selecting four examples for in-depth examination. Our analysis focused on how these stories capture and maintain audience interest through visual and interactive elements, the narrative techniques used to convey the environmental impact of food choices, and the underlying psychological drivers that these stories leverage to motivate behaviour change. The selected examples included infographics and interactive data stories that exemplify best practices in data storytelling.

The final step in our data analysis involved synthesizing the findings from the various digital tools, retail websites, games, and data stories. This synthesis was conducted narratively to identify overarching themes and insights into the efficacy of digital interventions across different contexts and user groups. We focused on identifying the key elements that contribute to the success of digital tools in promoting sustainable food practices, highlighting common barriers and challenges faced by these tools, and providing actionable recommendations for future development and implementation of digital tools in the food sector (Allende, Bover-Cid, & Fernández, 2022).

By integrating findings from diverse sources, our analysis offers a comprehensive understanding of the current landscape of digital tools in food mitigation and provides valuable insights for stakeholders in the food supply chain ecosystem (Sridhar, Balakrishnan, Jacob, Sillanpää, & Dayanandan, 2023). This detailed approach ensures our review captures the multifaceted nature of digital interventions in the food sector, providing a robust foundation for understanding their impact and identifying areas for improvement. (Benyam, Soma, & Fraser, 2021).

3.4 Synthesis of Findings

After reviewing various digital tools for food mitigation, we systematically selected tools from three key categories for in-depth analysis: retailer platforms, games, and digital storytelling. This selection process involved identifying tools that demonstrated significant potential in promoting sustainable food practices and had garnered considerable attention within their respective fields. To ensure a thorough evaluation, we enlisted experts from each of these categories to analyse the selected tools.

For retailer platforms, we focused on the online shopping experiences of Albert Heijn (Netherlands), Migros (Switzerland), and DM (Austria). These platforms were chosen for their integration of sustainability-related information, and examined how these websites communicate such information to consumers, evaluate their design and usability, and measure the sustainability impact of their products (Principato et al., 2023). In the realm of games, we selected "Gibbon: Beyond the Trees," "Beecarbonize," and "Bear & Breakfast" for their professional production quality, wide audience reach, and relevance to food and environmental themes. The core mechanics of these games were analysed, including their incorporation of sustainability themes and techniques used to engage players (Abbate, Centobelli, & Cerchione, 2023). For digital storytelling, we reviewed fifty data stories related to the food chain and its environmental impact, selecting four examples for detailed examination. Then we focused on the visual and interactive elements of these stories, the narrative techniques used to convey environmental impact, and the psychological drivers leveraged to motivate behaviour change (Garnett, 2011).

3.5 Quality Assessment

Ensuring the quality of digital tools for food mitigation involves a multi-faceted approach. Initially, we conducted a rigorous selection process to identify tools that had robust documentation, positive user feedback, and demonstrated efficacy through empirical studies (Chauhan et al., 2021). This preliminary assessment helped in shortlisting tools that met our quality criteria. To further assure quality, we employed a systematic evaluation framework that included several key components.

Reliability testing was a fundamental part of our quality assessment. We assessed the consistency and dependability of the digital tools by performing repeated trials and observing if the tools produced stable and accurate results over time. This involved testing under various conditions to ensure that the tools maintained their performance across different scenarios (Galanakis et al., 2021). User experience experts evaluated the interface design, ease of use, and accessibility of the tools. This assessment aimed to ensure that the tools were user-friendly and could be effectively utilised by a broad audience, including individuals with varying levels of technical expertise (Dittmer, Wollenberg, Burns, & Shelton, 2022). Additionally, we validated the outputs of the digital tools against independent data sources to check for accuracy. This step involved cross-referencing the tools' data with external datasets to ensure that the tools provided reliable and precise information (Chauhan et al., 2021). Gathering feedback from stakeholders, including end-users, developers, and subject matter experts, was crucial for assessing the tools' practical applicability and relevance. This feedback loop helped in identifying areas for improvement and ensuring that the tools met the needs of their intended audience (Dittmer et al., 2022).

3.6 Ethical Considerations

Ethical considerations are crucial for deploying digital tools in food mitigation measures. Our approach to ethical considerations encompassed several key areas. Ensuring the privacy and security of user data was a top priority. Addressing the digital divide was crucial in our ethical evaluation. We aimed to ensure that the benefits of digital tools were equitably distributed and accessible to all segments of the population, particularly marginalised and underserved communities.

Transparency in the use of digital tools and clear communication about their benefits and risks were also vital. We provided clear documentation and communication about how the tools operated, the data they used, and their potential impacts. This transparency fostered trust among users and allowed them to make informed decisions about the use of these tools. Emphasising the importance of informed consent in the deployment of digital tools, we provided users with comprehensive information about the purpose of data collection, how their data would be used, and the potential risks involved. Obtaining explicit consent from users ensured that they were fully aware of and agreed to the terms of data usage (Cafiero et al., 2022).

4. Overview of Digital Tools in Food Mitigation Measures

Various digital tools can promote sustainable food consumption, minimize food waste, and encourage sustainable and green farming practices.

4.1 Mobile Applications

- Educational apps like Fooducate provide information about the nutritional and environmental impact of food items.
- Food sharing apps like OLIO, which help minimize food waste by connecting neighbours to share surplus food.
- Grocery shopping apps like Imperfect Foods, which sell "imperfect" produce at a discount to reduce food waste.
- Meal planning apps like Mealime, which help users plan their meals based on dietary preferences, reducing food waste by ensuring only necessary groceries are purchased.
- Restaurant apps like Too Good To Go, which sell surplus food from restaurants at a reduced price.
- Farm management apps like Bushel, which help users locate farmers markets and locally grown produce.

4.2 Online Platforms and Websites

- Educational websites like the World's Largest Lesson, which educate the public about the Sustainable Development Goals, including responsible consumption and production.
- Online calculators like the Water Footprint Calculator, which help individuals and businesses calculate and understand their water footprint, including the water used in their food consumption.
- Sustainability certification platforms that help consumers find products from farms that use sustainable practices.
- Digital eco-labels like planet FWD provide information about each product's footprint, helping citizens make more sustainable options.
- Retailer’s website like Migros online a retailer from Switzerland, selling groceries.
- Software like FoodLogiQ, that a is company that offers Software as a Service solution to connect the world’s food supply chain, promoting food safety through traceability and sustainability.
- Lifestyle website like Zero Waste Home.

4.3 Games and Gamification

- Mainstream games like Fate of the World or Farming Simulator, which can incorporate sustainable farming practices.
- Citizens science like geo-wiki.org
- Gamification like JouleBug or EcoChallenge, which educate users about sustainable practices through gameplay.

- Educational / Serious Games like Zero Waste
- Modifications or add-ons for popular games, which can add an environmental or sustainability focus to existing games, like Minecraft.

4.4 Social media and Influencers

- Influencers and bloggers who focus on sustainable food and farming practices can have a significant impact on their followers' behaviors.
- Social media campaigns that promote sustainable food consumption and production.

4.5 Data Visualization and Storytelling Tools

- Data Journalism like Sustaining our oceans
- Infographics like Tableau can be used to tell compelling stories about the impact of our food choices on the environment.
- Graphs like Steak at a Time
- Interactive Dashboards like Drivers of the Emissions

4.6 Audio-visual Tools

- Documentaries
- Animations, such as those available on platforms like Netflix, can raise awareness about these issues.
- Films and series
- Podcasts

4.7 Virtual and Augmented Reality

- Virtual reality experiences
- Augmented Reality
- Mix Reality

4.8 Online Learning Platforms

- MOOC platforms like Coursera or edX often offer courses on sustainability, including sustainable food systems.
- Video Tutorials
- Educational Websites
- Educational apps

4.9 AI and Machine Learning Online Learning Platforms

- AI-powered analytics can help farmers optimize their practices for sustainability.
- AI-powered chatbot or add-on like climesumer, that is a ChatGPT add-on to find sustainable alternatives to products.

Each tool has its own potential for impact, depending on how it is used and who it reaches. A full list of the identified digital tools of this research is provided in annex 1.

5. Analysis

This chapter analyses digital tools used to promote food mitigation measures, focusing on online platforms and websites, games, and data storytelling. This analysis provides a comprehensive evaluation of user engagement, technical insights, user experiences, and motivational factors driving interaction. We will explore various engagement methodologies used by online platforms and websites, assessing their effectiveness in conveying sustainability-related information and encouraging sustainable consumer behaviour. Additionally, the chapter examines the role of gamification in raising awareness and promoting sustainable food practices, highlighting key elements that contribute to the success of these tools. The section on data storytelling evaluates the use of visual and interactive elements to communicate complex information about the food chain and its environmental impact, analysing how these techniques capture and maintain audience interest. By synthesizing findings from these diverse sources, we aim to provide actionable insights and recommendations for the future development and implementation of digital tools in the food sector.

5.1 Online Platforms & Websites

The tools analysed are online websites from three European retail chains – Albert Heijn (Netherlands), Migros (Switzerland), and DM (Austria). These tools were chosen because they communicate sustainability-related information to their online shoppers.

All three websites use several engagement methods at the same time. All these retailers' websites are communicating the health and nutritional information of the products better than sustainability related one.

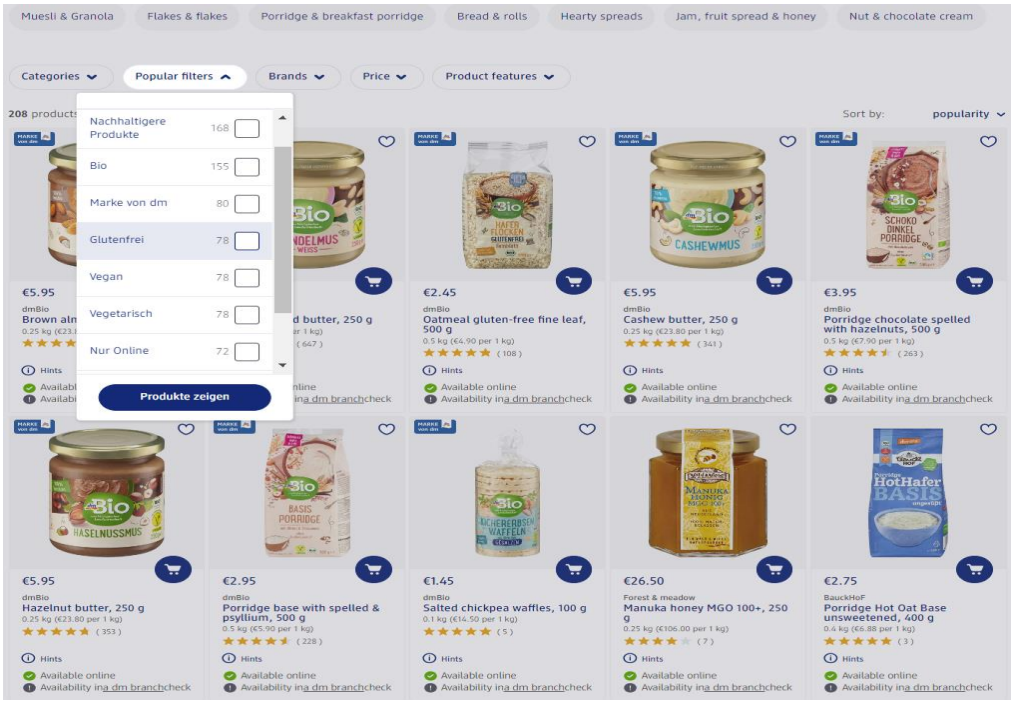

Image 1 DM Austria - Category Page

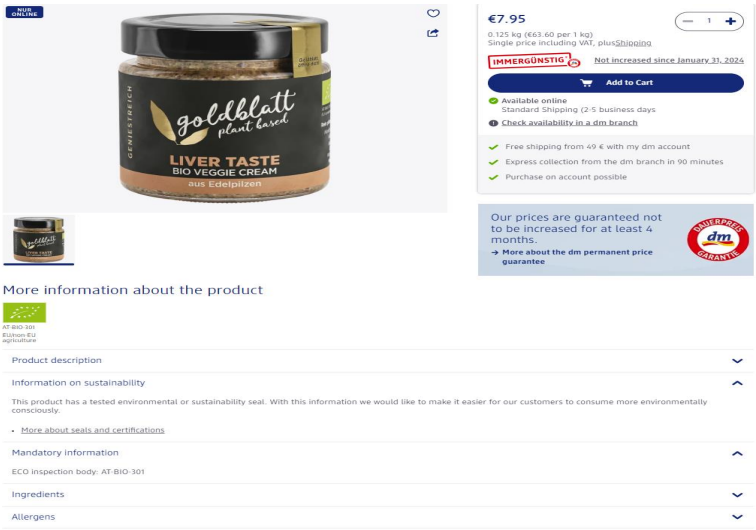

Image 2 DM Austria - Product Page

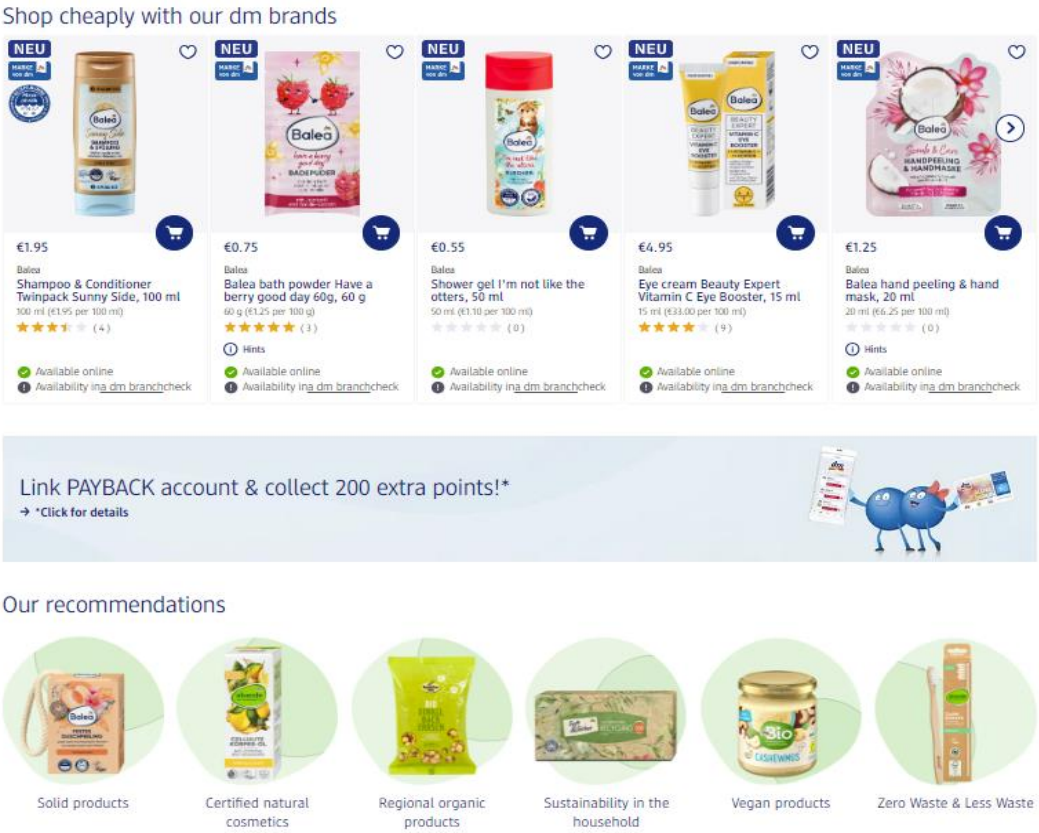

Image 3 DM - Recommendations and promotions

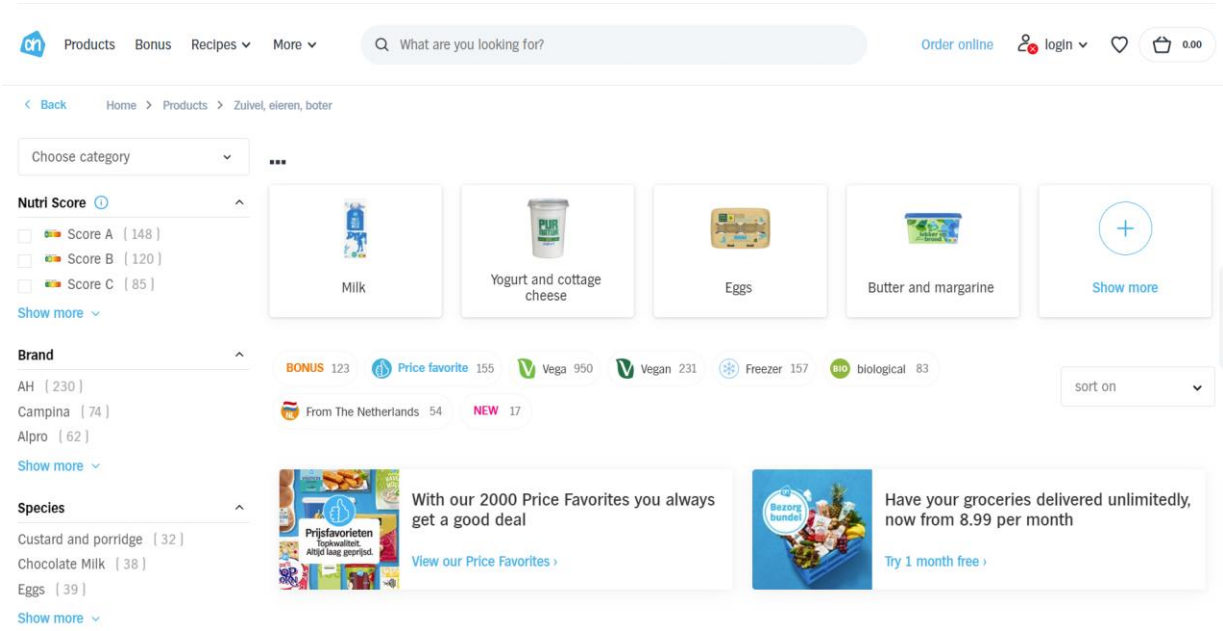

Image 4 Albert Heijn - Category Page

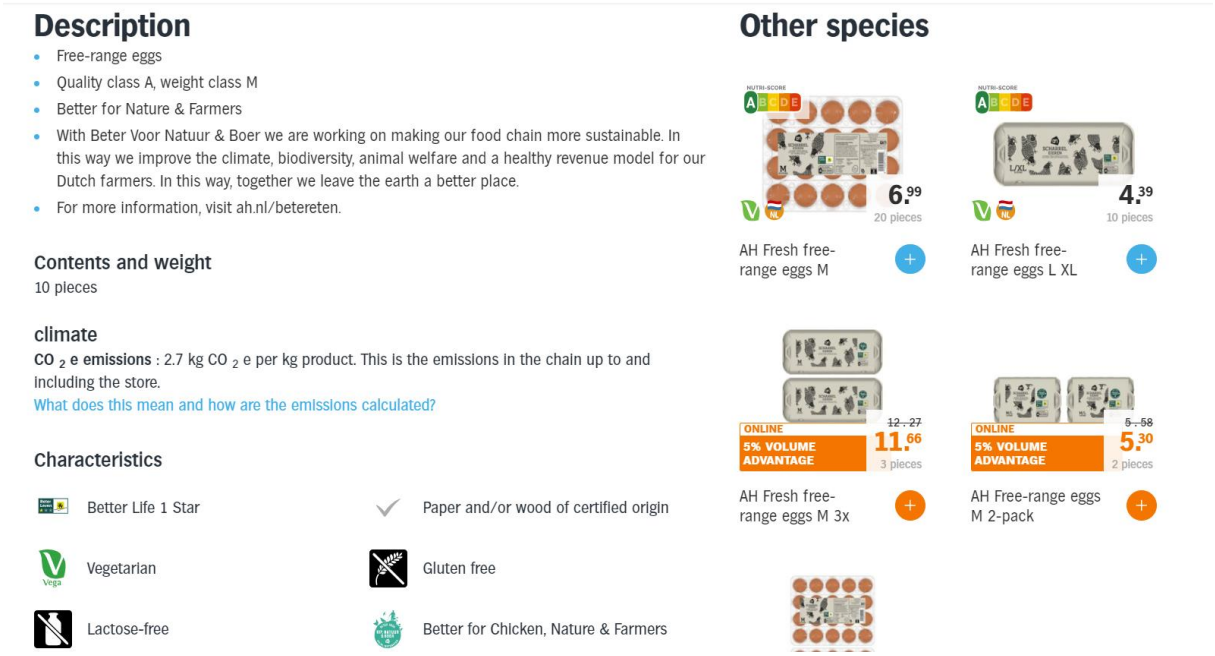

Image 5 Albert Heijn - Product Page

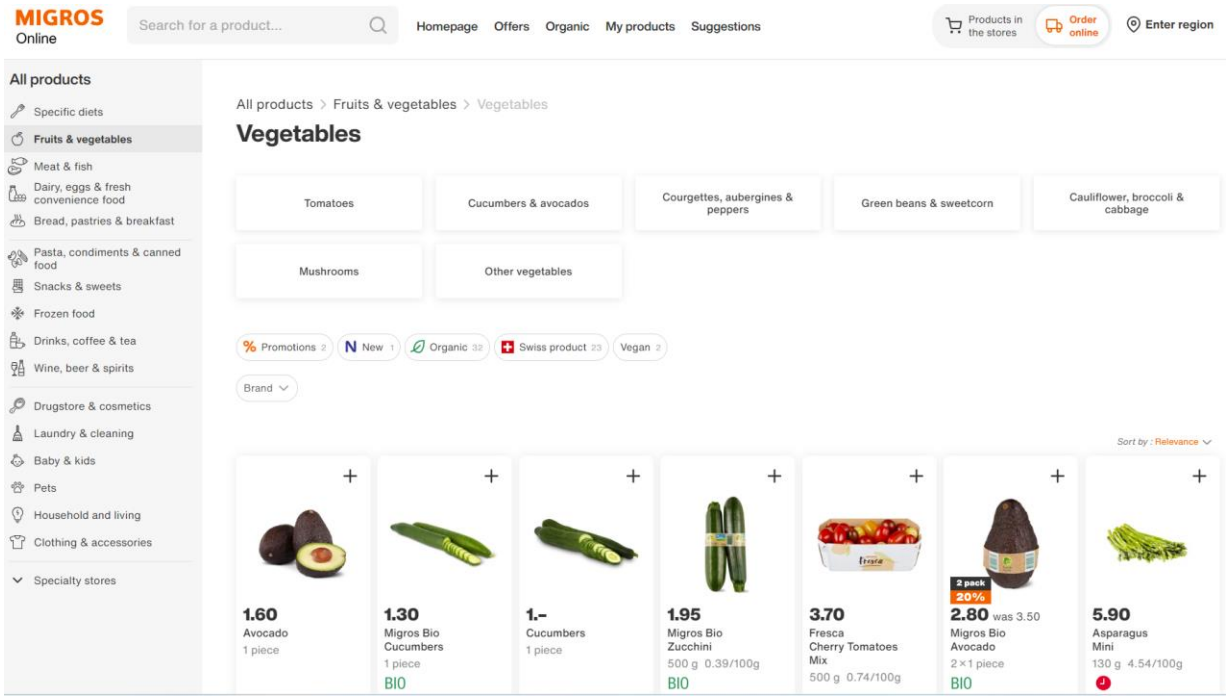

Image 6 Migros - Category Page

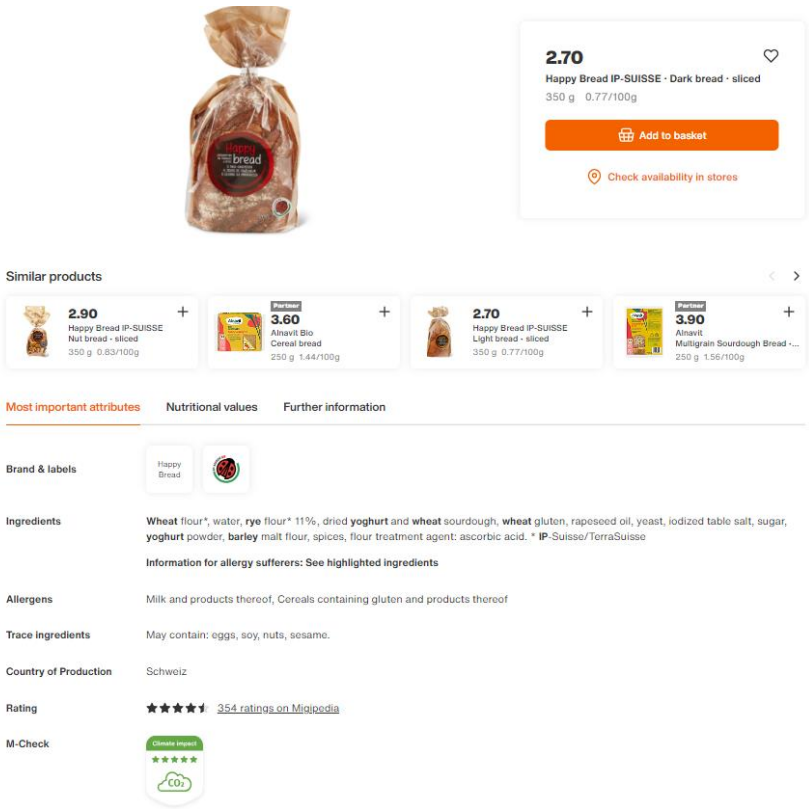

Image 7 Migros - Product Page

Analysis of Engagement Methodologies

Online stores engage consumers in food product sustainability in several ways. The engagement methods are:

- communication of sustainability-related information on the product pages
- enabling search and filter by sustainability-related criteria on the category page
- product placement and promotions

Engagement methods can be used individually or together. Here's how these methods are used on the reviewed websites.

DM Austria - Observations

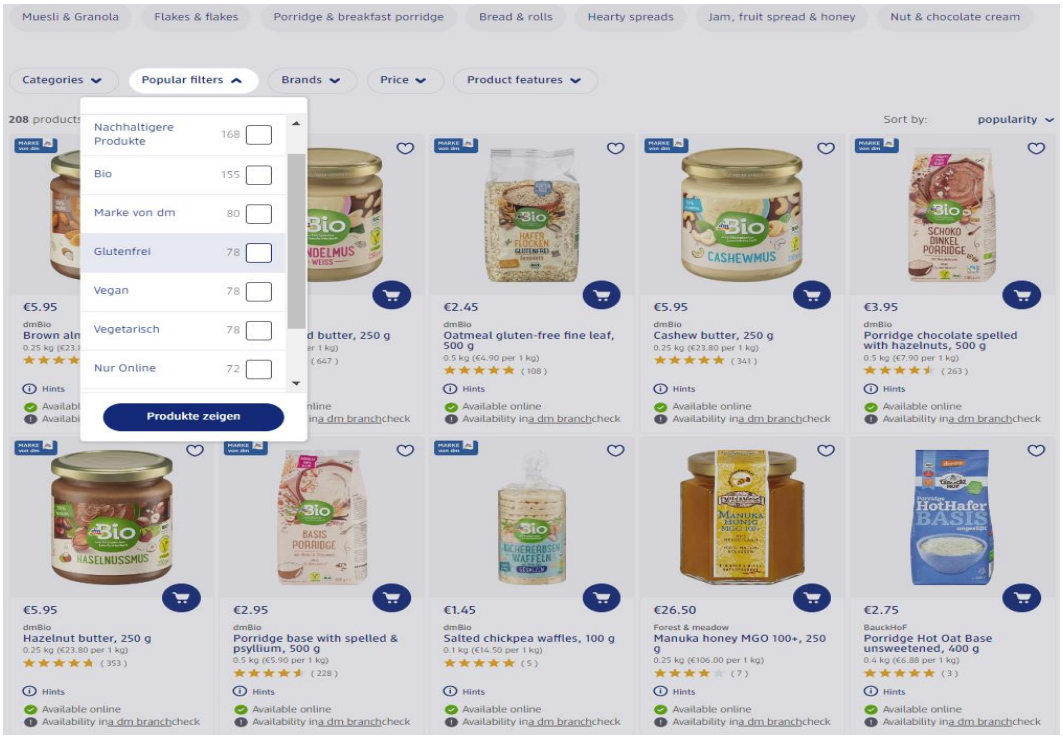

Image 8 DM Austria - Category Page

The category page above offers filtering functionality with various criteria. Diet-related filters are:

- Vegan
- Vegetarian
- Glutenfree
- Lactosefree

Marketing filters:

- Now online
- New

Sustainability-related filter:

- More sustainable products
- Bio

The environment-related 'bio' label indicates sustainable production from organic farming, as defined by EU regulations. "More sustainable products" filter reveals the products, which have been tested and have multiple certifications. The methodology for the label was developed by DM in collaboration with NGOs and institutions.

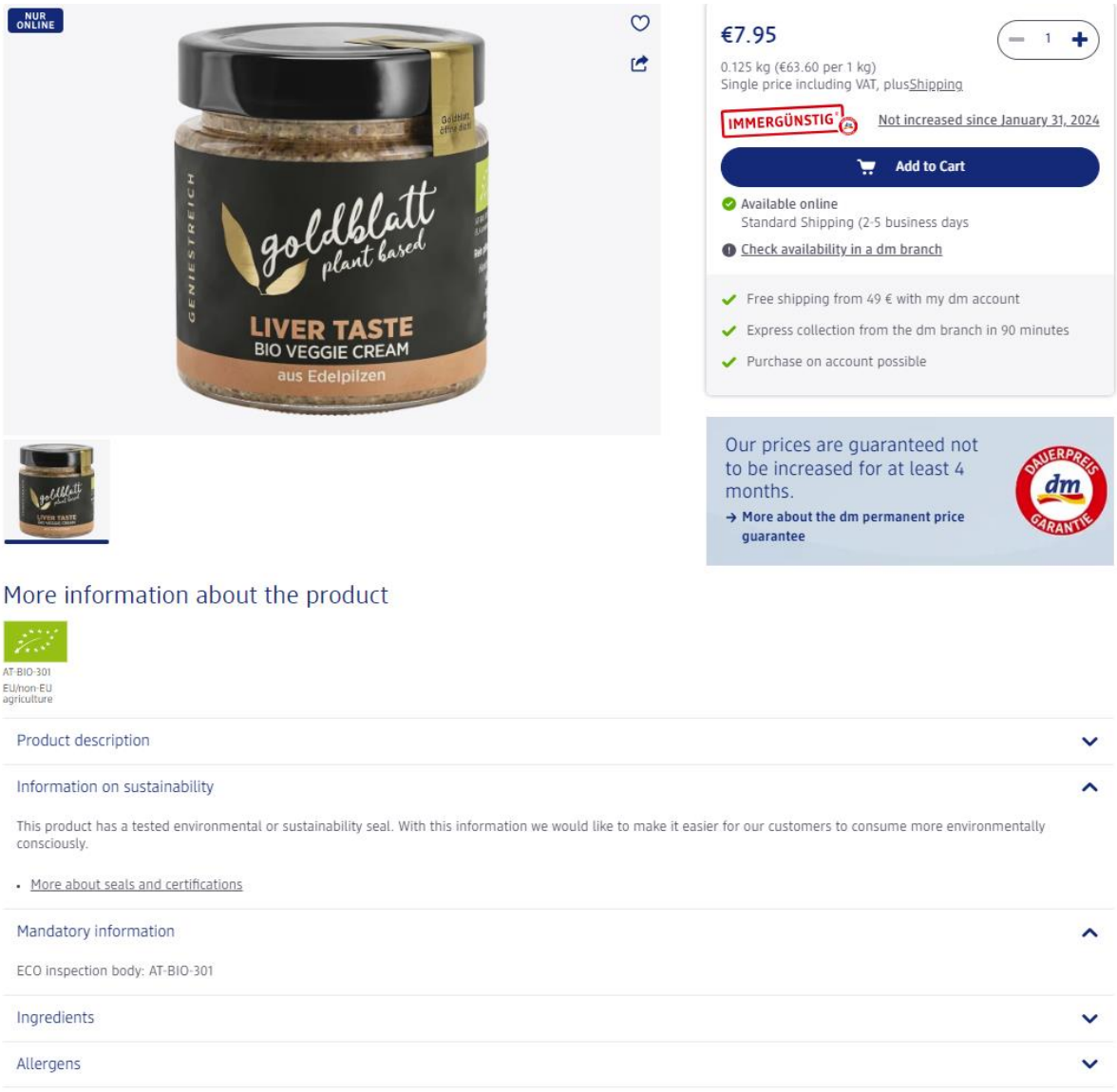

Image 9 DM Austria - Product Page

The product page example contains several information points related to sustainability.

- the organic label communicates that the product was created following the rules of EU organic farming and contains a country code (AT)
- Information on sustainability section explains the meaning of the organic menu in a text format

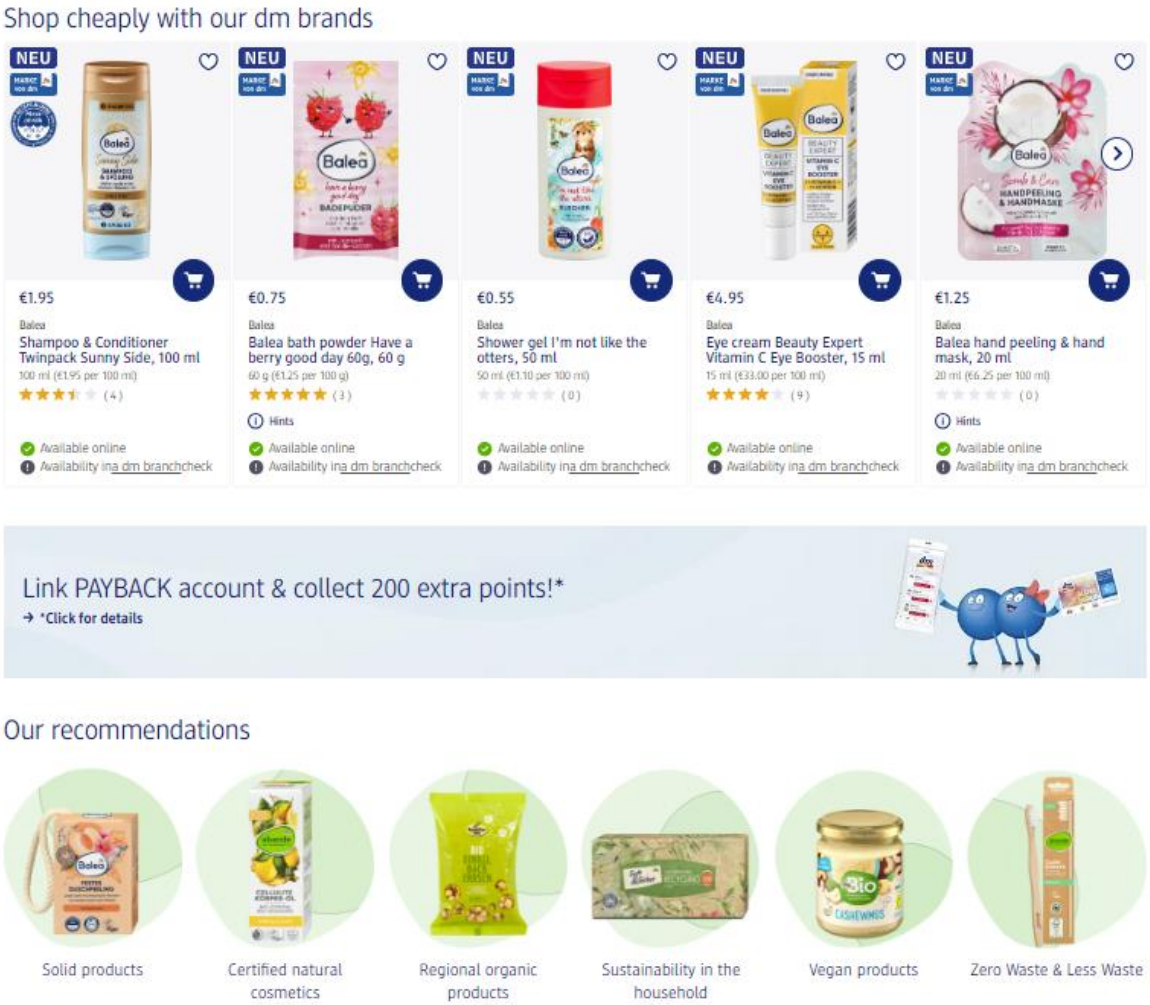

Image 10 DM - Recommendations and promotions

The promotions and recommendation page featured above contains a section dedicated to sustainable products and sustainable consumption. Each image is clickable and leads to an information page elaborating on the reasons a practice or product is more sustainable. The sustainable recommendations section addresses a wide range of sustainability-related topics and how different products contribute to it:

- reduction of packaging materials
  - solid products are more compact and don't require plastic packaging
- natural ingredients
  - reduced processing and sustainable farming practices of ingredients in cosmetics
- animal welfare
  - cosmetics not being tested on animals
  - food produced without the need of livestock farming, which is very energy-intensive and involves high CO_2 emissions
- lower transport emissions
  - regionally produced products require less transportation and support local agriculture

- usage of renewable and easily recyclable materials
    - in packaging and non-food products
- reusing
    - multiple uses of non-food products effectively reduce waste

Table 1: DM Austria - Engagement Analysis

Engagement placement	Implemented engagement	Potential for improvement
Category page	"Bio" and "More sustainable products" filter criteria	Carbon footprint in a form of impact class (A to E) or a number as a filter criterium
		Average carbon footprint of the category
Product page	Labels and certification logotypes	Explanations of the meaning of the labels and certifications
	Information about sustainability	Context-rich sustainability information about the product, e.g., explanation of what makes the category sustainable, commentary on packing materials
		Carbon footprint in a form of impact class (A to E) or several of the given product
		Sustainable alternatives recommendations
Recommendations and promotions page	Educational articles covering multiple aspects of sustainable consumptions with an option to buy the products	Reward schemes for more sustainable choices

Albert Heijn - Observations

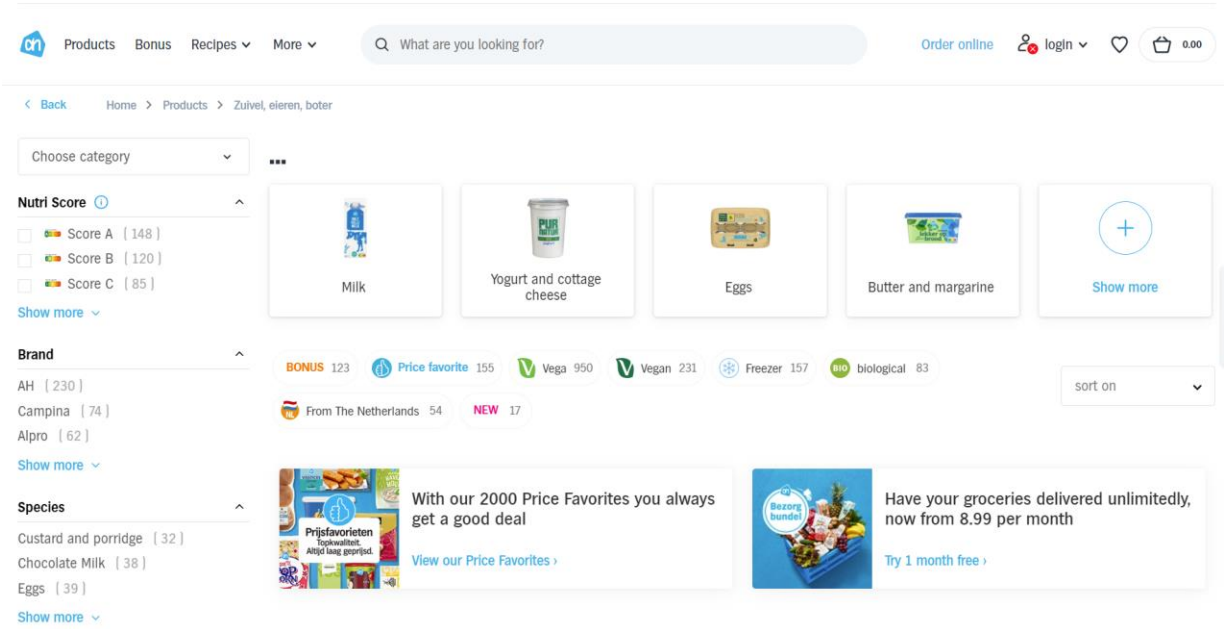

Image 11 Albert Heijn - Category Page

The category page above offers filtering functionality with several filtering criteria.

Diet-related filters are:

- Vega (vegetarian)
- Vegan

Marketing filters:

- Bonus
- Price favourite
- New

Sustainability-related filter:

- Biological
- From The Netherlands

The environment-related labels are “biological”, which stands for sustainable production in line with organic farming as defined in EU organic rules, and “From The Netherlands” pointing to the local origin of the products.

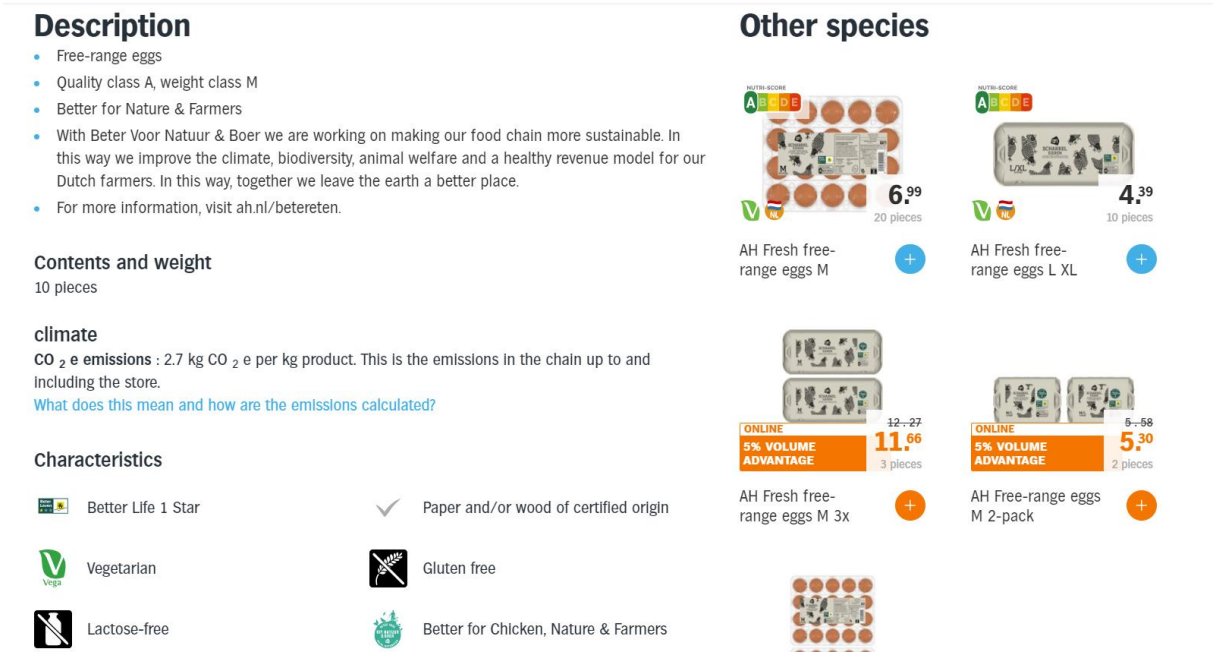

Image 12 Albert Heijn - Product Page

The product page example contains several information points related to sustainability.

- The paragraph about Climate contains a numerical value of the CO2e emissions assessed for this product
- A link to the methodology of the CO2e emissions assessment is provided
- the labels listed under “Characteristics” characterise the animal welfare (Better Life and Better for Chicken, Nature & Farmers)

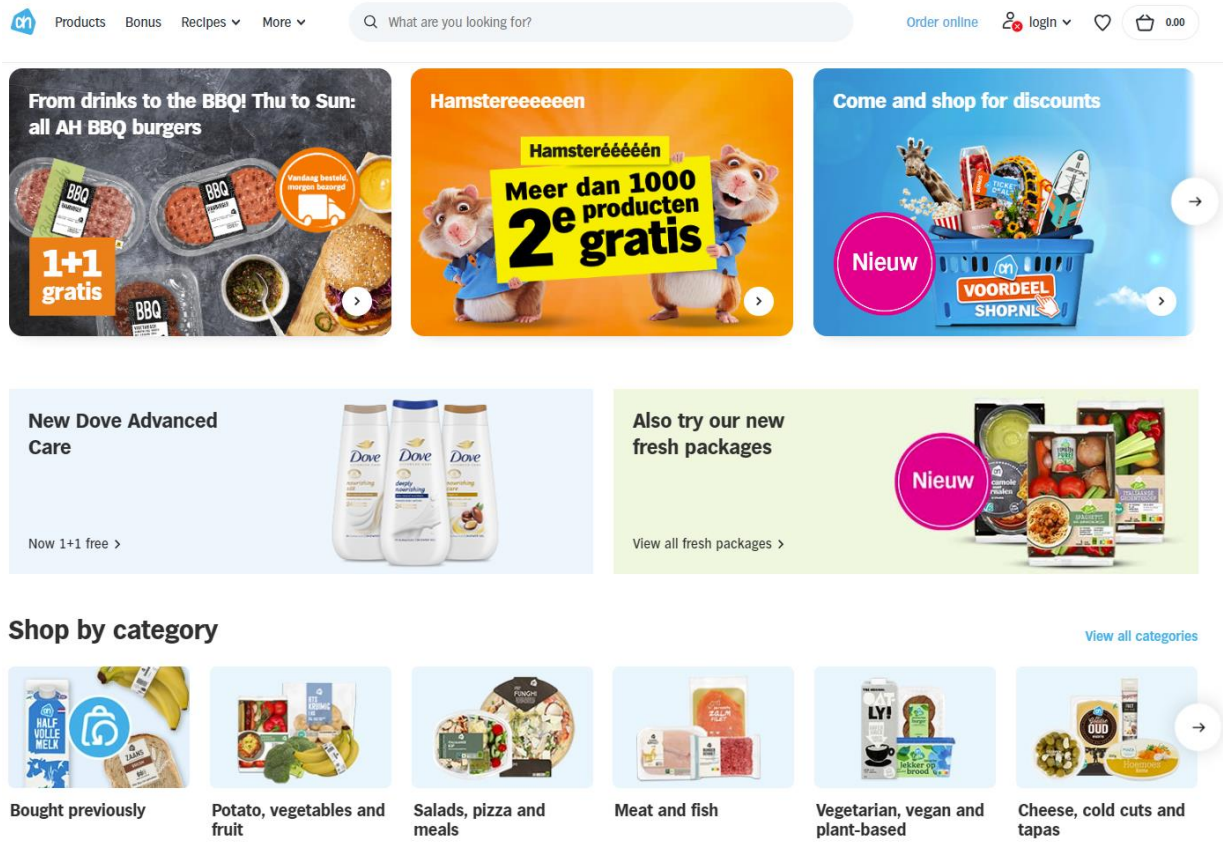

Image 13 Albert Heijn - Recommendations and promotions

The promotions and recommendation page featured above doesn't contain any offers incentivising sustainable consumption or educating the consumers about the sustainability aspect of their shopping. The promotions are focused on monetary benefits of buying some products now or buying them in larger volumes.

Table 2: Albert Heijn engagement analysis

Engagement placement	Implemented engagement	Potential for improvement
Category page	"Biological" and "From Netherlands" filter criteria	Carbon footprint in a form of impact class (A to E) or a number as a filter criterium
		Average carbon footprint of the category
Product page	Carbon footprint in numerical form of the given product	Impact class (A to E) with a colour code, which put the numerical value into a perspective and thus is more engaging
	Labels and certification logotypes	Explanations of the meaning of the labels and certifications

		Context-rich sustainability information about the product e.g. explanation of what makes the category sustainable, commentary on packing materials
		Sustainable alternatives recommendations
Recommendations and promotions page	Offers and promotions not related to sustainability	Educational articles covering multiple aspects of sustainable consumptions with an option to buy the products
		Reward schemes for more sustainable choices

Migros - Observations

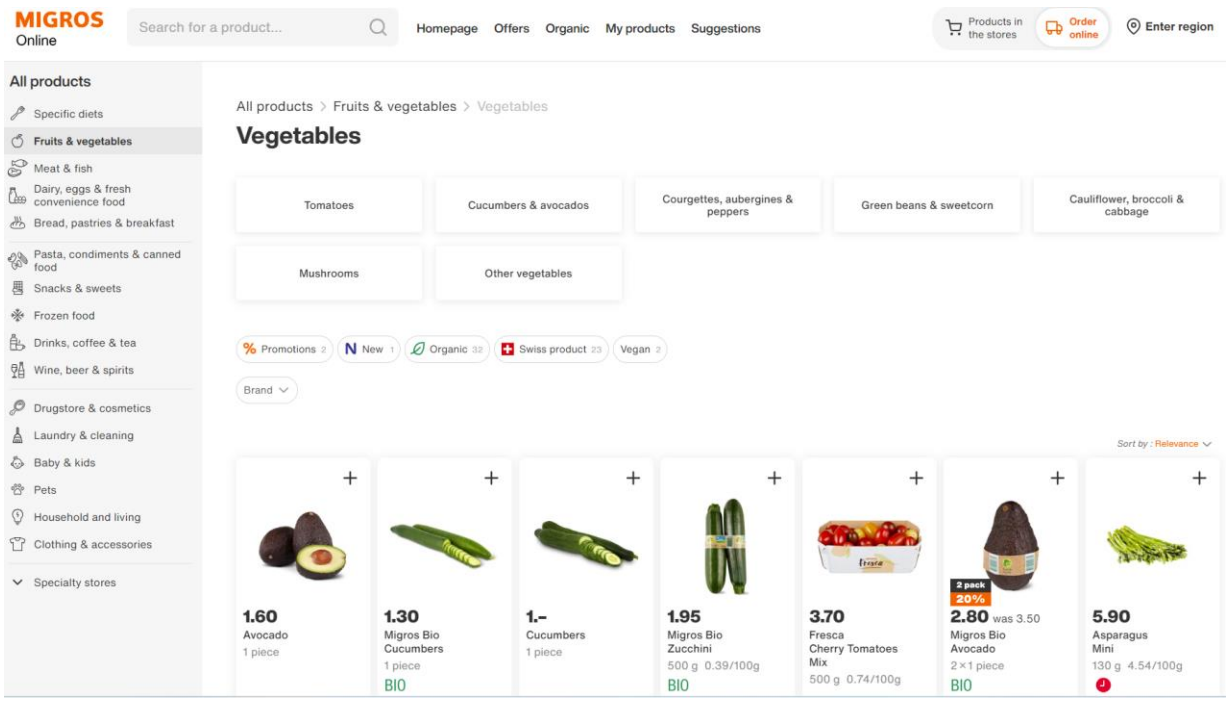

Image 14 Migros - Category Page

The category page above offers filtering functionality with several filtering criteria.

Diet-related filter:

- Vegan

Marketing filters:

- Promotions
- New

Sustainability-related filter:

- Organic
- Swiss product

The 'organic' label indicates sustainable production according to EU organic rules, while 'Swiss product' points to the local origin of the products.

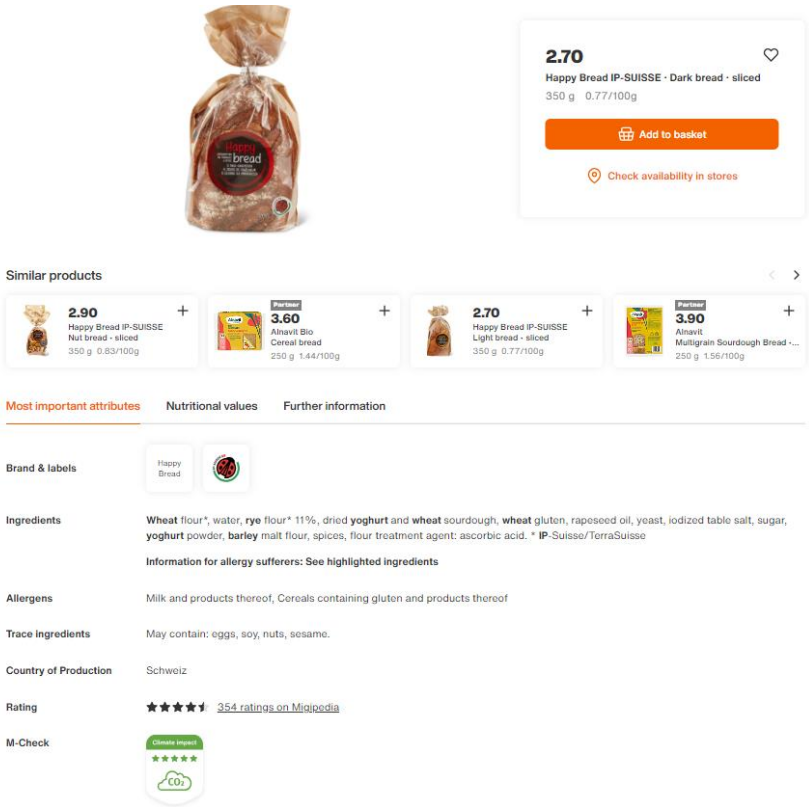

Image 15 Migros - Product Page

The product page example provides several sustainability-related information points.

- The "Brand and labels" paragraph points to the animal welfare and no use of insecticides
- M-Check is Migros created impact label, which communicates the carbon footprint of the product via the number of stars, where every star stands for a certain range of CO2e emissions

Extra information is provided when the users hover over M-Check:

- CO2e range per kg of product
- contextual information, helping the consumer put the CO2e number in perspective. E.g., "one kg of this product caused roughly as much CO2 as a 33 km car ride"
- breakdown of emissions by life cycle stages

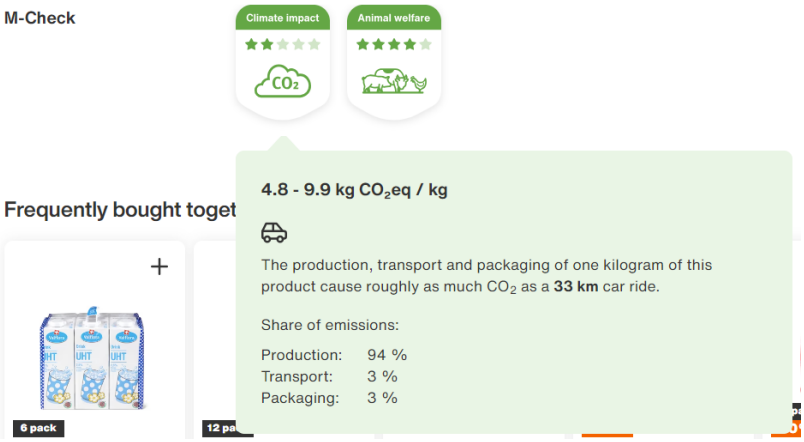

Image 16 contextual information

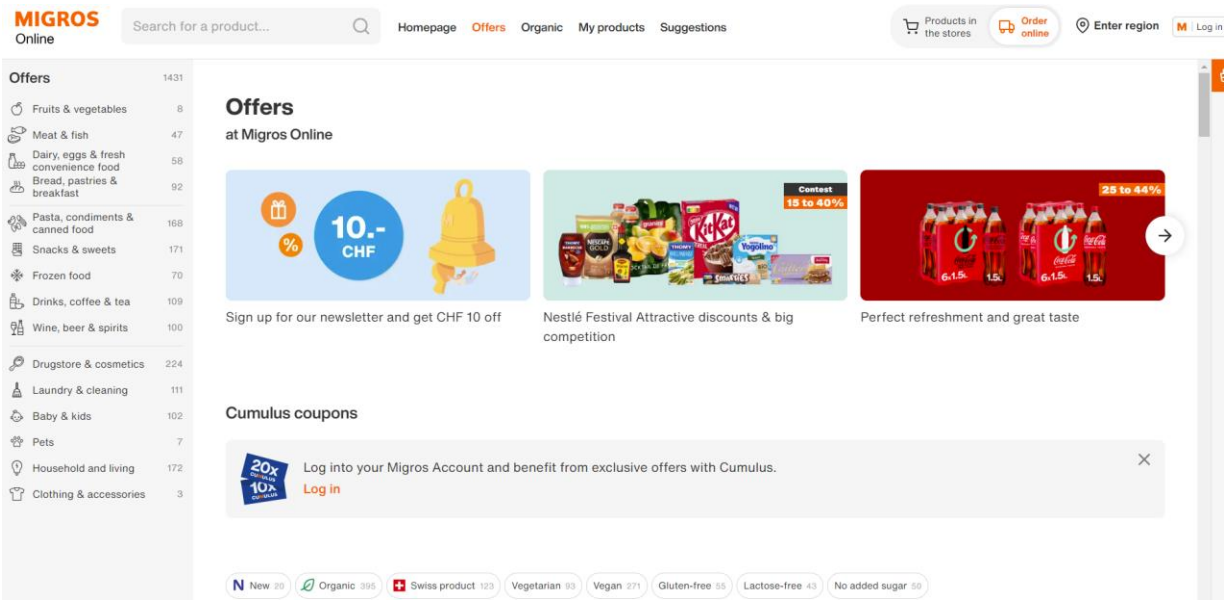

Image 17 Migros - Recommendations and promotions

The promotions and recommendation page featured above does not contain any offers incentivising sustainable consumption or educating the consumers about the sustainability aspect of their shopping. The promotions are focused on monetary benefits of buying some products now or buying them in larger volumes.

Table 3: Migros engagement analysis

Engagement placement	Implemented engagement	Potential for improvement
Category page	"Organic" and "Swiss product" filter criteria	Carbon footprint in a form of impact class (A to E) or a number as a filter criterium
		Average carbon footprint of the category

Product page	Carbon footprint communicated via animpact class, with a CO2e range and contextual information	
	Labels and certification logotypes with the explanations of the labels available on click	Brief explanations of the meaning of the labels and certifications on the same page
		Context-rich sustainability information about the product e.g. explanation of what makes the category sustainable, commentary on packing materials
		Sustainable alternatives recommendations
Recommendations and promotions page	Offers and promotions not related to sustainability	Educational articles covering multiple aspects of sustainable consumptions with an option to buy the products
		Reward schemas for more sustainable choices

Technical Insights and User Experience

This section evaluates the user interface and experience of online retail stores, discussing their potential to engage online shoppers in more sustainable consumption. Online stores have their primary set to revenue generation via sales and their user experience and design are optimised for it.

Category pages are laid out in grid view, featuring products in the category. These pages are built to showcase the assortment and allow product comparison within the category. To navigate the large volume of product searches, filtering and sorting functionalities are offered. These functionalities are a potent place for integrating sustainability into the shopping experience. The reviewed websites already provide filters on criteria like “bio” / ”organic”, local produce and “sustainable products”. Potential improvements are:

- more granular sustainability filters, like CO2e footprint or CO2e class
- explanations of the labels on hover or / and in an extra space on the page
- filters for the products with a short end/of/life date

Product pages are the pages available on a click on a specific product. They usually contain a large image of the product and its characteristics listed on the side. These pages usually offer more space and allow to provide more information about the product. All three reviewed retailers have chosen to communicate the largest volume of sustainability-related information on product pages. Some are using it in the open text (Albert Heijn), some introduce accordion elements, which show only the header of the text by default and open on click. This user interface layout allows the page to remain

visually minimalistic and clean while still being informative on demand. The downside of this approach is that the information only reaches the already interested audience, as someone who does not click on the "Sustainability information" header never sees the text below. Recommendations and promotions pages look like category pages, but the categorisation is done by a price (often reduced), a theme (Easter food and products needed for a typical Easter dinner) or novelty. These pages have large potential for engaging the online shoppers in the topic of sustainable consumption. This is visible through the example of DM Austria's recommendation page, which combines promotions with educational content and groups sustainable products together.

Reward schemes and motivational factors

This section reviews the feedback provided to consumers in the shopping process on retail e-shops.Retail stores compete for their customers. Their websites give a lot of positive feedback during the shopping process and not much negative one. Sustainability communication falls into the same pattern, where the user is encouraged to do good, e.g., choose a more sustainable product, but isn't given negative feedback when they chose poorly, e.g., by choosing unsustainable product.

Below is an example of negative feedback on one of the least sustainable products in the Swiss Retail Migros assortment: minced beef.

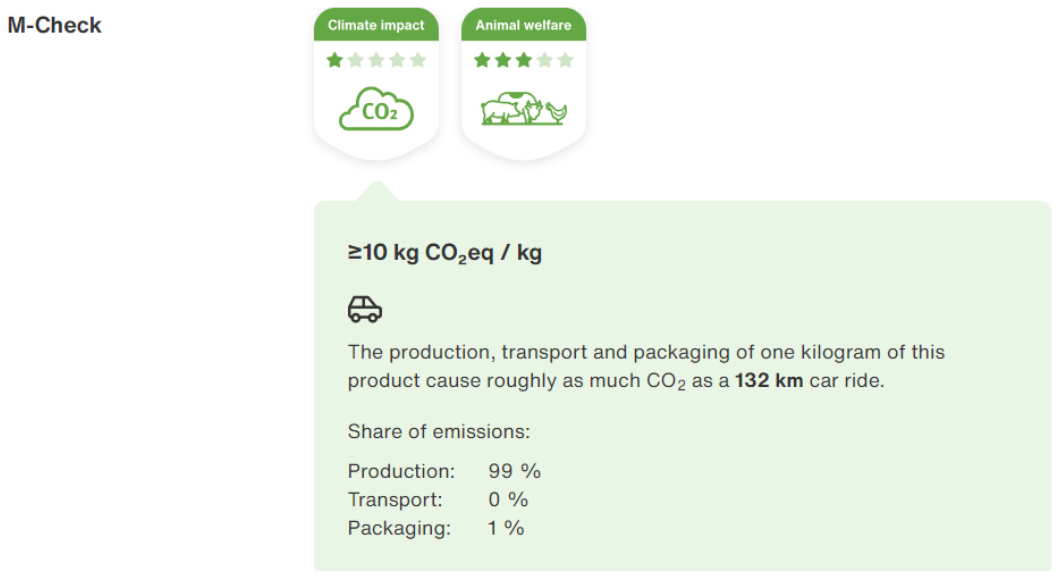

Image 18 Swiss Retail Migros Negative Feedback

- 1 star for climate impact is the worst climate impact class a product can get in Migros classification system. Yet the label is still of green colour, which looks less deterring for the user than making it red
- The contextual text frame, which appears on hover over the Climate Impact, is written in a neutral, non-blaming language

- The animal welfare label depicts the animals alive, switching the users' focus away from the topic of imminent and enforced slaughter an animal must go through for the product to be produced
- Hovering over the animal welfare label does not lead to any contextual text frames. The user cannot read about the method used to kill the animal

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Key Artefacts of Success and Lessons Learned

This chapter identifies best practices and pitfalls in integrating sustainability into the online shopping experience. The best practices are:

- On the Category pages:
  - search, filter and sorting functionalities with sustainability-related criteria
- On Product pages:
  - Carbon footprint communicated via an impact class, with a CO2e range and contextual information
  - Labels and certification logotypes with the explanations of the labels available on click
- On promotions and recommendation pages:
  - Educational articles covering multiple aspects of sustainable consumptions with an option to buy the products
  - Promotions on sustainable products
  - Gamification of more sustainable behaviours

The pitfalls to avoid are:

- On the Category pages:
  - Lack of search, filter and sorting parameters representing the sustainability of the product, e.g., a carbon footprint class (e.g., from A to E)
  - Lack of educational information about the category of the products
- On Product pages:
  - Lack of carbon footprint labels in a form or precise number or impact classes (e.g., from A to E)
  - Lack of contextual information, explaining why something is sustainable
  - Usage of obscure or confusing labels
    - a product with an "organic" label can still leave a high carbon footprint, be water-intensive in an area where it hurts the local population and involve unethical treatment of people and animals in the process
    - "Animal welfare" labels obscure the information about the routine practices in animal agriculture, which the consumers might be deterred by if they possessed more information about them, e.g., usage of CO2 gas chamber for pigs' slaughter or separation of calves from their mothers several hours after birth
- On promotions and recommendation pages:
  - Lack of any promotions for sustainable products
  - Promotions and discounts (monetary incentivisation) on non-sustainable products

Recommendations for Future Tool Development

The main recommendation is to scale current practices that engage consumers in sustainable shopping and introduce new ones.

The following user experience practices can put further the emphasis on sustainable consumption:

- The desired user behaviour should also be the easiest and most convenient for the users
  - e.g, applying default sorting by sustainability criteria, so that the sustainable products are visible on top and thus are easy to reach
  - e.g., offer more sustainable alternatives to a product with low sustainability class
- The undesired user behaviour should require confirmation
  - e.g., if the consumer basket is less sustainable than the average basket, highlight that and ask if the user would consider alternatives
- Gamification of elements in shopping process

Conclusions

We reviewed and analysed the online stores of three retailers. They all incorporate some information about product sustainability into the shopping experience of their consumers. The pages which are mainly used for this are category pages, product pages and pages for promotions, campaigns and recommendations. All these pages have potential to include additional engagement tools. The main engagements tools are:

- search, filter and sorting parameters
- visual presentation of information e.g. texts, images, labels

One of the factors impacting purchasing behaviour of the consumers is product pricing. Thus, an increase in promotions of sustainable products is needed as well as decrease of discounted non-sustainable products.

5.2 Games

In the games selection process, several databases for environmental and climate video games (Fernández Galeote & Hamari, 2021; 'Greener Games for Game Developers', n.d.; 'IGDA Climate SIG', n.d.) , were consulted in addition to exchanges on an expert forum and author knowledge. Games were considered if they a) are professionally produced by a commercial company or professional-level hobbyists, b) target a wide audience beyond classroom settings, and c) cover environmental issues related to the food system. Additionally, genre diversity between the games was considered.

We selected three games for this work: Gibbon: Beyond the Trees (Gibbon for short), developed and published by Broken Rules (Rules, n.d.), Beecarbonize, developed and published by Charles Games ('Beecarbonize – Charles Games', n.d.), and Bear & Breakfast, developed by Gummy Cat and published by Armor Games Studios ('Bear and Breakfast', n.d.), summarized in Table 4 below.

Table 4: Game selection

	Gibbon: Beyond the Trees	Beecarbonize	Bear & Breakfast

Developer	Broken Rules	Charles Games	Gummy Cat
Publisher	Broken Rules	Charles Games	Armor Games Studios
Genre	2D Platformer	Card-based strategy	Management simulator
Estimated reach (players)	Over 500,000	Over 300,000	Over 500,000
Ecological themes	Biodiversity, climate	Climate, biodiversity	Wildfire, pollution
Food themes	Palm oil / deforestation	Production systems	Cooking

Analysis of Engagement Methodologies

Various tools have been explored to spread awareness and foster climate engagement, including increasing media representation of the issue as well as gamification and nudging mechanisms (Douglas & Brauer, 2021; Lieberoth, Holm Jensen, & Bredahl, 2018). Games, too, are a promising channel for promoting societal and behavioral change (Douglas & Brauer, 2021; Fernández Galeote & Hamari, 2021; Fernández Galeote et al., 2021), especially now that they have left their initial niche existence to become a mainstream form of entertainment, drawing in a wide variety of people (Engelstätter & Ward, 2022). However, there is limited knowledge on their long-term impacts on behavior (Fernández Galeote et al., 2021).

Based on expert elicitation, reviewing existing literature and group discussions, (Ouariachi et al., 2019) have created a framework of 15 key attributes for games with climate communication purposes to potentially maximise their impact. They then classified them into three categories for climate change engagement, as shown in Fig. 1: cognitive, emotional, and behavioral reception. This lnkes with findings from another research (Lorenzoni, Nicholson-Cole, & Whitmarsh, 2007) that cognitive reception, i.e., knowledge about an issue, may not be sufficient to move someone to act. In the following, the 15 attributes from a study (Ouariachi et al., 2019) are listed and concisely described:

A. **Achievable**: Both the actions in the game as well as any potential behavioral change message need to be doable for the player.
B. **Challenging**: The game should be fair but at the same time push players towards their limits rather than being too easy.
C. **Concrete**: Instead of walls of texts, players should receive clear, simple messages, embedded into the gameplay.
D. **Credibility**: Reliable sources should support the messages of the game, at best considering audience trust.
E. **Efficacy-enhancing**: The game should give a feeling of agency by allowing the players to choose their own path and showing their impact.
F. **Experiential learning**: Players should not be forced to overthink their choices but rather intuitively experiment and experience the results.
G. **Feedback-oriented**: The game should provide clear feedback to player actions and do so in a timely fashion to ensure high efficacy.

H. **Fun**: Players should experience fun or be otherwise engaged by the game to ensure they spend sufficient time with it and its content.
I. **Identity-driven**: The game should connect to who the players are and would like to be to strengthen their emotional engagement.
J. **Leveling-up**: Difficulty and personal achievements should increase over time to keep players engaged.
K. **Meaningful**: The game needs to highlight the importance of the issue. It should show both negative impacts and positive visions for the future.
L. **Narrative-driven**: Coherent and well-written stories or real-life connections can foster engagement and support the game messages.
M. **Reward-driven**: Rewards are an important driver of long-term engagement and can be anything from high scores to badges and unlockables.
N. **Simulating**: Simulations allow players to experience real-world phenomena they otherwise might not or not on this timescale.
O. **Social**: Social interactions and norms are at the core of behavioral change. Highlighting sustainable behavior through high scores, multiplayer or real-world connections can strengthen the impact of the game.

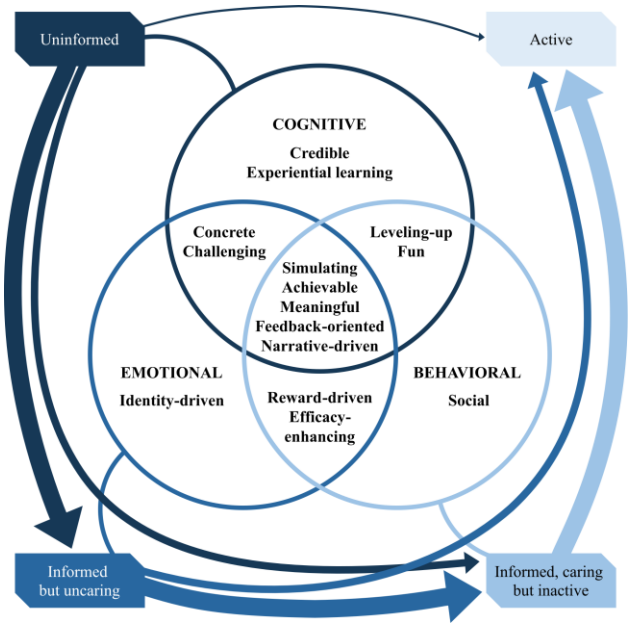

Figure 1 Illustration of how cognitive, emotional, and behavioural reception of video games support behavioural change.

Technical Insights and User Experience

Many successful games are now created in existing engines, such as Unreal or Unity. Additionally, Godot has recently increased in popularity due to being open source, free, and relatively easy to pick up while Unity in turn has received a lot of criticism for recent business decisions.

Big advantages of games as communication technology are of course its interactivity and resulting features. This is reflected in the framework by a study (Ouariachi et al., 2019), as they suggest

effective climate games should be efficacy-enhancing, feedback-oriented, simulating, and supporting experiential learning. The latter also directly features into the need for concrete messages instead of walls of text, as those would turn a game basically into a digital textbook. Experiential learning lets players experiment and experience the information, enabling them to find the solution by themselves without the feeling that they are being forced on a specific path. For example, there may be a difference between telling people to eat more vegetables and having them play a game where they see how a low-meat diet helps them achieve their goals more easily compared to a high-meat one.

This features into specific user interface and user experience decisions in the selected games, where two feature encyclopedias as optional source for background information. In the main game loop, this information may be helpful but overwhelming for some users, so it is slightly hidden to keep the main interface reduced and easy to read. This way the core game is more focused on experiential learning than the higher level of optimization that may occur if people have all information always in front of them.

Reward Schemes and Motivational Factors

Games usually are reward-driven, and their applications vary. *Gibbon* has direct gameplay rewards, as players receive a speed boost if they can successfully perform a back flip during a jump, and narrative progression rewards players for continuous play. Players are also rewarded with high scores and leaderboard positions for good performance in daily races. And in 'Liberation' mode, they can find tricky to reach unlockables for their encyclopedia. Similarly, *Beecarbonize*, has an encyclopedia as well, cataloging all available cards. However, they are only shown after they have been found and used in the main game mode for the first time. Beating the game unlocks a 'hardcore' mode, giving successful players a bigger challenge. While beating that mode does not unlock new features, it is a rewarding experience in itself. In *Bear & Breakfast*, players are rewarded for cleaning up trash as this trash is a currency they can use to buy new decorative items for their houses.

All three games come with so-called 'achievements', badges players can receive on platforms like Steam for solving specific tasks, like winning *Beecarbonize* for the first time or in all possible ways. Well-chosen achievements can show players what is possible beyond what they have done in the game so far and encourage them to experiment (or, at least, read a guide) to unlock them.

While it is currently hard to estimate how any of these mechanisms may impact behavioural change, they often will encourage longer play times and thus amplify the exposition to the games' messages and their overall impact.

Key Artefacts of Success and Lessons Learned

The most important aspect for any game is to avoid scope creep, i.e., the endless addition of feature ideas, and resulting 'development hell'. This is a common theme in the independent developer scene: keep in mind available time and budget, despite the many interesting ideas that may come up during development. To avoid this but allow for additional features, the game should be structured in modules, so that it is easy to finish the product, but at the same time add content that was out of scope of earlier versions.

Besides that, games are very diverse, differing in many as genre, core features, art style, or target audience, and finding success, i.e., reaching a lot of people, is hard to plan for. Table 5 does show a few engagement features that all three games in question share. Foremost, they are all fun (H), albeit of course not all to the same people. *Gibbon* has been lauded by some for its beautiful style and narrative, but also criticized for its lack of challenge and short run time. *Beecarbonize*'s strategy approach, in turn, may not appeal to fans of 2D platformers. Achievability (A) is important for the general flow of the game, but also to communicate messages that players can follow outside the game. These messages should also be concrete and clear and not hidden at the end of a multi-hour game. *Gibbon* features a vague call to action, but it is not clear how many people see, understand, and follow it due to its somewhat hidden position in the credits and its relatively vague text. All games in this selection give players an efficacy-enhancing (E) feeling of agency and support experiential learning (F), although this takes a very different form in *Gibbon*, compared to the other two.

Table 5: Evaluation of selected games and presence of attributes (Yes, No) defined by a study (Ouariachi et al., 2019).

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	
Bear & Breakfast	Y	N	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N	11
Beecarbonize	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	N	Y	Y	Y	N	12
Gibbon: Beyond the Trees	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	12
	3	1	3	2	3	3	3	3	2	3	2	3	3	1	1	

Recommendations for Future Tool Development

While none of the three games analyzed specifically focus on the interlinkages of climate and food – instead showcasing it as a sub-narrative or featuring both environmental and food narratives without a direct connection between them –, all three show several features that could be adopted into future climate games aiming to communicate food system changes.

- Good design, narrative, or characters can strengthen the enjoyment and connection players experience (*Gibbon*, *Bear & Breakfast*).
- Involving experts can strengthen the message, give it credibility, and makes for easy follow-up connections (*Beecarbonize*, *Gibbon*).
- Keeping the main game messages concrete and gameplay-focused, while offering optional background information in glossaries or an encyclopedia satisfies curious players without overwhelming others who want to focus on the main game (*Beecarbonize*, *Gibbon*).
- Sustainability messages, like the normalization of plant-based cooking, can be embedded into a game even without a direct connection to an environmental message (*Bear & Breakfast*).
- Using increasing difficulty, rewards, or leaderboards can foster the repeated exposition to the game message and, depending on the specific rewards, new sub-aspects of the message, such as new cards (*Beecarbonize*, *Gibbon*).

However, they also show points where specific mechanics may need improvement to better support sustainability messages.

- Mixed messages regarding player behavior and societal support as well as visions for a more sustainable future should not seemingly contradict each other but rather align. For example, in *Bear & Breakfast*, players are rewarded for collecting trash (positive behaviour and incentive) but also need it as currency, leading to players hoping for more trash rather than less in the game world (negative future vision). To link the positive future vision (less trash in the environment) and the gameplay need / incentive (trash as currency), the game design could include an evolving mechanism where players, for example, can unlock trash cans, so that there are only few, correct places to collect the waste while leaving most of the game world trash-free.
- Leaderboards can increase replayability, but if the leaderboard mode's link to the sustainability message is only limited, this replayability may not have much impact on the game's impact. For example, in *Gibbon*, the leaderboard mode is detached from the main narrative. The destructive scenes like burning jungles can still be randomly encountered, but the connection between the shown issues and solutions are weaker without the narrative guidance. Furthermore, such features can truely shine when combined with new experiences and input in every new try. At best, they should be combined with game play features that encourage experiments, such as the different card combinations in *Beecarbonize*. There, in turn, a social or competitive component is missing outside of Steam 'achievements' . However, at least players are informed about the amount of turns it took them to finish a try. This could be used in a leaderboard, especially if combined with more scoring mechanisms.

Achievability and calls to action should be clear, so that players can easily follow up on the cognitive and emotional reception of an environmental message. At the end of *Gibbon* as well as in the glossary, there are weak calls to action and links to the involved environmental groups. The call to action could be made stronger by phrasing it as active call to do something, e.g., read more about the issue on the groups' websites and become a donor or active member, instead of the relatively weak statement that the shown status quo is not set in stone. Similarly, Beecarbonize could use its end screen for more active engagement. The game reflects on specific choices by the players and encourages to experiment further, but there is no call to get involved outside the game to make the played vision a reality.

Conclusions

There are few games available that link climate and food system, and they usually do so only as a subaspect, side note or indirectly. Three current examples, Gibbon: Beyond the Trees, Beecarbonize, and Bear & Breakfast, all provide different examples of how to use the diverse sphere of games to communicate these issues but also of features that could be improved for increased efficacy. There areno examples yet of long-term assessments of behavioural change following game-based interventions. It would be particularly interesting to study the potential impact of large reach games in this context.

5.3 Data Storytelling

A thorough investigation of data stories about the food chain and its environmental impact has been performed. Fifty (50) such data stories that pass moderate quality criteria have been selected for a more in-depth analysis. Overall, the quantity and quality of the published data stories in this field

are not very high and lag other popular domains, such as health and environment in general. Regarding the data stories modalities, most of the data stories found are in infographic form, whereas others include interactive elements. No data story on the promising data scroll-telling format, where online long-form stories characterised by video and animation effects triggered by simply scrolling the webpage, were found.

For further discussion, we have hand-picked four data stories: three infographics and one interactive data story. The selection was based on the quality of the data stories, as well as different engagement practices, motives, and shortcomings to highlight.

Example A:

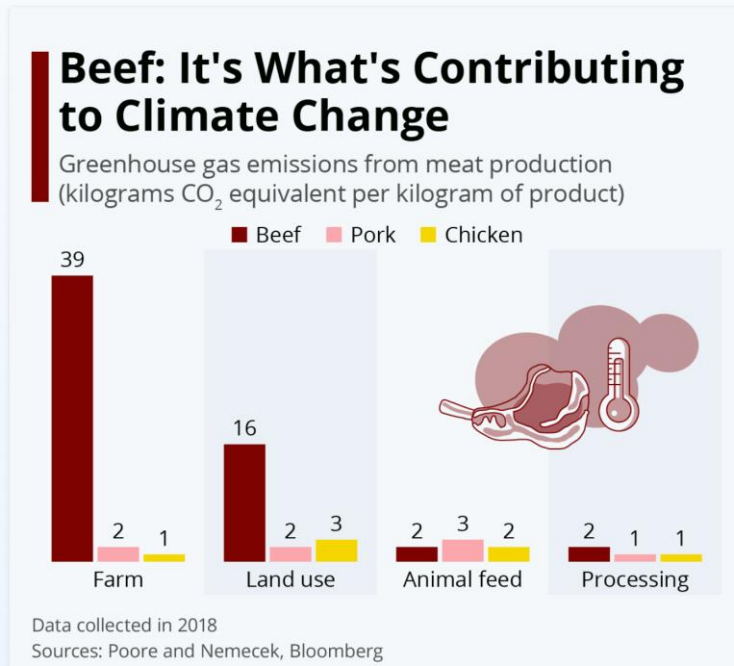

Figure 2 Beef: It's What's Contributing to climate change

This example serves as an entry point in the analysis, since it follows the baseline guidelines for an infographic to be characterised as a data story. It highlights the contribution of different meat types into climate change.

Example B:

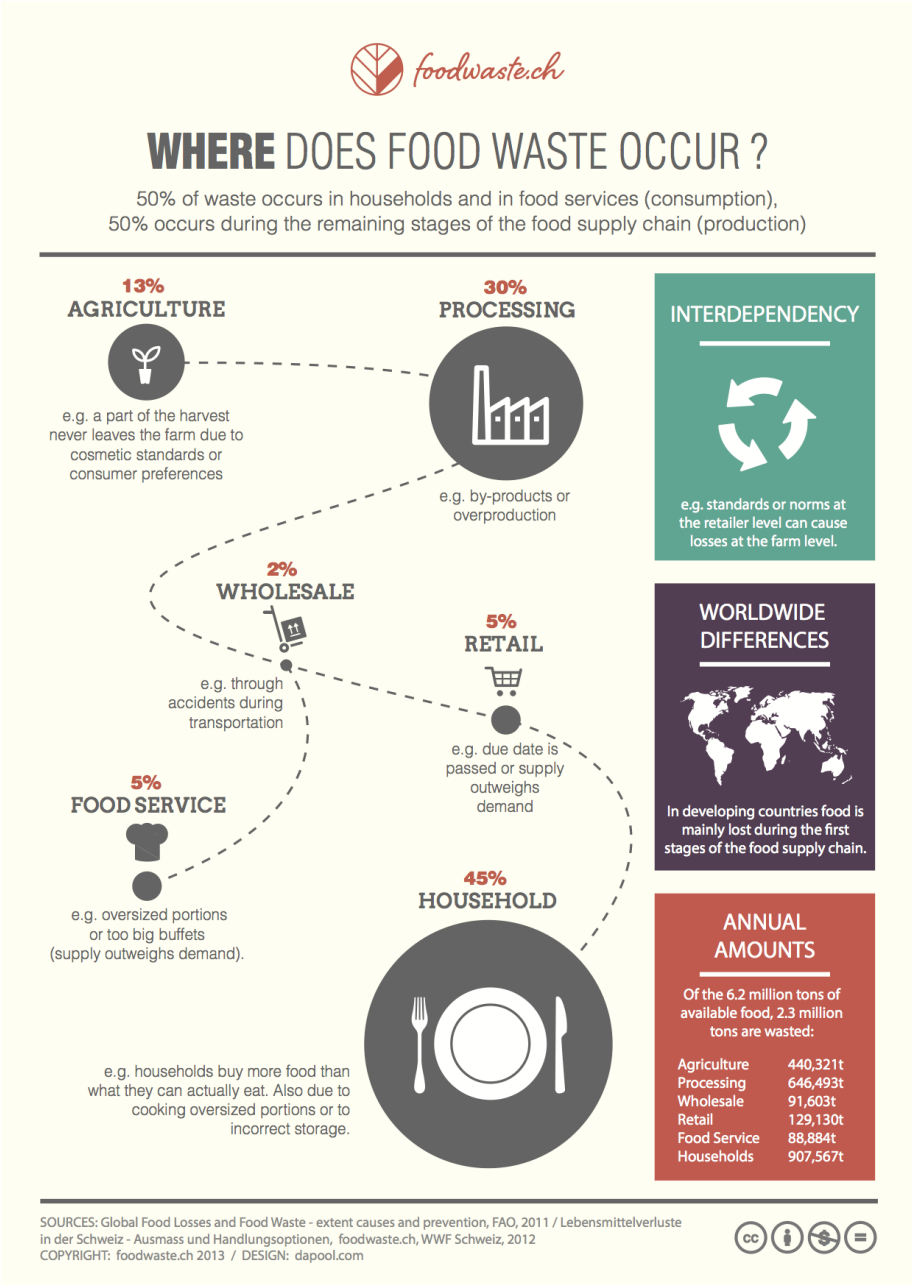

Figure 3 Where does food waste occur?

This example has been selected as a data story in infographic format, which is more elaborate than example A, complies with the good practices to follow along with CHOICE and deals with a problem different than that of example A, which is food waste.

Example C:

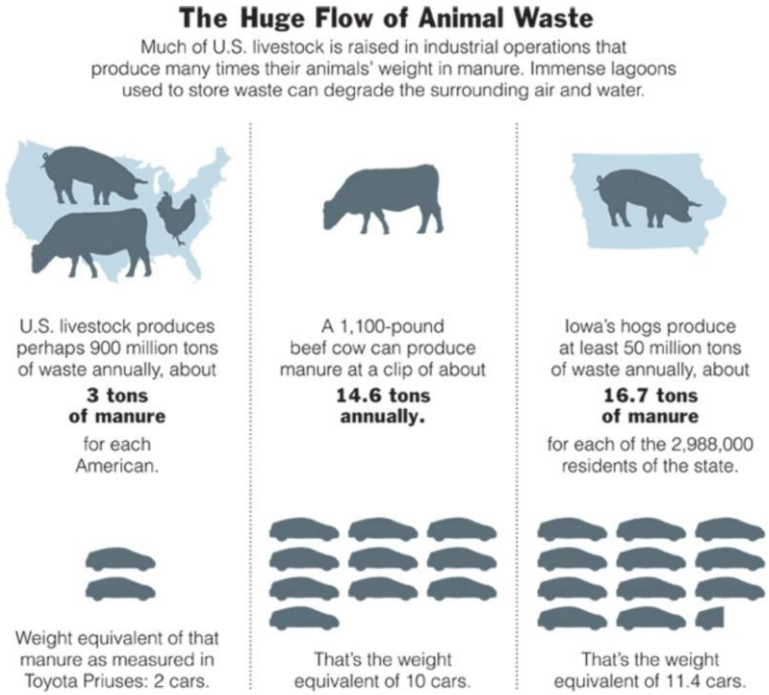

Figure 4 The huge flow of animal waste

Example C deals with another topic, animal waste. Although the infographic data story does not relate animal waste to climate change, it implicitly motivates daily changes towards more environmentally friendly choices. This infographic uses certain techniques that are good to discuss. Also, it suffers from well-noted shortcomings.

Example D: Food Carbon Foot-print Index 2018 ('VizForFuture - Food Carbon Footprint Index 2018 | 2 | Tableau Public', n.d.)

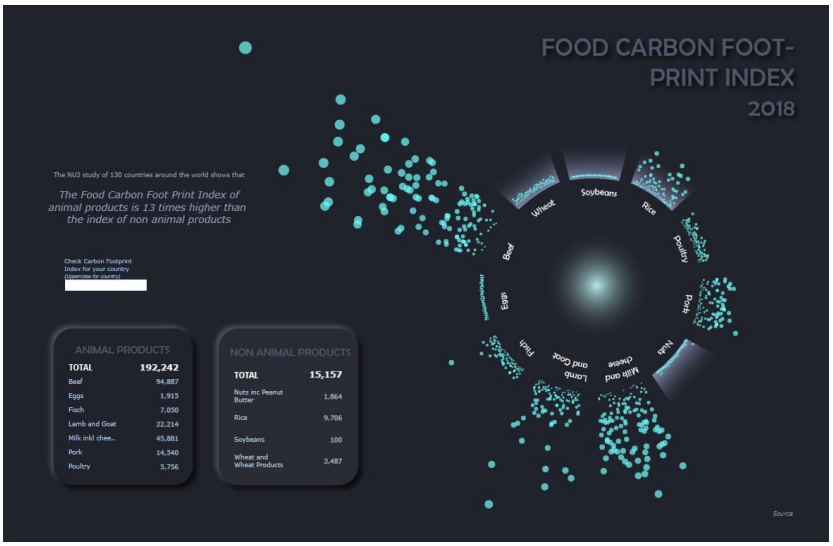

Figure 5 Food Carbon Foot-print Index 2018

Figure 6 Food Carbon Foot-print Index 2018 part 2

This data story differs from Examples A-C since it is interactive. It represents a nicely made example with many aspects regarding engagement and reward mechanisms to discuss.

Analysis of Engagement Methodologies

In this section, we will further elaborate on the messages and structures of the selected data stories, and engagement aspects as well as the psychological and motivational factors that support engagement will be discussed and analysed.

Example A: Beef: It's What's Contributing to climate change

This data story is a visual representation in the form of an infographic of the greenhouse gas emissions across all meat production stages, from farming processes and land use to animal feed and meat processing. It concerns the three more popular meat sources: beef, pork, and chicken. It presents data as a bar chart with emissions measured in kilograms of CO_2 equivalent per kilogram of product. It follows the baseline approach for an infographic to be characterised as data storytelling, which uses a regular chart type (here a bar chart) along with an "observation-chart title" style of description (Duarte, 2019).

Figure 7 observation-chart title

The data story **visual elements** comprise of

- **Colour coding:** The use of distinct colours—dark red for beef, pink for pork, and yellow for chicken—immediately draws attention to beef as the most impactful, creating a visual hierarchy that emphasises the narrative. The colour scheme also complies with the general notion of the audience for the specific types of meat.
- **Bar chart comparison:** The stark differences in bar lengths provide a clear, at-a-glance comparison of emissions. Beef's towering bars effectively communicate the urgency and magnitude of its impact.
- **Iconography:** Iconography is limited to thematic graphics that aim to help the audience understand the topic without explicitly reading the text. The presence of a thermometer alongside the beef steak attempts to do this, and the cloud subtly reinforces the connection between meat production and global warming.

The **engagement strategy** approaches that are followed are:

- **Data transparency:** The infographic fosters trust and credibility by providing the data source and collection year, encouraging deeper audience trustworthiness and engagement.
- **Focal point:** The '39' for beef farming emissions acts as a focal point, provoking immediate emotional and intellectual responses about the environmental cost of food choices.
- **Minimal text:** The concise use of text avoids overwhelming the audience, making the complex data accessible to a broad audience.

Relevancy: The topic taps into current environmental concerns, making it immediately relevant and engaging for viewers interested in sustainability and personal impact on climate change.The infographic harnesses visual storytelling to not only depict data but also to influence behaviour involving several psychological and motivational nudges:

- **Visual contrast and primacy:** The striking contrast in the bar sizes exploits the psychological principle of primacy, which ensures that the most dominant visual element (the beef emission figures) is perceived first and remembered longest.

- **Colour psychology:** The use of red for beef not only differentiates it but also invokes a sense of urgency and importance due to the colour's associations with warning signals.
- **Social responsibility cue:** The infographic implicitly calls out the individual's role in climate change, leveraging social responsibility to motivate a re-evaluation of diet-related personal choices.
- **Cognitive dissonance:** For those who prioritise sustainability, the stark visualisation of beef's impact may induce cognitive dissonance, i.e., discomfort when one's behaviour does not align with one's values or beliefs, motivating a change in behaviour to resolve the tension between values and actions.

  Fear appeals: The implied message that beef consumption significantly contributes to climate change can create fear about the future state of the environment, which can be a powerful motivator for change.

Example B: Where does food waste occur?

This example represents a more complex infographic that is well-crafted and has nice elements and approaches regarding engagement and drivers for behavioural change. This infographic, which is on food waste distribution throughout the food supply chain, is designed to inform and engage a diverse audience, from policymakers and businesses to consumers interested in sustainability. The graphic outlines the percentage breakdown of food waste from agriculture to household consumption.

The engagement strategies followed are:

- **Statistical highlighting:** The infographic uses statistical data effectively to grab attention. The coloured bold percentages, especially the prominent display of 45% household waste, highlight the critical areas where intervention can yield a significant impact. These statistics aim to immediately draw the viewer's focus to the most significant figures, promoting awareness and urging action.
- **Carefully selected visual elements:** Each sector of the food supply chain is represented by intuitive icons (e.g., a farm silhouette for agriculture, a factory for processing), which helps in quick identification and understanding, making the infographic universally understandable. The circular flow diagram with a dashed line connects different sectors, visually demonstrating the cyclical nature of the food supply chain and how waste in one sector can influence another. All these elements are designed to simplify complex information, making it accessible at a glance, which is crucial for engaging a non-specialist audience.
- **Design aesthetics:** Using familiar and simple icons aids in the rapid processing of information, reducing the barrier to understanding complex supply chains and their impact. The clear typography avoids sensory overload, keeping the audience focused on the data rather than the design elements.
- **Information depth:** By providing by text specific examples of waste sources in each sector (like cosmetic standards in agriculture or oversizing in food services), the infographic educates the audience on not just the 'what' but the 'why' of food waste. This depth helps in deeper engagement by fostering an understanding of underlying causes, which is more likely to stimulate thoughtful discussion and action.

This infographic targets psychological and motivational factors to enhance audience engagement and prompt action against food waste. It strategically employs design and content elements to tap into viewers' cognitive and emotional responses.

- **Cognitive load management and normative influence**: Using large, bold percentages reduces cognitive load, allowing the viewer to quickly grasp the scale of food waste in different sectors. This immediate understanding can lead to quicker emotional and rational responses. Highlighting the 45% household waste plays on social norms and personal responsibility, motivating individuals to consider their personal contribution to the issue and motivating change at a personal level.
- **Empathy and responsibility:** By detailing specific examples of waste, such as cosmetic standards in agriculture that lead to discarded perfectly edible food, the infographic taps into feelings of empathy and wastefulness. It challenges viewers to reconsider their values and behaviours regarding food consumption.
- **Action-oriented messaging:** While the infographic primarily informs, the underlying message encourages action by demonstrating how substantial changes can occur if behaviours are modified in the highlighted areas, especially at the household level.
- **Self-efficacy:** Showing specific points where waste occurs suggests that targeted actions can significantly reduce waste. This can boost viewers' belief in their ability to make a difference, a key component of self-efficacy in behavioural change.

Example C: The huge flow of animal waste

This represents an infographic trying to inform audience about the animal waste issue. The infographic includes some strong data story elements, it suffers, however, from shortcomings that need to be avoided.

The engagement strategy approaches that are followed are:

- **Visual comparison:** The infographic employs silhouettes of livestock against a backdrop of car silhouettes to provide a stark visual comparison, illustrating the vast waste produced.
- **Relatability through common objects:** By equating the amount of waste to the weight of Toyota Priuses—a familiar consumer item—the visualisation connects abstract numbers to concrete images, enhancing comprehension and retention.
- **Area-specific data:** Focusing on the livestock production of the U.S. as a whole and Iowa, a key state in U.S., personalises the data, making the impact more tangible for those connected to the region.

  Simplicity in design: The choice of a simple colour palette and minimalistic design elements aims to keep the focus on the key data points. However, the extensive text and the chosen typography distract nonetheless.

The psychological and motivational drives that are mobilised in the above engagement strategy are the following:

- **Conceptual metaphor:** Using car silhouettes as a comparative tool for manure volume employs a psychological technique known as conceptual metaphor. This helps the audience to understand and remember large quantities through visualisation.
- **Cognitive ease:** By comparing waste to the weight of a common object (Toyota Prius), the information is made more digestible, reducing cognitive strain and facilitating understanding. However, in the examples discussed in each column, the reference values are fundamentally

different, requiring careful study and text comprehension in order for the audience to understand the analogy. The first one refers to the animal waste analogy for each American, the second is the animal waste corresponding to a cow and the third is again the animal waste per person considering the population of a particular state. This is a shortcoming since it demands from the audience to carefully read and comprehend the analogies.

- **Alarm and urgency:** The sheer scale of waste presented (tons) aims to sound an alarm, potentially motivating advocacy for environmental policy change.
- **Social responsibility:** Presenting the data per American citizen and per Iowa resident leverages social identity, nudging individuals toward considering their personal or community role in a larger issue.
- **Empowerment through knowledge:** By informing the public with hard data, the infographic empowers viewers to make more informed decisions or to engage in conversations about environmental practices.

Example D: Food Carbon Foot-print Index 2018 ('VizForFuture - Food Carbon Footprint Index 2018 | 2 | Tableau Public', n.d.)

This data story engages its audience through interactive data visualisation, presenting a compelling narrative about the environmental impact of food consumption on a global scale. The major KPI involved is the Food Carbon Footprint Index (FCFI), which compares animal products' carbon footprint to non-animal products across 130 countries. The storytelling allows the user to investigate the FCFI of specific countries, drill down on specific figures across animal and non-animal products, and visually compare each country's performance across eleven key food items. The data story also conveys the message of the significant environmental impact associated with the production of animal products versus non-animal products.

The data story builds upon the following engagement elements:

- **Visual storytelling:** The core of the data story is a stark contrast between animal and non-animal product carbon footprints. This is immediately visible through the radial layout, which dramatically showcases the disproportionate impact of animal products, drawing the viewer's attention to the critical issue of sustainability in food production.
- **Interactivity:** The data story invites active participation by enabling the exploration of specific countries' data with mouseover pop-ups and searchable country-specific highlights. This approach personalises the data and educates users on the carbon footprint associated with different food items, promoting greater awareness of individual and collective environmental impacts.
- **Comparative data presentation:** Including total carbon footprint values alongside individual food categories allows for at-a-glance comparisons. It highlights the significance of dietary choices on carbon emissions, thus sparking conversation and potentially influencing consumer behaviour.
- **Information accessibility:** Through its intuitive design, the data story communicates complex data in an accessible manner, making it understandable for a broad audience regardless of their background in environmental studies or data analysis.
- **Aesthetic Appeal:** The data story balances aesthetic appeal with informational clarity, featuring a modern and sleek design that is both pleasing to the eye and functional. The colour choices and graphical elements make the data engaging rather than overwhelming.

The psychological and motivational factors mobilised to achieve engagement and impact are:

- **Social proof and benchmarking:** The presentation of data across 130 countries taps into the psychological concept of social proof, suggesting a collective concern and effort towards reducing carbon footprints. It also allows for benchmarking, where individuals or policymakers can compare their country's performance against others, which can motivate improvements and changes in policy or personal behaviour.
- **Contrast and salience:** The stark contrast in the visual size of the animal and non-animal product footprints leverages the salience effect — our tendency to focus on items that stand out. This draws immediate attention to the significant environmental impact of animal products, possibly motivating a shift toward more plant-based options.
- **Curiosity and engagement:** Interactive elements like hovering for detailed information and searching for specific countries satisfy the user's curiosity and foster engagement with the data. This direct interaction can deepen the user's connection to the information, making the message more memorable and persuasive.
- **Empowerment through knowledge:** The data story empowers users with knowledge by presenting actionable data—such as specific carbon footprint figures for individual countries and food categories. This can inspire a sense of responsibility and efficacy, motivating them to take personal action to reduce their carbon footprint.
- **Moral alignment and identity:** For some users, the information may align with their moral values regarding environmental conservation and ethical consumption, reinforcing their identity and potentially galvanising them to become advocates for change in their communities.

Technical Insights and User Experience

Interactive data storytelling presents distinct technical requirements and user experience challenges that set it apart from other digital tools such as games or applications. At the heart of data storytelling lies the crucial process of selecting, transforming, and presenting information effectively. However, the interactive elements of data storytelling demand particular attention to ensure they are intuitive and self-explanatory. Users should not require prior experience or the need to engage in trial-and-error to understand how to interact with the data. If the interaction mechanisms are not immediately clear, there is a risk that users may become distracted or disengaged. This requirement underscores the importance of designing interactions that are straightforward and seamlessly integrate with the narrative flow, thereby keeping the user's focus firmly anchored on the data and its implications. It is essential that these interactions enhance the storytelling by making the data more accessible and engaging, without detracting from the user's ability to absorb and reflect on the information presented.

Reward Schemes and Motivational Factors

Example A: While there is no direct reward system within the infographic itself, it indirectly promotes intrinsic rewards by providing knowledge, empowerment, and the potential for social reward. These factors can internally motivate individuals to engage with the content and potentially

alter their behaviour in line with the environmental ethos presented. The reward schemes and intrinsic motivation mechanisms followed are listed below:

- **Knowledge as reward:** The infographic provides valuable information, which can be intrinsically rewarding for individuals seeking to make informed decisions about their environmental impact. Moreover, by demystifying the emissions associated with different meat types and meat processing stages, the audience is empowered to make choices that align with their values, which can be intrinsically satisfying.
- **Social reinforcement:** The infographic format is well-defined for social media sharing. The option to share the infographic acts as a social reward mechanism. Users motivated by social validation can share their environmentally conscious stance, which may influence others in their network to change their behaviour. The action reinforces the sharer's identity as an environmentally conscious person.
- **Moral alignment:** Understanding the impact of their choices can give individuals a sense of moral satisfaction, aligning their actions with their beliefs about climate change, which is an intrinsic reward.
- **Self-efficacy:** The clear presentation of the data may encourage viewers to believe that their individual choices can make a difference, enhancing their sense of self-efficacy.
- **Affirmation of beliefs:** For those already environmentally aware, the infographic reinforces their beliefs, serving as an intrinsic reward that may strengthen the commitment to sustained behaviour change.

Example B: This infographic does not explicitly detail a reward scheme within its design; however, it implicitly employs the principles of these schemes to influence user motivation and behaviour change regarding food waste. Understanding how these underlying mechanisms are presented can offer insights into their potential impact on behaviour. The analysis of implicit reward schemes follows:

- **Recognition of impact:** Highlighting the significant percentages of waste in household and processing sectors indirectly suggests that actions to reduce waste in these areas can have a large impact. This recognition can be a form of positive reinforcement, where individuals feel their efforts are meaningful.
- **Social approval:** The infographic taps into social norms and the desire for social approval by addressing consumer behaviour. Reducing food waste, as suggested, might lead individuals to perceive themselves as part of a solution, aligning with societal values of sustainability and responsibility.

  Empowerment through information: By providing information about where and how waste occurs, the infographic educates the audience, equipping them with the knowledge needed to make informed decisions. This can be motivational in itself, as awareness often precedes action. Understanding the specifics of food waste can empower individuals to make changes that they believe will contribute to waste reduction, fostering a sense of agency and personal efficacy.

Example C: In this example, there is not a clearly implied call to action; that is a shortcoming. The rewards and motivation mechanisms are implicit and aim to drive behavioural change mostly based on new impactful knowledge. The reward schemes chosen are:

- **Cognitive reward:** The infographic simplifies complex data through familiar comparisons, offering cognitive rewards to users in the form of 'wow' moments when they grasp the scale of waste production.
- **Social validation:** For individuals particularly invested in environmental causes, sharing this information could offer social rewards in the form of approval or praise from like-minded peers, thus reinforcing environmentally conscious behaviors.
- **Empathetic response:** The visualization may tap into empathetic concerns for the environment, rewarding users with a sense of moral satisfaction for understanding and potentially advocating for change regarding environmental issues.

Regarding motivation triggers for behavior change:

- **Knowledge empowerment:** The infographic provides knowledge in a powerful visual format, which can be a motivator for change. It empowers users to make more informed choices or engage in environmental discussions and actions.
- **Normalization of big data:** By breaking down intimidating data into relatable terms, the infographic normalises the consumption of big data, potentially motivating users to seek out and understand more such information, leading to increased awareness and informed behaviour.
- **Behavioural catalyst:** For some viewers, understanding the scale of the issue might catalyse behaviour change, such as reducing meat consumption, supporting sustainable farming, or engaging in community action.

Example D: This data story subtly incorporates elements of reward schemes to influence user motivation and behaviour change, predominantly through positive reinforcement:

- **Information reward:** The interactive feature that reveals country-specific carbon footprint data upon hovering or searching provides immediate informational gratification. This kind of positive feedback encourages continued exploration of the data, reinforcing learning and retention.
- **Visual rewards:** The use of visually appealing graphics and the highlighted contrast between the footprints of animal and non-animal products serve as a form of visual reward. The aesthetic pleasure derived from engaging with the dashboard may subconsciously encourage users to revisit and share the information, thus amplifying the reach and impact of the data.
- **Cognitive rewards:** By enabling users to discover data for themselves, the dashboard offers a sense of cognitive achievement. This self-driven discovery can be intrinsically rewarding, as users feel a sense of accomplishment in unveiling the information that is not immediately apparent.
- **Social rewards:** The potential for social interaction and comparison, such as seeing how one's country stacks up against others, leverages the reward mechanism of social standing. Users are motivated to engage with the data and possibly to act to improve their country's standing, which would be a source of national pride.

  Normative rewards: Presenting the data normatively, with clear indications of 'better' or 'worse' outcomes, might align with users' desire to conform to environmental norms. Users motivated by normative rewards may seek to reduce their carbon footprint to align with the positive normative behaviours implied by the data.

Key Artefacts of Success and Lessons Learned

Based on the analysis of the examples above as well of the rest of the about 45 data stories on the domain that we have collected, we discuss below the common features among the most successful cases:

A good data story should have a clear and compelling narrative that guides the audience through the data, explaining why it matters and how it relates to them. This involves setting up a problem, discussing the analysis, and concluding with insights. Moreover, raw data display is often not enough to draw the audience's full attention. Techniques such as visual comparisons, i.e., using familiar objects in visual metaphors, can make abstract or complex data more tangible and easier to understand. Such visual comparisons must be well-thought-out since this approach risks simplifying the data too much or may seem patronizing if not well-matched to the audience's level of expertise. Another effective technique is to quantify the KPI of interest, e.g. animal waste or environmental impact, in everyday terms because it relates to common experiences, making the data more relatable and impactful. Also, the human brain is attracted to novel stimuli. So, surprising facts or unconventional insights in the data story, i.e., presenting data in a new format, revealing hidden trends, or debunking common misconceptions, can have a long-lasting effect and impact behavioral change.

Providing context around the data is crucial. This involves explaining what the data represents, its importance, and how it should be interpreted. Context helps prevent misinterpretation and increases the data's impact. Moreover, it is useful to convey compactly and appealingly not only the "what" but also the "why" something is happening. However, the key insight and message of the data story need to be focused, and to the point and the data, story needs to be kept simple and clear. This makes the story accessible to a broader audience and prevents information overload. In this regard, the story should be tailored to the audience's interests, knowledge level, and needs. Ensuring the data and insights are relevant to them enhances engagement and comprehension.

Regarding visualization techniques, concentrating on a focal point in the visual design can effectively guide the viewer's attention to the most crucial information, helping to organize the narrative and prioritize data interpretation. Overemphasis on a single focal point, however, might detract from other important data elements that could provide essential context or supporting evidence, potentially leading to a skewed understanding of the issue. Also, highlighting key statistics helps them stand out, aiding in quicker comprehension and better retention of critical information.

Design aesthetics are also very important. Simplicity in design helps prevent cognitive overload, making data easier to absorb and understand immediately. Well-chosen images, icons, or charts can aid understanding and retention by providing visual shortcuts to complex information. Professional typography and good design can enhance understanding and retention of information. An attractive presentation can also increase credibility and encourage more significant engagement from the audience.

Finally, interactive elements in data storytelling engage the audience actively, providing a hands-on experience that can deepen understanding and retention. However, these elements can be complex to implement, require additional technological access, and overwhelm or confuse users unfamiliar with interactive data tools. Thus, they need a more thoughtful approach to achieve their full potential, which is high.

In data storytelling, reward schemes generally aren't discussed in the conventional sense of customer loyalty programs or employee incentives. However, if we think of rewards in terms of audience

engagement and motivational outcomes, successful "rewards" can be framed as the benefits audiences gain from the story. These include clearer understanding, actionable insights, and emotional connection.

Conclusions

The thorough investigation of data stories examples in the food chain-triggered environmental impact and climate change appeared to be relatively poor compared to data stories from other domains. While the data storytelling in the food chain domain shows promise, it requires further development and integration of advanced storytelling techniques. The collaboration of multidisciplinary teams, including design, copywriting, behavioral science, and data science experts, is essential for creating high-quality, impactful data stories that drive engagement and behavioral change. Future tool development should focus on leveraging insights from more mature domains to enhance the effectiveness of data stories in promoting environmental awareness and action.

6. Discussion

6.1 Effectiveness of Digital Tools

The effectiveness of digital tools in promoting food mitigation measures is underscored by their ability to engage users, influence behaviors, and enhance the communication of sustainability information. Our detailed analysis provides substantial evidence of their efficacy across various dimensions.

The online shopping platforms of Albert Heijn (Netherlands), Migros (Switzerland), and DM (Austria) exemplify the impactful use of digital tools in promoting sustainable consumer behavior. These platforms effectively use detailed product pages, sustainability filters, and promotional content to guide consumers towards environmentally friendly choices. For instance, DM's use of filters such as "Bio" and "More sustainable products" significantly aids consumers in identifying sustainable options. This feature not only simplifies the decision-making process but also actively nudges consumers towards making more sustainable purchases (Principato et al., 2023). Moreover, the clear and accessible presentation of sustainability labels, along with detailed product information, greatly enhances consumer awareness. This approach ensures that consumers are well-informed about the environmental impact of their choices, fostering a culture of conscious consumption.

The platforms' effectiveness is further amplified by their user-friendly design and intuitive navigation, which reduce the barriers to accessing sustainability information. By integrating such features, these online platforms have succeeded in not only informing consumers but also in making sustainable choices the default and most straightforward option. This integration of detailed information with ease of use demonstrates a significant advancement in how digital tools can drive sustainable consumer behavior.

Our analysis of games like "Gibbon: Beyond the Trees," "Beecarbonize," and "Bear & Breakfast" reveals their substantial potential in promoting sustainability through engaging and interactive methods. These games incorporate environmental themes and use various engagement techniques such as narrative elements, rewards, and challenges. For example, "Gibbon: Beyond the Trees" immerses players in a storyline that emphasizes the importance of conservation and the impact of deforestation, thereby educating players about environmental issues in a compelling way. The use of rewards and challenges not only makes the learning process enjoyable but also reinforces the importance of sustainable practices through repeated engagement (Abbate et al., 2023).

The effectiveness of these games lies in their ability to make complex sustainability concepts accessible and enjoyable. By translating abstract environmental issues into interactive and relatable scenarios, these games foster greater awareness and encourage behavioural change among players. Furthermore, the high production quality and wide reach of these games ensure significant user engagement, making them powerful tools for sustainability education. The immersive experience provided by these games helps to internalize the importance of sustainable practices, making the lessons learned more likely to be carried into real-world behavior.

Data storytelling has proven to be a particularly powerful tool in communicating the complexities of the food chain and its environmental impact. Our review of fifty data stories highlighted four cases that effectively utilized visual and interactive elements, clear narrative techniques, and psychological drivers to engage audiences. These stories, using interactive dashboards and infographics, were able to convey critical information about the environmental impact of food choices in a compelling and accessible manner (Garnett, 2011). For instance, interactive dashboards that allow users to visualize data on food waste and its environmental impact make the information more tangible and understandable.

The effectiveness of data storytelling lies in its ability to simplify complex data and present it in a visually appealing and engaging format. This approach not only captures and maintains audience interest but also facilitates a deeper understanding of sustainability issues. By leveraging clear narratives and interactive elements, data storytelling tools make it easier for audiences to grasp the significance of their food choices and the broader environmental implications. This method has proven effective in motivating behavior change, as it provides users with actionable insights in an engaging and memorable format.

In summary, our research found that digital tools are highly effective in promoting sustainable food practices. Online platforms excel in providing accessible and detailed sustainability information, games engage users through interactive and enjoyable experiences, and data storytelling tools make complex information relatable and actionable. These tools collectively contribute to a greater awareness of sustainability issues and encourage more sustainable behaviors among users. However, to fully realize their potential, it is essential to address the challenges and limitations identified in our study.

6.2 Challenges and Limitations

Despite the overall effectiveness of digital tools in promoting sustainable food practices, several challenges and limitations were identified in our research. One of the primary technical challenges is the lack of interoperability between different digital systems, which hampers the seamless integration of various tools and data sources. This issue leads to inconsistencies in data quality and usability, affecting the overall effectiveness of these tools. Additionally, the technical complexity involved in developing and maintaining these systems requires substantial resources and expertise, posing a significant barrier to their widespread adoption and implementation (Galanakis et al., 2021).

User engagement issues also present a significant challenge. While digital tools have shown potential in engaging users, there remains a portion of the population that is resistant to adopting new technologies. Factors such as digital literacy, access to technology, and user preferences play crucial roles in determining the effectiveness of these tools. Ensuring that digital tools are accessible and user-friendly for diverse audiences is essential for broad adoption and maximizing their impact (Dittmer et al., 2022).

Data privacy and security concerns further complicate the deployment of digital tools. The collection and processing of user data raise significant ethical issues, requiring robust data governance frameworks to protect personal information and maintain user trust. Data breaches and misuse of personal information can severely undermine the effectiveness of these tools, highlighting the need for stringent data protection measures (World Health Organization, 2021).

Finally, achieving scalability and sustainability for digital tools in food mitigation measures is a major challenge. Many tools require continuous updates, maintenance, and user support to remain effective, necessitating long-term funding and resources. Securing these resources can be difficult, limiting the tools' impact and reach (Onwude et al., 2020).

6.3 Recommendations for Practitioners

To enhance the effectiveness and adoption of digital tools in food mitigation measures, practitioners should consider several key recommendations. Firstly, enhancing interoperability between different digital tools and systems is crucial. Developing standards and protocols to ensure seamless integration of data and functionalities can significantly improve the user experience and overall effectiveness of these tools (Galanakis et al., 2021).

Incorporating user-centered design principles can also greatly enhance usability and accessibility. Engaging with users during the design and development process helps identify their needs and preferences, ensuring that the tools are tailored to meet their requirements. This approach can lead to higher user satisfaction and greater adoption rates (Dittmer et al., 2022).

Ensuring data privacy and security is paramount. Implementing robust data governance frameworks and security measures can protect user data and maintain trust. Adhering to industry standards and regulatory requirements helps mitigate privacy and security risks, ensuring ethical use of data (World Health Organization, 2021).

Promoting digital literacy is another critical factor. Providing training and resources to enhance digital literacy can facilitate the adoption of digital tools. Educating users on the benefits and functionalities of these tools can help overcome resistance to technology and promote wider use (Onwude et al., 2020).

Finally, securing long-term funding and resources is essential for the sustainability of digital tools. Developing business models that include funding strategies, partnerships, and revenue streams can help ensure continuous development and maintenance, maximizing the tools' impact (Cafiero et al., 2022).

6.4 Future Directions

Future research and development in the field of digital tools for food mitigation measures should focus on addressing identified challenges and exploring new opportunities for innovation. Integrating advanced technologies such as artificial intelligence, machine learning, and blockchain

can enhance the functionality and effectiveness of digital tools. These technologies can provide more accurate predictions, improve data security, and enable real-time monitoring and decision-making (Abbate et al., 2023).

Developing innovative user engagement strategies, such as gamification and social incentives, can enhance the adoption and effectiveness of digital tools. Personalised experiences and rewards can motivate users to engage with the tools and adopt sustainable practices. Additionally, creating collaborative platforms that involve multiple stakeholders, including consumers, producers, and policymakers, can foster a more integrated approach to food mitigation measures, facilitating knowledge sharing and collective action towards sustainability goals (Principato et al., 2023).

Exploring scalable solutions, such as cloud-based platforms and modular tool designs, can help overcome scalability challenges. These solutions provide flexibility and adaptability, allowing tools to be easily updated and expanded to meet growing demands. Conducting comprehensive impact evaluations can provide valuable insights into the effectiveness of digital tools. Longitudinal studies and real-world trials can help assess the long-term impact of these tools on sustainable food practices and inform future development (Galanakis et al., 2021).

By addressing these areas, future research and development can enhance the effectiveness and sustainability of digital tools in promoting food mitigation measures, ultimately contributing to more sustainable food systems.

7. Conclusions

The effectiveness of digital tools in promoting food mitigation measures is underscored by their ability to engage users, influence behaviours, and enhance the communication of sustainability information. Our detailed analysis provides substantial evidence of their efficacy across various dimensions.

The online shopping platforms analysed, exemplify the impactful use of digital tools in promoting sustainable consumer behaviour. These platforms effectively leverage detailed product pages, sustainability filters, and promotional content to guide consumers towards environmentally friendly choices. For instance, DM's use of filters such as "Bio" and "More sustainable products" significantly aids consumers in identifying sustainable options. This feature not only simplifies the decision-making process but also actively nudges consumers towards making more sustainable purchases (Principato et al., 2023). Moreover, the clear and accessible presentation of sustainability labels, along with detailed product information, greatly enhances consumer awareness. However, it is noted that these retailers communicate health and nutritional information more effectively than sustainability-related information, indicating an area for improvement. Increasing the promotion of sustainable products while reducing the discounts on non-sustainable products can further influence consumer behavior positively. This approach ensures that consumers are well-informed about the environmental impact of their choices, fostering a culture of conscious consumption.

The platforms' effectiveness is further amplified by their user-friendly design and intuitive navigation, which reduce the barriers to accessing sustainability information. By integrating such features, these online platforms have succeeded in not only informing consumers but also in making sustainable choices the default and most straightforward option. This integration of detailed information with ease of use demonstrates a significant advancement in how digital tools can drive sustainable consumer behavior.

Our analysis of games, reveals their substantial potential in promoting sustainability through engaging and interactive means. These games incorporate environmental themes and utilize various engagement techniques such as narrative elements, rewards, and challenges. For example, "Gibbon: Beyond the Trees" immerses players in a storyline that emphasizes the importance of conservation and the impact of deforestation, thereby educating players about environmental issues in a compelling way. The use of rewards and challenges not only makes the learning process enjoyable but also reinforces the importance of sustainable practices through repeated engagement (Abbate et al., 2023). However, there are currently few games available that link climate and food systems, and there are no long-term assessments of behavioural change following game-based interventions. Exploring the potential of large-reach games for sustained behavioral impact could be a valuable area for future research and development.

The effectiveness of these games lies in their ability to make complex sustainability concepts accessible and enjoyable. By translating abstract environmental issues into interactive and relatable scenarios, these games foster greater awareness and encourage behavioural change among players. Furthermore, the high production quality and wide reach of these games ensure significant user engagement, making them powerful tools for sustainability education. The immersive experience provided by these games can help to internalize the importance of sustainable practices, making the lessons learned more likely to be carried into real-world behavior. At the same time, there are still

only few games that link the food sector to environmental issues and protection, especially as their main focus. The games that at least go in this direction, like the ones assessed here, do not just function as positive examples but also highlight design choices that should be avoided or used with care so that the intended message is not negated.

Data storytelling has proven to be a particularly powerful tool in communicating the complexities of the food chain and its environmental impact. Our review of fifty data stories highlighted four cases that effectively utilized visual and interactive elements, clear narrative techniques, and psychological drivers to engage audiences. These stories, through the use of interactive dashboards and infographics, were able to convey critical information about the environmental impact of food choices in a compelling and accessible manner (Garnett, 2011). For instance, interactive dashboards that allow users to visualize data on food waste and its environmental impact make the information more tangible and understandable. However, the investigation revealed that data stories in the food chain domain are relatively poor compared to other domains. There is a need for further development and integration of advanced storytelling techniques. Collaboration among multidisciplinary teams, including experts in design, copywriting, behavioral science, and data science, is essential to create high-quality, impactful data stories that drive engagement and behavioral change. Future tool development should leverage insights from more mature domains to enhance the effectiveness of data stories in promoting environmental awareness and action.

The effectiveness of data storytelling lies in its ability to simplify complex data and present it in a visually appealing and engaging format. This approach not only captures and maintains audience interest but also facilitates a deeper understanding of sustainability issues. By leveraging clear narratives and interactive elements, data storytelling tools make it easier for audiences to grasp the significance of their food choices and the broader environmental implications. This method has proven effective in motivating behavior change, as it provides users with actionable insights in an engaging and memorable format.

In summary, our research found that **digital tools are highly effective in promoting sustainable food practices.** Online platforms excel in providing accessible and detailed sustainability information, games engage users through interactive and enjoyable experiences, and data storytelling tools make complex information relatable and actionable. Retailers' websites currently communicate health and nutritional information more effectively than sustainability-related information, indicating an area for improvement. **The promotion of sustainable products should be increased**, while **discounts on non-sustainable products should be decreased** to influence consumer behavior positively. Additionally, while games have shown potential, **there is a lack of long-term assessments on behavioral change following game-based interventions**. **Data storytelling in the food chain domain requires further development**, with a focus on collaboration among multidisciplinary teams. These tools **collectively contribute to a greater awareness of sustainability issues and encourage more sustainable behaviors among users**. However, to fully realize their potential, it is essential to address the challenges and limitations identified in our study.

By integrating these enhancements and specific inputs, your conclusions will be enriched with detailed information, making them more comprehensive and impactful.

References

Abbate, S., Centobelli, P., & Cerchione, R. (2023). The digital and sustainable transition of the agri-food sector. *Technological Forecasting and Social Change*, *187*, 122222.

Allende, A., Bover-Cid, S., & Fernández, P. S. (2022). Challenges and opportunities related to the use of innovative modelling approaches and tools for microbiological food safety management. *Current Opinion in Food Science*, *45*, 100839.

Balasundram, S. K., Shamshiri, R. R., Sridhara, S., & Rizan, N. (2023). The role of digital agriculture in mitigating climate change and ensuring food security: An overview. *Sustainability*, *15*(6), 5325.

Bear and Breakfast. (n.d.). Retrieved 31 May 2024, from https://www.bear.game/

Beecarbonize – Charles Games. (n.d.). Retrieved 31 May 2024, from https://charlesgames.net/beecarbonize/

Benyam, A. A., Soma, T., & Fraser, E. (2021). Digital agricultural technologies for food loss and waste prevention and reduction: Global trends, adoption opportunities and barriers. *Journal of Cleaner Production*, *323*, 129099.

Cafiero, C., Blanco Fonseca, M., Chelle, M., Egamberdieva, D., Kanter, R., Kimani, S., … Schader, C. (2022). *Data collection and analysis tools for food security and nutrition. Towards enhancing effective, inclusive, evidence-informed, decision making*.

Chauhan, C., Dhir, A., Akram, M. U., & Salo, J. (2021). Food loss and waste in food supply chains. A systematic literature review and framework development approach. *Journal of Cleaner Production*, *295*, 126438.

Chen, J., Grech, A., & Allman-Farinelli, M. (2022). Using popular foods consumed to inform development of digital tools for dietary assessment and monitoring. *Nutrients*, *14*(22), 4822.

Dittmer, K. M., Wollenberg, E. K., Burns, S., & Shelton, S. W. (2022). *Digital tools for climate change adaptation and mitigation*.

Douglas, B. D., & Brauer, M. (2021). Gamification to prevent climate change: A review of games and apps for sustainability. *Current Opinion in Psychology*, *42*, 89–94. https://doi.org/10.1016/j.copsyc.2021.04.008

Duarte, N. (2019). *Data story: Explain data and inspire action through story* (Vol. 1). Ideapress Publishing.

Engelstätter, B., & Ward, M. R. (2022). Video games become more mainstream. *Entertainment Computing*, *42*, 100494. https://doi.org/10.1016/j.entcom.2022.100494

FAO. (2019). *The state of food and agriculture 2019: Moving forward on food loss and waste reduction*. UN.

Fernández Galeote, D., & Hamari, J. (2021). Game-based climate change engagement: Analyzing the potential of entertainment and serious games. *Proceedings of the ACM on Human-Computer Interaction*, *5*(CHI PLAY), 1–21.

Fernández Galeote, D., Rajanen, M., Rajanen, D., Legaki, N.-Z., Langley, D. J., & Hamari, J. (2021).

Gamification for climate change engagement: Review of corpus and future agenda. *Environmental Research Letters*, *16*(6), 063004. https://doi.org/10.1088/1748-9326/abec05

Galanakis, C. M., Rizou, M., Aldawoud, T. M., Ucak, I., & Rowan, N. J. (2021). Innovations and technology disruptions in the food sector within the COVID-19 pandemic and post-lockdown era. *Trends in Food Science & Technology*, *110*, 193–200.

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

Goedde, L., McCullough, R., Ooko-Ombaka, A., & Pais, G. (2021). How digital tools can help transform African agri-food systems. *McKinsey Co*.

Greener games for game developers. (n.d.). Retrieved 31 May 2024, from https://www.greengamedesign.com/?tool=games

Gustavsson, J., Cederberg, C., Sonesson, U., Van Otterdijk, R., & Meybeck, A. (2011). *Global food losses and food waste*. FAO Rome.

IGDA Climate SIG: Games Database V1. (n.d.). Retrieved 31 May 2024, from Google Docs website: https://docs.google.com/spreadsheets/d/1qdGB8W5FOUQKS_hlhHSInHqFZX75Ok2VXk-rURVFHBA/edit?usp=embed_facebook

Lieberoth, A., Holm Jensen, N., & Bredahl, T. (2018). Selective psychological effects of nudging, gamification and rational information in converting commuters from cars to buses: A controlled field experiment. *Transportation Research Part F: Traffic Psychology and Behaviour*, *55*, 246–261. https://doi.org/10.1016/j.trf.2018.02.016

Lorenzoni, I., Nicholson-Cole, S., & Whitmarsh, L. (2007). Barriers perceived to engaging with climate change among the UK public and their policy implications. *Global Environmental Change*, *17*(3–4), 445–459. https://doi.org/10.1016/j.gloenvcha.2007.01.004

Manners, R., Adewopo, J., Niyibituronsa, M., Remans, R., Ghosh, A., Schut, M., … Fraenzel, A. (2022). Leveraging digital tools and crowdsourcing approaches to generate high-frequency data for diet quality monitoring at population scale in Rwanda. *Frontiers in Sustainable Food Systems*, *5*, 804821.

Marra, F. (2022). Food products and digital tools: The unexpected interconnections. *Frontiers in Nutrition*, *9*, 847038.

Onwude, D. I., Chen, G., Eke-emezie, N., Kabutey, A., Khaled, A. Y., & Sturm, B. (2020). Recent Advances in Reducing Food Losses in the Supply Chain of Fresh Agricultural Produce. *Processes*, *8*(11), 1431. https://doi.org/10.3390/pr8111431

Ouariachi, T., Olvera-Lobo, M. D., Gutiérrez-Pérez, J., & Maibach, E. (2019). A framework for climate change engagement through video games. *Environmental Education Research*, *25*(5), 701–716. https://doi.org/10.1080/13504622.2018.1545156

Pan, S., Ren, X., Vos, S., & Brombacher, A. (2021). Digital tools to promote healthy eating for working-age individuals: A scoping review. *The Ninth International Symposium of Chinese CHI*, 1–8.

Principato, L., Marchetti, S., Barbanera, M., Ruini, L., Capoccia, L., Comis, C., & Secondi, L. (2023). Introducing digital tools for sustainable food supply management: Tackling food loss and waste in

industrial canteens. *Journal of Industrial Ecology*, *27*(4), 1060–1075.

Rules, B. (n.d.). Gibbon: Beyond the Trees. Retrieved 31 May 2024, from Https://gibbongame.com/ website: https://www.gibbongame.com

Sridhar, A., Balakrishnan, A., Jacob, M. M., Sillanpää, M., & Dayanandan, N. (2023). Global impact of COVID-19 on agriculture: Role of sustainable agriculture and digital farming. *Environmental Science and Pollution Research*, *30*(15), 42509–42525.

Stankovic, M., Neftenov, N., & Gupta, R. (n.d.). Use of Digital Tools in Fighting Climate Change: A Review of Best Practices. *Availabe Online: Https://Bit. Ly/3Gxodt6 (Accessed on 21 October 2022)*.

Tancredi, G. P., Vignali, G., & Bottani, E. (2022). Integration of digital twin, machine-learning and industry 4.0 tools for anomaly detection: An application to a food plant. *Sensors*, *22*(11), 4143.

Telukdarie, A., Munsamy, M., & Mohlala, P. (2020). Analysis of the Impact of COVID-19 on the Food and Beverages Manufacturing Sector. *Sustainability*, *12*(22), 9331.

VizForFuture—Food Carbon Footprint Index 2018 | 2 | Tableau Public. (n.d.). Retrieved 1 June 2024, from https://public.tableau.com/app/profile/vizpilgrim/viz/VizForFuture-FoodCarbonFootprintIndex20182/FCFPI2018

World Health Organization, W. H. (2021). *WHO guidelines on ethical issues in public health surveillance. 2017*.

Annex 1: List of Digital tools for food mitigation

No	Name of Digital tool	Digital Tool	Type of Digital tool	Description	Availability	Available link	Manufacturer
1.	Inoqo personal lifestyle app'	Mobile Application	Educational app	An app that you can check the impact of your products, before you buy them. Reward system by scanning the receipt of your grocery shopping calculate your impact and get rewarded with vouchers on your next shopping according to your sustainable choices	Austria (only in german) so far	www.inoqo.com	inoqo gmbh (inoqo)
2.	'Shrink your Food Waste' app	Mobile Application	Meal planning app	Shrink your food waste app, will enable users track their food items and when they are expiring, with reminders when food is ready to 'go off'. It will provide information to assist the user preserve its food in better conditions. Locally inspired recipe recommendations. the app will offer convenient features, such as integrated shopping lists with smart prioritisation, focusing on previously tracked targets and achieved goals. The app will indicate the impact of food waste reduction at a personal level, but also, capitalising on IAM models' simplified interfaces and associated results, will reflect the impacts of such behavioural shift potential when adopted at large-scale.	Everywhere	N/A yet	CHOICE? Not mentioned
3.	Just Salad	Mobile Application	Restaurant app	An app that is a tool to make healthy eating (ordering) options and to take action for the planet, by knowing the environmental impact of what you eat. calculation of environmental impact by https://www.planetfwd.com/	USA & Dubai	https://justsalad.com/	Just Salad LLC (USA)
4.	ForkRanger	Mobile Application	Educational app	The app provides users with one story a day about sustainable food, infographics about the food system, and easy, vegetarian recipes. The app is designed to help users eat more plant-based and seasonal foods, understand how to eat sustainably, and discover new recipes.	Everywhere	https://www.forkranger.com/	Fork Ranger (Netherlands)
5.	Fooducate	Mobile Application	Educational app	An app that educates users about the nutritional value of foods.	EU + other countries	https://www.fooducate.com/	Fooducate, Ltd.
7.	EAT Club	Mobile Application	Educational app	A corporate food delivery service that calculates and offsets the carbon footprint of meals.	USA	https://www.eatclub.com/	EATCLUB PTY LTD
8.	Olio	Mobile Application	Food sharing app	An app that facilitates the sharing of everything including surplus food items within a local community to reduce waste.	Everywhere	https://olioapp.com/en/	OLIO Exchange Ltd (UK)
9.	FlashFood	Mobile Application	Food sharing app	Helps retailers sell surplus food before it becomes waste.	USA & CANADA	https://www.flashfood.com/	Flashfood Inc
10.	Seasonal Food Guide	Mobile Application	Grocery shopping app	Helps users find seasonal foods in their area.	EU + other countries	https://www.seasonalfoodguide.org/	Seasonal Food Guide
11.	Imperfect Food	Mobile Application	Grocery shopping app	a grocery delivery service that aims to reduce food waste by selling reclaimed produce that would otherwise be thrown away, along with a number of other reclaimed grocery items.	USA	https://www.imperfectfoods.com/	Imperfect Foods

12.	Misfits Market	Mobile Application	Grocery shopping app	Misfits Market is an app that allows users to shop for deeply discounted, high-quality groceries at prices up to 40% less than traditional grocery stores	USA	https://apps.apple.com/us/app/misfits-market-groceries/id1564147180	Misfits Market, Inc. (USA)
14.	Farmstand	Mobile Application	Grocery shopping app	Farmstand is an app that helps users find farm fresh food	USA	https://apps.apple.com/ae/app/farmstand-find-farm-fresh/id1586367019	Provider Erik Johnson
15.	Frigo Magic	Mobile Application	Meal planning app	Frigo Magic is an app that offers recipes that can be made with the products available in your kitchen.	Everywhere	https://www.frigomagic.com/	Frigo Magic SAS
16.	No Waste	Mobile Application	Meal planning app	Helps users track food at home to reduce waste.	Everywhere	https://www.nowasteapp.com/	No Waste, LLC
17.	Mealime	Mobile Application	Meal planning app	Mealime is a meal planning app designed to simplify the lives of busy individuals and families. The app offers personalized meal plans, grocery lists, and step-by-step cooking instructions to make meal preparation easier.Mealime encourages efficient grocery shopping and meal planning, which can help reduce food waste. By providing grocery lists that are tailored to the meals you plan to cook, the app ensures that you buy only what you need. This can minimize food waste, thereby contributing to more sustainable food consumption practices.	Everywhere	https://www.mealime.com/	Mealime Meal Plans Inc
18.	Green Kitchen	Mobile Application	Meal planning app	Offers a collection of tasty and healthy vegetarian recipes.	EU + other countries	https://www.greenkitchenapps.com/	Green Kitchen
19.	Yummly	Mobile Application	Meal planning app	Offers a vast collection of recipes with dietary filters.	EU + other countries	https://www.yummly.com/	Yummly
20.	Too Good To Go	Mobile Application	Restaurant app	Helps restaurants reduce food waste by selling surplus food at discounted prices.Too Good to Go is available in many cities across Europe and North America.	EU, USA & Canada	https://www.toogoodtogo.com/	Too Good To Go
22.	Happy Cow	Mobile Application	Restaurant app	Helps users locate vegan and vegetarian restaurants, promoting plant-based diets which are typically more sustainable.	Everywhere	https://www.happycow.net/	HappyCow, Inc. (USA)
23.	Savery	Mobile Application	Restaurant app	Savery delivers unsold, sumptuous restaurant food at a fraction of the price, offering quality meals with a feel-good flavour!	USA	https://www.thesaveryapp.com/	Moonsted IVS(USA)
24.	FoodBag	Mobile Application	Restaurant app	Every day food is rejected from catering outlets such as bakeries - restaurants - hotels - grocery stores - supermarkets etc., because they simply did not have time to sell within opening hours. The FoodBag app enables consumers to buy Surprise Bags of fresh food - at a great discount - directly from the stores.	Greece	https://foodbag.gr/	FOODBAG IKE (Greece)

25.	BringItBack	Mobile Application	Restaurant app	a food management app that manages food that is fresh today, but at the end of the day will not be disposed of and will be withdrawn and thrown away. This contributes to a vicious cycle, which results in a negative impact on the environment, increasing food waste	Greece	https://bringit-back.com/	BRING IT BACK I.K.E (GREECE)
26.	Food for All	Mobile Application	Restaurant app	App where you can buy fresh meals that restaurants did not sell by the end of the day, up to 80% cheaper.	USA (Boston & NY)	https://play.google.com/store/apps/details?id=com.foodforall.foodforallapp&hl=en&gl=US	Food for All Technologies, Inc. (USA)
28.	Yindii	Mobile Application	Restaurant app	connect surplus food providers with consumers. Through its mobile app, launched in 2020, individuals can purchase surplus food from restaurants across the city and choose to pick up their orders or have them delivered to their home	Thailand & Hong Kong	https://www.yindii.co/	Yindii Co., Ltd. (Thailand)
29.	Bushel (ex farmlog)	Mobile Application	Farm management app	Helps farmers manage and track their farm's operations.	EU + other countries	https://bushelfarm.com/	Bushel Inc.
1.	PLANET FWD	Online Platform and Website	Digital eco-label	Company that calculates the carbon footprint of individual products or entire company, reduce emissions, achieve carbon neutrality.	Everywhere	https://www.planetfwd.com/	PLANET FWD
2.	World's Largest Lesson	Online Platform and Website	Educational website	The World's Largest Lesson is a platform that promotes the use of the Sustainable Development Goals in learning so that children can contribute to a better future for all. It provides free, open-source resources for educators and action-focused learning experiences for children and young people that build skills and motivation to take action for the SDGs12. The platform is a program from Project Everyone and has reached over 130 countries, impacting over 8 million children each year3. There are many lessons and resources available on sustainable food consumption and minimizing food waste. Some examples include: "Towards More Sustainable Food Systems—14 Lessons Learned" by Sigrid Kusch-Brandt "15 quick tips for reducing food waste and becoming a Food hero" by the Food and Agriculture Organization of the United Nations "Be a food hero!" by the United Nations "Food Heroes lesson plan" by Electrolux Group or "Food Tales"	Everywhere & many languages	https://worldslargestlesson.globalgoals.org/resource/food-tales-investigating-climate-change-through-literacy/	PROJECT EVERYONE
3.	Seasonal Food Guide	Online Platform and Website	Educational website	The Seasonal Food Guide is a website and app that helps you find local, in-season produce based on your location and the time of year. Eating local, seasonal food supports your local economy, reduces the environmental damage caused by shipping foods long distances, and can be fresher and more nutritious. Choosing local, seasonal foods also helps reduce food waste by supporting farmers who grow produce that is in season and less likely to go to waste.	Everywhere	https://www.seasonalfoodguide.org/	GRACE Communications Foundation
4.	Eat Well Guide	Online Platform and Website	Educational website	Helps users find local, sustainable food sources.Sustainable dining guide. Eat Well Guide is a curated directory of over 25,000 hand-picked restaurants, farms, markets and other sources of local, sustainable food throughout the US.	USA	Eat Well Guide	Eat Well Guide
5.	Local Harvest	Online Platform and Website	Educational website	A directory of farmers' markets, CSAs, and other local food sources, that also allows you to shop	USA	Local Harvest	Local Harvest
6.	Water Footprint Calculator	Online Platform and Website	Online calculator	Calculates the water footprint of food and other products.	Worldwide	https://www.watercalculator.org/	Water Footprint Network

7.	Harvard foodprint calculator	Online Platform and Website	Online calculator	The Harvard Foodprint Calculator is a food logger designed to allow users to track the environmental footprints of their dietary consumption. It tracks the user's food intake along 14 different food groups, from beef and chicken to grains and fruit1. The calculator provides an easy way to calculate the carbon, nitrogen, and water footprints of your diet. The results page provides relatable context for the footprints and provides the upper limit of per capita carbon emissions to avoid a climate disaster2. By using this calculator, you can gain insight into the environmental impact of your dietary choices and make more informed decisions about what you eat. This can help you reduce your carbon footprint and contribute to a more sustainable future.	Everywhere	https://harvard-foodprint-calculator.github.io/	Harvard Ver-Eat-Tas! Initiative, with direction from Dr. Stacy Blondin of the Harvard T.H. Chan School of Public Health
8.	BBC Climate Change Food Calculator	Online Platform and Website	Online calculator	calculates how your food intake compares to emissions of driving, heating a home and consuming water.	Everywhere	https://www.bbc.com/news/science-environment-46459714	Design by Prina Shah, development by Felix Stephenson and Becky Rush
9.	Eat Lower Carbon	Online Platform and Website	Online calculator	compares the carbon foodprint of different meals, and tests your knowledge on common foods.	Everywhere	http://www.eatlowcarbon.org/	Bon Appétit Management Company
10.	Food Carbon Emissions Calculator	Online Platform and Website	Online calculator	provides a comprehensive approach to calculating your foodprint. It accounts for transport, waste, and quantity purchased.	Everywhere	http://www.foodemissions.com/foodemissions/Calculator	CleanMetrics
11.	FoodPrint	Online Platform and Website	Online calculator	quiz that helps you better understand the concept of a foodprint and shows you how well you're doing so far.	Everywhere	https://foodprint.org/quiz/	GRACE Communications Foundation
12.	How Does Your Diet Contribute to Climate Change?	Online Platform and Website	Online calculator	The New York Times quiz allows you to choose common meals and beverages to see how your carbon foodprint compares to others.	Everywhere	https://www.nytimes.com/interactive/2019/04/30/climate/your-diet-quiz-global-warming.html	New York Times
13.	The Meat Calculator	Online Platform and Website	Online calculator	shows you how much water and carbon dioxide you save if reducing your meat consumption. It also tells you the approximate number of animals that could live from your reduction.	Everywhere	https://www.blitzresults.com/en/meat/#meat-calculator	BlitzResults (Tim Lilling) based on data from the United States Federal Department of Agriculture, OECD
14.	The Carbon Calculator	Online Platform and Website	Online calculator	Calculates the carbon footprint of various activities, including food consumption.	Worldwide	https://www.carboncalculator.co.uk/	The Carbon Calculator
15.	FoodLogiQ	Online Platform and Website	Software	FoodLogiQ is a company that offers Software as a Service solutions to connect the world's food supply chain, promoting food safety through traceability and sustainability1. Their solutions include managing and monitoring the supply chain, centralizing supplier management, and taking control of quality issues. They also offer FSMA-compliant, tech-enabled traceability, and increase supply chain transparency by +75%2.	137 countries	https://www.foodlogiq.com/	Clarkston Consulting (2006)
16.	Sustained	Online Platform and Website	Software	Sustained helping you make more sustainable choices, starting with eco-friendly food, it also empowers food manufacturers and brands to reduce the environmental impact of the products they sell using next generation life cycle assessment at scale. Automation through tech and software allows product designers	UK	https://sustained.com/	Sustained (UK)

				to factor in environmental impact from the start, not as an afterthought.			
17.	EAT Cloud	Online Platform and Website	Software	connects food manufacturers and retailers with food banks. Making use of digitalization and artificial intelligence, the EatCloud platform identifies the places and moments when food is being wasted throughout the supply chain. As vendors provide real-time data to the platform, measures can be taken before the food is thrown away. Fed with data from the food suppliers and using AI, the platform automatically chooses the ideal beneficiary for each kind of food waste. Since its creation, the data shared through EatCloud has provided more than 34 million meals for people in need.	Colombia	https://www.eatcloud.com/como-funciona/	EAT Club Inc.
18.	Fair Trade Certified	Online Platform and Website	Sustainability certification platform	Certifies products that adhere to fair trade standards.	Worldwide	https://www.fairtradecertified.org/	Fair Trade USA
19.	Zero Waste Home	Online Platform and Website	Lifestyle website	Promotes a zero-waste lifestyle with tips and resources.	Worldwide	https://zerowastehome.com/	Bea Johnson
20.	Migros online store	Online Platform and Website	retail website	Online store of a retailer from Switzerland, selling groceries	Switzerland	https://www.migros.ch/en	Migros
21.	DM Austria online store	Online Platform and Website	retail website	Online retail store, operating in several countries, including Austria, selling mong other goods, food and beverge items	Austria	https://www.dm.at/	DM
22.	Albert Heijn	Online Platform and Website	retail website	Online store of the biggest retailer in the Netherlands	Netherlands	https://www.ah.nl/producten	Albert Heijn
1.	Climate Survivors	Game and Gamification	Mainstream game	Action game educating players about sustainable food system options and other climate mitigation and adaptation options. Partnerships and integration with larger games is being investigated.	Worldwide	https://climate-survivors.com	CHOICE, Terragami
2.	Geo-Wiki	Game and Gamification	Citizen Science	A platform where users can contribute to environmental monitoring.	Worldwide	https://www.geo-wiki.org/	IIASA
3.	World Cereal	Game and Gamification	Citizen Science	A platform for cropland and crop type maps, high quality reference data is indispensable for both training classification algorithms and validation of the final products.	Worldwide	https://worldcereal-rdm.geo-wiki.org/	IIASA
4.	GROW Observatory	Game and Gamification	Citizen Science	A cross-platform application offering plant information tailored to specific locations across Europe	Worldwide	https://growobservatory.org/	IIASA
5.	Crop Observe	Game and Gamification	Citizen Science	A mobile application in support of the Food Security & Sustainable Agriculture Showcase in e-Shape	Worldwide	https://cropobserve.org/	IIASA
6.	AgroTutor	Game and Gamification	Citizen Science	A mobile application in support of the Food Security & Sustainable Agriculture Showcase in e-Shape	Worldwide	https://apps.apple.com/at/app/agrotutor/id1457033299	IIASA
7.	Recyclebank	Game and Gamification	Gamification	Recyclebank is an online platform that rewards individuals for taking sustainable actions, such as recycling and reducing energy	partner cities and brands	https://www.recyclebank.com/	RTS Recyclebank, LLC

				use. The platform includes leaderboards and allows users to earn points that can be redeemed for prizes.			
8.	JouleBug	Game and Gamification	Gamification	JouleBug is a mobile app that gamifies sustainable living by allowing users to earn points and badges for taking eco-friendly actions. The app includes leaderboards and challenges to motivate users to reduce their environmental impact.	Worldwide	https://joulebug.com/	JouleBug, powered by Carimus
9.	EcoChallenge	Game and Gamification	Gamification	A platform that challenges users to adopt sustainable habits.	EU + other countries	https://www.ecochallenge.org/	Northwest Earth Institute
10.	Zero Waste	Game and Gamification	Educational / Serious Game	This game is part of the Kids' Science Challenge, which is full of inspiring videos, fun games, and downloadable hands-on science activities. The game aims to teach kids about reducing waste and recycling.	Worldwide	http://www.kidsciencechallenge.com/year-four/zw_game.php	
11.	Recycle City Challenge	Game and Gamification	Educational / Serious Game	This game is developed by the US EPA and tests the knowledge of how everyday decisions can cut waste and energy use – at home, school, and throughout the community.	Worldwide	https://www3.epa.gov/recyclecity/challenge/index.html	
12.	EarthGames	Game and Gamification	Educational / Serious Game	EarthGames is a growing community of researchers, game developers, and students who share a passion for games and the environment. They develop amazing video and board games to teach and inspire players about the natural world and our role within it. Some of their latest work includes Deal: A Green New Election, Climate Quest, EcoTrivia: Save the Animals!, Infrared Escape, ClimateConversations, Erode Runner, A Caribou's Tale, Sustainability Action Arena6	Worldwide	https://earthgames.org/	
13.	60 Second Sustainability!	Game and Gamification	Educational / Serious Game	Minigame collection - 21 different minigames.	Worldwide	https://earthgames.org/2018/09/21/60-second-sustainability/	student organizations at University of Washington
14.	Journey 2050	Game and Gamification	Educational / Serious Game	A farming game that educates players about sustainable agriculture.	Worldwide	https://www.journey2050.com/2050-games/	Nutrien
15.	Farmers 2050	Game and Gamification	Educational / Serious Game	A farming game that educates players about sustainable agriculture.	Worldwide	https://www.farmers2050.com/	Nutrien
16.	Eco	Game and Gamification	Educational / Serious Game	A multiplayer game where players must build a civilization and manage the ecosystem to prevent a global catastrophe. It involves food production, resource management, and environmental impact, teaching players about the balance of natural ecosystems.	Worldwide	https://play.eco/	Strange Loop Games
17.	Farming Simulator	Game and Gamification	Mainstream game	A farming simulation game that can incorporate sustainable farming practices.	Worldwide	https://www.farming-simulator.com/	GIANTS Software
18.	Minecraft / Sustainable Food Production	Game and Gamification	Modifications/Add-Ons	Begin at a grocery store where farm products are bought and sold. Explore a sustainable farm and learn about soil conservation, crop rotation, and water pollution. Visit a waste facility and learn how fertile soil is created from waste products. Walk through a recycling facility and learn how old packaging is recycled into new packaging. Visit the shop where the farm products are being packaged and sold back to the grocery store.	Worldwide	https://education.minecraft.net/en-us/lessons/sustainable-food-production	Minecraft Education
19.	Minecraft / Journey of food	Game and Gamification	Modifications/Add-Ons	Students should be able to Analyze and Compost recyclable food Students should be able to develop habits to reduce wastage of food and segregate it into recyclable and non recyclable Students should be able to Identify the root cause of food waste	Worldwide	https://education.minecraft.net/en-us/lessons/journey-of-food	Minecraft Education

20	Climate Trail	Game and Gamification	Educational / Serious Game	The Climate Trail is about climate refugees fleeing ever-worsening conditions after inaction on climate has rendered much of the USA (and the world) uninhabitable. The game combines the adventure and play of the journey north with visual novel elements.	Worldwide	https://store.steampowered.com/app/1162400/The_Climate_Trail/	Deep State Games
21	Anno 1800 / Eden Burning Scenario	Game and Gamification	Modifications/Add-Ons	Anno 1800 is a city-building real-time strategy video game, taking place during the Industrial Revolution in the 19th century. Players have to create and manage cities and trade-networks to fullfill their citizens' needs. In the Eden Burning Scenario, stakes are higher as the "Eco Balance" feature is introduced where players need to make sure soil, air and ocean stay healthy despite industrialization efforts.	Worldwide	https://store.steampowered.com/app/916440/Anno_1800/	Ubisoft Blue Byte
22	The Climate Game	Game and Gamification	Educational / Serious Game	A Decision Tree / Choose your own adventure based on climate simulations (IEA, MAGICC), covering mostly non-food options but including a few core decisions (i.e., not ignoring methane, changing the general food trend (or not))	Worldwide	https://ig.ft.com/climate-game/	Financial Times
23	Klim:S21	Game and Gamification	Educational / Serious Game	Focussing on climate adaptation, this game includes several scenarios where diverse stakeholders debate the pros and cons of different adaptation strategies - including those affecting the food and land sector, like e.g. GM cops or different tilling	Germany	https://www.klims21.rgeo.de/spiel	Gentle Troll Entertainment
24	Fate of the World	Game and Gamification	Mainstream game	Complex strategy game where players use their resources to manage a multi-crisis world focused around various regions with high-level policies / societal changes. Includes options like a "vegetarian revolution"	Worldwide	https://store.steampowered.com/app/80200/Fate_of_the_World/	Red Redemption
25	Climate Crisis	Game and Gamification	Educational / Serious Game	A city manager where people choose sustainable options in several sectors, including land and food. In addition to the core loop, quizes can be answered for extra resources	Worldwide	https://climatecrisis.zenergi.co.uk/	Zenergi
26	Green New Deal Simulator	Game and Gamification	Educational / Serious Game	Energy-focused simple manager game where decarbonization and unemployment need to be balanced; includes several land-system options like carbon farming. Call to action at the end to now act on the gained knowledge despite opposition.	Worldwide	https://store.steampowered.com/app/2334990/Green_New_Deal_Simulator/	Molleindustria
27	Half-Earth Socialism	Game and Gamification	Mainstream game	"Half-Earth Socialism allows anyone to try their hand as a global planner of a future society. " Invest political capital into new policies, technologies, research etc, includes the land-use and food sector, such as a vegetarian mandate and different production systems for crops and livestock	Worldwide	https://store.steampowered.com/app/2071530/HalfEarth_Socialism/	Francis Tseng et al
28	Gibbon: Among the Trees	Game and Gamification	Mainstream game	"Gibbon: Beyond the Trees is a hand-drawn adventure following a lost gibbon as they embark on a dangerous journey into unknown lands. Race to freedom in liberation mode, or play through an hour-long narrative that captures the real struggle of living creatures around the world." The game starts in a lush green forest untouched by humans, but brings them closer and closer, showing the impact of unsustainable land-use on wildlife. This is combined with information on gibbons, work with NGOs and related C2As to protect the animals.	Worldwide	https://store.steampowered.com/app/1837330/Gibbon_Beyond_the_Trees/	Broken Rules
29	Bear and Breakfast	Game and Gamification	Mainstream game	"Bear and Breakfast is a laid-back management adventure game where you play as a well-meaning bear trying to run a B+B in the woods." Amongst the needs of the customers is also food. All recipes in the game are plant-based and can inspire real-life cooks.	Worldwide	https://store.steampowered.com/app/1136370/Bear_and_Breakfast/	Gummy Cat
30	Beecarbonize	Game and Gamification	Educational / Serious Game	"Beecarbonize is an environmental card strategy game with climate change as your opponent." Includes options from industry, ecology, society, and research, such as agroecology and agroforestry.	Worldwide	https://store.steampowered.com/app/2486750/Beecarbonize/	Charles Games
1.	Zero Waste Chef (Blogger)	Social Media and Influencers	Influencer and / or blogger	A blog that promotes zero waste cooking and sustainable eating.	Worldwide	https://zerowastechef.com/	Anne-Marie Bonneau

2.	Sustainable Dish (Blogger)	Social Media and Influencers	Influencer and / or blogger	A blog that focuses on sustainable food and farming practices.	Worldwide	https://sustainabledish.com/	Diana Rodgers
3.	Eco Warrior Princess (Blogger)	Social Media and Influencers	Influencer and / or blogger	A blog that covers sustainable fashion, beauty, and lifestyle, including food.	Worldwide	https://ecowarriorprincess.net/	Jennifer Nini
4.	The Minimalist Vegan (Blogger)	Social Media and Influencers	Influencer and / or blogger	A blog that promotes a minimalist and vegan lifestyle.	Worldwide	https://theminimalistvegan.com/	Maša and Michael Ofei
5.	Earthy Andy (Instagram Influencer)	Social Media and Influencers	Influencer and / or blogger	An Instagram influencer promoting plant-based diets and sustainable living.	Worldwide	https://www.instagram.com/earthyandy/	Andrea Hannemann
6.	#SustainableEating	Social Media and Influencers	Social media campaign	This campaign is about promoting sustainable eating habits	Worldwide	https://twitter.com/search?q=%23SustainableEating&src=typed_query&f=live	
7.	#ZeroWasteChallenge	Social Media and Influencers	Social media campaign	This campaign is about reducing waste and recycling. It is part of the Kids' Science Challenge, which is full of inspiring videos, fun games, and downloadable hands-on science activities1. The challenge aims to teach kids about reducing waste and recycling1.	Worldwide	https://twitter.com/search?q=%23ZeroWasteChallenge&src=typed_query&f=live	
8.	#EcoFriendlyFood	Social Media and Influencers	Social media campaign	This campaign is about promoting sustainable and eco-friendly food choices. It encourages people to eat foods that are good for the environment and for their health.	Worldwide	https://twitter.com/search?q=%23EcoFriendlyFood&src=typed_query&f=live	
9.	#GreenFarming	Social Media and Influencers	Social media campaign	This campaign is about promoting sustainable and eco-friendly farming practices. Green farming involves using methods that promote soil health, minimize water use, and lower pollution levels on the farm. The shift toward green farming practices could stimulate demand for the supplies and equipment that enable on-farm decarbonization	Worldwide	https://twitter.com/search?q=%23GreenFarming&src=typed_query&f=live	
10.	#SustainableAgriculture	Social Media and Influencers	Social media campaign	This campaign is about promoting sustainable agriculture practices. Practitioners of sustainable agriculture seek to integrate three main objectives into their work: a healthy environment, economic profitability, and social and economic equity	Worldwide	https://twitter.com/search?q=%23SustainableAgriculture&src=typed_query&f=live	
1	Eat Local or Eat Better	Data Visualization and Storytelling Tools	Infographic and data visualization tool	Greenhouse gas emissions across supply chain by food product	Worldwide	here	Ahmad Grewal (creator)
2	Food carbon foot-print index 2018	Data Visualization and Storytelling Tools	Infographic and data visualization tool	NU3 study from 130 countries about food carbon footprint index of 2018	Worldwide	here	Dilyana Bossenz (creator)
3	How does the food we buy, eat and don't eat impact the environment?	Data Visualization and Storytelling Tools	Infographic and data visualization tool	environmental impact of food we buy and eat	Worldwide	here	EEA European Environment Agency

4	Beyond the price tag (fao.org)	Data Visualization and Storytelling Tools	Data Journalism	Examining the hidden costs of agrifood systems to enhance their true value	Worldwide	Link	F.A.O.
5	The State of Agricultural Commodity Markets (fao.org)	Data Visualization and Storytelling Tools	Data Journalism	The environmental impacts of food and agricultural trade	Worldwide	link	F.A.O.
6	Damage and loss	Data Visualization and Storytelling Tools	Data Journalism	agriculture on the proving grounds	Worldwide	link	F.A.O.
7	Sustaining our oceans	Data Visualization and Storytelling Tools	Data Journalism	fishery sustainability	Worldwide	link	F.A.O.
8	TOWARDS BLUE TRANSFORMATION	Data Visualization and Storytelling Tools	Data Journalism	transforming aquatic food systems	Worldwide	link	F.A.O.
9	The State of World Fisheries and Aquaculture	Data Visualization and Storytelling Tools	Data Journalism	state of fisheriesh and aquaculture in the world	Worldwide	link	F.A.O.
10	The State of Food and Agriculture - 2019 (fao.org)	Data Visualization and Storytelling Tools	Data Journalism	MOVING FORWARD ON FOOD LOSS AND WASTE REDUCTION	Worldwide	link	F.A.O.
11	what-we-eat-makes-a-difference (verdeprofundo.net)	Data Visualization and Storytelling Tools	Infographic	Collection	Worldwide	link	University of British Columbia
12	Would carbon food labels change the way you shop?	Data Visualization and Storytelling Tools	Graph		Worldwide	link	Financial Times
13	Collection	Data Visualization and	Graph	Collection	Worldwide	link	Our World in Data

		Storytelling Tools					
14	Meat or no meat	Data Visualization and Storytelling Tools	Interactive Dashboard	how meat consumption affects human life span	Worldwide	link	Institute of Business Inteligence
15	Food waste in the us	Data Visualization and Storytelling Tools	Infographic	The product labels lead to food waste	Worldwide	link	USA Congresswoman
16	How much we ate	Data Visualization and Storytelling Tools	Graph	data for 1970 through 2019, so we can for example, see how much beef Americans consume per year on average and how that has changed over four decades	Worldwide	link	Flow in Data
17	Awareness of food waste can help us appreciate holiday meals (theconversation.com)	Data Visualization and Storytelling Tools	Infographic	Food waste in the USA, nothing to do with hollidays!	Worldwide	link	The Conversation
18	Food waste in Europe: statistics and facts about the problem	Data Visualization and Storytelling Tools	Data Journalism	This page explains the difference between food loss and food waste, their causes and impacts, and some possible solutions to reduce them	Worldwide	link	Eufic
19	Collection	Data Visualization and Storytelling Tools	Infographic	Collection	Worldwide	link	Statista
20	Greenhouse gas from wasting food at home	Data Visualization and Storytelling Tools	Infographic	The infographic is about landfils and home waste	Worldwide	link	Flow in Data
21	What's your diet's carbon footprint?	Data Visualization and Storytelling Tools	Graph	Avoiding meat and dairy products is one of the biggest ways to reduce your environmental impact, according to scientific studies.	Worldwide	Link	BBC
22	Collection	Data Visualization and Storytelling Tools	Graph	Collection	Worldwide	Link	Our World in Data
23	Ranked: The Foods With the Largest Environmental Impact	Data Visualization and Storytelling Tools	Graph and Infographic	visualize how different food items contribute to this environmental impact, the above graphic ranks foods based on their greenhouse gas (GHG) emissions and water withdrawals, using data from Poore and Nemecek and Our World in Data.	Worldwide	Link	Visual Capitalist
24	Visualizing the Environme	Data Visualization and	Graph	These articles consider the environmental impacts of food production, milk, and transportation.	Worldwide	Link	TDWI

	ntal Impact of Food and Transportation	Storytelling Tools					
25	The Carbon Footprint of the Food Supply Chain	Data Visualization and Storytelling Tools	Graph	The web page context discusses the carbon footprint of different food types, the stages of the food supply chain, and the global risks for 2024.	Worldwide	Link	Visual Capitalist
26	What Common Food Pollutes The Most	Data Visualization and Storytelling Tools	Graph	Argues that beef production is harmful for the environment and urges people to eat less meat.	Worldwide	Link	Venngage
27	ENVIRONMENTALLY FRIENDLY PROTEIN SOURCES	Data Visualization and Storytelling Tools	Graph	How can we reduce the carbon footprint of our diets? Substituting meat with these high-protein, low-carbon foods can help	Worldwide	Link	Fair Planet
28	Healthy diets for a healthier planet	Data Visualization and Storytelling Tools	Graph	Food needs to be grown and processed, transported, distributed, prepared, consumed, and sometimes disposed of. Each of these steps creates greenhouse gases that trap the sun's heat and contribute to climate change.	Worldwide	link	UN
29	Which food is better for the planet?	Data Visualization and Storytelling Tools	Data Journalism	Knowing what to eat to minimize impact on the planet can feel like an impossible task: Eat locally? Skip meat? Opt for organic, free range, humanely raised?'	Worldwide	link	Washington Post
30	Drivers of Emissions	Data Visualization and Storytelling Tools	Interactive Graphs		Worldwide	link	Climate Watch Data
31	CLIMATE CHANGE AND FARMING:	Data Visualization and Storytelling Tools	Graphs and Infographic	how the climate change is affecting the food chain	Worldwide	Link	CCAFS/CGIAR
32	Climate Change and Food Security in Asia	Data Visualization and Storytelling Tools	Infographic	how the climate change is affecting the food chain	Worldwide	link	ADB institute
33	The food waste iceberg	Data Visualization and Storytelling Tools	Infographic	contains an infographic that emerges the problems behind the food consumption	Worldwide	link	F.A.O.
34	REDUCE YOUR FOOD FOOTPRINT	Data Visualization and Storytelling Tools	Infographic	The way we eat has a massive impact on the planet. It's not just about the enormous amount of food we consume but how much of that food we waste.	Worldwide	Link	WWF
35	Food and Climate Change	Data Visualization and	Graph	multiple graphs focused on specific region	Worldwide	Link	Rhode Island Council

		Storytelling Tools					
36	collection	Data Visualization and Storytelling Tools	Graph		Worldwide	link	Food Systems Dashboard
37	Will changing what we eat help save the planet?	Data Visualization and Storytelling Tools	Graph	With the spotlight being shone on how food production and consumption can have a detrimental impact on the environment, CNA looks at how what we eat - or don't eat - can make a difference.	Worldwide	Link	CNA (Channel News Asia)
38	Here's How Much Food Contributes to Climate Change	Data Visualization and Storytelling Tools	Graph	Animal-based foods produce about twice the emissions of plant-based ones, a new comprehensive study finds	Worldwide	Link	Scientific American
39	Beef: It's What's Contributing to Climate Change	Data Visualization and Storytelling Tools	Graph	Emphasises on the beef contribution on GHG emissions	Worldwide	Link	Statista
40	Climate action: 10 steps to cut down on meat and dairy	Data Visualization and Storytelling Tools	Infographic	Long data journalism article with infographics	Worldwide	Link	Ethical Consumer
41	Learn how meat consumption contributes to your carbon footprint	Data Visualization and Storytelling Tools	Infographic	The environmental impact of meat production is a pressing issue that deserves more attention. Raising livestock for meat takes a toll on the environment in a number of ways	Worldwide	Link	My Green Toddler
42	Is Plant-Based Meat Better for the Environment?	Data Visualization and Storytelling Tools	Graph	When it comes to the environment, meat is bad and plants are good. But what about plant-based meat..	Worldwide	Link	Readers Digest
43	On The Impact Of Meat Consumption On The Environment And My Incapability Of Not Eating Chicken	Data Visualization and Storytelling Tools	Infographic	a blog post by a user who wants to reduce their meat consumption for environmental reasons and decides to only eat chicken.	Worldwide	Link	Steemit
44	Animal Agriculture & the Environment By the Numbers	Data Visualization and Storytelling Tools	Infographic		Worldwide	Link	Farm Sanctuary

45	The Environmental Impact of Animal Agriculture	Data Visualization and Storytelling Tools	Infographic		Worldwide	Link	Medium
46	Animal Agriculture's Impact on Climate Change	Data Visualization and Storytelling Tools	Infographic		Worldwide	Link	Climate Nexus
47	Here's the real impact of the food we eat on the environment	Data Visualization and Storytelling Tools	Infographic	ranks fresh foods based on their greenhouse gas emissions from farm to fork, and suggests ways to reduce the carbon footprint of our diet	Worldwide	link	World economic Forum
48	The Environmental Impact of Meat	Data Visualization and Storytelling Tools	Infographic	displays two infographs about food waste from animals and energy cost	Worldwide	Link	NY times
49	Slowing Climate Change, One Steak at a Time	Data Visualization and Storytelling Tools	Graph	argues for reducing meat consumption to combat climate change and improve health	Worldwide	link	MIT admissions
50	Beyond the price tag (fao.org)	Data Visualization and Storytelling Tools	Data Journalism	Examining the hidden costs of agrifood systems to enhance their true value	Worldwide	Link	F.A.O.
51	Tableau	Data Visualization and Storytelling Tools	Infographic	A tool for creating interactive and shareable data visualizations.	Worldwide	https://www.tableau.com/	Salesforce
52	Tableau (with sustainability datasets)	Data Visualization and Storytelling Tools	Infographic	A tool for visualizing data, which can be used to display sustainability metrics.	Worldwide	Tableau	Tableau Software
53	Our World in Data	Data Visualization and Storytelling Tools	Infographic	Presenting data and scenarios, an online publication that presents comprehensive and research-based data about the world's largest problems, including food sustainability.	Worldwide	https://ourworldindata.org/food-emissions-carbon-budget	
1.	Eat Local or Eat Better	Audiovisual Tools	Infographic and data visualization tool	Greenhouse gas emissions across supply chain by food product	Worldwide	here	Ahmad Grewal (creator)
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3.	How does the food we buy, eat and don't	Audiovisual Tools	Infographic and data	environmental impact of food we buy and eat	Worldwide	here	EEA European Environment Agency

	eat impact the environment?		visualization tool				
4	Kiss the ground	Audiovisual Tools	Documentary or animation	2020 Documentary film Available from Netflix and a free 45 mins version for schools	Worldwide	https://kissthegroundmovie.com/	
5	Food Waste: The Hidden Cost of the Food We Throw Out I ClimateScience #9	Audiovisual Tools	Documentary or animation		Worldwide		
6	You've Got Sustainable Food "In Your Hands"	Audiovisual Tools	Documentary or animation	animation film helps raise awareness for sustainable food choices and how those choices impact the planet	Worldwide	https://www.stashmedia.tv/followfood-in-hands-le-cube/	
7	Before the Flood	Audiovisual Tools	Documentary or animation	A documentary on climate change featuring Leonardo DiCaprio.	Worldwide		National Geographic
8	Our Planet	Audiovisual Tools	Documentary or animation	A documentary series on the beauty of the natural world and the impacts of climate change.	Worldwide		Silverback Films, WWF, Netflix
9	Kiss the Ground (2020)	Audiovisual Tools	Documentary	This documentary explores the topic of "regenerative agriculture" and how the regeneration of our soil might hold the key to a more sustainable future.	Worldwide		
10	Honeyland (2019)	Audiovisual Tools	Documentary	This documentary tells the story of Hatidže Muratova, one of the last beekeepers in Macedonia keeping wild bees, and explores topics including climate change and the loss of biodiversity.	Worldwide		
11	The Pollinators (2019)	Audiovisual Tools	Documentary	This documentary traces the path of migratory beekeepers as they travel across the United States, taking their bees to farms across the country so that they can do the critical job of pollinating flower and food crops.	Worldwide		
12	Before the Plate (2018)	Audiovisual Tools	Documentary	This documentary follows John Horne, one of Canada's most renowned chefs, as he dives deeper into where the ingredients used in dishes at his restaurant, Canoe, come from.	Worldwide		
13	The Need to GROW (2019)	Audiovisual Tools	Documentary	Narrated by Rosario Dawson, this documentary tells the story of three very different environmental leaders: an eight-year-old girl, an inventor, and a farmer. The documentary explores potential approaches to revolutionizing our food system and growing practices.	Worldwide		
14	Wasted! The Story of Food Waste (2017)	Audiovisual Tools	Documentary	Narrated by the late chef Anthony Bourdain, this documentary takes viewers around the world to show the devastating impacts of food waste and the visionaries fighting to prevent it.	Worldwide		
15	Just Eat it! A Food Waste Story (2014)	Audiovisual Tools	Documentary	The film follows a Vancouver couple, Grant Baldwin and Jen Rustemeyer, as they attempt to survive exclusively on food waste over the course of six months to illustrate our "systematic obsession with expiry dates, perfect produce, and portion sizes."	Worldwide		

16	A Place At The Table (2012)	Audiovisual Tools	Documentary	One of the best documentaries on food waste, this film is a detailed examination on the issue of hunger in the US, and is centred around the daily lives of three food-insecure Americans as they struggle to feed themselves.	Worldwide		
17	Cowspiracy: The Sustainability Secret (2014)	Audiovisual Tools	Documentary	This documentary investigates how animal agriculture is one of the most destructive industries facing our planet today and offers a path to global sustainability for a growing population	Worldwide		
18	The Biggest Little Farm (2018)	Audiovisual Tools	Documentary	This documentary follows two dreamers and their beloved dog when they make a choice that takes them out of their tiny L.A. apartment and into the countryside to build one of the most diverse farms of its kind in complete coexistence with nature	Worldwide		
19	Follow The Food (2019)	Audiovisual Tools	Documentary	This BBC docuseries offers an examination of our food chain from its roots	Worldwide		
20	Down To Earth With Zac Efron (2020)	Audiovisual Tools	Documentary	Actor Zac Efron journeys around the world with wellness expert Darin Olien in a travel show that explores healthy, sustainable ways to live	Worldwide		
21	Flavorful Origins (2019)	Audiovisual Tools	Documentary	This documentary series takes viewers on a culinary journey across China. Each season highlights a different region of the country along with that region's traditional cooking techniques and ingredients	Worldwide		
22	Gather (2020)	Audiovisual Tools	Documentary	Directed by the James Beard Award winning filmmaker Sanjay Rawal, "Gather" follows Native American individuals working to reclaim their spiritual, political, and cultural identities through food sovereignty	Worldwide		
23	André & His Olive Tree (2020)	Audiovisual Tools	Documentary	André & His Olive Tree follows the famed Taiwan-born chef, André Chiang. In 2018 Chiang made the decision to close his esteemed restaurant, Restaurant André, shocking his staff, family, friends, and the greater culinary world	Worldwide		
24	The True Cost (2015)	Audiovisual Tools	Documentary	This documentary explores the impact of fast fashion on people and the planet, including issues such as worker exploitation and environmental degradation.	Worldwide		
25	Food Inc. (2008)	Audiovisual Tools	Documentary	This documentary takes a critical look at the corporate food industry in the United States, including issues such as animal welfare, worker exploitation, and environmental degradation.	Worldwide		
26	The Meatrix (2003)	Audiovisual Tools	Animation	This animated short film parodies The Matrix to raise awareness about factory farming and its impact on animals, people, and the environment.	Worldwide		
27	The Story of Stuff (2007)	Audiovisual Tools	Animation	This animated short film explores the lifecycle of material goods and the impact of consumer culture on people and the planet.	Worldwide		
28	Food Inc.	Audiovisual Tools	Film / series	A documentary film that examines corporate farming in the United States.	Worldwide	Food Inc.	Participant Media
29	An Inconvenient Truth	Audiovisual Tools	Film / series	A documentary on Al Gore's campaign to educate people about global warming.	Worldwide	An Inconvenient Truth	Paramount Pictures
30	Waffles + Mochi (2021)	Audiovisual Tools	Film / series	This family-friendly cooking series follows aspiring chefs Waffles and Mochi as they travel around the world to learn about different foods and cultures, and whip up delectable dishes along the way	Worldwide		

31	What You're Eating	Audiovisual Tools	Podcast	This family-friendly cooking series follows aspiring chefs Waffles and Mochi as they travel around the world to learn about different foods and cultures, and whip up delectable dishes along the way	Worldwide	https://foodprint.org/what-youre-eating/	
1.	Earth VR	Virtual and Augmented Reality	Virtual reality experience	A VR experience that allows users to explore Earth from space.	Worldwide	https://store.steampowered.com/app/348250/Google_Earth_VR/	Google
2.	Eco VR	Virtual and Augmented Reality	Virtual reality experience	A VR game that educates users on environmental issues.	EU + other countries	https://www.oculus.com/echo-vr/	Strange Loop Games
3.	Our Blue Planet VR	Virtual and Augmented Reality	Virtual reality experience	A VR experience that showcases the beauty and fragility of our oceans.	Worldwide	https://blueplanetvr.com/	BBC Earth
4.	AR Forest App	Virtual and Augmented Reality	Augmented Reality	An AR app that educates users about forests and conservation.	EU + other countries	https://www.worldwildlife.org/pages/wwf-forests	AR Forest
5.	Mixed Reality for Sustainable Farming	Virtual and Augmented Reality	Mix Reality	A scientific paper for the creation of a mixed reality tool that aids farmers in sustainable practices.	EU + other countries	https://ieeexplore.ieee.org/document/10005505	MR Farming Inc.
1.	Food & Climate: The Impact of Food on the Environment	Online Learning Platform	MOOC platform	online learning platform that offers a MOOC (Massive Open Online Course) on the impact of food on the environment	Worldwide	https://climatescience.org/advanced-food-climate	Climate Science Ltd (UK)
2.	World's Largest Lesson	Online Learning Platform	MOOC platform	online learning platform that offers MOOCs on sustainable food production and consumption. Its goal is to promote the use of the Sustainable Development Goals in learning so that children can contribute to a better future for all. From citizenship and justice to climate change and the environment, it aims to inspire children to make a difference!	Worldwide	https://worldslargestlesson.globalgoals.org/	World's Largest Lesson
3.	World's Largest Lesson	Online Learning Platform	Educational website	A platform that offers lessons on the SDGs, including sustainable consumption.	Worldwide	http://worldslargestlesson.globalgoals.org/	Project Everyone
4.	Coursera	Online Learning Platform	MOOC platform	Offers online courses on various topics, including sustainability.	Worldwide	https://www.coursera.org/	Coursera Inc.
5.	Coursera (Sustainable Food Systems course)	Online Learning Platform	MOOC platform	Online learning platform that offers a MOOC on sustainable food systems, exploring the challenges and potential solutions.	Worldwide	https://www.coursera.org/specializations/food-sustainability-mindful-eating-healthy-cooking?isNewUser=true	Coursera Inc.
6.	edX (Sustainable Agriculture course)	Online Learning Platform	MOOC platform	A course that delves into sustainable agriculture and its importance in modern farming.	Worldwide	https://www.edx.org/course/sustainable-agriculture-and-food-systems	edX

7.	Udemy (Organic Farming course)	Online Learning Platform	Video Tutorial	Online learning platform that offers a video tutorial on organic farming, teaching the basics and benefits.	Worldwide	https://www.udemy.com/course/organic-farming/	Udemy
8.	Khan Academy (Ecosystems course)	Online Learning Platform	Video Tutorial	Online learning platform that offers a video tutorial on ecosystems, their importance, and conservation.	Worldwide	https://www.khanacademy.org/science/biology/ecology/intro-to-ecosystems/a/what-is-an-ecosystem	Khan Academy
9.	FutureLearn (Nature and Environment courses)	Online Learning Platform	MOOC platform	Online learning platform that offers various courses related to nature and the environment, including sustainable food topics.	Worldwide	https://www.futurelearn.com/courses/collections/nature-and-environment	FutureLearn
10.	Green Learning Online	Online Learning Platform	MOOC platform	GreenLearning Canada offers interactive and dynamic educational programs focused on environmental science, clean energy, and climate change, designed to engage and empower students and educators alike.	Worldwide	https://greenlearning.ca/	Green Learning
11.	Sustainable Food Trust Lessons	Online Learning Platform	MOOC platform	The Sustainable Food Trust's Education section highlights the importance of integrating sustainable food production and consumption knowledge into mainstream education, aiming to cultivate an informed and responsible approach towards our food systems.	Worldwide	https://sustainablefoodtrust.org/key-issues/education/	
12.	Open University (Food and Climate Change)	Online Learning Platform	MOOC platform	OpenLearn's "Environment, Food, and Climate Change" course, offered by The Open University, provides a comprehensive overview of the complex interconnections between the environment, food production, and climate change, emphasizing the need for sustainable practices.	Worldwide	http://www.open.edu/openlearn/nature-environment/the-environment/environment-food-and-climate-change/content-section-overview?active-tab=description-tab	
13.	MIT OpenCourseWare (Sustainable Food Production)	Online Learning Platform	MOOC platform	MIT's OpenCourseWare offers "Sustainable Food Production" (MAS.S62) for Spring 2021, a course exploring innovative methods and technologies in agriculture aimed at enhancing food production sustainability and environmental compatibility.	Worldwide	https://ocw.mit.edu/courses/media-arts-and-sciences/mas-s62-sustainable-food-production-spring-2021/	
14.	SDG Academy (Food Security and Sustainability)	Online Learning Platform	MOOC platform	The SDG Academy's course "Feeding a Hungry Planet: Agriculture, Food Security, and Sustainability" delves into the challenges and solutions surrounding global food security and sustainable agriculture, aligned with the Sustainable Development Goals.	Worldwide	https://sdgacademy.org/course/feeding-a-hungry-planet-agriculture-food-security-and-sustainability/	
15.	ForkRanger	Online Learning Platform	Educational app	The Fork Ranger Campfire is monthly online meetup about 'solving climate change with food'. It's an introduction to Fork Ranger and the bigger picture of sustainable food. For anyone who is new to Fork Ranger or wants to learn more.	Worldwide	https://www.forkranger.com/campfire/	Fork Ranger (Netherlands)

1.	Blue River Technology (weed control)	AI and Machine Learning	AI-powered analytics	Uses AI to identify and manage weeds in farming.	EU + other countries	https://blueivertechnology.com/our-products/	John Deere
2.	FarmBot	AI and Machine Learning	AI-powered analytics	An open-source CNC farming machine that automates planting, watering, and weeding.	Worldwide	https://farm.bot/	FarmBot Inc.
3.	PEAT (Plantix app for diagnosing plant diseases)	AI and Machine Learning	AI-powered analytics	Uses AI to diagnose plant diseases, pests, and nutrient deficiencies.	EU + other countries	https://plantix.net/	PEAT GmbH
4.	Agrosmart	AI and Machine Learning	AI-powered analytics	Utilizes AI to provide real-time data and insights for farmers to optimize irrigation and other practices.	Worldwide	Agrosmart	Agrosmart
5.	Ripe.io (Blockchain for food)	AI and Machine Learning	AI-powered analytics	Uses blockchain technology to create a transparent and trustworthy food supply chain.	Worldwide	Ripe.io	Ripe Technology, Inc.
6.	Gro Intelligence	AI and Machine Learning	AI-powered analytics	Uses AI to provide insights into global agricultural data, helping stakeholders make informed decisions.	Worldwide	Gro Intelligence	Gro Intelligence
7.	Prospera Technologies	AI and Machine Learning	AI-powered analytics	Utilizes AI to analyze farm data and provide actionable insights for farmers.	EU + other countries	Prospera Technologies	Prospera Technologies
8.	Wasteless	AI and Machine Learning	AI-powered analytics	Wasteless is a tech startup that uses AI to cut down on food waste. The company uses AI to give retailers dynamic rather than fixed pricing for perishable food products	Worldwide	https://wasteless.app/	
9.	Winnow	AI and Machine Learning	AI-powered analytics	Winnow is a US-based company that uses computer vision to help commercial kitchens around the world understand how food is being wasted. The app measures the amounts discarded using smart sensors attached to waste bins and proposes strategies to prevent waste while saving money	Worldwide	https://www.winnowsolutions.com/	
10.	Climesumer	AI and Machine Learning	AI chatbot	Add-on on ChatGPT to Find sustainable alternatives to products.	Worldwide	https://climesumer.earth-gpt.com/	

Choice

Mainstreaming Integrated Assessment Models by embedding behavioural change and actor heterogeneity, and increasing their outreach to citizens, communities and industrial actors

CHOICE Consortium:

Contact

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