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DELIVERABLE 3.6

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Food and biomass production systems are among the most prominent drivers of biodiversity loss worldwide. Halting and reversing the loss of biodiversity therefore requires transformative change of food and biomass systems, addressing the nexus of agricultural production, processing and transport, retailing, consumer preferences and diets, as well as investment, climate action and ecosystem conservation and restoration. The RAINFOREST project will contribute to enabling, upscaling and accelerating transformative change to reduce biodiversity impacts of major food and biomass value chains. Together with stakeholders, we will co-develop and evaluate just and viable transformative change pathways and interventions. We will identify stakeholder preferences for a range of policy and technology-based solutions, as well as governance enablers, for more sustainable food and biomass value chains. We will then evaluate these pathways and solutions using a novel combination of integrated assessment modelling, input-output modelling and life cycle assessment, based on case studies in various stages of the nexus, at different spatial scales and organizational levels. This coproduction approach enables the identification and evaluation of just and viable transformative change leverage points, levers and their impacts for conserving biodiversity (SDGs 12, 14-15) that minimize trade-offs with targets related to climate (SDG13) and socioeconomic developments (SDGs 1-3). We will elucidate leverage points, impacts, and obstacles for transformative change and provide concrete and actionable recommendations for transformative change for consumers, producers, investors, and policymakers.

EXECUTIVE SUMMARY

The RAINFOREST project aims to enable, upscale and accelerate transformative change to reduce the biodiversity impacts of major food and biomass value chains. Within this objective, the case study on the food supply chain in Cyprus's tourism industry serves as an example of how tourism-driven economies exert pressure on global food trade patterns. In particular, it aims to map and assess environmental and socio-economic impacts of the food chain for the touristic industry in Cyprus.

To map the current state of Cyprus's tourism and food supply chain, both secondary and primary data were collected. Secondary data was collected from the Cyprus Statistical Service (CYSTAT) and FAOSTAT, covering tourism demographics, tourist food consumption patterns and changes in dietary preferences over the past decade. The findings revealed that the tourism sector in Cyprus is highly seasonal, which in turn affects food availability and consumption patterns. Furthermore, the varying mix of tourist nationalities and the type of accommodation influence food preferences and spending patterns of tourists. Tourism in Cyprus has a modest but notable impact on total food consumption, particularly for beverages and animal-based products. While much of the livestock is produced locally, its dependency on imported feed means that tourism indirectly increases the island's reliance on external natural resources.

Additionally, two empirical surveys in collaboration with the Cyprus Sustainable Tourism Initiative (CSTI), a local NGO, were conducted: a hotel survey to understand food supply dynamics and current perceptions and practices of the industry stakeholders, and a second survey to investigate tourist behaviours, dietary preferences and their level of engagement in pro-environmental activities related to the food value chain. Survey results suggest a growing awareness and adoption of sustainability practices, particularly in high-end establishments and is primarily driven by tour operator requirements for sustainability certifications. However, challenges remain in aligning environmental goals with guest satisfaction and engaging tourists in sustainability efforts. Tourists generally express a strong interest in knowing the origin of the food they consume, are willing to pay a premium for local and eco-labelled products, are open to meat-free days at hotel buffets and in

lowering their food waste (leftovers) during meals. However, their participation in sustainable practices within the food value chain remains inconsistent, e.g., purchasing organic food, composting food waste when at home. Tourists generally find interactive technologies (QR codes, NFC, RFID, and Blockchain) useful, time-saving, and effective for retrieving information, despite differences in usage and ease of understanding.

Regarding the quantification of impacts, the **Life Cycle Assessment (LCA)** of typical hotel buffet menus that are used as proxies of different dietary preferences, indicates that fish consumption contributes most to the biodiversity impact, followed by beef and dairy products, while plant-based foods and lean meats (e.g. chicken) have much lower impacts and thus offer more sustainable alternatives. This pattern reflects both the per-kilogram endpoint characterisation factors and the quantities served in the buffet menus; animal-based dishes generally carry higher factors (e.g. feed conversion, land use and supply-chain energy), whereas most plant-based items are lower. These LCA results are reported as ecosystem-quality impacts using the GLAM method (global PDF·yr). In addition, the **Waste Input-Output (WIO)** analysis shows significant waste generation by the accommodation and food services sector, with spillover effects across the economy. Lastly, application of the **FABIO model** (2010–2022) shows that tourism-related land use fell by ~40% from 2010 to 2022 but remains dominated by meat, especially pigmeat, with mid-decade beef peaks, while poultry's share has risen. Water footprints are led by green water and are roughly an order of magnitude above blue water, largely externalised to European and, to a lesser extent, Latin American supply chains; blue water is chiefly domestic. Note that FABIO reports resource-use footprints (pressures) which are methodologically distinct from the LCA's GLAM impacts and are not directly comparable.

Overall, the findings of this report offer valuable insights and guidance for both private and public stakeholders to develop appropriate strategies for a more sustainable food value chain within the rapidly growing tourism industry.

1. INTRODUCTION

The RAINFOREST project aims to explore pathways for transformative change to reduce the biodiversity impacts of major food and biomass value chains. This includes case studies of interventions that may drive such change by influencing food consumption patterns (WP3). Within this objective, the case study on the food supply chain in Cyprus's tourism industry - an illustrative example of how tourism-driven economies exert pressure on global food trade patterns - seeks to develop alternative pathways for transformative change that benefit biodiversity at both the system and behavioural levels. This involves identifying new tourist behaviours, as well as transformative policy and technological solutions specific to the Cyprus tourism food value chain.

The island of Cyprus, located in the north-eastern Mediterranean basin with a population of just under 1 million inhabitants, is renowned for its stunning beaches, rugged mountainous landscapes and rich culture and history. Since the 1980s, Cyprus has been established as a sought-after "sun and sea" mass tourism destination, attracting around 4 million tourists annually in recent years. The tourism sector constitutes the backbone of Cyprus' economy, contributing significantly to the island's employment and GDP. According to the World Travel and Tourism Council (Nejc et al., 2023), the Cyprus travel and tourism sector in 2022 directly generated 26,144 jobs representing 6.1% of total employment, with the total contribution to employment (direct and indirect) to be at 54,072 jobs (12.6% of total employment). The same report projects that by 2033, the sector is estimated to support 84,480 jobs (19% of total employment). In economic terms, the total contribution of travel and tourism to GDP was 12.2%, equivalent to € 3.2 billion in 2022, and has been estimated to increase to 17.8% of GDP, or € 5.5 billion by 2033 (Nejc et al., 2023).

In this deliverable, a comprehensive system mapping of the current situation in the Cyprus tourism sector has been carried out, with a focus on identifying food chain patterns. Secondary data covering a range of tourist statistics, including demographics, arrivals, accommodation, length of stay, expenditure, and revenue, have been collected from the Cyprus Statistical Service (CYSTAT) database. Additionally, Supply Utilization Accounts (SUA) and Food Balance Sheets (FBS) from

FAOSTAT database have been collected to identify consumption patterns and changes in dietary preferences over the last decade. These datasets also detail the origins of food items consumed by tourists. Trade data of food commodities for Cyprus has also been gathered from the annual trade matrix available in FAOSTAT.

Furthermore, two surveys have been conducted as part of empirical field studies to collect primary data regarding the supply and demand aspects of the food value chain in Cyprus's tourism industry. The first survey involved a hotel survey, which aimed to identify tourists' food consumption patterns as well as the perceptions and practices of industry stakeholders, i.e., hotel owners and managers. The second survey targeted the demand side and specifically aimed to explore tourists' behaviours, dietary preferences, and the extent of their pro-environmental behaviours related to food consumption and waste, including their understanding and use of interactive digital technologies. The primary and secondary data collected for this case study serve as the foundation to be further explored in the transformative pathways developed in the project, towards a more sustainable food supply in the tourism industry.

Collaboration with stakeholders has been integral to this case study. The Cyprus Institute (CyI) has been collaborating with the Cyprus Sustainable Tourism Initiative (CSTI), a local NGO dedicated to promoting sustainable tourism in the island. This partnership has led to the co-design and distribution of the aforementioned surveys, leveraging on CSTI's connections within the hospitality industry, especially its hotel members and tour operators.

The overall aim of this scientific report is to guide private-sector and governmental policy-making pathways for sustainable food chains in the tourism industry. To achieve this:

- both primary and secondary data have been collected to assess the current situation of the Cyprus tourism sector, identify tourists' food-consumption preferences and behaviour patterns, as well as the perceptions and practices of stakeholders (hotel owners/managers) within Cyprus's tourist food supply chain (Sections 3–5);
- the ecosystem-quality impacts of different food options in Cyprus hotels have been quantified using a Life Cycle Assessment (LCA) approach based on

primary data (i.e., typical buffet menus), applying GLAM characterisation to consumptive flows and reporting global PDF·yr results (Section 6.1);

- the interconnections between economic activity and waste generation across sectors of the Cypriot economy, including tourism, are explored through a Waste Input–Output (WIO) analysis (Section 6.2); and
- at sectoral (tourism) level, the FABIO physical input–output model is applied to attribute resource-use footprints — cropland and grassland (ha) and blue/green water use (m^3) — by food commodity and country of origin (Section 6.3).

It should be noted that the methods and approaches used are complementary, e.g., LCA applying GLAM to report ecosystem-quality impacts (global PDF·yr), and FABIO, reporting pressure footprints, i.e., land use (cropland and grassland, ha) and blue/green water footprints (m^3), along food supply chains. These indicators serve different purposes (impact vs pressure) and are not directly comparable.

2. EXISTING TOURISM POLICIES & PATHWAYS

As tourism is one of the major economic sectors across the European Union (EU), it has been prioritized as a key industry for the transition to circular economy. In recent years, there has been a growing interest in the need to identify tourism pathways that will be long-term, sustainable, resilient, and respectful of destinations' natural and local ecosystems. In light of this, the European Commission introduced the *Transition Pathway for Tourism* and published a report in February 2022 identifying twenty-seven action areas to navigate the European tourism's sector recovery from the COVID-19 pandemic, while also emphasizing the acceleration of the green and digital transitions (European Commission, 2022). This report was the outcome of stakeholder consultation across the tourism ecosystem and EU Member States. The detailed actions outlined in this report operationalize the overarching goals and long-term vision for the transition laid out in the EU Agenda for Tourism 2030 (Directorate-General for Internal Market Industry Entrepreneurship and SMEs, 2022; European Commission, 2022), which serves as a

strategic framework for the European tourism policy adopted by the Member States. The action areas are divided into the following building blocks or broad areas, namely *regulation and public governance; green and digital transition; resilience; and, investments and funding*.

In the context of the RAINFOREST project, three transformative change pathways have been developed for the transition to environmentally sustainable food and biomass value chains (WP1). A detailed description of these pathway narratives is available in D1.1 In short, **global green innovation** focuses on private sector actors that are driven by risks to the global food and biomass value chains from environmental breakdown as well as by the potential for product development and input cost reduction. However, their ambitions are constrained by their need to maintain commercial value. **Needs-based and nature-connected local stewardship** focuses on citizens and local communities that are ethically motivated, but their ambitions are limited by their limited access to levers to enact change. **Global stewardship towards co-existence** focuses on public sector actors who are driven by the goal of reducing societal risks caused by environmental breakdown and the potential to enhance social well-being. However, their ambitions are constrained by their need to maintain welfare standards that are currently expected by different communities affected by interventions.

Cyprus, like other Mediterranean destinations, appears to have adopted an unsustainable model of tourism development (Farmaki et al., 2014). The mass tourism product of the island is exerting great pressures on the limited natural and human resources, and erodes the socio-cultural fabric (Boukas & Ziakas, 2016; Sharpley, 2003). The Cypriot authorities have acknowledged these challenges, particularly the high vulnerability of the island's tourism sector to climate change. The most recent tourism-related policies aimed at ensuring a sustainable future for the sector are outlined in the updated National Climate Change Adaptation Strategy (NAS) (Ministry of Agriculture Rural Development and Environment, 2025) and the National Tourism Strategy (NTS) 2030. It is important to note that both of these local-level strategies are not legally mandatory in nature but serve as guiding frameworks. Likwise, while the European Transition Pathway for Tourism is not mandatory for EU members, it is strongly encouraged as a voluntary roadmap designed to support the green and digital transitions of the tourism sector, as well

as boost its resilience in the aftermath of the COVID-19 pandemic.

The NAS outlines specific measures to adapt to the impacts of climate change in various sectors, including tourism, and the planned implementation period is between 2025 to 2050. The adaptation measures for the tourism sector focus on three key areas:

- strengthening institutional collaboration to incorporate climate adaptation into the sector's strategic planning;
- diversifying tourism models away from the mass "sun and sea" model; and
- promoting resilience of tourism resources and infrastructure.

For each of these areas, specific sub-measures are detailed in the National Climate Change Adaptation Action Plan that accompanies the NAS.

In a similar vein, the vision of the NTS 2030 is the sustainability of tourism in Cyprus, with a positive impact on the environment, society, and the economy. The main objectives of the NTS 2030 – although independently developed - are also closely aligned with the broader action areas of the European Transition Pathway for Tourism, both prioritizing *green* and *digital transformation*, and strengthening *resilience* within the tourism sector. For instance, the NTS 2030 highlights the importance of sustainable tourism development and establishing Cyprus as a climate-friendly destination. Initiatives include the promotion of eco-friendly practices such as supporting green certifications for hotel units, encouraging carbon footprint reduction activities in tourism activities, introducing food waste management practices, managing visual pollution, which is particularly prevalent in tourist areas, protecting beaches and benchmarking the carrying capacity of Cyprus against a set of climate-related key performance indicators. These efforts correspond to the focus of the Transition Pathway for Tourism on the ***green transition***, aiming to enhance the environmental sustainability of tourism, promote environmental protection, and achieve climate neutrality.

Both the EU and Cyprus strategies place strong emphasis on the ***digital transition*** of the tourism sector. The NTS 2030 aims to modernize the legislative framework for the licencing and operation of tourism businesses, while also enhancing digital transformation to improve the delivery of tourism services and marketing effectiveness. Initiatives for establishing Cyprus as a digitally smart destination

include:

- investing in digitization of tourist experiences through the 3D digital restoration of archaeological sites and the integration of AR and VR technologies in museums and,
- through applications such as MITOS which is a comprehensive and dynamic tourism guide for Cyprus featuring approximately 8,000 points of interest including among many other attractions, religious monuments, archaeological sites, and points of interest in both urban and rural areas, cycling routes, hiking trails, wetlands, birdwatching spots, accessible shipwrecks, and diving locations, wine routes, wineries, and workshops producing traditional products.

Similarly, the European Transition Pathway for Tourism emphasizes the importance of digital tools, along with data collection and sharing, in supporting the sustainable management of tourist destinations.

To mitigate seasonality and strengthen resilience, the NTS 2030 is actively promoting Cyprus as a year-round destination by diversifying its tourism offerings and supporting investments in special forms of tourism (e.g., agritourism, enogastronomy, weddings, casino entertainment, sports, nautical, and health and wellness). This objective is in line with the Transition Pathway focus on improving ***resilience*** of the tourism ecosystem by adapting to changing tourist demands and boosting overall competitiveness. In doing so, it aims to benefit both residents and visitors, while fostering authentic tourism experiences that are closely tied to local culture and heritage. Furthermore, the NTS 2030 acknowledges the need for upskilling the tourism workforce to improve the quality of services offered, aligning with the EU focus on developing a qualified workforce with green and digital skills to facilitate the sector's twin transition.

Additionally, a thorough examination of the environmental and climate change impacts affecting tourism in Cyprus has been undertaken in the NAS. The results of the climate change impact assessments indicate an increase in the intensity and frequency of heatwaves, forest fires, wildfires, and coastal beach erosion. The three main adaptation measures outlined above were specifically designed to address these risks. Ecosystems impact, including the loss of biodiversity, are also recognized in the NAS as a high-priority climate impact for the tourism sector. However, no

explicit adaptation measures have been proposed in the NAS to address this issue, nor has it been acknowledged as a priority in the NTS 2030. The food supply chain within the tourism sector in Cyprus, which is assessed in this deliverable, is representative of the pressure on biodiversity, given the island's dependence on food imports. Essentially, adaptation measures that also consider food supply and resource use for their production are necessary for developing a sustainable tourism food chain in Cyprus.

3. MAPPING OF CYPRUS TOURISM SECTOR

This section outlines the data collected at national level, which are instrumental in mapping the current state of Cyprus's tourism sector and in understanding the dynamics of food consumption and value chain. What follows is a detailed description of each dataset collected, including the variables, sources, and relevance to the case study.

3.1 Tourism statistics (CYSTAT) data

Cyprus Statistical Service (CYSTAT), the official department responsible for collecting comprehensive data from censuses, surveys, and specialized studies on economic, demographic, social, and environmental indicators. For the tourism sector in particular, CYSTAT datasets encompass 24 distinct metrics across three main categories: revenue metrics, which include estimates of revenue and tourist expenditure patterns broken down by type, location, and length of stay; tourism demographics and behaviour, which detail arrivals by country of residence, purpose of visit, sex, and accommodation type; and travel logistics, which track arrivals and departures by airport/port and mode of travel. The advantage of these datasets lies in their coverage of both annual and monthly timeframes, providing longitudinal and seasonal insights. The data spans from 1976 to 2024, with more detailed information available from 2017 onward. Data collection occurs through surveys conducted at entry points, i.e., airports and ports, and through accommodations to gather information on expenditures and travel behaviour. The sample size of tourists corresponds to 2% of the total number of individuals arriving in Cyprus. Between June 2020 and April 2022 (the COVID-19 period), tourist-arrival data was compiled

by processing records from the Cyprus Flight Pass platform.

More precisely, the CYSTAT dataset provides a range tourist statistics including:

- Tourist Arrivals: number of tourists per month, country of origin, purpose of visit
- Accommodation: types and occupancy rates
- Expenditure: average spending per tourist broken down into categories (accommodation, other)
- Length of Stay: number of nights spent by tourists in the destination
- Tourism Revenue: total revenue generated from tourism
- Tourist Demographics: age, gender, and other demographic details

Figure 1 shows tourist arrivals and revenue per year from 2001 until 2024. Following 2001, arrivals began to decline, likely due to the September 11 terrorist attacks and the Iraq war (Clerides & Pashourtidou, 2007) which also caused immediate declines in airline passenger loads and hotel occupancy in the United States (Corbet et al., 2019; Goodrich, 2002) and severely affected global cruise tourism (Diakomihalis & Syriopoulos, 2009). Since then, tourist arrivals have steadily decreased throughout the first decade of the 2000s. Notably, tourist arrivals decreased by half a million, from around 2.7 million in 2001 to 2.2 million in 2010. Signs of recovery emerged in 2004 and 2005 but the global economic crisis of 2008 (Boukas & Ziakas, 2013) and the subsequent Cypriot banking crisis in 2013 worsened the temporary downward spiral (Boukas & Ziakas, 2014). However, the sector demonstrated resilience and swiftly rebounded since a sharp increase in the number of tourist arrivals was recorded between 2014 and 2019. Tourist arrivals peaked at close to four million in 2018 (3.94 million) and 2019 (3.98 million). The COVID-19 pandemic severely affected Cyprus touristic sector (Giannakis et al., 2020; Prodromou et al., 2024) with 2020 figures suggesting a decrease of 84% in arrivals compared to the previous year. In 2023, tourist arrivals (3.85 million) recovered to pre-pandemic levels, closely matching those of 2019. In 2024, the number of tourist arrivals increased further to a record-high 4.04 million. Regarding tourism revenue, the top performance year was 2024 (€3.21 billion) followed by 2023 (€2.99 billion) and 2018 (€ 2.71 billion).

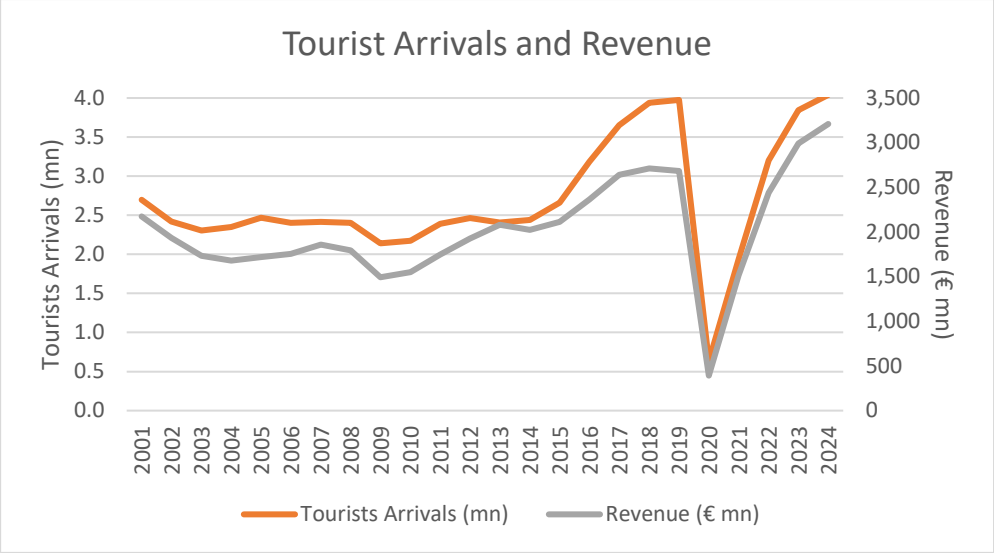

Figure 1: Tourist arrivals & revenue per year. Source: CYSTAT

Great Britain has traditionally been the most important tourism market for Cyprus. The long-standing relationship between Great Britain and Cyprus is due to several factors, including historical ties since Cyprus was part of the British Empire, the wide use of the English language in Cyprus, and the attractiveness of Cyprus as a premier "sun and sea" destination for British holidaymakers. While Brexit has introduced significant uncertainties and instability for Cyprus tourism, Great Britain remains the leading market with British tourists constituting a significant portion of the total visitors to Cyprus over time as shown in Figure 2. In 2023, for example, tourist arrivals from Great Britain represented 48% of total arrivals from major markets. Other traditional markets include Germany, Greece and Sweden accounting for around 8%, 7% and 5% respectively of the total arrivals from major markets in 2023.

The composition of tourist arrivals varies from year to year and is often vulnerable and negatively affected by exogenous shocks. International political instability and wars seem to affect the origin of tourists. For example, the ongoing Russo-Ukrainian war, has significant negative impact on Russian tourism to Cyprus. The international travel restrictions and sanctions imposed on Russia have significantly reduced the number of Russian tourists to Cyprus in the post COVID-19 period. To counterbalance the absence of Russian tourists, there have efforts to replace the lost arrivals by attracting tourists from new regions such as Israel and Poland. Hence, since 2022 Israel became the second largest source of tourists to Cyprus (11% of total tourist

arrivals in 2024) followed by Poland (8% of total tourist arrivals in 2024). At the time of writing, the effects of the ongoing Israel-Hamas war are still unfolding.

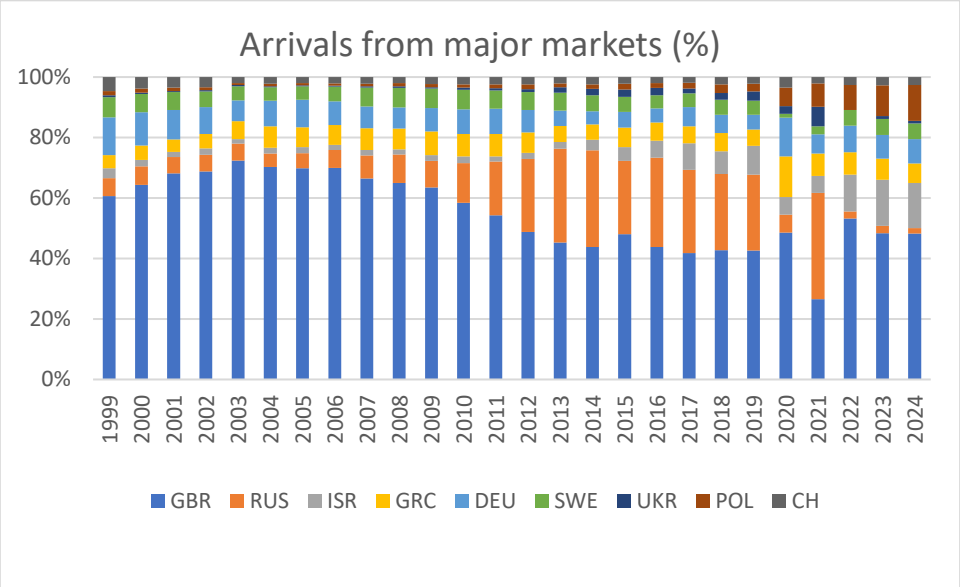

Figure 2: Arrivals by country of usual residence. Country codes (ISO 3166-1): GBR = United Kingdom; RUS = Russia; ISR = Israel; GRC = Greece; DEU = Germany; SWE = Sweden; UKR = Ukraine; POL = Poland; CH = Switzerland. Source: CYSTAT

Cyprus tourism experiences strong seasonality, as shown in Figures 3 and 4. Most tourist arrivals and revenue take place between May and October every year. The increasing number of tourism arrivals in recent years indicated above, is also depicted in these monthly figures.

Arrivals of tourists (millions)													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2001	64213	83568	137577	237228	324901	322835	373385	371536	329400	269744	107454	74887	2696728
2002	54067	71950	138625	180481	279070	293192	327404	301724	306731	275840	111327	77822	2418233
2003	59529	77972	91634	169891	231527	262100	318143	325390	287358	271980	123800	83919	2303243
2004	56504	75705	111945	191251	261646	264799	305978	305926	303506	278976	114048	78723	2349007
2005	58894	72600	137075	183561	284132	282652	338972	336587	302833	292273	104822	75656	2470057
2006	54875	66151	107071	206548	283513	280164	341443	314872	296532	283046	95682	71022	2400919
2007	51848	63098	104316	189310	273058	282465	352423	340534	315437	275103	94741	73742	2416075
2008	50658	70140	108164	182091	271559	307237	342554	328100	305348	267866	97900	72127	2403744
2009	47066	56626	90434	181395	246546	260931	304126	291583	276178	230431	89670	66201	2141187
2010	45952	55250	103803	139658	258014	275280	306106	304264	289126	241698	92643	61199	2172993
2011	44442	62294	98964	199762	267487	300817	359104	337013	304260	259863	92878	65339	2392223
2012	47610	55420	94300	189648	276781	329977	371453	363573	335352	261997	84020	54772	2464903
2013	42286	42327	92620	162439	276244	308219	361442	352215	357653	273587	81542	54813	2405387
2014	40675	45227	77533	180998	293181	342221	381955	373086	316602	251453	81437	56863	2441231
2015	41799	50709	97479	201495	307449	336967	414527	392272	360899	269363	108093	78348	2659400
2016	48607	65988	137013	225575	364943	413114	482132	458645	421201	357194	124192	87927	3186531
2017	62611	82209	140873	286331	418732	472450	531030	523651	483716	406870	144676	98924	3652073
2018	75867	101481	192090	314143	450495	511073	539626	534847	520138	433617	158685	106563	3938625
2019	81970	105571	169934	329308	434578	509662	550971	553845	524707	436509	169392	110330	3976777
2020	85622	105592	55342	0	0	9119	64914	104261	87334	100791	8952	9682	631609
2021	3889	5047	8811	38226	100852	184159	297308	321858	339242	391638	148973	96928	1936931
2022	43944	71921	128840	289335	315018	372324	454657	451133	413382	400628	149857	110041	3201080
2023	90549	119081	184263	342736	420076	456985	523718	511387	487350	426272	159605	123630	3845652
2024	87961	125034	202256	333563	421400	482261	551229	554923	509463	459106	179941	133063	4040200

Figure 3: Monthly arrivals of tourists in Cyprus, 2001-2024. Heat map colours across all monthly cells denote dark red for the lowest arrivals, yellow-orange mid-range, dark-green the highest. Source: CYSTAT

Revenue (€ mn)													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2001	42.6	49.8	85	153.5	237.6	268.9	328	350.2	301.2	222.5	83.4	49.9	2172.6
2002	36.9	49.3	101	131.6	204.3	238	274.5	262.7	268.9	218.8	87.8	60.8	1934.6
2003	43.8	53.7	64.6	114.6	158.1	196.1	260.4	282.4	229.1	192.1	83.2	56.1	1734.2
2004	37.2	43.4	71.9	123.2	170	186.8	230.8	253	241.3	198	73.7	49.2	1678.5
2005	35.4	40.1	81.3	105.9	180.1	193.6	239.4	275.6	235.6	205.8	73.7	51.8	1718.3
2006	36.2	39.4	66.5	127.2	191.1	201.1	264.9	264.8	240.8	209.9	64.3	49.1	1755.3
2007	33.6	38.5	68.5	123.7	204.6	207.4	287.3	306	263	206.3	67.8	51.4	1858.1
2008	35.3	40.6	67.3	107.8	191.3	229.6	272.9	278	247.4	198.6	72.4	51.6	1792.8
2009	31.2	36.3	57.4	107.4	158.1	175.4	232.5	234.8	200.2	156.3	61	42.7	1493.3
2010	29.7	33.9	65.6	89	164.8	195.3	231.1	241.1	220.5	175.5	62.4	40.9	1549.8
2011	29.8	36.9	66.4	136.7	187.1	220	274.4	267	235.8	188.8	64.8	41.6	1749.3
2012	30	32.3	62.5	114.6	214.3	254.5	301.5	312.1	289.9	211.5	62.8	41.6	1927.6
2013	30.9	28.3	66	110.4	202.1	259.8	338.6	349.5	353.4	246.6	59.2	37.6	2082.4
2014	30.7	31.3	56.5	132.9	224.1	303.2	321.2	324.3	273.4	217.1	65	43.7	2023.4
2015	28.4	30.9	65	130.5	217.1	259	342.1	358.5	321.1	225	81.9	52.6	2112.1
2016	29.1	37.6	80.9	137.9	244.7	301	402.2	392.2	337.1	266	83.8	50.9	2363.4
2017	35.4	46.6	86.1	189.6	291.5	347.2	425.7	423.6	371	277.1	89.5	55.8	2639.1
2018	38.4	52.7	110	181.4	294.7	357.7	426.6	428.2	378.8	293.8	91.9	56.4	2710.6
2019	39.6	52.4	96.6	186.6	277.6	350.4	422	431.6	377.2	299.4	95	54.6	2683
2020	40.2	49.5	25.6	0	0	6.7	42.5	71.1	63.3	77.4	6.6	9.1	392
2021	2.8	3.8	8	31.7	76.7	135.8	245.7	272.5	268.2	310.2	104.2	54	1513.6
2022	28.2	39.6	69.1	185.1	221	292.7	381.7	399.7	348.3	319.8	96.4	57.6	2439.2
2023	45.6	56.6	97.8	217.6	311	361.5	454.6	483	428.4	346.5	113.7	74.3	2990.6
2024	45.2	65.1	113	217.4	310.5	385.2	474	511.4	454.1	407.9	138.7	86.9	3209.4

Figure 4: Monthly tourist-related revenue in Cyprus, 2001-2024. Heat map colours across monthly cells denote dark red for the lowest revenue, yellow-orange mid-range, dark-green the highest Source: CYSTAT

As shown in Figure 5, the majority of tourists stay in star-rated hotels. Package

tourism surpassed individual travel historically. The majority of incoming tourists opted for travel packages that typically include transportation, accommodation, as well as food and beverage services. In recent years, however, package travel tends to decrease (50% in 2019) compared to individual travel as illustrated in Figure 6; such shifts also have a potential effect on food consumed by tourists, which is not captured in these statistics.

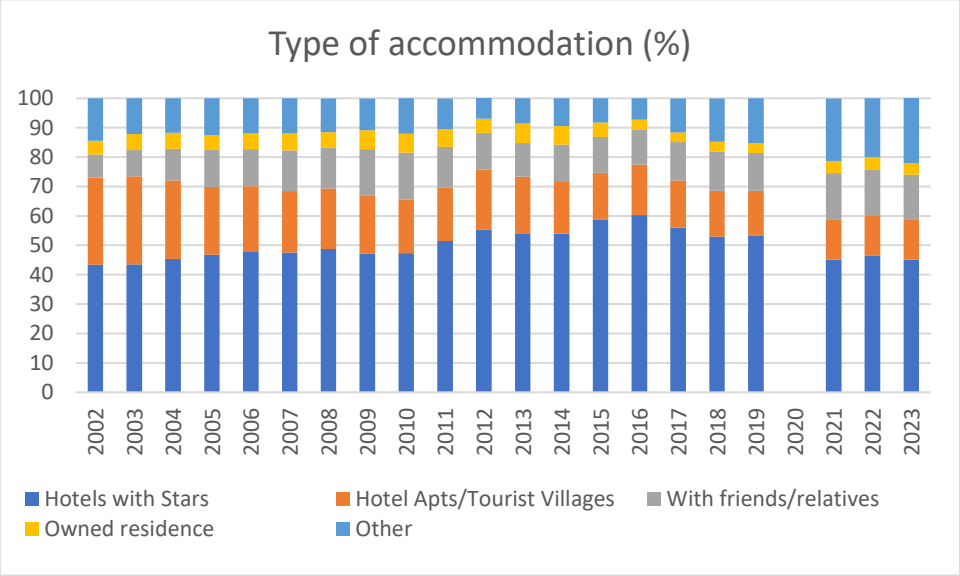

Figure 5: Type of accommodation;the survey was not contacted in 2020 due to COVID-19 restrictions. Source: CYSTAT

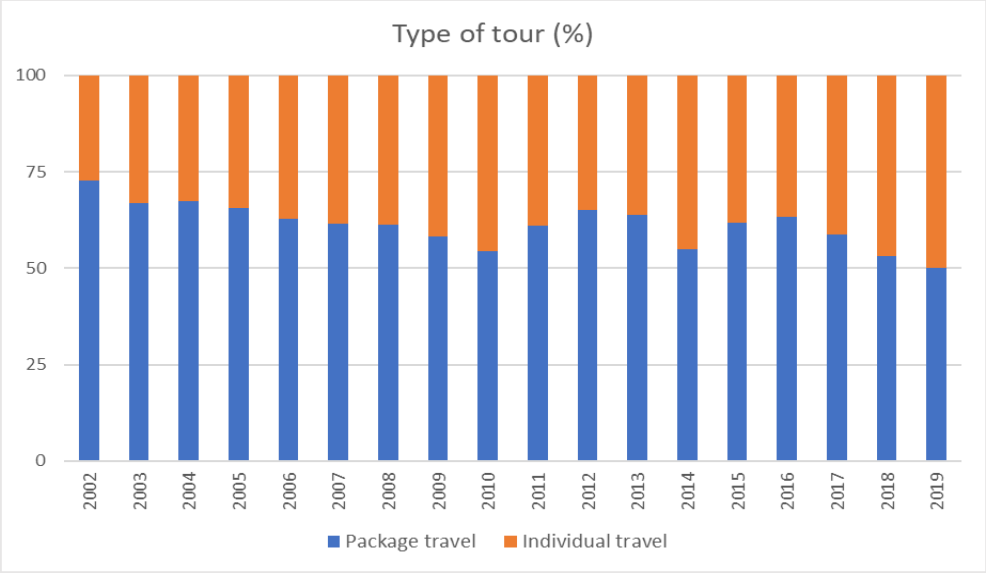

Figure 6: Type of tour. Source: CYSTAT

Table 1 presents total expenditure per person, tourists' country of usual residence, and average length of stay (number of nights) in Cyprus for 2023, together with the corresponding percentage changes from 2022; only countries for which CYSTAT provides data for both variables in 2023 are included. The length of stay is a key driver of total spending at the destination. In 2023, per-person tourist expenditure rose by 2.1% even though the average stay shortened by 8.5%, to 8.6 nights. Russian visitors were the highest spenders per person, closely followed by Swiss tourists. Israelis stayed the shortest time (4.6 nights on average), whereas Russians stayed the longest (16.4 nights). When adjusted for stay length, however, Israeli tourists registered the highest daily spending (€129.80 per person), while Russian visitors recorded the second-lowest (€63.71). Greek tourists had both the lowest overall per-person expenditure (€380.60) and the lowest daily expenditure (€42.76).

Spending patterns reflect differences in consumption behaviour—including food preferences—across nationalities. In addition, year-to-year shifts in seasonality and in the source-market mix complicate the precise quantification and attribution of impacts to specific nationalities.

Table 1: Total expenditure and average length of stay per person (pp)

	Total expenditure per person (€)		Average length of stay (nights)	
Country of usual residence	**2023**	**% change from 2022**	**2023**	**% change from 2022**
Austria	895.46	-0.7	7.2	-7.7
Finland	772.93	7.1	7.4	-8.6
France	728.34	6.7	8	-11.1
Germany	869.24	-0.2	9.1	-3.2
Greece	380.60	2.9	8.9	-9.2
Israel	597.10	-0.6	4.6	2.2
Italy	607.66	-3.0	7.3	-17.0
Lebanon	850.60	8.2	6.9	-10.4
Netherlands	768.77	-5.1	8.7	-9.4
Norway	865.45	-9.9	8.7	-18.7
Russia	1044.85	n/a	16.4	n/a
Sweden	768.05	6.7	9.2	5.7
Switzerland	1041.31	-5.4	8.2	-5.7
United Kingdom	848.52	1.4	9.9	-10.0
USA	979.47	n/a	12.6	-6.7
All countries (average pp)	777.68	2.1	8.6	-8.5

Source: CYSTAT

3.2 Food and Tourism consumption (FAOSTAT) data

FAO's global statistical database (FAOSTAT) provides access to food production, consumption and trade data, including Supply Utilization Accounts (SUA) and Food Balance Sheets (FBS). These datasets give a comprehensive picture of the pattern of a country's food supply per year. Specifically, SUAs track the supply and utilization of all individual food products, both primary and derived food commodities. These accounting balances serve as the building blocks for the FBS. To facilitate the interpretation of a country's overall food supply and consumption patterns, the SUA data are converted into primary commodity equivalents and aggregated into a standardized format. The FBS present for each food item, i.e. both primary commodities and a number of processed commodities potentially available for human consumption, the sources of supply and its utilization (e.g., food, feed, processing, seed, etc.). The total available *supply* during a given period is calculated by adding production and imports and adjusting to any changes in stocks since the beginning of that period. On the *utilization* side, the FBS distinguishes between the quantities exported, animal feed, seed, processing for food and non-food purposes, losses during storage and transport, and food supplies available for human consumption at the retail level, i.e. the food that reaches households or is sold through retail outlets.

FBS over a series of years can highlight trends in a country's overall food supply, reveal changes in dietary composition and growth of consumption in new products, and indicate the extent to which the national food supply is sufficient to meet nutritional requirement. Thus, FBS are useful for estimating overall food surpluses and shortages within a country, supporting projections of future food supply and demand, setting goals for agricultural production and trade, and serving as a valuable tool for policy analysis and decision-making aimed at ensuring food security.

Since 2010, FAO implements a new method that also includes tourists food consumption in SUA and FBS. This is particularly important for countries like Cyprus, where a high number of tourists relative to the resident population can significantly impact the structure and interpretation of the FBS (FAO, 2025). Food consumed by

tourists is expressed in net terms in the FBS (**NetTF**). It refers to the amount of food available to incoming tourists minus the amount of food that would have been available to residents had they been present in the country. In other words, this information in the FBS is populated through imputation, and its derived using visitor numbers, visit lengths and the amount of calories historically available in both the home and destination countries (see New Food Balances). For each commodity, this quantity is calculated by first multiplying the number of tourist days by the average amount of that commodity consumed daily and then subtracting from this value the product of the number of outgoing tourist days and the average amount of that commodity consumed daily:

$$NetTF = (No.\,Incoming\ visitor\ days\ \times daily\ food\ available\ for\ visitors) - (No.\,Outgoing\ travel\ days \times daily\ food\ available\ for\ residents)$$

Thus, while the approach offers a standardized method, it relies on imputation and estimation based on a set of assumptions for tourism-related food consumption. In particular, it is assumed that tourists follow the consumption patterns of the local population, but at a scale that reflects their typical daily caloric intake as in their home country.

Figure 7 below shows tourists' total food consumption, as well as the total food supply in Cyprus (both in tonnes), and the share of tourism consumption to food supply, as obtained from FAOSTAT. Four reference years are presented; 2010 (first available year with tourism consumption), 2015, 2019 (pre-COVID19) and 2022 (post-COVID19 and latest available year at the time of writing). Across the four reference years, tourists' total food consumption account for a modest but important share of the island's food supply. For most major categories the tourist share lies around 4–8% of total supply. The largest relative contributions are observed for beverages (alcoholic and non-alcoholic) and animal-based products (notably meat, dairy and fish/seafood), where the tourist share frequently reaches 7–10%, and even peaks at 17% for pork meat in 2010. By contrast, tourists contribute the least to staple commodities such as cereals, oils & fats and sugar/sweets, generally ~1–5% of supply. In absolute terms, tourist food consumption increases from the 2010 to 2015 and softens in the last available year, whereas overall national food supply for most categories remains comparatively stable. Together, these patterns indicate that

tourism in Cyprus disproportionately drives demand for livestock and beverages and higher-value foods, while having a smaller direct influence on staple items.

Food Group	Tourist consumption (tonnes)				Food supply quantity (tonnes)				% Tourism to food supply			
	2010	2015	2019	2022	2010	2015	2019	2022	2010	2015	2019	2022
CEREALS	3766	5002	6445	5095	127649	143341	141819	137080	3%	3%	5%	4%
STARCHY ROOTS	1329	1662	1377	1289	24405	28405	19421	31986	5%	6%	7%	4%
SWEETENERS	2643	4512	5221	4768	64744	69160	65746	85337	4%	7%	8%	6%
PULSES	475	239	241	188	3567	3657	3329	3879	13%	7%	7%	5%
TREENUTS	147	135	333	152	2798	1909	2657	2682	5%	7%	13%	6%
OILCROPS	411	545	962	510	6514	5693	5427	5428	6%	10%	18%	9%
VEGETABLE OILS	1617	1236	1247	914	17306	16450	18869	19628	9%	8%	7%	5%
VEGETABLES	5181	6073	6813	4703	102308	100663	83332	88549	5%	6%	8%	5%
FRUITS	3870	4396	4891	3025	78760	88710	59805	59300	5%	5%	8%	5%
STIMULANTS	421	501	664	481	8606	8923	8772	8489	5%	6%	8%	6%
SPICES	31	38	73	55	461	478	800	860	7%	8%	9%	6%
ALCOHOLIC BEVERAGES	4015	3497	4648	3181	68828	68071	68538	64503	6%	5%	7%	5%
MEAT*	7220	4195	5195	3336	75140	70280	82936	78123	10%	6%	6%	4%
OFFALS	173	143	137	53	3134	2336	2110	1465	6%	6%	6%	4%
ANIMAL FATS	72	89	113	59	1698	2087	6803	5661	4%	4%	2%	1%
MILK	5291	6693	8977	6937	122689	119165	187356	213148	4%	6%	5%	3%
EGGS	452	583	709	378	7787	8799	9512	7847	6%	7%	7%	5%
***MEAT**												
BOVINE	288	353	431	286	5955	5982	7436	7821	5%	6%	6%	4%
MUTTON/GOAT	286	344	403	228	5673	5603	6112	5187	5%	6%	7%	4%
PIG MEAT	5058	1717	1964	1174	30073	28702	31740	28407	17%	6%	6%	4%
POULTRY	1284	1690	2347	1619	31525	28440	36908	36078	4%	6%	6%	4%
OTHER MEAT	304	92	50	30	1913	1554	739	631	16%	6%	7%	5%

Figure 7: Total tourism food consumption and food supply in Cyprus. Asterics in meat category denotes disaggregation by animal of origin. Source: FAOSTAT

Figure 8 below shows the import dependency ratio (IDR, %) for major crop categories, which were cacluated based on FAOSTAT data as follows:

$$IDR = \frac{import}{production + import - export} \times 100$$

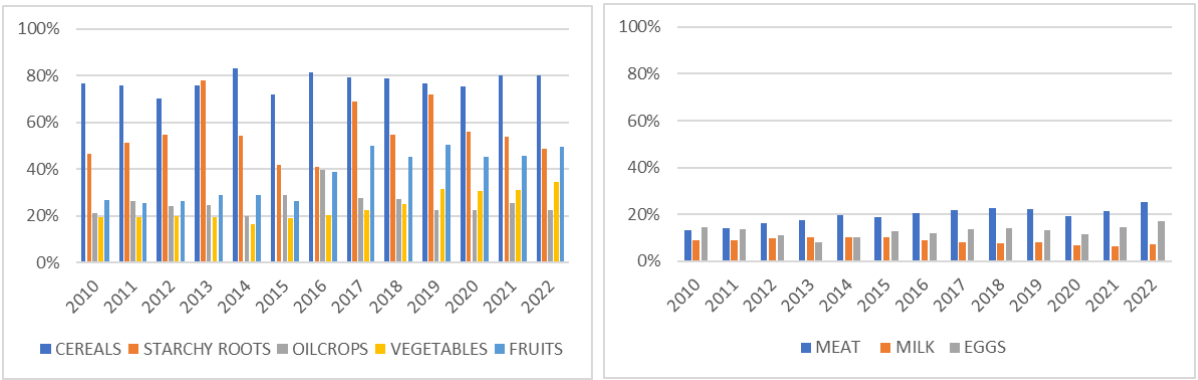

Figure 8: Cyprus' import dependency in major crop and livestock food categories

Across 2010–2022, cereals show persistently high import dependency (~70–85%), peaking around 2014 and 2022. This largely reflects feed use; although most livestock products are produced domestically, the sector relies heavily on imported feed cereals (e.g., barley/maize) — so the high cereal dependency is indirectly embedded in local meat and dairy products (Zoumides et al., 2014). Among crops, fruits and starchy roots exhibit moderate dependency (~40–55%), oilcrops are ~25–35%, and vegetables are lower (~20–30%, with a dip around 2016). In livestock categories, meat dependency is modest but rising (reaching ~20–30% by 2022), milk remains largely domestic (≈5–10%), and eggs are minimal for most years but increase in 2021–2022 (~15–20%); although, as mentioned, these products may be produced locally but rely on imported feed.

4. EMPIRICAL STUDY I: INSIGHTS FROM THE HOTEL INDUSTRY

This section outlines the empirical research methodology and findings related to food consumption behaviors and sustainability practices within the hotel industry and tourism sector in Cyprus. In particular, two structured questionnaires were designed, targeting hotel managers and tourists. A stratified random sampling method was employed for hotels to ensure a representative cross-section of the industry.

4.1 Hotel Survey Sampling Methodology

The objective of the questionnaire was to gather information on tourists' food consumption behaviours and preferences in the hotel sector. The target group comprised hotel managers, including food and beverage (F&B) managers; their insights were considered critical for identifying trends, preferences, and practices in the food options offered by hotels, as well as managers' perceptions of the tourist food supply chain. We also explored willingness to adopt sustainable practices and the barriers and opportunities to realising transformational change.

The questionnaire consisted of structured questions intended to gather both

quantitative and qualitative information aligned with the research objective. More precisely, the questionnaire was divided into seven main sections: i) General Information, ii) Guest Demographics, iii) Consumption Information, iv) Kitchen Operation Practices, v) Supplier Information, vi) Utilization of Class II agricultural products, and vii) Monthly food consumption data, reservations and occupancy rate (Appendix 1). The Kitchen Operation Practices section used closed-ended questions with a fixed set of responses to make it user-friendly, increase participation, and enable quantification of results, with the aim of capturing the food-waste management and sustainability practices employed by hotel establishments (Zhou et al., 2017). The sixth section employed Likert-scale questions to capture perceptions and potential limitations in the adoption of Class II agricultural products, and the factors that most encourage establishments to consider these products viable alternatives (Baburajan et al., 2022). Unlike binary questions, which only have two answer options, Likert-type questions allow respondents to provide more granular feedback and express varying degrees of opinion (Claveria, 2021).

Developing the questionnaire was challenging, as it needed to address local and industry realities and to consider the wide range of hotel rankings in Cyprus, each with different internal organizational structures. For example, lower-rated hotels with smaller capacities typically do not have an appointed F&B manager, so the hotel manager or chef is often the person directly responsible and has the necessary knowledge/experience for the topics the survey focuses on. However, due to their numerous duties and busy schedules, they often have limited time. To address this challenge and improve the clarity and consistency of the questions, a pilot test was conducted with three respondents. Based on their feedback, minor revisions were made and a final version was prepared.

A stratified random sampling method was employed to select the hotel sample. Stratified random sampling is particularly practical when the population under study is heterogeneous and a complete sampling frame is available (Arrogante, 2022; Hayes, 2025). The population is divided into homogeneous subgroups, known as strata, based on specific characteristics defined by the researcher. Each member of the population belongs to only one stratum. Finally, simple random sampling was used to select the sampled units from each stratum. The advantages of this approach include greater generalisability and reduced selection bias.

A complete list of licensed hotels was obtained from the Cyprus Tourism Organization (CTO, 2024); the list includes the hotel name, ranking, capacity, and contact information (Table 2). As a first step, the hotels were divided into distinct strata based on their district and, secondly, their hotel classification (e.g., 5-star, 4-star). A total sample of 50 hotels was proportionally distributed across the five districts of Cyprus as an initial target, based on the number of hotels located in each area. For example, 48 out of the 234 hotels in Cyprus are located in Ayia Napa, corresponding to approximately 20.5% of the 50-hotel sample. The second stage then allocated the 13-hotel sample proportionately based on the distribution of hotel classes in the region. The required number of hotels for each stratum was then randomly selected using simple random sampling.

Table 2: Structure of Tourist Accommodation Establishments in Cyprus

Hotel Ranking	No Hotels	Rooms	Beds
5 stars	35	8439	16744
4 stars	70	12519	24777
3 stars	74	7259	14262
2 stars	40	2018	3929
1 star	15	309	624
Hotel Total	234	30544	60336
Hotel *Apartments* Class A'	44	3689	7734
Hotel *Apartments* Class B'	75	3056	6320
Hotel *Apartments* Class C'	15	424	878
Hotel *Apartments* Class N/A	78	1804	4036
Hotel Apartments (Total	212	8973	18968
Traditional Villages	16	2702	5522
Tourist Villas	49	113	608
Traditional Houses - Apartments	91	327	766
Traditional Houses - Hotels	17	146	275
Town - Hotels	3	135	270
Total	*622*	*42940*	*86745*

Source: CTO, 2024

Initial contact was made by phone, during which we outlined the survey's purpose and the data that would be required (e.g., occupancy rates and tourist demographics) so they could be prepared if not readily accessible. To allow sufficient time for completion, the questionnaire was then sent via email. In cases where phone contact was not possible, members of the research team visited the establishment and interviewed the responsible person directly. If time permitted, the survey was completed on-site in a semi-structured interview format; otherwise, the questionnaire was emailed with the relevant instructions.

The response rate to telephone outreach was initially very low, with in-person visits proving the most effective means for data collection. Participation in the survey was higher among 4- and 5-star hotels, most likely because they are better organised, keep consistent records, and often have an F&B manager in place who is familiar with the survey questions and data requirements. The data collection period began in May 2024 and concluded in October 2024. Out of the 50 initially sampled hotels, 29 completed the questionnaire up to Section 6, and 10 of these completed it in full, as shown in Table 3.

Table 3: Response Overview by Hotel Category

Hotel Category	Total Hotels	Initial sample selection of Hotels	Sampled Hotels	Partial Responses (up to Q6)	Full Responses
5 stars	35	7	3	1	2
4 stars	70	15	18	13	5
3 stars	74	13	3	2	1
2 stars	40	6	1	1	0
Hotel Apts	212	9	4	2	2
Total	431	50	29	19	10

4.2. Managerial Practices and Sustainability Trends

The characteristics of the hotel establishments that participated in this survey represent a diverse cross-section of the Cypriot tourism sector. The majority of respondents were 4-star establishments (62%), while the rest included hotel apartments (14%), 2-star (4%), 3-star (10%), and 5-star (10%) hotels. The size and capacity of these hotels varied significantly, ranging from small establishments with 41 rooms to large resorts with up to 375 rooms, and bed capacity ranging from 82 to 1,100. In terms of guest profiles, the majority of visitors fell into the 45–64 age group (75%), indicating a mature clientele who may have different expectations and sensitivities regarding service and sustainability compared with younger demographics. In line with Cyprus's tourist mix, the United Kingdom was the most common country of origin for tourists, followed by Israel, Germany, and other European countries.

Hotels often operate more than one type of restaurant, depending primarily on their classification and capacity. Casual-dining restaurants, which offer a relaxed atmosphere and moderately priced menus suitable for everyday meals and family

dining, are among the most prominent types, present in 86% of hotels, as are buffet restaurants. In contrast, fine-dining restaurants, characterized by a more formal setting, high-quality cuisine, and higher price points, are typically found in 4- and 5-star hotels, with only 28% of hotels offering this type of restaurant (Table 4).

Table 4: Hotel Establisments Characteristics

Variable	%
Hotel Ranking	
5 stars	10
4 stars	62
3 stars	10
2 stars	4
Hotel *Apartments*	14
Type of Restaurants	
Casual Dining	86
Fine Dining	28
Buffet	86
Café	24
Booking Method	
Tour Operators	79.46
Direct Booking	20.54

Regarding the perceptions and practices of hoteliers, the results show that sustainability awareness is growing among hoteliers, driven primarily by tour operators' requirements for sustainability certification. Most respondents are familiar with sustainability certification schemes, with 46% holding Travelife certification, 50% ISO 14001, and 23% Green Key; however, 27% still operate without any certification.

When it comes to understanding guest preferences, 59% of hoteliers track their best-selling menu items (Table 5), which tend to be fast-food favourites such as club sandwiches, burgers, and kebabs. This likely reflects visitors' preference for quick, inexpensive lunches prior to buffet service. At the same time, 79% of establishments showcase local cuisine through themed buffet nights, or a section of the à la carte menu offering traditional Cypriot dishes, such as *moussaka* and *stifado* (beef stew). While 93% of hotels provide vegetarian and/or vegan options, the response to evolving dietary trends remains limited, as only two hotels feature a dedicated section specifically addressing these preferences.

A commonly employed tactic to reduce food waste is redistributing safe, surplus buffet items to hotel staff, which, although often informal, can be effective in

minimising waste and operational costs. Ninety-five percent of hotels report this practice, followed by repurposing surplus, unserved food in subsequent meals (86%) (e.g., using vegetables from dinner service to prepare omelettes the next morning) in line with food-safety and hygiene guidelines. Guest engagement in minimising food waste remains limited (41%), with hotels prioritising customer satisfaction and reputation.

Table 5: Willingness of hotels to reduce food waste

Question	Responses	
	Yes	**No**
Q17: Do you track which dishes are most frequently ordered in your restaurant?	59%	41%
Q23: Do you encourage staff to reduce food waste?	79%	21%
Q27: Do you encourage tourists/consumers to reduce food waste?	41%	59%
	Important	**Very Important**
Q29: How important is reducing food waste at your establishment?	20%	80%
Q30: How important is it to incorporate food waste management practices into employee training?	31%	69%
Note: The table presents only a subset of the questionnaire (see Appendix 1 for all questions)		

However, the hotel industry demonstrates a strong internal commitment to reducing food waste, with 79% of establishments actively encouraging staff to adopt waste-reduction practices (Table 5). Hotels implement internal measures, including standard operating procedures (SOPs), staff training, and the development of tracking and monitoring systems. This commitment could strengthen further; all participants indicated that reducing food waste is important and that training employees in food-waste management is favoured.

Nonetheless, only 41% of hotels actively encourage guest participation in food-waste reduction (Table 5). Most of these hotels integrate sustainability communication into the guest experience through digital tools (e.g., QR codes, informational videos) as well as signage in buffet areas to raise awareness.

Considering the selection of plate size as a behavioural intervention to reduce food waste, it is not widely used: 52% (15 out of 29) report explicitly considering this measure. Instead, respondents prioritise purchasing costs (77%) and design (61%) when selecting plate sizes (Figure 9). Five-star hotels, in particular, are less likely

to adopt smaller plates, viewing them as inconsistent with the luxury experience they aim to offer.

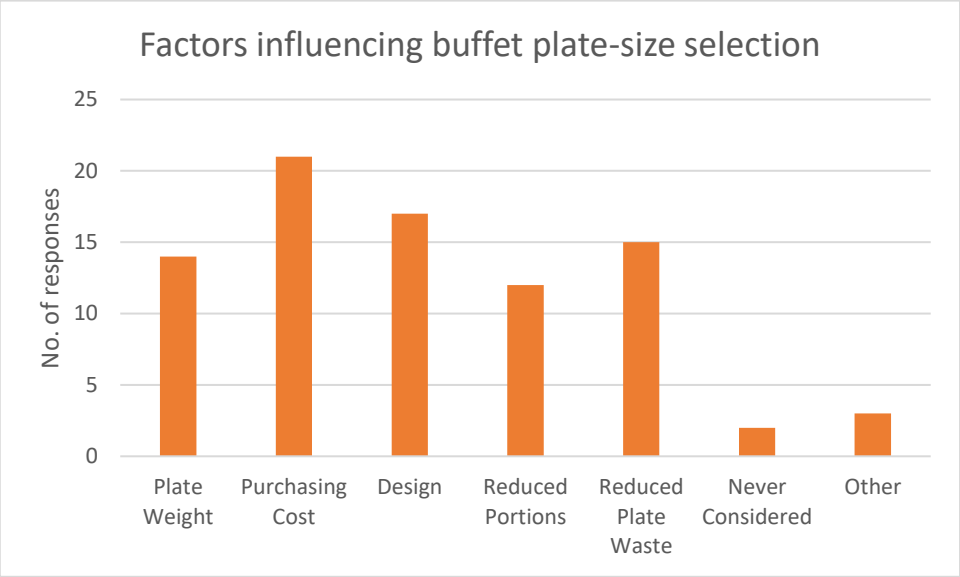

Figure 9: Criteria used by hotels when selecting buffet plate size

Nonetheless, F&B managers' motivation to minimise food waste is increasing because it directly reduces costs. The most commonly adopted food-waste-reduction practices among respondents include prioritising seasonal and local ingredients (90%), cooking to order (86%), and maximising the use of edible portions (86%); by contrast, only 55% report using Class II vegetables in their kitchen operations (Table 6). Other practices reported to reduce food waste include careful menu planning, portion control, and stock monitoring.

Table 6: Practices to reduce food waste

Variable	**%**
Which of the following practices are incorporated in the kitchen operations?	
Cook on demand	86
Prioritize the use of seasonal and locally produced ingredients	90
Utilize frozen food products to extend storage life	72
Actively monitor food stock levels and repurpose excess ingredients	86
Incorporate Class II vegetable products to reduce food waste	55
Maximize the use of all edible parts of food (zero-waste kitchen approach)	86

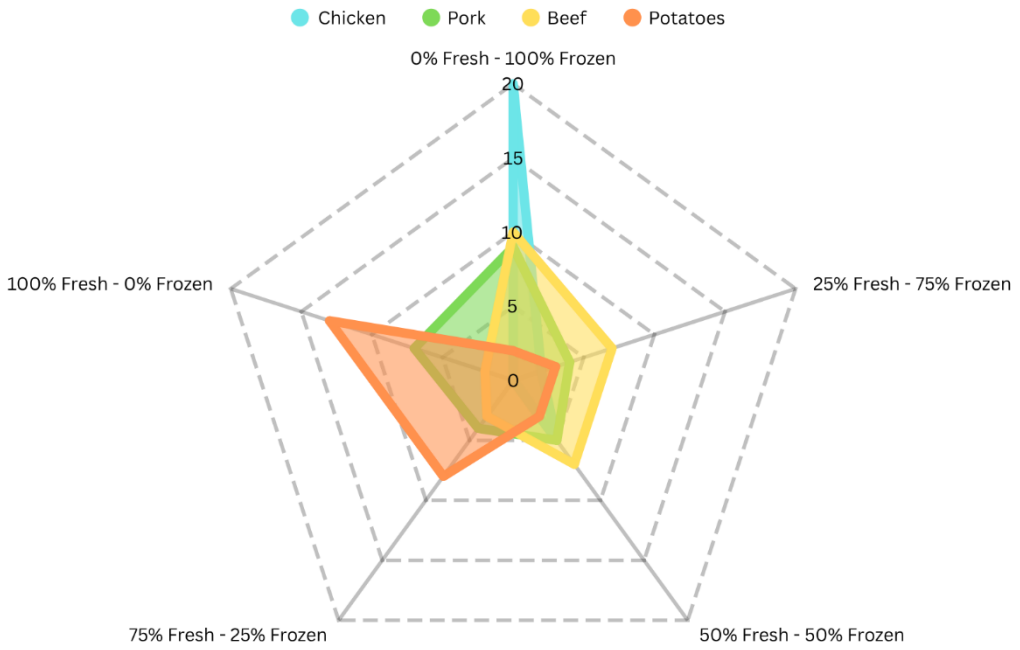

Figure 10: Preference on fresh or frozen meat products

Figure 10 shows the share of fresh vs. frozen use for four key ingredients. Chicken is reported as exclusively frozen (100% of respondents), whereas potatoes are more commonly used fresh. The fresh–frozen split may serve as a proxy for origin; though not definitive, frozen items typically suggest imports, while fresh products are more likely to be locally sourced.

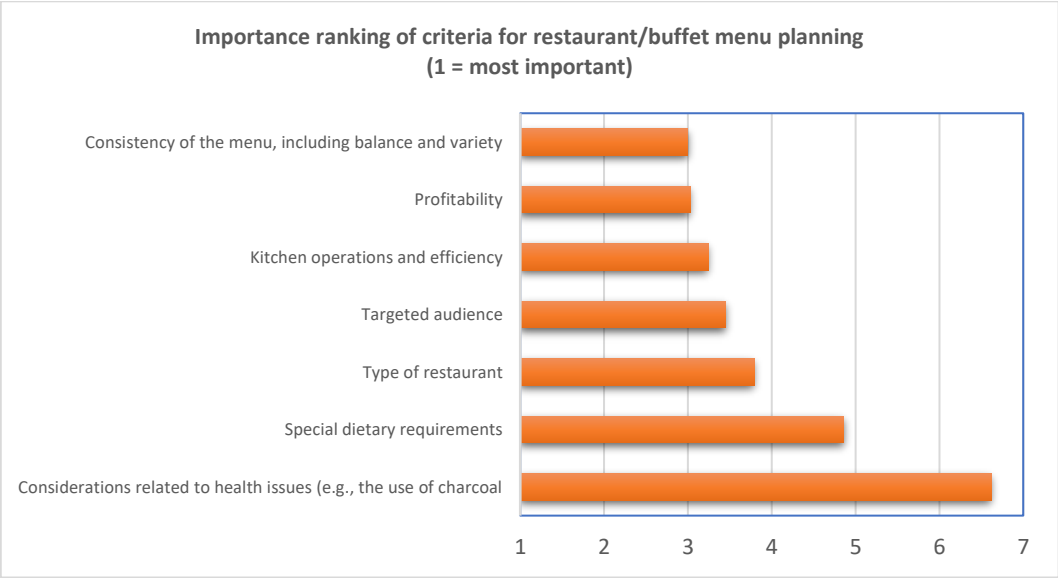

Figure 11: Importance ranking of criteria for buffet menu design

When designing buffet menus, hoteliers prioritise, in order of importance, (i) menu consistency (balance and variety), (ii) profitability, and (iii) kitchen operations and efficiency (Figure 11)

Figure 12: Factors influencing food supplier selection

The choice of food suppliers (Figure 12) is a critical lever for advancing a successful transition in the hotel food supply chain. On a 1–5 importance scale, the top-rated criteria were product quality (4.88) and food-safety certification (4.88), e.g., Ministry of Health requirements, followed by supply reliability/consistency (4.73) and order flexibility (4.23), e.g., the ability to address discrepancies or quality issues. These factors underpin uninterrupted kitchen operations and consistent output quality. Environmental-sustainability practices (3.50) were rated comparatively lower, viewed more as complementary than decisive in supplier selection.

Interestingly, 58% of hotels already use Class II (cosmetically imperfect) produce in their buffet offerings. Of respondents, 62% rated the quality acceptable and 31% acceptable with conditions (Figure 13). Key drivers are cost-effectiveness and environmental benefits, while barriers include quality specifications/standards and concerns about flavour differences.

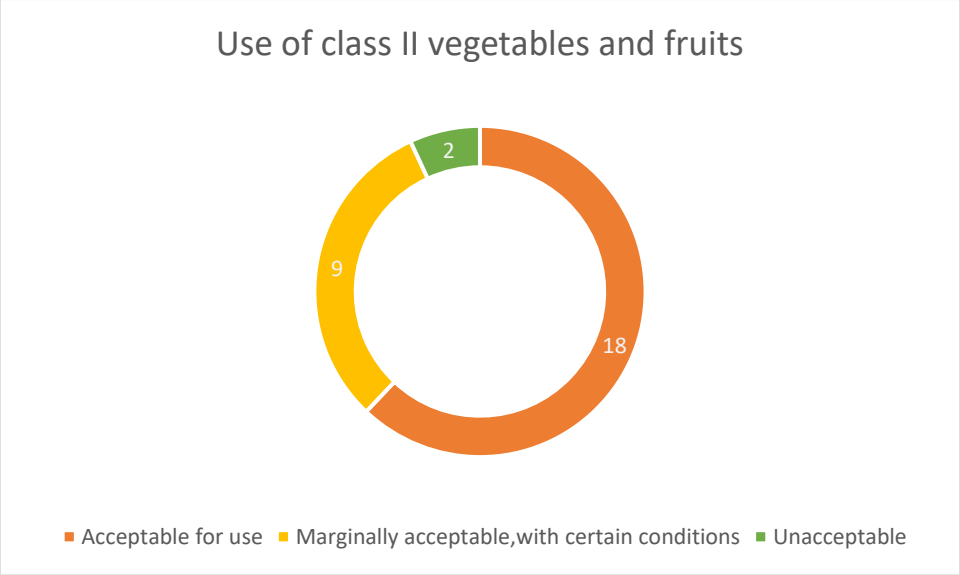

Figure 13: Use of class II agricultural products by hotel establishements

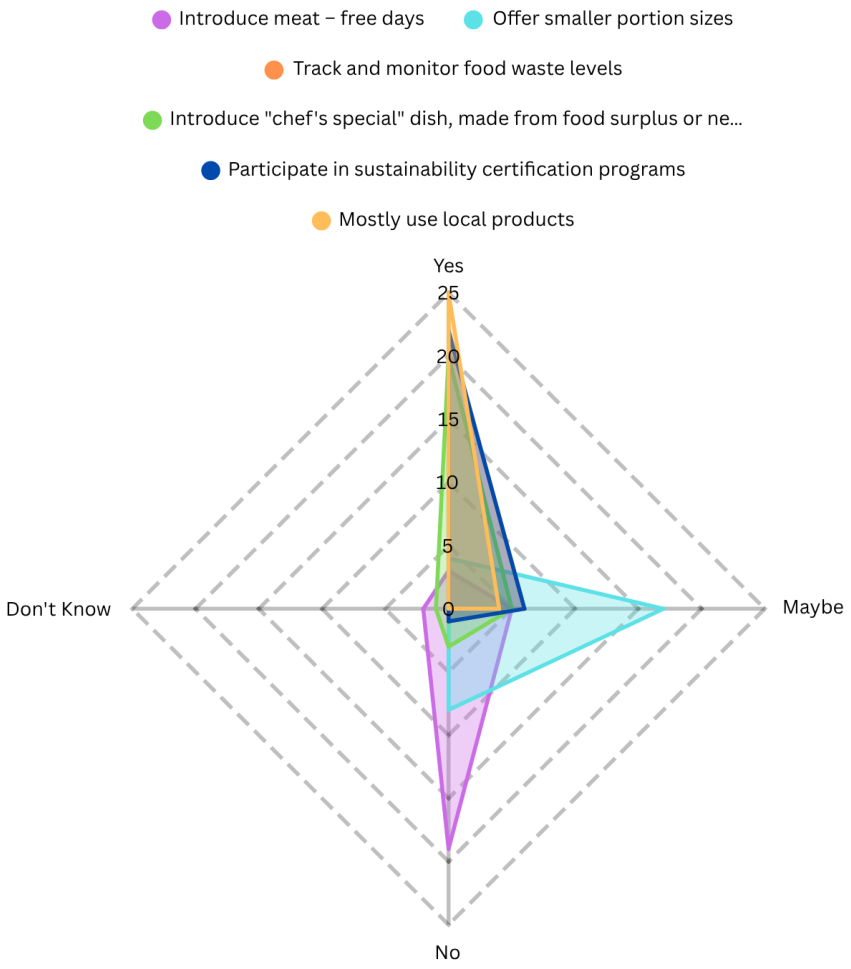

Figure 14: Willingness of hotels to adopt sustainable food practices

Figure 14 shows willingness to adopt practical sustainability initiatives, with broad alignment across establishments. The most feasible initiative is tracking and monitoring food waste (81% positive), which would help hoteliers more accurately identify sources of waste and act accordingly. Participation in sustainability certification programmes and introducing a chef's special made from surplus or near-expiry ingredients received similar positive feedback, and both are already implemented in several establishments. By contrast, introducing a meat-free day appears more challenging due to concerns about guest satisfaction and the risk of negative reviews. Thus, while hotels are open to sustainability principles, their willingness is shaped by the perceived trade-off between environmental responsibility and guest satisfaction.

Overall, the survey findings indicate a growing uptake of sustainability practices across the Cypriot hotel sector, particularly in food provision and food-waste reduction. Staff engagement, use of local and seasonal ingredients when available, and repurposing surplus food are widely adopted. By contrast, measures such as smaller plates and meat-free days are less favoured, owing to concerns about guest satisfaction. This is especially evident in 4- and 5-star hotels, where maintaining perceived service quality can conflict with environmental objectives. Supplier-selection priorities and buffet-planning criteria offer leverage points to advance sustainability—for example, by implementing food-waste tracking systems, reducing meat availability at buffets, and expanding the use of cosmetically imperfect produce.

4.3. Sustainability Governance and Operations

The hospitality sector in Cyprus requires continuous adaptation of hotels' organisational structures and services to cope with external pressures and remain internationally competitive. It is therefore unsurprising that awareness of sustainability has increased—both to minimise environmental footprint and pressure on natural resources and to meet the growing expectations of eco-conscious travellers.

A large majority of hotel managers (89.7%; n=29, 2024) report that rising temperatures influence tourists' decisions, with some effects already observable. Opinions diverge on whether the net impact is positive or negative. Potential

positives include extending the tourist season and increasing revenue. Nearly 70% also indicated that changing climate conditions (e.g., heatwaves) may shift the timing of visits as tourists seek optimal weather windows, prompting seasonal adjustments and retargeting of marketing efforts.

On the negative side, more frequent and intense heatwaves could make Cyprus a less attractive tourism destination. Adverse or unpredictable weather may discourage longer stays; over 40% of managers report shorter visit durations, while 17% anticipate no effect. This pattern aligns with findings by Deason et al (2023), who reported that 70% of respondents in southern Mexico would adjust trip length under climate-change projections, with some opting for shorter visits. Water scarcity may not directly disrupt hotel operations—desalination can buffer municipal supply—but it can constrain local food sourcing, particularly irrigated fruits and vegetables (Zoumides et al., 2014). Drought and rising temperatures also elevate wildfire risk, especially for mountain resorts and attractions; in July 2025, a major wildfire burned over 100 km^2 in a wine-producing region north of Limassol, causing fatalities and widespread damage (Reuters, 2025).

Climate change can increase operating costs for tourism businesses, especially in the Mediterranean region, via higher summer cooling demand, infrastructure repairs after extreme events, and investments in adaptation (e.g., water-conservation systems, flood defences) (Dogru et al., 2019). Hoteliers increasingly recognise the need for sustainable practices; most prioritise energy- and water-saving technologies (80%), while only 20% report considering strategies to shift demand toward off-peak seasons.

The increased focus on sustainability is also driven by regulatory changes, industry certifications, and government support schemes that encourage hotels to adopt greener initiatives and infrastructure. In recent years, many tour operators have made sustainability certification a prerequisite, with some setting mandatory requirements by 2030. Consequently, numerous establishments are pursuing internationally recognised certifications such as Travelife and the Global Sustainable Tourism Council (GSTC) frameworks, which help standardise sustainable practices. Beyond environmental gains and cost savings, hotels also benefit from enhanced reputation among environmentally conscious guests who are willing to pay a price

premium.

Through participation in these certification schemes, hotels are expected to demonstrate effective sustainable management; maximise social and economic benefits for local communities; protect and present cultural heritage; and reduce negative environmental impacts while conserving biodiversity. Both Travelife and GSTC include criteria on sustainable food sourcing and food-waste minimisation and disposal. Hotels are expected to maintain a documented sustainable procurement policy that supports local economies and gives preference to certified suppliers (e.g., Fairtrade, Rainforest Alliance; MSC-certified seafood; FSC-certified paper/wood products). Preference is also given to products sourced from locally owned or operated small businesses. Where certified products or suppliers are unavailable, priority should go to goods produced under recognised sustainability principles, with due consideration to transport and logistics (e.g., lower-emission options and shorter supply distances).

Another key requirement is to minimise the environmental footprint of procurement by carefully managing the purchase of consumable and disposable goods—including food—to prevent waste. Hotels must annually record and report, based on monthly purchase data, the total amounts of fresh and frozen meat, dairy and seafood (categorised as high-emission foods). They must also implement a solid-waste management plan that includes actions to reduce waste at source, separate materials, and reuse or recycle food waste across operations, while tracking the amount of solid waste generated per guest-night.

Finally, Travelife and GSTC require hotels to maintain publicly available sustainability statements that clearly set out commitments to, among other areas, reducing GHG emissions (e.g., by cutting food waste and the use of high-emission foods), protecting and supporting biodiversity, respecting human rights, and safeguarding children. Through these measures, hotels are encouraged to contribute actively to sustainable tourism and to reduce not only their environmental footprint but also adverse social impacts.

5. EMPIRICAL STUDY II: TOURISTS PREFERENCES

5.1 Tourists' Survey Sampling Methodology

The aim of this survey was to investigate tourists' behaviors, dietary preferences, and attitudes. A digital questionnaire was developed and administered on the Free-Online-Surveys platform (Appendix 2) served as the primary data-collection instrument for investigating tourists' behaviours, dietary preferences, and attitudes. A QR code linking directly to the questionnaire was generated and distributed via (i) posters, (ii) social-media platforms, and (iii) face-to-face outreach. The questionnaire was structured into five sections. The first section gathered demographic information (gender, age, education level, country of residence, monthly income). The questionnaires were anonymous; no personally identifying information was collected. The second section focused on trip-related characteristics (accommodation type, terms of stay, travel-party size and composition, location of stay, trip expenditure). The third section comprised eleven questions exploring dietary preferences, willingness to pay more for local and certified/eco-labelled food products (if perceived as more expensive), and awareness of food waste and handling of leftovers. The fourth section examined pro-environmental behaviours related to the food value chain, measured on a seven-point Likert scale from "Never" (1) to "As often as possible" (7). The fifth and final section assessed tourists' understanding and use of interactive technologies (e.g., NFC, RFID, QR codes, blockchain).

Posters displaying the QR code and a brief description of the study were placed in high-traffic tourist locations — including bus stops, airport dining areas, hotels, and beach promenades — to maximise visibility and engagement, particularly where visitors tend to wait (Figure 15). In addition, members of the research team conducted evening outreach in key tourist areas to promote the survey and encourage participation, using the QR code as the primary access method.

As a supplementary channel, the survey was shared on social-media platforms targeting pages for popular destinations in Cyprus to reach individuals who had recently visited the island. The survey was live from 1 August to 1 November 2024. Of 232 responses collected, 180 were fully completed. The main barrier to data

collection, noted by the field researcher, was tourist hesitancy, with many wary of online scams and "tourist traps." The distribution strategy sought to randomise data collection to reflect, as far as possible, tourists' experiences and preferences and to limit bias. Regarding ethics, all participants were informed about the purpose of the survey and assured that their responses would remain anonymous. Participation was entirely voluntary, and respondents could withdraw at any time.

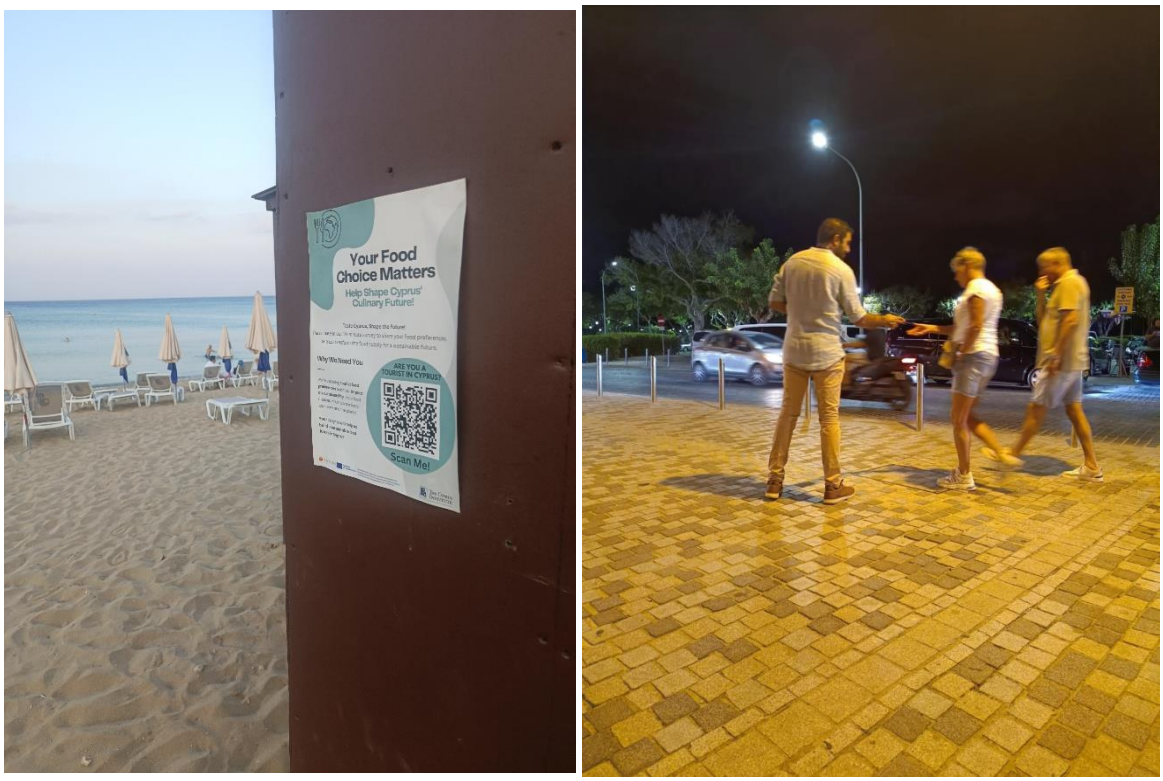

Figure 15: Recruitment methods used to promote the online tourist survey; QR-code poster with a brief study description installed in popular tourist locations (left), and evening street intercepts inviting scans (right). Both methods directed tourists to the online questionnaire.

5.2. Tourists' Food Consumption Behaviors and Preferences

The demographic characteristics of surveyed tourists are presented in Table 7. By gender, 47% identified as male and 52% as female, with a mean age of 39 years. The highest educational attainment was most commonly a bachelor's degree (35.6%), followed by a master's or doctorate (26.1%). Around 59% reported a pre-tax annual income below €60,000. Most respondents were from the United Kingdom (41.7%), Germany (8.9%), and Sweden (6.7%). Overall, the sample broadly mirrors the country-of-origin profile of tourists visiting the island, as indicated by official national tourism statistics (see Section 3.1).

Table 7: Demorgraphics of surveyed tourists (n = 180)

Variable	%
Gender	46.7
Male	52.2
Female	
Age group (years)	
Less than 35	80
35–55	70
More than 55	30
Education level	
Secondary school	16.1
Technical/vocational training	13.9
Bachelor degree	35.6
Master or Doctorate degree	26.1
Prefer not to say	8.3
Individual annual income before taxes	
Less than €15.000	7.8
€15.000-€30.000	18.9
€30.000-€60.000	32.2
More than €60.000	25.0
Prefer not to say	16.1
Country of usual residence	
United Kingdom	41.7
Germany	8.9
Sweden	7.2
Poland	3.3
Israel	3.3

Table 8 displays trip-related information for the sample. A majority of respondents were repeat visitors to Cyprus (54.4%), and around 40% had visited more than twice. The average travel party comprised 2.6 persons, with most respondents travelling with a partner (46.7%). The average length of stay was 12.1 nights. With regard to accommodation on the island, the most common choice was four-star hotels. Preferred terms of stay were accommodation only (37.8%) and bed-and-breakfast (36.1%), while around 14% opted for all-inclusive packages. By location of stay, most tourists (52%) chose the south-eastern coastal regions of Ayia Napa and Protaras, followed by Paphos (24%) on the western coast. On average, respondents spent €2,870 in total on their trip to Cyprus. Approximately one-third of expenditure was on food and beverages, and about one-fifth on transport.

Around one-third of respondents reported dietary preferences or restrictions that influence their food choices while travelling, and a further one-third identified as vegetarian (Figure 16). The vast majority (79%) expressed interest in knowing the origin of food consumed during their stay in Cyprus (Figure 17). In addition, 81% did not consider local food products to be more expensive than imported options (Figure

18). Among the one-fifth who perceived local products as more expensive, roughly half (48.6%) were willing to pay 10–20% more, while about a third (31.4%) were willing to pay up to 10% more. By contrast, a significant share (65%) viewed certified/eco-labelled products as more expensive than non-certified alternatives (Figure 19); of these respondents, the majority (56%) would be willing to pay up to 10% more.

Table 8: Trip characteristics (n = 180)

Variable	%/Mean
Type of accommodation	
2 stars hotel	1.1
3 stars hotel	15.0
4 stars hotel	33.9
5 stars hotel	13.3
Hotel apartment	14.4
Other	22.2
Number of people coming to the trip	
1	15.0
2	68.9
3	3.9
4	7.2
More than 4	5.0
Terms of stay	
Accommodation Only	37.8
Bed & Breakfast	36.1
Half Board	7.8
Full Board	3.9
All Inclusive	14.4
Visits to Cyprus	
First time	45.6
Once before	15.0
Two times + before	39.4
Location of stay	
Ayia Napa	21.7
Protaras	30.0
Paphos	24.4
Larnaca	11.7
Limassol	5.0
Nicosia	2.2
Other	
Travelling	
Alone	10.0
With partner	46.7
With children	33.9
With friends	9.4
Average nights spent	12.1
Average total cost of trip to Cyprus (€)	2870
Average trip expenditure (% of the total trip cost)	
Food and beverages	31.7
Transport	20.3

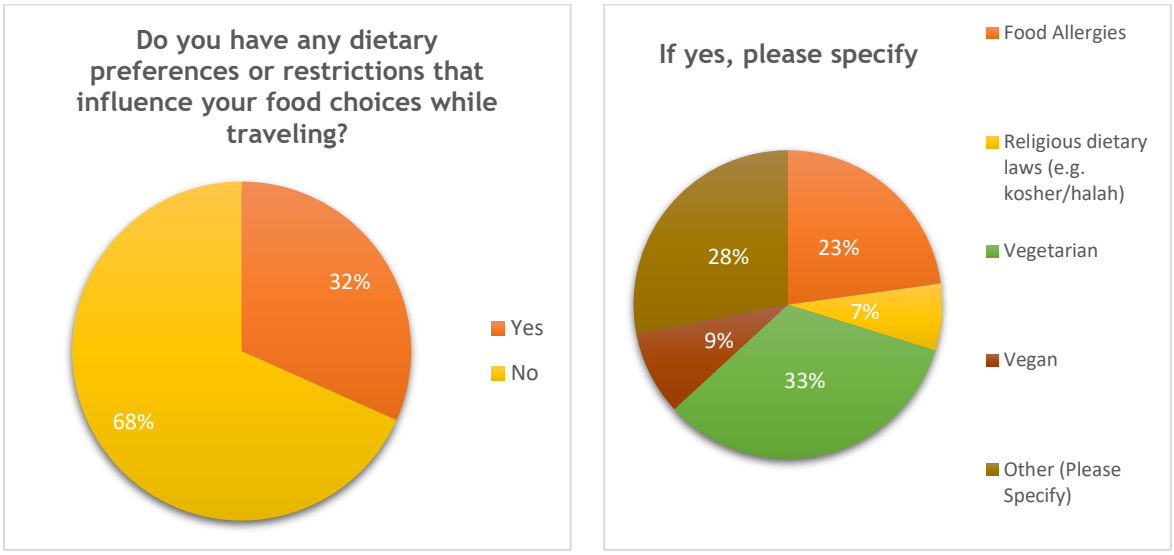

Figure 16: Tourists' dietary preferences

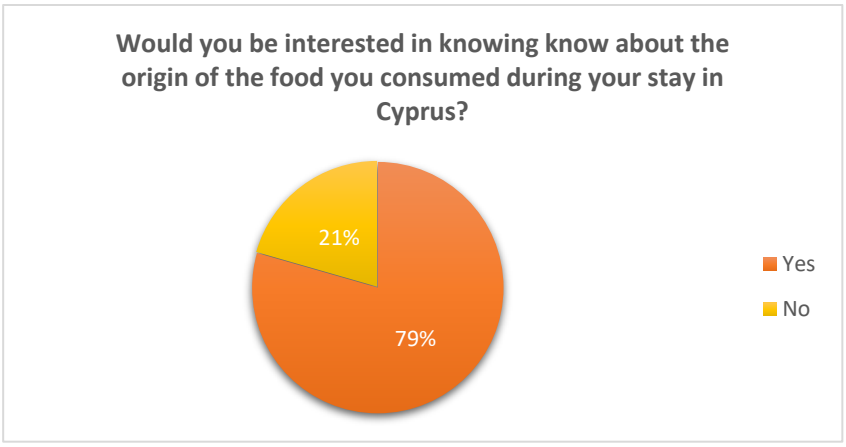

Figure 17 : Interest in knowing the origin of food consumed

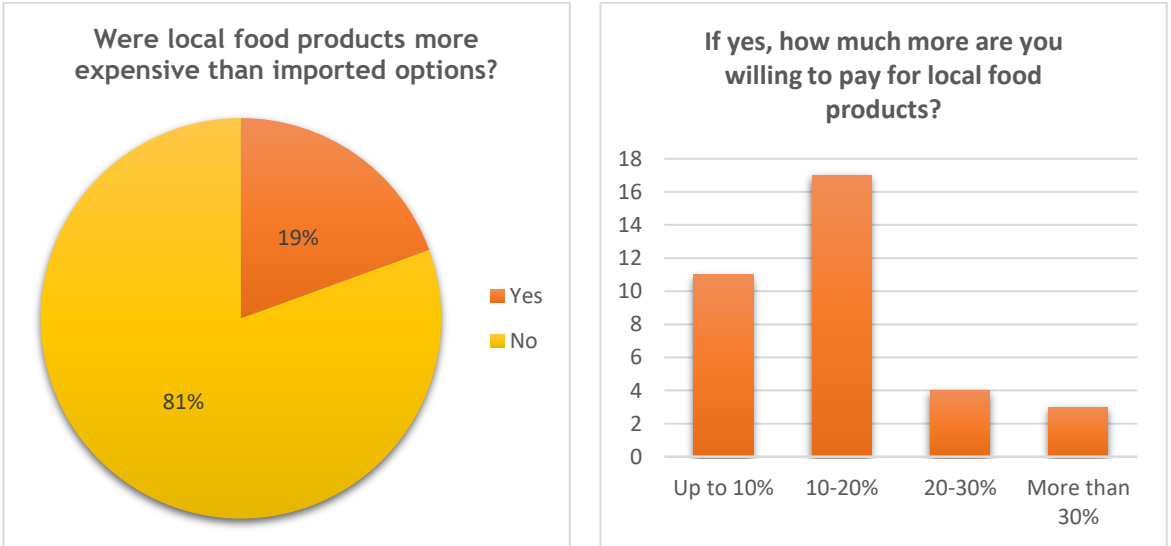

Figure 18: Cost perceptions and willingness to pay for local food

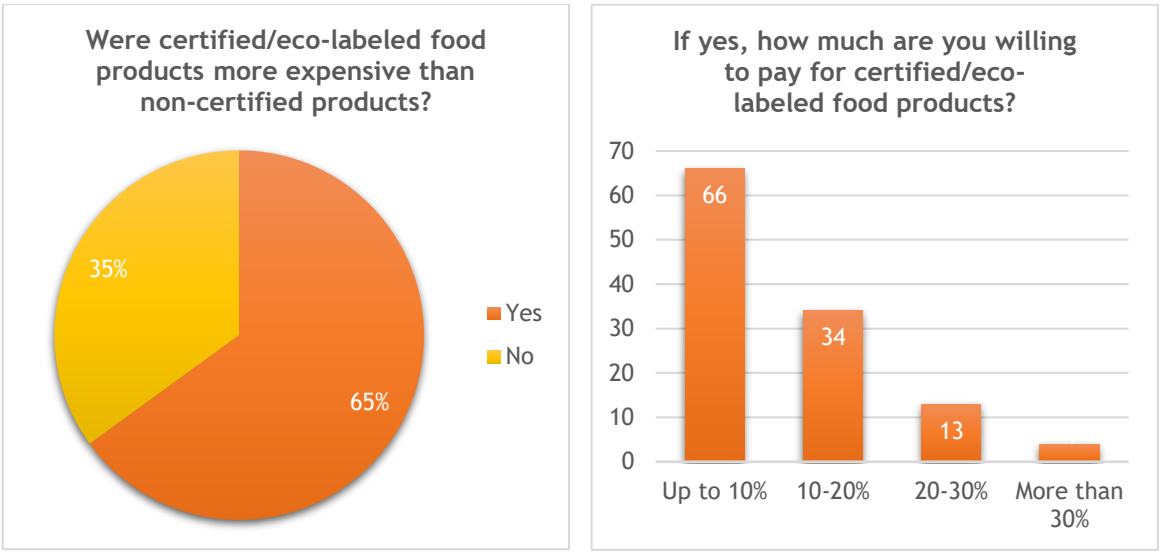

Figure 19: Cost perceptions and willingness to pay for certified foods

The likelihood of revisiting Cyprus if more local/eco-labelled food options were available was measured on a 10-point scale (1 = very unlikely; 10 = very likely). Nearly one-fifth of respondents (18.9%) selected 4, followed by 18.3% who selected 5; 15.6% selected 6, and 10.0% selected 10 (very likely). By contrast, 12.2% selected 1 (very unlikely) (Figure 20).

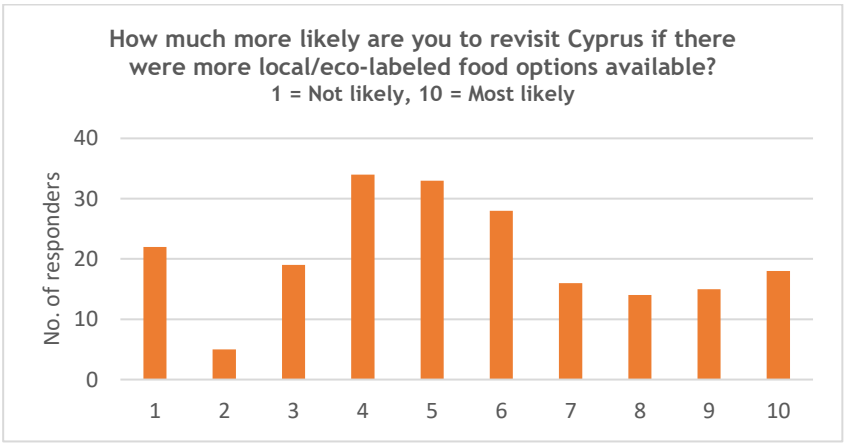

Figure 20: Effect of local/eco-labelled options on tourists' revisit intentions

Interestingly, just over half (52.8%) of tourists support designated meat-free days at hotel buffets (Figure 21). Most respondents (48.9%) reported very little leftover food (<10%), 21.7% reported around 10%, and 17.8% reported none (Figure 22). Regarding leftover management, responses were split among leaving leftovers to be

discarded (34.4%), sharing with a dining companion (33.9%), and taking them away in a container (28.3%).

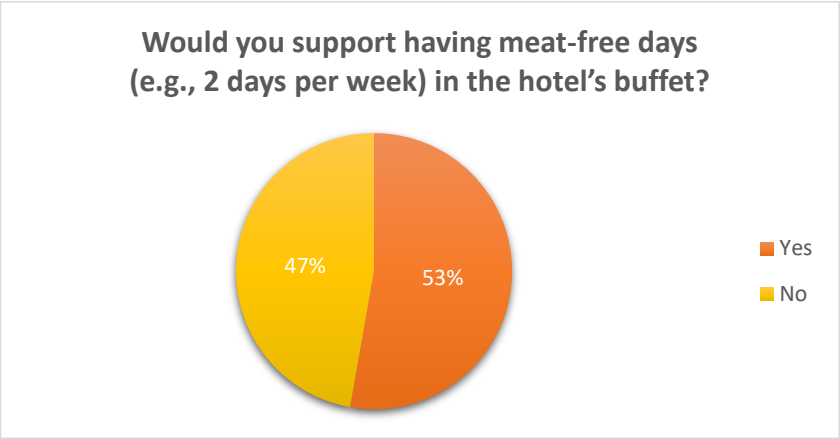

Figure 21: Acceptance of meat-free days in hotel buffets

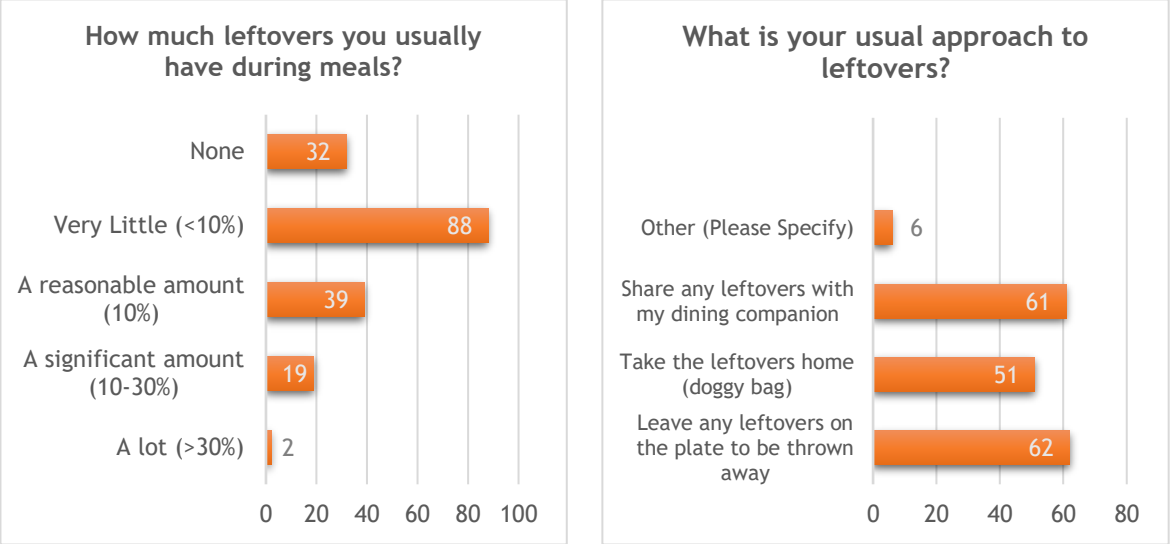

Figure 22: Amount and handling approach of leftovers

Tourists' environmental behaviour was measured using nine questions on a 7-point Likert-type scale to determine the frequency of their participation in several activities related to the food value chain. For purchasing environmentally friendly and/or energy-efficient products, responses showed a mixed pattern: the largest share selected "Occasionally" (43.3%), followed by "Often" (13.9%); only 6.1% chose "Very often" and 4.4% "As often as possible," indicating limited habitual commitment. For purchasing items without excessive packaging, most respondents selected "Often" (51.7%), with 12.8% choosing "As often as possible" and 10.6% "Very often"; only 5.6% chose "Never" and 3.3% "Rarely," suggesting most surveyed tourists consider packaging waste. For reusing or mending items rather than

discarding them, the most common response was “Sometimes” (45.6%); 12.2% chose “As often as possible,” while 13.9% selected “Occasionally” and 13.9% “Often,” indicating willingness but not yet a strong habit.

Regarding purchases of organic food in the past six months, most respondents (45%) reported rarely buying organic products, while only 4.4% selected “As often as possible.” “Occasionally” and “Sometimes” were chosen by 8.9% and 14.4% of respondents, respectively, suggesting some consideration but not widespread practice. By contrast, many respondents reported reducing food waste by reusing ingredients from home cooking: 55.6% selected “Often,” 12.2% “Very often,” and 13.9% “As often as possible,” indicating this is a regularly practised activity. Interestingly, 55.6% stated they never compost food waste at home, suggesting composting is either not a priority or not readily accessible; only 12.2% selected “As often as possible,” indicating that, while some are committed to composting, it is not widely practised.

When asked about discussing environmental issues within their community and working with others to address environmental problems, most respondents selected “Rarely” (46.7% and 50.6%, respectively), underscoring a significant barrier to community-based initiatives. For choosing not to purchase a food item due to its environmental impact, the modal response was “Sometimes” (42.8%), suggesting that most surveyed tourists do not consistently factor environmental considerations into food choices.

Overall, tourists appear receptive to sustainability behaviours related to the food and environmental issues, but engagement is uneven. Actions such as reducing packaging waste and reusing cooking ingredients are relatively widespread, whereas composting, discussing environmental issues, and collective action show low participation. Purchases of organic foods and avoidance of environmentally harmful products are limited, likely constrained by cost and convenience.

5.2.1. Awareness and use of interactive technologies

The final section of the tourist survey concentrated on evaluating tourists’ awareness and utilization of interactive technologies such as QR codes, NFC, RFID,

and Blockchain. A QR code is a two-dimensional printed code introduced to food products and has become increasingly prevalent in product packaging, marketing materials, and retail environments (Dobrescu, 2015; Tarjan et al., 2014). QR codes provide instant access to consumer information through smartphone scanning (Higgins et al., 2014; Sahinoglu et al., 2002). Unlike one-dimensional (1D) barcodes which store data in a linear format, QR codes encode data in 2D horizontal and vertical dimensions using a matrix format, allowing them to hold more information and making them a valuable tool for improving traceability and consumer engagement.

Studies have shown that the perceived usefulness of QR codes in the food and beverage (F&B) sector is highly linked to how consumers perceive the value of the information provided (Davis, 1989; Kim & Woo, 2016). Radio frequency identification (RFID) as the name suggests, utilises radio frequencies to transfer data. RFID devices are categorized into groups depending on their working frequency and the energy source: low frequency (LF), high frequency (HF), and ultrahigh frequency (UHF) (Byers et al., 2025). RFID's subset, near field communication (NFC), operates at the same frequencies but over a shorter range, and enables consumers to access information in record time. Such data can be shared downstream via the same tag through a consumer's smartphone (Badia-Melis et al., 2015; Mehannaoui et al., 2023).

In terms of usage, QR codes stand out with 42.7%, followed by NFC (35.1%). RFID and blockchain trail at 15.1% and 7.1%, respectively. Ease of understanding was measured on a seven-point Likert scale (1 = not easy; 7 = extremely easy). QR codes and NFC are widely understood, with most responses in the "very easy" or "extremely easy" categories. RFID is less well understood, with many rating it difficult or only slightly easy. Blockchain is the least understood, with a majority selecting "not easy" and very few choosing the easier categories. Perceived usefulness is high: 96 of 112 respondents agreed or strongly agreed that these technologies are useful. Perceived time-saving is similarly strong, with 95 of 113 agreeing or strongly agreeing. A majority also felt the technologies make information easier to obtain (89 of 113 agreed or strongly agreed), though consensus here was slightly lower than for usefulness or time-saving.In sum, most tourists view these technologies as useful and time-saving, while a somewhat smaller majority believe

they facilitate information retrieval—differences likely reflecting varying familiarity and perceived complexity across technologies.

6. QUANTIFICATION TOOLS

6.1 Life Cycle Assessment

6.1.1. Goal and Scope

The goal of this Life Cycle Assessment (LCA) is to compare the environmental impacts of different typical buffet formats and to identify dietary patterns that, if adopted more broadly in the hotel sector, could reduce biodiversity impacts. Specifically, it assesses biodiversity-related impacts associated with food consumed by tourists, including traded items. The functional unit is defined as "food provision for one tourist per day."

6.1.2. System Boundary

To conduct the LCA and compile the Life Cycle Inventory (LCI), the system boundary includes the production of food commodities in their countries of origin; environmental impacts from transport to Cyprus are excluded.

6.1.3. Life Cycle Inventory (LCI)

For this application, we used primary data from a representative hotel in Cyprus. The dataset covers a typical weekly buffet cycle, including the specific items served each day, the quantities consumed, and the number of guests served. This approach enables a more accurate assessment of consumption patterns than relying on generic dietary assumptions.

6.1.4. Calculation and Mapping

- **Step 1: Recipe breakdown and ingredient aggregation**

For each selected buffet theme (e.g., Cyprus buffet; 340 guests), dishes were decomposed into their constituent ingredients. Seven nightly themes were examined, i.e., Cyprus, American, BBQ, Indian, Asian, Tex-Mex, and Street Food,

each comprising a distinct set of culturally relevant dishes and ingredient types, enabling comparison across styles and environmental impacts.

The obtained data included an itemised buffet list with quantities for each dish (kg or litres). From these data, we calculated the required amounts of raw ingredients for each dish. For multi-ingredient recipes, we derived the grams of each ingredient needed per kilogram of finished dish and multiplied by the kilograms served per night. As an example, Table 9 shows the case of Main Dish *Grilled Cherry Tomato*, and the base recipe for a 1 kg recipie.

Table 9: Ingredient quantities for 1 kg of a "Grilled Cherry Tomato" dish

Main Dish	Ingredient	Per 1 kg Recipe (g)
Grilled Cherry Tomato	Cherry tomatoes	1040
	Olive oil	40
	Salt	10
	Garlic	20
	Total (g)	1110

This process was repeated for every dish on the buffet. The raw-ingredient amounts were then summed across recipes to determine the total consumption of each ingredient for each buffet menu.

- **Step 2: Inventory Process Matching**

Each food item was matched to the most appropriate life-cycle process in AGRIBALYSE 3.0, which draws on datasets from ecoinvent 3.7. In most cases, the "consumption mix – France" processes were used, as they are the most comprehensive and readily available in AGRIBALYSE. These processes represent average sourcing and production for foods consumed on the French market. While this may not perfectly reflect the Cypriot context, it provides a consistent, well-documented baseline for LCA modelling.

- **Step 3: Elementary Flow Matching**

To align the LCI with the International Life Cycle Data System (ILCD) GLAM-compatible format required for impact assessment, elementary flows from ecoinvent 3.7 were mapped using the authoritative flow-matching file "ecoinventEFv3.7-ILCD-EFv3.0.xlsx." This file, developed under the Global LCA Data Access network (GLAD), covers approximately 5,400 flow matches; despite this limitation, it remains a widely used and reliable mapping resource (Valente et al.,

2024).

- **Step 4: Characterization Factor (CF) application**

The characterization step was conducted using custom MATLAB scripts, as the GLAM characterization factors (CFs) are not yet fully implemented in commonly used LCA software packages (e.g. OpenLCA) (Life Cycle Initiative, 2024). Within the land use impact category, only land occupation was considered, while land transformation processes were excluded, consistent with current limitations in CF availability and methodological alignment. For the ecosystem quality impact, characterization was performed using the global Potentially Disappeared Fraction of species (PDF) to quantify biodiversity loss, which expresses the fraction of species projected to become irreversibly lost at a global scale.

Given the limited coverage of midpoint indicators in the GLAM framework and the lack of midpoint-level detail in the LC-Impact method, the assessment focused solely on endpoint-level characterisation (Verones et al., 2020).

CFs and endpoint indicators were sourced from the GLAM project (V1.0.2024.10) to provide scientifically consistent and policy-relevant guidance for the LCA. These CFs translate elementary flows into potential environmental impact indicators. During implementation, one manual correction was applied to the Ecosystem Quality – water-consumption CFs to address a known misattribution between regional and global potentially disappeared fraction of species (PDF) values. Specifically, we replaced the misattributed regional value with the corresponding global PDF factor in the GLAM tables and flagged this change in our calculation.

The applied CFs enabled direct conversion of life-cycle inventory flows into endpoint indicators for the following areas of protection: (i) human health, (ii) ecosystem quality, and (iii) resource scarcity; however, this assessment focuses solely on ecosystem quality. Where no exact match was found, the following selection hierarchy was applied to maintain consistency and relevance:

- Preferred: Country-specific CF with a specified compartment
- Fallback 1: Country-specific CF with an unspecified compartment
- Fallback 2: Global CF with a specified compartment
- Fallback 3: Global CF with an unspecified compartment

Note that GLAM yields impact scores (ecosystem-quality, global PDF·yr) from consumptive flows; these are not volumes/areas and thus are not directly comparable to FABIO pressure accounts reported later (m^3; ha)—see Section 6.3.

6.1.5. Assumptions and limitations

The analysis rests on the following assumptions and study limitations, which should be considered when interpreting the results:

- Flow matching: the analysis relied on a matching file limited to ~5,400 elementary flows, while the Ecoinvent database includes more substances and emissions. This limited scope may have excluded relevant flows that contribute to environmental impacts, leading to incomplete or underestimated results.
- Each food item was mapped to the closest available process in AGRIBALYSE 3.0 or ecoinvent 3.7 (e.g., Parmesan cheese → hard cow's-milk cheese).
- The selected processes primarily represent conventional production and consumption in France and were used as proxies.
- Recipe simplifications were applied, i.e., multi-ingredient recipes were decomposed into individual components, assuming available recipe proportions are consistent.
- Transport emissions to Cyprus for imported foods were excluded.
- ILCD/GLAM characterisation factors were assumed valid across the countries considered.
- Available database processes generally reflect conventional systems typical of selected regions (France, Spain, Germany, Canada, Switzerland, USA).
- There are no Cyprus-specific (or source-country) processes; given Cyprus's reliance on imported feedstock, fertilisers, and pesticides, and limited grazing land, using proxy processes inherently introduces uncertainty.
- Land-use requirements and yields vary by country and production system for the same product, which can affect land-use and biodiversity results when proxies are used; this limitation is partly addressed further below through the FABIO model application.

6.1.6. Biodiversity-related impacts per buffet

The analysis uses primary consumption data (g/person) for key food groups and quantifies environmental pressures on terrestrial, freshwater and marine ecosystems using the GLAM-Impact methodology. This section presents LCA results by comparing buffet types and their associated biodiversity impacts on a per-person basis. First buffets are categorised into three groups, based on the quantities of key food categories per person (Table 10) to examine how composition relates to biodiversity impacts and to identify opportunities for improvement:

- Group 1: High red meat
- Group 2: High plant-based, moderate meat
- Group 3: Balanced, culturally diverse

As each buffet type presents a unique nutritional and cultural composition, the key food categories have been identified for analysis in order to help explain their ecological impact scores. For a more comprehensive analysis of the environmental impact, each buffet ingredients were grouped into 27 categories based on the country of trade mix and the type of ingredient(s) (see Table 14, below). Results are presented across three key dimensions derived from LCA, i.e., Freshwater, Terrestrial and Marine impact on biodiversity loss; the reference unit is global Potentially Disappeared Fraction per year (PDF*y), representing global irresverisble species loss. Midpoint indicators (Figure 23) were included to help identify which specific environmental processes (e.g., climate change, eutrophication) were contributing most to the overall impact shown by the endpoint indicator.

Table 10: Buffet item quantities per person, by main food group

Buffet item (g/person)	Cyprus	Tex Mex	American	BBQ	Asian	Indian	Street Food
Beef	17.31	190.20	106.15	276.15	11.02	42.00	49.62
Pork	207.47	77.26	57.40	270.14	57.97	83.47	75.71
Chicken	107.59	93.78	185.92	224.64	152.30	163.73	247.00
Lamb	25.65	0.00	0.00	8.48	45.27	52.00	0.00
Eggs	12.37	12.98	10.47	0.65	5.30	18.04	0.48
Fish	0.00	82.33	69.17	47.81	61.99	82.04	106.08
Cereals	139.07	180.61	167.00	30.25	65.49	120.04	124.68
Dairy Products	124.37	130.62	103.87	129.12	13.59	118.73	44.02
Veg & Fruits	671.93	1222.10	592.61	1208.08	277.05	638.37	567.76

Group 1: High Red Meat

The **BBQ buffet** shows the highest per-person consumption of meat products—approximately 276 g beef, 270 g pork, and 225 g chicken (Table 10). These protein sources are among the most environmentally intensive, yielding the highest terrestrial biodiversity impact (1.04×10^{-8}), with meat alone contributing over 70% of the total (7.66×10^{-9}). Its freshwater impact (3.63×10^{-7}) is the second highest overall (Figure 23), largely driven by meat (3.41×10^{-7}; >95% of the total impact). The marine impact (2.17×10^{-8}) also stems almost entirely from meat (2.16×10^{-8}), reinforcing the buffet's red-meat intensity and associated footprint. In addition, cereals are low (30 g) and dairy is moderate (129 g). Despite a high intake of vegetables and fruit (1,208 g), the dominance of red meat and large portion sizes make the BBQ buffet the largest contributor to land-related impacts and the second-largest to freshwater impacts (Figure 24).

Buffet	Climate Change (kg CO_2 eq)			Freshwater Ecotoxicity (CTUe)	Terrestrial Ecotoxicity (CTUe)	Freshwater Eutrophication (kg P eq)	Land Use (m^2)	Marine Eutrophication (kg N eq)	Terrestrial Acidification (kg SO_2 eq)	Water Consumption (m^3 world eq. deprived water)
	Freshwater	Marine	Terrestrial							
American	5.19E-09	2.81E-10	1.15E-10	7.10E-09	1.12E-09	3.32E-07	1.53E-08	2.36E-08	9.11E-13	2.47E-08
Asian	5.78E-09	3.11E-10	1.27E-10	5.37E-09	2.95E-10	2.53E-07	6.34E-09	1.94E-08	7.17E-13	3.34E-08
BBQ	5.26E-09	2.83E-10	1.16E-10	4.88E-09	2.68E-10	2.30E-07	5.77E-09	1.77E+06	6.52E-13	3.03E-08
Cyprus	2.09E-09	1.13E-10	4.61E-11	5.14E-09	1.02E-09	1.36E-07	7.66E-09	1.17E-08	7.34E-13	2.17E-08
Indian	1.68E-09	9.15E-11	3.74E-11	4.36E-09	1.07E-09	5.21E-08	9.21E-11	3.06E-09	9.93E-13	1.92E-08
Street Food	3.00E-09	1.62E-10	6.62E-11	6.31E-09	6.56E-10	9.83E-08	1.43E-09	7.14E-09	2.68E-13	2.36E-08
Tex Mex	2.08E-09	1.12E-10	4.58E-11	4.04E-09	8.13E-10	1.25E-07	1.31E-08	1.12E-08	3.50E-13	1.47E-08

Figure 23: Environmental mid-point indicators per buffet

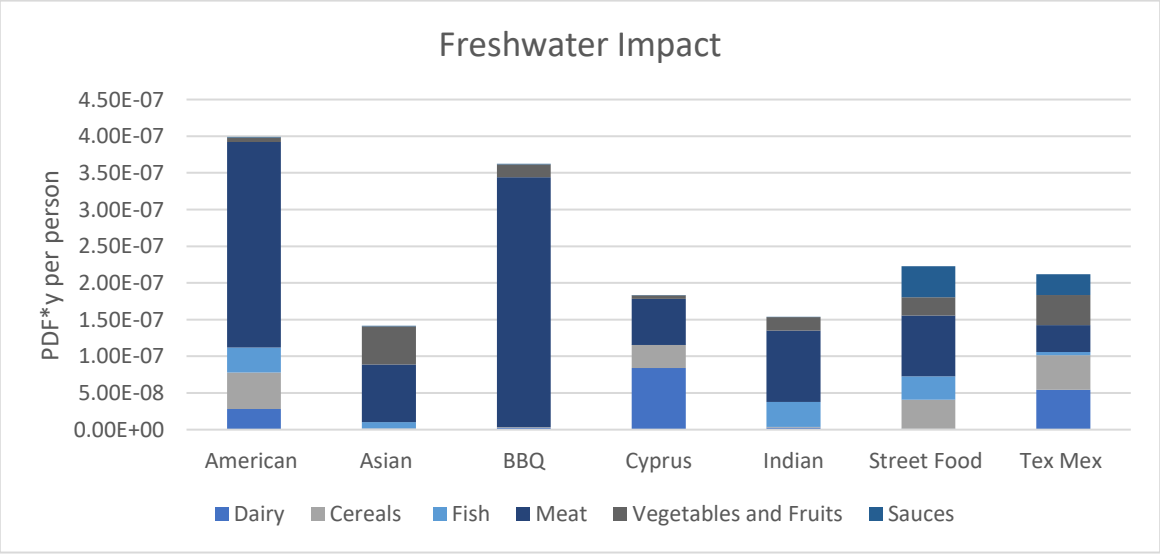

Figure 24: Freshwater impact per person by buffet type

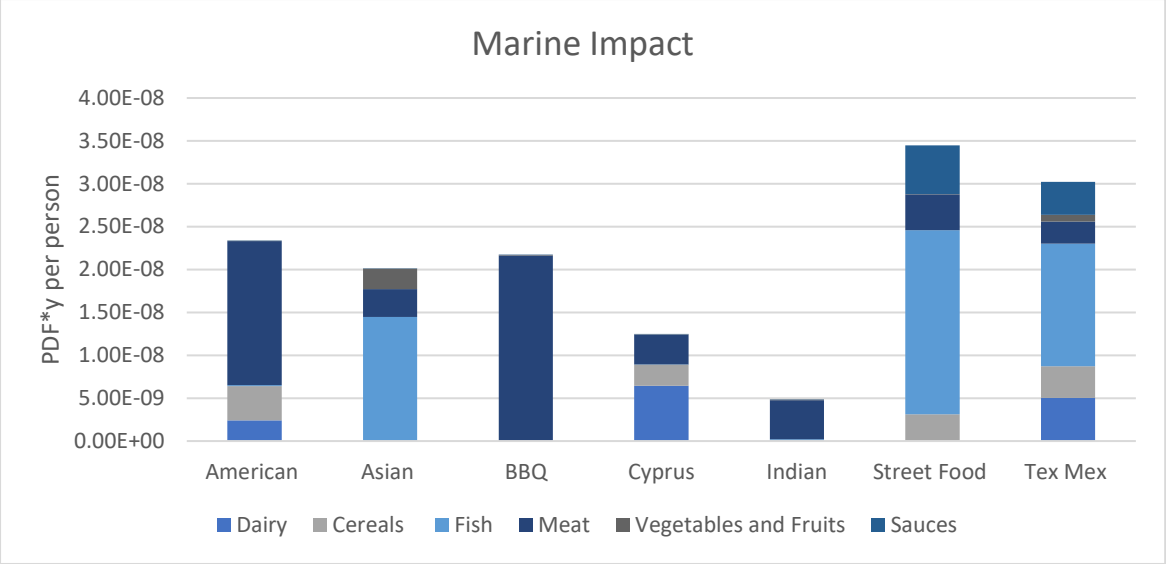

Figure 25: Marine impact per person by buffet type

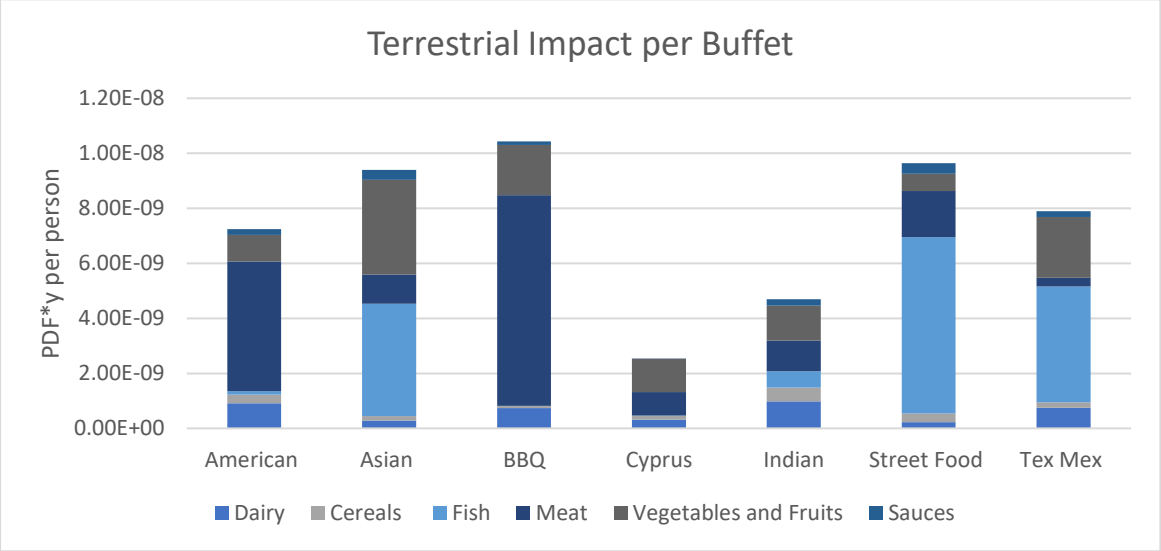

Figure 26: Terrestrial impact per person by buffet type

The **American buffet** leans heavily on chicken (186 g) and beef (106 g), with a relatively low intake of fruit and vegetables (593 g), and moderate dairy (104 g) and cereals (167 g) (Table 10). Consequently, its terrestrial impact is moderate (7.24×10^{-9}), notably lower than the BBQ buffet due to reduced beef and greater plant-based content. However, it records the highest freshwater impact (3.99×10^{-7}), driven mainly by meat (2.80×10^{-7}) and cereals (4.99×10^{-8}). This suggests that even with less red meat, grain production, particularly for livestock feed, imposes substantial pressure on freshwater resourecs. The marine impact (2.34×10^{-8}) is also sizeable and primarily meat-driven (1.68×10^{-8}) (Figure 25). In general, this buffet mirrors common Western consumption patterns, which entail extensive land and water use for

livestock, yielding significant impacts across terrestrial, freshwater and marine domains.

Group 2: High plant-based and moderate meat

The **Cyprus buffet** features relatively high pork (208 g) and dairy (124 g), reflecting traditional dishes such as *souvlaki* and *halloumi*; chicken is moderate (108 g). This dietary option yields the lowest terrestrial biodiversity impact among all buffets (2.54×10^{-8}), with meat contributing about one-third (8.48×10^{-10}) and vegetables the largest share, ~50% (1.22×10^{-9}). Marine impacts are the second-lowest (1.25×10^{-9}; Figure 25), though over half of the marine footprint is attributed to dairy (6.46×10^{-9}), driven by *halloumi* production, which is milk-based and energy-intensive. Despite the presence of animal products, the Cyprus buffet illustrates how Mediterranean-style menus can deliver balanced nutrition with lower ecological pressures when beef is minimised and ingredients are locally sourced.

Group 3: Balanced and culturally diverse

The **Street Food buffet** focuses heavily on chicken (247 g), seafood (107 g), and has the highest cereal intake (181 g), while showing moderate vegetables (577 g) and minimal dairy (44 g). Despite diverse sourcing and high protein intake, red meat consumption is relatively low. Nonetheless, it records the highest marine impact (3.45×10^{-8}) and the second-highest terrestrial impact (9.64×10^{-9}). Fish consumption alone contributes nearly 60% (2.15×10^{-9}) of the marine impact, followed by cereals and sauces. The terrestrial impact is driven largely by the need for fish feed, including grain (e.g., rapeseed) and fertiliser use. This dietary option also has the highest impacts for climate change, marine eutrophication, terrestrial acidification, and water consumption, indicating reliance on water-intensive crops. Overall, it indicates the ecological impact of seafood, especially in marine systems, and can indirectly increase land use through feed production, potentially rivaling beef-related impacts.

Similarly, the **Tex-Mex buffet** features high vegetables and fruit (1,222 g) and cereals (181 g) intake, with additional moderate consumption of beef (190 g) and fish (82 g). While plant intake is high, the presence of fish keeps marine and

terrestrial impacts relatively high, but below Street Food, at 3.02×10^{-8} and 7.90×10^{-9}, respectively. Impacts are generally low in many categories except terrestrial acidification and marine eutrophication, suggesting reliance on water-intensive crops. Freshwater impact (2.12×10^{-7}) is relatively low, with food categories contributing in roughly equal shares. Overall, despite substantial plant-based content, the inclusion of multiple higher-impact proteins places this buffet closer to the "high-burden" group, particularly given the combined effects of fish and beef.

The **Indian buffet** features a moderate, well-distributed composition, with an emphasis on dairy (119 g) and a relatively balanced mix of meat and vegetables. Notably, it includes the highest lamb intake (52 g), yet the overall footprint remains low due to moderate quantities. Although dairy-rich, the Indian buffet maintains a relatively low footprint overall; the absence of fish and limited cereals help avoid freshwater intensification. It records the second-lowest terrestrial (4.70×10^{-9}) and freshwater (1.54×10^{-7}) impacts, and by far the lowest marine impact (4.85×10^{-9}). The one standout burden is terrestrial ecotoxicity, for which it scores the highest among all buffets.

Lastly, the **Asian buffet** presents a balanced nutritional profile, with the lowest red-meat intake (11 g of beef and 58 g of pork) and moderate chicken (152 g). Unexpectedly, it shows a high terrestrial impact ($9.40\times10^{-}9$), driven mainly by fish (62 g) and vegetable intake (277 g), the latter being the lowest vegetable quantity among the buffets. It records the lowest freshwater impact (1.42×10-7) and the third-lowest marine impact (2.01×10^{-8}).

Table 11 summarises the overall biodiversity impacts of the different buffet types, ordering them from highest to lowest environmental footprint. It also presents domain-specific rankings, from most to least impactful, highlighting variation across terrestrial, freshwater and marine indicators. A tourist diet based on BBQ-style food optionbs registers the highest impacts, largely due to substantial red-meat use (and accompanying dairy), whereas the options in an Indian buffet record the lowest overall footprint, reflecting its more balanced composition.

Table 11: Ranking of Buffet Types based on the Overall Impact

Rank	Buffet Type	Overall Impact	Key Observations
1	BBQ	● Highest	Extremely meat-heavy; top-tier impact in all categories - Highest terrestrial impact
2	American	● Very High	Heavy reliance on red meat and dairy products - Highest freshwater impact
3	Street Food	● High	High protein intake (meat), but mostly chicken - Highest marine impact
4	Tex Mex	● Moderate-high	High fruit and vegetable content but offset by moderate beef and fish; land and water use impacts
5	Asian	● Moderate	Mainly plant-based food and lean meat, but surprisingly high terrestrial impact from fish and vegetable production; - Lowest Freshwater Impact
6	Cyprus	● Moderate - Low	Relatively high pork and cheese consumption, but low overall environmental load - Lowest Terrestrial Impact
7	Indian	● Lowest	Balanced diet, only issue with terrestrial ecotoxicity - Lowest Marine Impact

Table 12: Biodiversity loss impact per person for each buffet setting

Buffet Day	Terrestrial Impact	Freshwater Impact	Marine Impact
Cyprus Buffet	2.54×10^{-9}	1.83×10^{-7}	1.25×10^{-8}
Tex Mex Buffet	7.90×10^{-9}	2.12×10^{-7}	3.02×10^{-8}
American Buffet	7.24×10^{-9}	3.99×10^{-7}	2.34×10^{-8}
BBQ Buffet	1.04×10^{-8}	3.63×10^{-7}	2.17×10^{-8}
Asian Buffet	9.40×10^{-9}	1.42×10^{-7}	2.01×10^{-8}
Indian Buffet	4.70×10^{-9}	1.54×10^{-7}	4.85×10^{-9}
Street Food Buffet	9.64×10^{-9}	2.23×10^{-7}	3.45×10^{-8}

6.1.7. Biodiversity-related impacts per food category

This section presents the LCA findings regarding biodiversity loss by individual food categories (e.g., beef, chicken, vegetables), identifying which ingredients contribute most to pressures on terrestrial, freshwater, and marine ecosystems. We compare the principal categories using the three biodiversity-related indicators and, for each category, aggregate impacts across all buffet types and normalise them by the total quantity of that category used across all buffets to enable comparisons. The specific food items included in each category are listed in Table 13.

Table 13: Ingredients per Food Category

Category Code	Food Ingredient(s)
CY01	Cow Milk & Butter
CY02	Chicken Egg
CY03	Yoghurt, Cream(s)
CY04	Sugar, Cooking Oil, Sauces (Ketchup, Mustard etc.)
CY05	Cheese
CY06	Pasta(s)
CY07	Cereals (Flour etc.)
CY08	Pork Meat and products
CY09	Lamb Meat
CY10	Chicken Meat and products
CY11	Beef Meat and products
CY12	Cold/Processed Meat(s)
CY13	Olives, Orange, Watermelon, Beans, Melon
CY14	Kiwi
CY15	Banana
CY16	Apple
CY17	Pear
CY18	Zucchini, Cucumber, Green cabbage
CY19	Potato
CY20	Leafy greens
CY21	Tomatoes
CY22	Other Vegetables
CY23	Onions
CY24	Carrot
CY25	Fish
CY26	Sweet Corn
CY27	Pepper

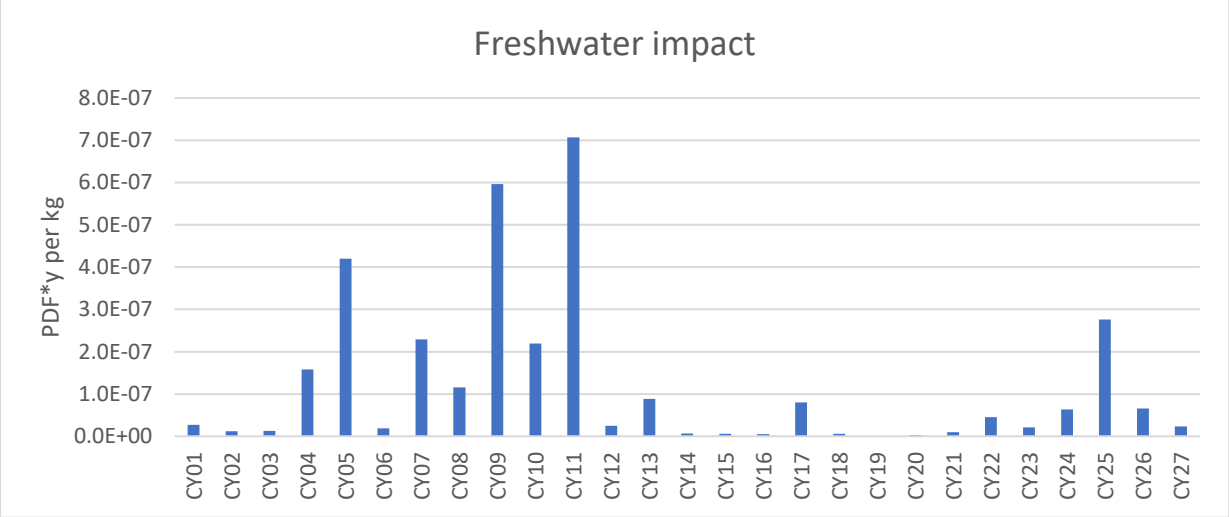

Figure 27: Freshwater impact by food category per kg

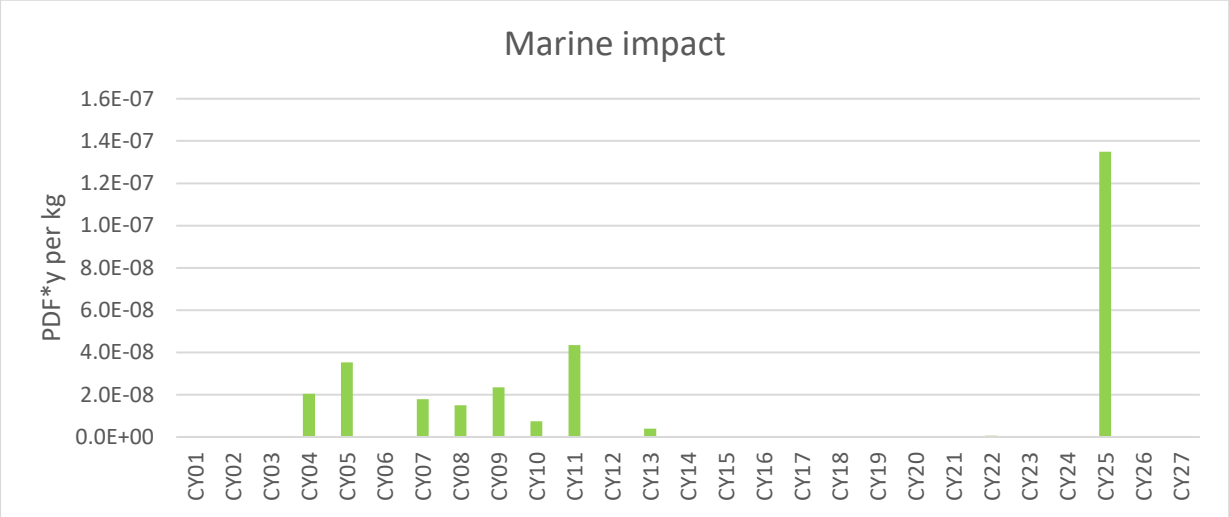

Figure 28: Marine impact by food category per kg

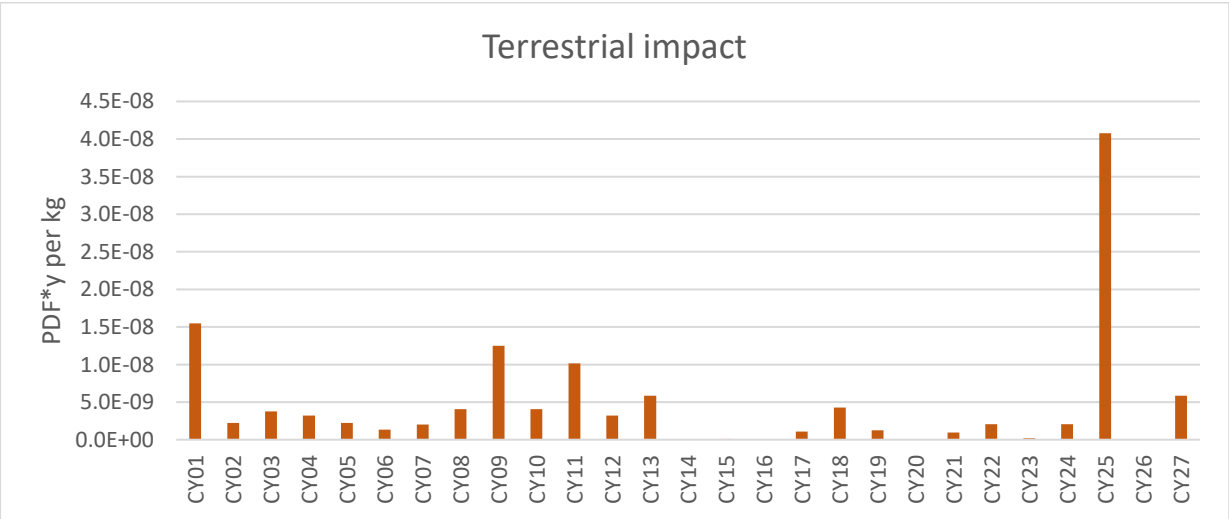

Figure 29: Terrestrial impact by food category per kg

The most notable finding is the considerable ecological impact of fish (CY25) consumption on marine (1.35×10^{-7} PDF*y/kg) and terrestrial (4.08×10^{-8} PDF*y/kg) indicators, largely linked to feed production (e.g., rapeseed cultivation). This challenges the conventional narrative that red meat is necessarily the highest-impact choice and underscores the need for closer scrutiny of seafood options; fish should not be assumed a low-impact alternative in buffet offerings. Beef (CY11), lamb (CY09), and cheese (CY05) also exhibit substantial biodiversity impacts across all three indicators, reaffirming that livestock, especially ruminants, impose disproportionate pressures relative to plant-based categories, driven by resource-intensive production, land requirements for feed, and manure-related emissions. Pork and chicken present intermediate-impact options that could serve as transitional substitutes for red meat while maintaining protein content in tourist food options.

Vegetables and fruits generally show lower biodiversity impacts across all indicators, with a few exceptions. Pepper (CY27) and tomato (CY21) display notably higher terrestrial impacts, approaching levels of some dairy products, likely reflecting intensive cultivation practices. Pear (CY17) exhibits a relatively elevated freshwater impact compared with other fruits, potentially due to irrigation demands or specific agricultural practices. Overall, the results support expanding plant-based items in food options in buffet menus, particularly when locally sourced when possible, to reduce ecological pressures.

For freshwater impacts (Figure 27), beef is by far the most environmentally intensive food option, with the highest damage to freshwater ecosystems, ~15% higher than the second-largest contributor and ~40% higher than the third (cheese). This reflects the high water demand of beef production, both for direct use and for growing feed crops, as well as fertiliser use and manure-related emissions affecting freshwater ecosystems. Pork (CY08) and chicken (CY10) show moderate freshwater impacts; production still requires substantial feed cultivation, yet they remain lower-impact than beef. By contrast, plant-based ingredients such as tropical fruits (CY14 and CY15), potatoes (CY19), and leafy greens (CY20) lower freshwater impacts.

Marine biodiversity impacts arise mainly from nutrient runoff (nitrogen and phosphorus) leading to eutrophication, ecotoxicity from pesticide use, and waste entering waterways that discharge to the sea. The pattern broadly mirrors freshwater results: fish (CY25) is the largest contributor at 1.35×10^{-7} PDF*y/kg, followed by beef at 4.35×10^{-8} PDF*y/kg and cheese at 3.52×10^{-8} PDF*y/kg (Figure 28). Other food items, such as pork, chicken and cereals, have moderate marine impacts, associated with feed-crop cultivation and processing.

The terrestrial impact indicator reflects land occupation and transformation, which are directly linked to habitat loss; it also captures chemical inputs (e.g., pesticides) that contribute to soil ecotoxicity. Again, fish leads by a considerable margin (4.10×10^{-8} PDF*y/kg), primarily due to fishmeal production (Figure 29). This impact is more than twice that of the second-highest contributor, milk (1.55×10^{-8} PDF*y/kg), followed by lamb (1.25×10^{-8} PDF*y/kg) and beef (1.01×10^{-8} PDF*y/kg), which also show substantial terrestrial pressures. These impacts are largely attributable to grazing and feed-crop production, which together drive land conversion (including deforestation). Among plant-based items, pepper (CY27) stands out with a relatively high terrestrial effect (5.86×10^{-9} PDF*y/kg), suggesting intensive cultivation, land-use change or higher pesticide application.

6.2 Waste Input-Output Analysis

This section presents a Waste Input-Output (WIO) analysis undertaken to examine the interconnections between economic activity and waste generation across sectors of the Cypriot economy. Building upon the traditional Input-Output (IO) model, the WIO framework integrates waste intensity coefficients to assess both direct and indirect waste outputs linked to final demand in each sector.

Input-Output (IO) analysis is an analytical framework that models the interdependencies among sectors of an economy through a system of linear equations. It quantifies how the output of each sector is distributed across the economy and how changes in final demand or policy interventions in one sector propagate through others (Miller & Blair, 2009). By tracing the flow of goods and services, IO captures both direct and indirect effects of economic activities, offering a comprehensive view of sectoral linkages and their multiplier effects (Leontief,

1986). The method has been extensively employed for policy evaluation, economic impact assessment, and analysis of technological change (Giannakis & Bruggeman, 2017; Rose, 1984).

Over the past decades, the traditional IO framework has been extended to include environmental dimensions, giving rise to Environmental Input-Output (EIO) models. These models incorporate vectors representing sector-specific emissions or resource use intensities, thereby linking economic outputs with environmental pressures (Cortés-Borda et al., 2015). The first notable application of this approach was introduced by Wassily Leontief in the 1970s, when he integrated air pollution emissions into the economic input-output model (Leontief, 1970). EIO models aim to systematically assess the environmental consequences of economic activity, providing vital insights for formulating integrated economic and environmental policies (Wiedmann et al., 2007).

Among the various extensions of EIO models, Waste Input-Output (WIO) models have gained prominence for their ability to incorporate waste generation, treatment technologies, and feedback loops between the economy and the environment. These models offer a more nuanced and systemic understanding of material flows, making them particularly suitable for circular economy and sustainability assessments (Towa et al., 2020).

6.2.1 Empirical model

The standard IO model is typically expressed in matrix notation as follows:

$$X = AX + Y \qquad (1)$$

$$X = (I - A)^{-1}Y \qquad (2)$$

where X is the vector of total output of each sector, Y is the vector of final demand (including household and government consumption, investment, gross capital formation and exports), A is a matrix of technical coefficients (i.e., the input requirements from other sectors per unit of output) and I is the identity matrix.

The matrix $(I - A)^{-1} = L$ is known as the Leontief inverse (Leontief, 1986) and it quantifies the impact exerted by changes in final demand (ΔY) on the output of sectors (ΔX). Each element l_{ij} of the matrix L represents the total (direct and indirect) output required from sector i to deliver one unit of final demand in sector

j (Miller & Blair, 2009).

The output multiplier for a particular sector j is defined as the column sums of the L matrix, that is, $\sum_{i=1}^{n} l_{ij}$.

To extend the IO model to assess waste generation, we incorporate a waste intensity matrix $W = (w_{kj})$, where each element w_{kj} represents the amount of waste type k generated per unit of output from sector j. Hence, the total waste generated (G) associated with a given level of sectoral output is given by:

$$G = WX \qquad (3)$$

Substituting Equation (2) into Equation (3), we obtain:

$$G = W(I - A)^{-1}Y \qquad (4)$$

Equation (4) provides a comprehensive estimate of total waste generation (direct and indirect) associated with supporting a given vector of final demand. Each element in the resulting matrix $W(I - A)^{-1}$ reflects the total quantity of a specific waste type generated per Euro of final demand in each sector.

In addition to these waste multipliers, Type I waste multipliers can be computed to assess the economy-wide repercussions of sector-specific waste generation. These are calculated by dividing the total (direct and indirect) waste generation coefficients matrix $(W(I - A)^{-1})$ by the direct waste coefficients matrix (W), assuming non-zero values.

Type I waste multipliers thus quantify the amplification of waste generation across the supply chain relative to the sector's own direct waste output, providing valuable insights into the systemic environmental pressures linked to sectoral activities.

6.2.2 Data

The most recent symmetric IO table for Cyprus, corresponding to the year 2021, obtained from Eurostat (Eurostat, 2025b), is employed to estimate the waste multiplier effects across economic sectors. Complementary data on sectoral waste generation, disaggregated by waste category and hazardousness, were also sourced from Eurostat (Eurostat, 2025a). The original classification of 65 economic sectors in the IO table was aggregated into a 25-sector scheme, aligned with the availability

and resolution of waste data (see Table 15). To disaggregate waste associated with the broad services sector into specific tertiary sectors, two approaches were combined: (a) expert judgment provided by officials from the Cyprus Department of Environment, and (b) the proportional distribution of each service sector's intermediate inputs relative to its gross output, thereby reflecting the sectoral contribution to overall production processes.

6.2.3 Results

The IO multiplier analysis identifies the sectors with the strongest capacity to stimulate economic activity across the Cypriot economy (Table 14). The construction sector exhibits the highest output multiplier at 2.1, meaning that for every €1 million increase in final demand, total economic output rises by €2.1 million. Other sectors with substantial backward linkages include water supply and treatment (2.0) and food manufacturing (1.9). In contrast, service sectors such as public administration and education have relatively low output multipliers (1.2 each), indicating weaker intersectoral linkages. Notably, the accommodation and food services sector ranks seventh in terms of output multiplier, reflecting a relatively strong ability to generate economic activity through its supply chain.

In terms of employment generation, the coke and petroleum products sector has the highest employment multiplier (100.7), implying that an increase of €1 million in final demand leads to the creation of 100.7 jobs. The accommodation and food services sector also performs well, generating 19 jobs per €1 million increase in final demand. On the other hand, employment multipliers are lowest in service sectors such as financial and insurance services (5.6) and real estate (2.5), reflecting their relatively limited labour intensity.

The WIO multiplier analysis reveals each sector's contribution to different waste categories. For total waste generation, the mining sector has the highest multiplier (2448 tonnes per €1 million of final demand), followed by sewerage services (1533 tonnes) and agriculture (885 tonnes). The accommodation and food services sector ranks 10th, generating 122 tonnes of total waste per €1 million of final demand.

Examining specific waste types:

- For animal and mixed food waste, the food manufacturing sector leads with a

multiplier of 152 tonnes, while the accommodation and food services sector also ranks high (22 tonnes, 4th overall).

- In the vegetal waste category, the food manufacturing (10 tonnes) and accommodation and food services (3 tonnes) sectors generate the largest effects.
- Regarding used oils, the accommodation and food services sector contributes the second highest indirect and direct waste generation (1 tonne), underscoring its environmental footprint in this category.

Finally, we estimate the Type I waste multipliers for the accommodation and food services sector, capturing both direct and indirect waste generation across the economy. The results indicate that for every 1 tonne of waste produced by the sector, a total of 4.1 tonnes are generated economy-wide. This effect is even more pronounced in the animal and mixed food waste category, where the multiplier reaches 7.5, implying significant spillovers across related sectors. The corresponding multipliers for vegetal waste and used oils are 1.7 and 1.1, respectively, highlighting the broader waste generation impact of this sector beyond its direct footprint.

Table 14: Economic output, employment, and waste multipliers by sector (2021)

Economic sectors	Output	Employment	Total waste	Animal & mixed food waste	Vegetal wastes	Used oils
Agriculture	1.65	22.0	884.7	34.4	1.4	0.8
Mining	1.63	13.8	2447.6	0.3	0.1	6.1
Food manufacturing	1.94	17.8	447.9	151.8	9.7	0.4
Textiles	1.51	27.3	24.7	0.3	0.1	0.2
Wood products	1.74	29.0	85.3	0.2	0.1	0.3
Paper products	1.31	12.8	76.2	0.3	0.1	0.1
Coke and petroleum products	1.37	100.7	519.5	0.3	0.1	0.0
Chemical products	1.31	12.1	188.5	0.7	0.1	0.1
Non-metallic mineral products	1.70	10.6	313.7	0.2	0.4	0.5
Metal products	1.40	12.4	60.6	0.2	0.1	0.2
Computer & elect. products	1.30	9.5	21.9	0.2	0.1	0.1
Furniture	1.32	10.7	25.3	0.3	0.1	0.1
Electricity and gas	1.54	8.7	10.0	0.2	0.1	0.3
Water supply and treatment	2.05	9.1	168.5	34.0	0.2	0.3
Sewerage services	1.75	14.3	1533.5	10.3	1.4	0.3
Construction	2.12	17.8	332.8	0.3	0.1	0.3
Trade	1.29	19.1	15.0	0.6	0.2	0.1
Transportation	1.51	6.4	12.2	0.8	0.4	0.2
Accommodation & food services	1.67	19.1	121.7	22.4	3.1	1.0
Financial - Insurance services	1.38	5.6	9.8	0.6	0.3	0.1
Real estate	1.25	2.5	44.1	0.4	0.2	0.1
Health	1.27	17.1	26.8	2.6	0.3	0.1
Public Administration	1.22	21.2	17.5	1.7	0.2	0.1
Education	1.19	22.5	12.6	0.3	0.1	0.1
Other services	1.31	10.0	9.7	0.7	0.2	0.1

Source: own compilation

Table 15: NACE codes of Cyprus input-output table economic sectors, 2021

n/n	Sector	Description NACE*
G1	Agriculture	A
G2	Mining	B
G3	Food manufacturing	C10-C12
G4	Textiles	C13-C15
G5	Wood products	C16
G6	Paper products	C17_C18
G7	Coke and petroleum products	C19
G8	Chemical products	C20-C22
G9	Non-metallic mineral products	C23
G10	Metal products	C24_C25
G11	Computer and electronic products	C26-C30
G12	Furniture	C31-C33
G13	Electricity and gas	D
G14	Water supply and treatment	CPA_E36
G15	Sewerage services	CPA_E37-39
G16	Construction	F
G17	Trade	G
G18	Transportation	H
G19	Accommodation and food services	I
G20	Financial - Insurance services	K
G21	Real estate	L
G22	Health	Q
G23	Public Administration	O
G24	Education	P
G25	Other services	J, M, N, R, S, T, U

Source: Eurostat (2008).

*NACE: Statistical classification of economic activities in the European Union.

6.3 FABIO model

FABIO (Food and Agriculture Biomass Input–Output) is a global, multiregional input–output framework that compiles physical supply-, use- and input–output tables for agriculture and food, linking primary production, processing, trade and final use at high product and country resolution (see D2.1). Built mainly from FAOSTAT commodity balances and bilateral trade (see Section 3), FABIO v1 covers ~130 agri-food products across 191 countries plus a rest-of-world region for 1986–2013 (Bruckner et al., 2019). In this study, we use a beta FABIO v.2.0 (Aug. 2025) to quantify Cyprus's food (consumed by residents) and tourism footprints for 2010–2022; note that the years 2020 and 2021 are missing due to COVID-19 pandemic. This version implements the revised FAOSTAT FBS/SUA methodology and includes 186 countries (+ RoW), with countries that did not exist during the covered period removed. Using FABIO's physical-flow basis allows us to trace embodied resource use through international supply chains at the food-commodity level.

Compared with the LCA (Section 6.1) which quantifies impacts for specific buffet (diet) variants consumed by tourists, the FABIO analysis as applied here covers the tourism sector as a whole. We report footprints for cropland (ha), grassland (ha), biomass (t), blue water (m^3) and green water (m^3), attributing them by country of origin and food commodity; for presentation, results are aggregated to main food categories and continents of origin.

The cropland, grassland and water footprints reported are calculated inside FABIO and then attributed to Cyprus tourism demand by tracing physical product flows through processing and trade. For cropland, embodied primary crops are converted to harvested area with producer-country, year-specific yields within FABIO's physical input–output framework (Bruckner et al., 2019). Grazing land reflects the grass actually eaten by livestock (from feed balances/diets) and is mapped to a *hypothetical grazed area* using country-average grassland productivity consistent with LPJmL "daily grazing" runs (country averages circa 2000–2009), harmonised with the approach used in Vanham et al., (2023). Water footprints track green (rain) and blue (irrigation) water volumes (m^3): for crops and crop-based feeds the model uses crop- and country-specific intensities (1996–2005 averages) from Mekonnen amd Hoekstra (2011) at farm gate and propagate them through FABIO's supply chains;

livestock products inherit the crop water embedded in their feeds Mekonnen amd Hoekstra (2012) , while grazing contributes only green water (actual evapotranspiration on grazed pastures) from an LPJmL-based dataset (Schyns et al., 2019). Regarding the types of water, blue and green water footpritns are reported as these are FABIO's native water accounts and represent consumptive use, i.e., grey water is not included since it is a pollution-dilution proxy that requires pollutant loads and receiving-water standards (Hoekstra et al., 2011) and its outside FABIO's scope. The categories used (cropland, grassland, blue/green water) therefore follow FABIO's standard pressure indicators and align with recent FABIO applications in the literature. For presentation purposes in this report, cropland and grassland footprints are agreegated to land use to summarise total area requirements by food category. Finally, note that these FABIO pressure volumes (m^3; ha) are not directly comparable to the LCA "water consumption" impact reported in Section 6.1 of this deliverable: our LCA applies GLAM/LC-IMPACT *damage-level* characterisation to consumptive water flows and reports ecosystem-quality impacts (e.g., global PDF·yr), which are location-dependent impact scores rather than use volumes (see also, GLAM global guidance and RAINFOREST Toolbox in D2.1).

6.3.1 Crop and grassland footprints

Tourism food-related land use (cropland and grassland footprints combined; Figure 30) declined from 27,589 ha in 2010 to 19,460 ha in 2019 (≈–30%), collapsed in 2020–2021 with travel restrictions, and partly recovered to 16,518 ha in 2022 (≈–15% vs. 2019; –40% vs. 2010). Meat is the dominant driver every year, accounting for ~48–58% of the footprint (e.g., 9,164 ha; 47% in 2019, 7,912 ha; 48% in 2022), followed by cereals and milk (2019: 13% and 12%, respectively). The long-run reduction is largely explained by a halving of meat-related area (15,935 ha in 2010 → 7,912 ha in 2022). Other categories (vegetable oils, coffee/tea/cocoa, fruit/vegetables, eggs) contribute smaller shares and show year-to-year variation. Overall, the land-use footprint is highly sensitive to the volume and composition of tourist food demand, with meat intensity remaining the key lever for area use.

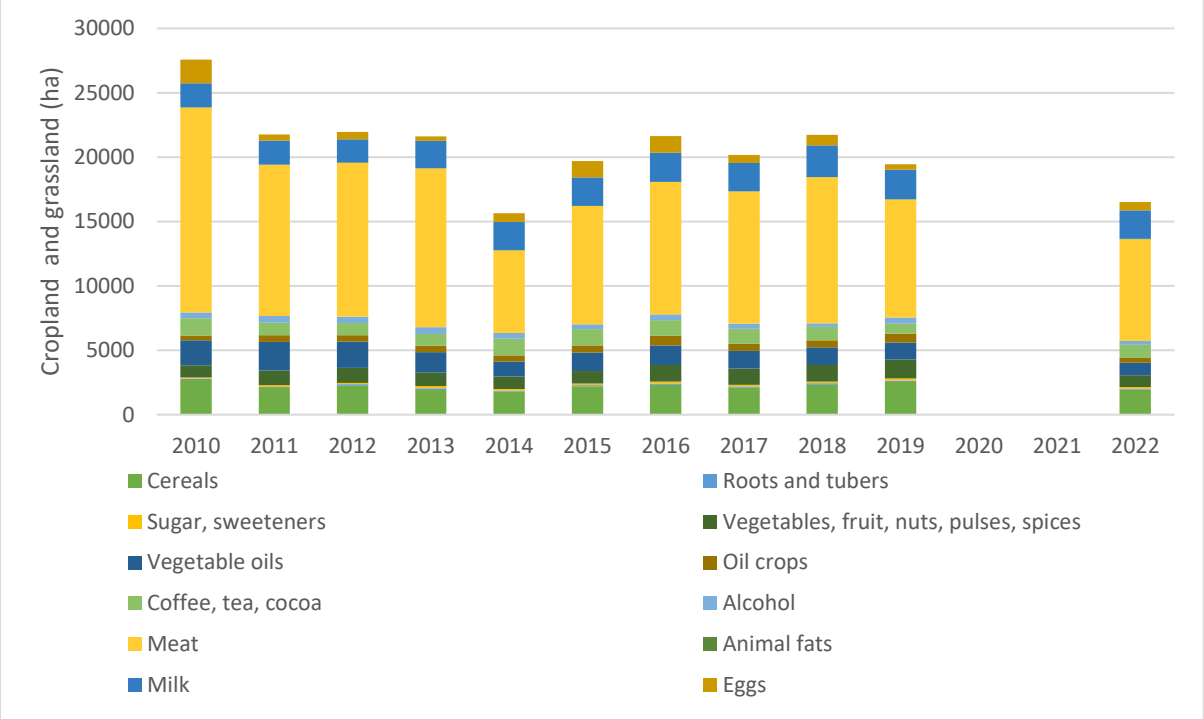

Figure 30: Land use (cropland + grassland) embodied in tourists' food consumption by category

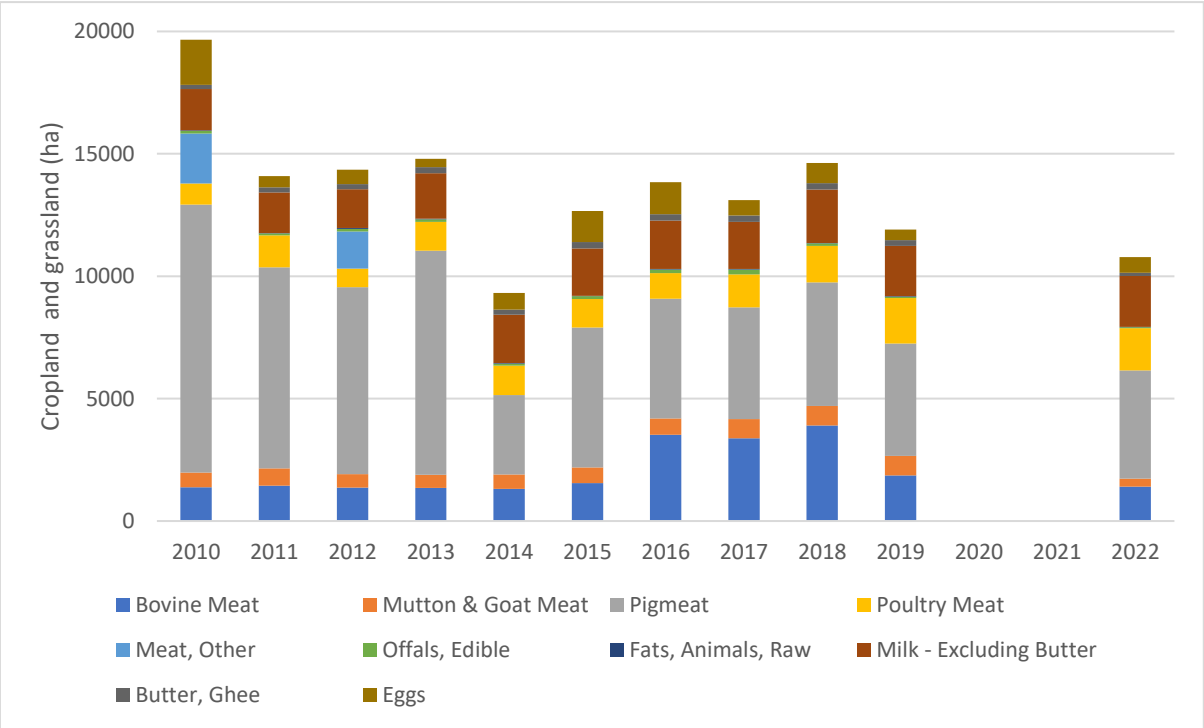

Figure 31: Land use (cropland + grassland) embodied in livestock products

Figure 31 shows the land embodied in livestock products consumed by tourists. Pigmeat is the dominant driver of land use in the livestock basket throughout the period, peaking at **10,946 ha in 2010** (≈56% of livestock area) and remaining the

largest item in **2019 (4,586 ha; ~39%)** and **2022 (4,419 ha)**. Bovine meat rises sharply in **2016-2018** (up to **3,901 ha**), then falls in **2019 (1,866 ha)** and **2022 (1,402 ha)**; poultry shows a steady increase, reaching **1,856 ha in 2019** and **1,726 ha in 2022**. Dairy-related land use is relatively stable (**milk: ~1,650-2,180 ha**, **butter: ~120-270 ha**), while **mutton & goat** remains a smaller, fairly steady contributor (**~500-800 ha**, **336 ha in 2022**). Eggs vary markedly (from **1,840 ha in 2010** to **649 ha in 2022**). Overall livestock-related land use declines from **~19,700 ha (2010)** to **~10,800 ha (2022)**, with the long-run reduction driven mainly by lower pigmeat and, more recently, beef-related area, while poultry gains offset some of the decline.

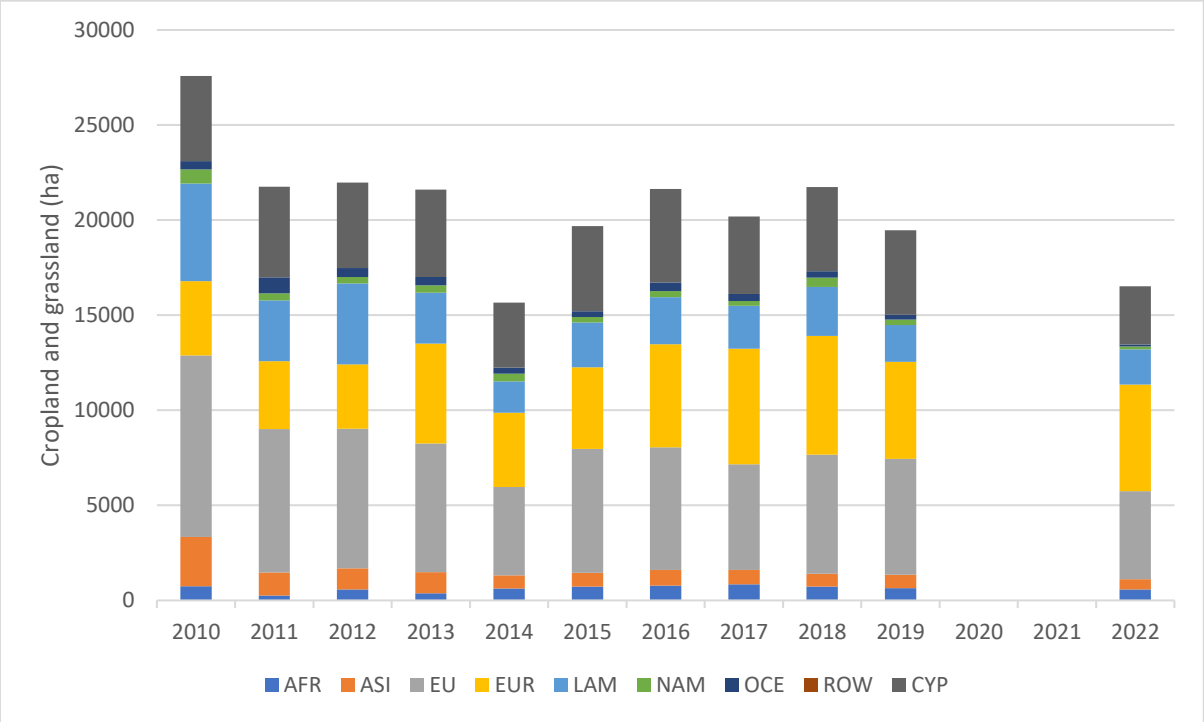

Figure 32: *Land use (cropland + grassland) embodied in tourists' food consumption by origin*

Regarding origin of embodied cropland/grassland in tourists' food, the footprint is concentrated in European supply chains (Figure 32). Across 2010–2019, EU-27 plus other European countries (EU+EUR) consistently supplied >55% of the area (e.g., 2019: EU 6,100 ha ~31%; EUR 5,097 ha ~26%), with Cyprus itself contributing a further ~20–23% (4,0–4.9 k ha). Latin America provided a smaller but material share that fell over time (from ~19% in 2010 to ~10% in 2019), while Asia and Africa remained low single-digit shares; North America and Oceania were marginal. After the pandemic

collapse (2020–2021), the footprint partly recovered in 2022 with a similar pattern but a shift toward non-EU Europe (EUR 5,593 ha; ~34%), a lower EU share (4,628 ha; ~28%), and a reduced domestic contribution (3,056 ha; ~19%). Overall, the geography indicates strong dependence on European and domestic sources, with declining reliance on Latin American and Asian origins over the period.

6.3.2 Water footprints

The total blue and green water footprints (WF) related to tourism food consumption (2010–2022) are shown in Figure 33, in million m^3 (Mm^3). Total blue WF fluctuates between 9.5–13.1 Mm^3 during 2010–2019 (peak ~2016/2019), to 9.29 Mm^3 in 2022 (~29% below 2019) after the pandemic. The green WF dominates overall, ranging 75–112 Mm^3 pre-pandemic (peak 2018: 104.4 Mm^3) and recovering to 80.1 Mm^3 in 2022 (~21% below 2019). Compositionally, livestock products drive the water footprint for ~55–64% of green WF each year, while primary crops contribute ~28–36% and crop products the remainder. For blue WF, shares are more balanced, i.e., primary crops ~45–52%, livestock ~30–42%, crop products ~11–19%, reflecting irrigation of food and feed crops alongside animal-product supply chains. The pattern tracks tourism activity, and the prominence of livestock/feed indicates that reducing meat intensity and favouring rain-fed or less water-intensive supply chains are key challenges to lower both blue and green water footprints within the tourist industry of Cyprus.

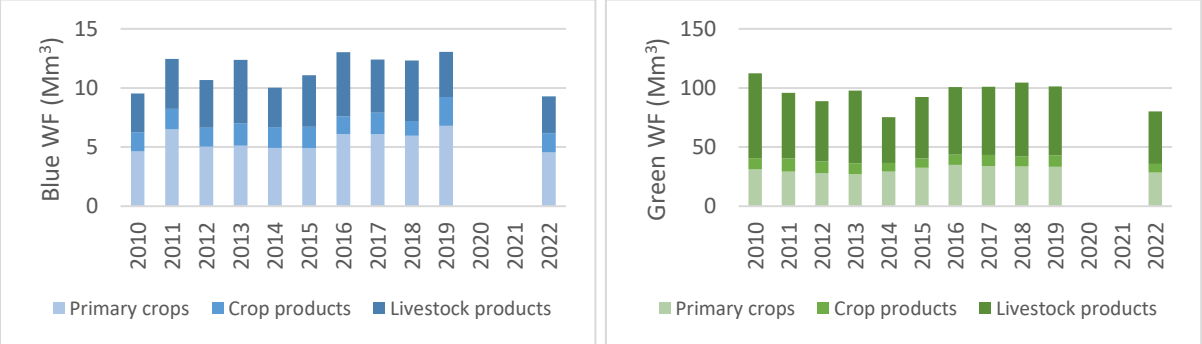

Figure 33: Total blue and green water footprints (WF) related to tourism food consumption; note that the scales are different.

As regards the origin of water footprints, the blue WF (irrigation) is dominated by domestic supply (Figure 34); Cyprus accounts for roughly 60–70% each year (e.g., 8.7

Mm^3 of 13.1 Mm^3 in 2019), with the remainder largely from Europe (EU + other European countries ~20–25%) and small shares from Asia/Africa/Americas. By 2022, after partial recovery, the pattern persists; CYP ~62%, other Europen countries up to ~18%, EU ~11%.

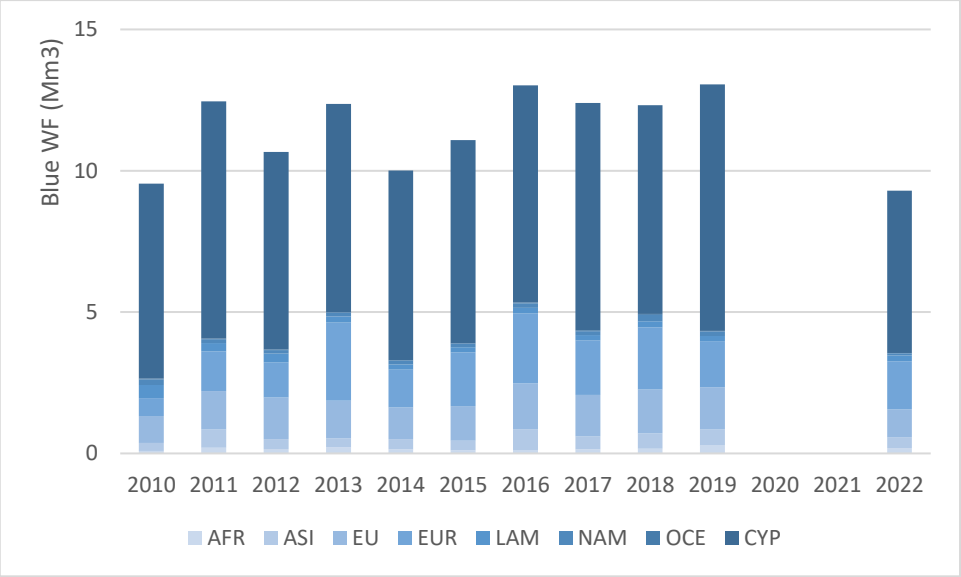

Figure 34: Total blue WF by origin

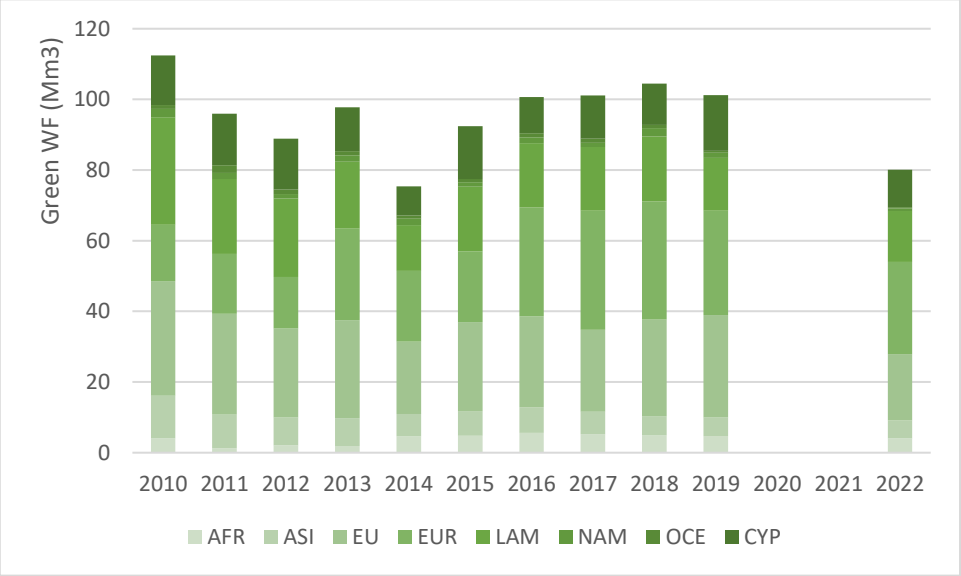

Figure 35: *Total green WF by origin*

On the other hand, the green WF (rainwater) is more import-driven and dispersed (Figure 35); Europe supplies about half to three-fifths of the total (2019: EU 28.7% + other Europe 29.2%; 2022: ~56% combined), Latin America remains a major source (~27% in 2010 to ~18% in 2022), and Cyprus contributes ~12–16% through the period. Contributions from Asia and Africa are modest (together ~10–15%), while North

America/Oceania are minor (<3%). Overall, irrigation pressure is chiefly domestic, whereas rain-fed pressures are largely externalised to European and Latin American supply chains

7. CONCLUSIONS AND MAIN FINDINGS

This deliverable aimed to assess the environmental and socio-economic impacts of the food chain in Cyprus' tourism sector. The main findings from the mapping assessment of Cyprus's tourism sector, the two surveys (hotel and tourist) and impact quantification tools are summarized below.

The **mapping of the current state of Cyprus's tourism sector** has revealed the following factors that make quantifiying impacts challenging and need to be considered when interpreting our results:

- Tourism in Cyprus remains highly seasonal (Figures 3 and 4), with the majority of tourist arrivals occuring between May and October each year. The availability of certain foods during specific seasons can also affect what is offered to tourists. First, seasonal variations influence the availability and freshness of ingredients. For example, vegetables and fruits, and certain meats and seafood have specific seasons when they are most fresh and available affecting eating establishments' menu offerings, thereby influencing food consumption patterns among tourists. Second, seasonality impact can be observed in economic aspects such as price variations of food items. Out-of-season food products are often more expensive due to the need to be imported compared to fresh, readily available local produce.
- The mix of tourist nationalities varies each year and often affected by exogenous shocks, (Figure 2). The origin of tourists can affect food consumption patterns, which is also reflected in their spending patterns and average length of stay (see Table 1).
- The type of accommodation determines the food options available to tourists, influencing both the type and quantity of food consumed. Notably, there has been a decreasing trend in the number of tourists opting for all-inclusive packages in Cyprus in recent years (as shown in Figure 6).
- Tourism in Cyprus contributes modestly but significantly to the island's total

food consumption with the largest relative contributions observed in the consumption of beverages (alcoholic and non-alcoholic) and animal-based products (particularly meat, dairy and fish/seafood) (Figure 7). Although, the majority of livestock products are produced domestically, the sector remains heavily dependent on imported feed cereals such as barley and maize As a result, tourism indirectly increases the island's dependency on cereal imports through meat and dairy consumption (Figure 8).

The main findings from the **hotel survey** include a growing sustainability awareness and food waste reduction among hoteliers mainly driven by the prerequisite of tour operators for sustainability certificates. However, there is is still room for improvement in engaging tourists in these efforts. While hotels actively implement sustainability initiatives and work towards reducing food waste (particularly 4- and 5-star rated hotels), challenges remain in aligning environmental goals with guest satisfaction. It is worth noting that these initiatives often come at a premium for tourists, as higher-end hotels are more inclined to adopt sustainability practices that can increase costs. Key areas for further improvement include encouraging tourists to participate in food waste reduction, redesigning menus to offer more sustainable food choices (e.g., meat-free days in buffets), reducing plate sizes, and incorporating more Class II vegetable products into their buffets to reduce food waste.

The **tourist survey** revealed a varied but generally positive attitude among tourists towards sustainable food practices. Key findings include tourists' strong interest in knowing the origin of the food consumed during their stay in Cyprus, the majority not finding local food products more expensive than imported ones and those who perceive local food as more expensive are willing to pay a little more for it. Similarly, many tourists find eco-labeled food products more expensive but are still willing to incur a modest premium for these products. Interestingly, a significant portion of tourists are open to meat-free days at hotel buffets and report having little to no leftover food during meals, with some either discarding or sharing their leftovers. Additionally, the tourist survey results suggest that while tourists are generally receptive to sustainable practices within the food value chain, their involvement remains inconsistent. The more widely adopted practices include reducing packaging waste and reusing cooking ingredients, while activities like

composting, discussions on environmental issues, and activism aimed at addressing environmental problems show lower levels of engagement. The purchase of organic foods and efforts to avoid environmentally harmful products remain limited, possibly due to factors such as cost and convenience. Finally, the results on the awareness and use of **interactive technologies** (QR codes, NFC, RFID, and Blockchain) indicate that despite differences in terms of usage and ease of understanding, all these technologies are considered to be useful, time-saving and effective in making information retrieval easier.

The analysis of typical buffet settings in Cypriot hotels confirms the strong relationship between diet composition and ecological impact. The **LCA results** revealed that, contrary to previous assumptions, fish consumption is the leading contributor to biodiversity loss, followed by beef consumption and dairy product consumption. The high impact of fish consumption is due to the resource-intensive nature of fishmeal production and associated land-use changes. Lean meats, such as chicken, offer a much more sustainable alternative, with their biodiversity impact ranging from 15% to 40% of that of beef. Plant-based foods, excluding cereals, capture the lowest impact scores for biodiversity loss. Thus, buffets high in red meat and fish (American, BBQ) consistently show greater environmental impacts towards terrestrial, freshwater, and marine ecosystems. In contrast, those with a more balanced or plant-forward composition (Indian, Asian) have a significantly lower impact. Additionally, disaggregated, category-level results clarify why buffet types differ in their biodiversity impacts and point to targeted actions to reduce them. Integrating these insights into sustainable menu planning, or adjusting existing buffet settings, can guide practical measures within hotel sustainability strategies and support transformative change in the sector.

Futhermore, a significant finding of the **WIO multiplier analysis** pertains to the accommodation and food services sector. For every tonne of waste from this sector, 4.1 tonnes are generated across the entire economy. This effect appears to be stongest in the animal and mixed food waste category (7.5 multiplier), suggesting considerable spillover effects across related sectors. In comparison, the multipliers for vegetal waste and used oils are 1.7 and 1.1, respectively, emphasizing the broader waste generation impact of this sector beyond its direct contribution.

Finally, from the **FABIO model** results regarding tourist food consumption based on 2010-2022 FAOSTAT data, three patterns stand out. First, commodity mix: livestock products dominate the key footprints - both cropland/grassland and green water - with pigmeat the largest contributor, beef peaking mid-decade, poultry rising, and dairy relatively stable; shifting menus away from red meat (and reducing waste) is the main lever to cut area and water use. Second, water type: the green water footprint (rainwater in feed and crops) is an order of magnitude larger than the blue footprint and is mostly tied to livestock/feed supply chains; blue water is smaller and more evenly split across commodities but is strongly linked to irrigated primary crops. Third, origin: embodied land and green water are largely externalised to Europe (EU + other Europe) and, to a lesser extent, Latin America, whereas blue water is predominantly domestic, with Cyprus supplying ~60–70% via irrigation of local crops. Overall, the tourism food consumption footprint is driven by meat-intensive demand, rain-fed feed production abroad, and irrigation at home. This implies that lower meat intensity, more plant-forward menus, and sourcing from less water-stressed, rain-fed systems would yield the largest reductions.

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APPENDIX 1:

HOTEL SURVEY

Dear participant,

We are researchers at the Science and Technology Driven Policy and Innovation Research Center (STeDI-RC) of The Cyprus Institute (CyI), a regional non-profit research and educational Center of Excellence. Our team comprises experts in sustainability, business administration, economy, and environmental studies, oriented towards finding economically viable alternatives that will promote sustainable practices and mitigate the environmental impacts within the touristic sector.

Currently we are involved in the European-funded RAINFOREST project, which focuses on enabling transformative change to reduce environmental and biodiversity impacts within major food and biomass value chains. The purpose of this questionnaire is to investigate tourists' food consumption patterns and the perception of stakeholder groups in the tourist food supply chain of Cyprus, which is one of the case studies in this project.

As a hotelier, your insights are invaluable to understanding the challenges and opportunities in the hospitality industry of Cyprus. Your participation will significantly contribute to devising strategies that enhance sustainability in the food supply chain of the tourism industry.

We greatly appreciate your interest and time in taking part to our study. Should you have any questions or require further information, please feel free to contact us.

Kind regards,
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Tourists' Food Consumption in the Hotel Industry

Food supply chain (FSC) is a highly complex process that involves numerous interconnected stages, from agricultural production to consumption. However, its effect on environmental sustainability is often overlooked. The RAINFOREST project aims to address this issue by enabling, upscaling and accelerating transformative change to reduce the environmental impacts of major food value chains.

This questionnaire seeks to uncover key insights into the preferences of the tourists in Cyprus, as well as the implemented practices and criteria used in the Cyprus tourist industry. Your knowledge and experience can therefore offer valuable insights in understanding the dynamics surrounding food supply chains and consumption patterns within the tourism sector.

Please note that any data provided will be used exclusively for research purposes with discretion.

Thank you for your time and invaluable contribution to this research.

1.1. Name

First Name Last Name

1.2. Position

1.3. Email

example@example.com

1.4. Telephone Number

Area Code Phone Number

1.5. Hotel Name

1.6. Location

1.7. Hotel Ranking

Please Select

1.8. Number of Rooms

1.9. Number of Beds

1.10. Number of Restaurant (s)

1.11. Type of Restaurant(s)

- ☐ Casual Dining
- ☐ Fine Dining
- ☐ Buffet
- ☐ Café
- ☐ Other

1.12. What percentage (%) of your total bookings are made through formal contracts with tour operators compared to direct bookings by individuals?

Tour Operators (%)	
Direct Bookings by Individuals (%)	

1.13. Which of the following certification schemes does your organization currently adhere to? Please select all that apply.

- ☐ Green tea
- ☐ EMAS
- ☐ ISO 14001
- ☐ Travel life
- ☐ Green globe
- ☐ None
- ☐ Other

Section 2: Guest Demographics

2.1. Please provide the number of accommodation days per age group and year.

	Adults (18+)	Children
2019		
2023		

2.2. What is the predominant age profile of your guests?

Please Select

2.3. Please provide the approximate percentage (%) of tourists accommodated by country at your facility for the years 2019 and 2023.

	UK	Israel	Germany	Greece	Poland	Sweden	Russia	Other
2019								
2023								

Section 3: Consumption Information

3.1. Do you track which dishes are most frequently ordered in your restaurant?

- ◯ Yes
- ◯ No

If yes, please provide the three most ordered items and their average daily orders per day.

	Food Name	Average orders per day
1st most ordered dish		
2nd most ordered dish		
3rd most ordered dish		

3.2. Does the hotel offer any promotions or special menus featuring local cuisine?

- ◯ Yes
- ◯ No

If yes, please specify three(3) main local dish(es).

3.3. Do you offer vegan/vegetarian food choices in the menu?

- ◯ Yes
- ◯ No

If yes, please specify three(3) indicative vegan/vegetarian food options.

3.4. Do you encourage staff to reduce food waste?

- ◯ Yes
- ◯ No

If yes, please specify the main practices implemented

3.5. Do you take measures to reduce energy consumption?

- ◯ Yes
- ◯ No

If yes, please specify three(3) measures that apply.

3.6. Do you take measures to reduce water consumption?

- ◯ Yes
- ◯ No

If yes, please specify three (3) measures that apply.

3.7. Do you encourage tourists/consumers to reduce food waste?

- ◯ Yes
- ◯ No

If yes, please describe how you do that

3.8. How important is reducing food waste at your establishment ?

- ◯ Very important
- ◯ Important
- ◯ Neutral
- ◯ Not important
- ◯ Not applicable

3.9. How important is it to incorporate food waste management practices into the training programs for employees at your hotel?

- ◯ Very High
- ◯ High
- ◯ Moderate
- ◯ Low
- ◯ Very Low

3.10. Does your hotel compost its food waste?

- ◯ Yes, currently composting
- ◯ Planning to start composting soon
- ◯ No current or planned composting

3.11. If your hotel does not currently compost its food waste, please indicate the reasons why. Select all that apply.

- ☐ Odor
- ☐ Practicality
- ☐ Space restriction
- ☐ Not enough quantities
- ☐ Insufficient Municipality Solid Waste Management
- ☐ Lack of Incentive
- ☐ Other

3.12. What are the main factors affecting your decisions when selecting the plate size for the buffet? Please select all options that apply.

- ☐ Plate weight
- ☐ Purchasing cost
- ☐ Design
- ☐ Reduced portions
- ☐ Reduced plate waste
- ☐ Never considered
- ☐ Other

3.13. What efforts are currently implemented at your facility to reduce the volume of unconsumed food and leftovers? Please select all options that apply.

- ☐ Give leftover to the staff
- ☐ Use leftovers in subsequent meals (directly or as ingredients)
- ☐ Composting
- ☐ Donating to charities
- ☐ None of the above (food is disposed as waste)
- ☐ Other _____

3.14. Please rank the following factors in order of their importance from 1 to 7 (where 1 denotes the most significant factor) when planning the restaurant or buffet menu. Each number can be assigned only once.

	Order of Importance
Type of restaurant	☐
Targeted audience	☐
Profitability	☐
Kitchen operations and efficiency	☐
Consistency of the menu, including balance and variety	☐
Special dietary requirements	☐
Considerations related to health issues (e.g., the use of charcoal)	☐

Section 4: Kitchen Operation

4.1. Which of the following practices are integrated into your kitchen operations? Please select all options that apply.

- ☐ Cooking to order (on demand)
- ☐ Prioritizing the use of seasonal and locally produced ingredients
- ☐ Utilizing frozen food products to extend storage life
- ☐ Employing experienced chefs and kitchen staff who actively monitor food stock levels and repurpose excess ingredients as necessary
- ☐ Incorporating Class II vegetable products (e.g., those with slight imperfections) to reduce food waste and support sustainability
- ☐ None of the above practices are currently implemented
- ☐ Other _____

4.2. Which practices are employed to optimize kitchen operations, ensure food safety, and minimize food waste? Please select all options that apply.

- ☐ Adoption of international standards such as ISO 9001 and HACCP to enhance food safety and prevent food waste.
- ☐ Involvement of the Chef in menu planning to align with kitchen capacity and operational capabilities.
- ☐ Maximizing the use of all edible parts of food ingredients in various recipes to reduce waste (zero-waste kitchen approach).
- ☐ None of the above
- ☐ Other _____

4.3. Please estimate the proportion of the following products that are procured as fresh vs. frozen in your kitchen operations. For each product, select the percentage that best represents your typical procurement practice.

	0% Fresh 100% Frozen	25% Fresh 75% Frozen	50% Fresh 50% Frozen	75% Fresh 25% Frozen	100% Fresh 0% Frozen
Chicken	○	○	○	○	○
Pork	○	○	○	○	○
Beef	○	○	○	○	○
Potatoes	○	○	○	○	○

4.4. Would you be open to adopting the following initiatives

	Yes	Maybe	No	Don't know
Introduce meat–free days	○	○	○	○
Mostly use local products	○	○	○	○
Offer smaller portion sizes	○	○	○	○
Track and monitor food waste levels	○	○	○	○
Introduce "chef's special" dish, made from food surplus or nearly expired food supplies	○	○	○	○
Participate in sustainability certification programs	○	○	○	○

4.4.1. Assuming widespread implementation of the sustainability measures listed above in your hotel, do you anticipate these measures would result in changes to the expenses of the restaurant operation? If yes, could you provide a rough estimate of the percentage change in expenses?

Increase by (%)	
Decrease by (%)	
No significant change (0)	

4.4.2. Assuming these sustainability measures are implemented, what do you anticipate will be the effect on tourists' average daily expenditure on food at your hotel? Please provide an approximate percentage to indicate the change.

Increase by (%)	
Decrease by (%)	
No significant change (0)	

Section 5: Supplier Information

5.1. Please indicate the frequency at which your review and select your food suppliers. Choose the option that best reflects your standard procurement practice.

- ◯ Weekly
- ◯ Monthly
- ◯ Quarterly
- ◯ Annually
- ◯ Never

5.2. Please assign a score to each of the following factors based on their importance in your decision-making process when selecting food suppliers. Use a scale from 1 to 5, where 1 indicates 'Least Important' and 5 signifies 'Most Important'." Please check only one box per row to indicate the importance of each factor.

	1	2	3	4	5
Quality of products	◯	◯	◯	◯	◯
Price competitiveness	◯	◯	◯	◯	◯
Reliability and consistency in supply	◯	◯	◯	◯	◯
Food safety standards and certifications	◯	◯	◯	◯	◯
Variety and range of products	◯	◯	◯	◯	◯
Responsiveness to requests and complaints	◯	◯	◯	◯	◯
Flexibility in orders/ Readiness	◯	◯	◯	◯	◯
Environmental sustainability practices	◯	◯	◯	◯	◯
Reputation and references	◯	◯	◯	◯	◯
Flexible payment terms	◯	◯	◯	◯	◯
Discounts for bulk orders	◯	◯	◯	◯	◯
Local products	◯	◯	◯	◯	◯

5.3. What methods do you employ to evaluate the quality of food products offered by potential suppliers? Please select all that apply.

- ☐ Sampling and Taste Testing
- ☐ Supplier Audits and Inspections
- ☐ Certifications (e.g., ISO, HACCP)
- ☐ Customer Feedback
- ☐ Other _____

5.4. Are there specific quality standards or certifications that you require from your food suppliers?

- ◯ Yes
- ◯ No

If yes, please specify the quality standards or certifications requires.

5.5. What are the biggest challenges you face when selecting food suppliers?

5.6. Do you have any additional comments or feedback regarding the process of selecting food suppliers for your hotel?

Section 6: Utilization of Class II quality products

Class II products: are vegetable and fruit products with minor defects or flaws mainly in appearance (e.g. discoloration, irregular shapes, and minor spots) but without any discernible difference in taste compared with Class I products.

6.1. Does your establishment currently use any Class II quality products?

- ◯ Yes
- ◯ No

If yes, what are the main Class II products utilized?

1st product	
2nd product	
3rd product	

6.2. What are your perceptions about the quality of Class II products?

- ◯ Acceptable for use
- ◯ Marginally acceptable, with certain conditions
- ◯ Unacceptable

6.3. What factors influence your decision to consider Class II products as an alternative within your establishment? Use a scale from 1 to 5, where 1 indicates 'Least Important' and 5 signifies 'Most Important'." Please check only one box per row to indicate the importance of each factor.

	1	2	3	4	5
Cost-effectiveness	◯	◯	◯	◯	◯
Environmental sustainability	◯	◯	◯	◯	◯
Availability	◯	◯	◯	◯	◯
Ease of use in recipes	◯	◯	◯	◯	◯
Purpose of use	◯	◯	◯	◯	◯
Part of the product utilized	◯	◯	◯	◯	◯
Quality characteristics	◯	◯	◯	◯	◯
Marketing Strategy	◯	◯	◯	◯	◯

6.4. What are your main concerns or reservations, regarding the use of Class II products in your establishment? Use a scale from 1 to 5, where 1 indicates 'Least Important' and 5 signifies 'Most Important'." Please check only one box per row to indicate the importance of each factor.

	1	2	3	4	5
Quality may not meet customer expectations	○	○	○	○	○
Potential impact on reputation	○	○	○	○	○
Uncertainty about safety and hygiene standards	○	○	○	○	○
Limited availability or consistency of Class II quality products	○	○	○	○	○
Concerns about flavor or taste differences	○	○	○	○	○
Regulatory compliance issues	○	○	○	○	○

6.5. Would you be open to initiatives or programs that facilitate the utilization of Class II products?

- ○ Yes, definitely
- ○ Maybe, depending on the specifics
- ○ No, not interested

Section 7.1: Monthly Reservation and Occupancy data for 2019

Reservation Package Data for 2019

	BB	HB	FB	All inclusive	No Meal Included
What is the total number of reservations per package ?					
What was the average cost per night for each package?					
What percentage (%) of the total cost was allocated to food for each package?					
In which dining option are the following packages provided? (Buffet/ A la carte/ Other)					

Monthly Occupancy data for 2019

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Occupancy rate per month (%)													
Accommodation days per month													
Number of BB per month													
Number of HB per month													
Number of FB per month													

Section 7.2: Monthly Reservation and Occupancy data for 2023

Reservation Package Data for 2019

	BB	HB	FB	All inclusive	No Meal Included
What is the total number of reservations per package ?					
What was the average cost per night for each package?					
What percentage (%) of the total cost was allocated to food for each package?					
In which dining option are the following packages provided? (Buffet/ A la carte/ Other)					

Monthly Occupancy data for 2019

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Occupancy rate per month (%)													
Accommodation days per month													
Number of BB per month													
Number of HB per month													
Number of FB per month													

Section 7.3: Monthly food consumption data for 2019

Meat Consumption	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Beef (kg)													
Pork (kg)													
Lamb (kg)													
Chicken(kg)													
Poultry - Duck etc. (kg)													
Cold Cuts - Ham etc. (kg)													
Eggs (pcs)													
Eggs Liquid (L)													

Dairy Consumption	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Fresh Milk (L)													
UHT Milk (L)													
Halloumi (kg)													
Cheese (kg)													
Yoghurt (kg)													
Butter (kg)													
Cooking cream (L)													

Cereals Consumption (kg)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Pasta													
Rice													
Cereals													
Pastry													
Bread													

Fruits & Vegetables (kg)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Orange													
Other Citrus													
Apple & Pear													
Banana													
Stonefruits													
Watermelon													
Melon													
Strawberries													
Tropical Fruits													
Dried Fruits													
Nuts													
Tomato													
Cucumber													
Potato													
Zuchini													
Eggplant													
Pepper													
Onions													
Leafy Vegetables													
Other Vegetables													

Beverages Consumption	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Wine													
Beer													
Soft Drinks													
Soft Drink (Post-mix)													
Orange Juice													
Apple Juice													
Orange Juice (Post-mix)													
Apple Juice (Post-mix)													
Other Juices													

Other Products	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Olive Oil (L)													
Cooking Oil (L)													
Sugars (kg)													
Coffee (kg)													

Section 7.4: Monthly food consumption data for 2023

Meat Consumption	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Beef (kg)													
Pork (kg)													
Lamb (kg)													
Chicken(kg)													
Poultry - Duck etc. (kg)													
Cold Cuts - Ham etc. (kg)													
Eggs (pcs)													
Eggs Liquid (L)													

Dairy Consumption	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Fresh Milk (L)													
UHT Milk (L)													
Halloumi (kg)													
Cheese (kg)													
Yoghurt (kg)													
Butter (kg)													
Cooking cream (L)													

Cereals Consumption (kg)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Pasta													
Rice													
Cereals													
Pastry													
Bread													

Fruits & Vegetables (kg)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Orange													
Other Citrus													
Apple & Pear													
Banana													
Stonefruits													
Watermelon													
Melon													
Strawberries													
Tropical Fruits													
Dried Fruits													
Nuts													
Tomato													
Cucumber													
Potato													
Zuchini													
Eggplant													
Pepper													
Onions													
Leafy Vegetables													
Other Vegetables													

Beverages Consumption	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Wine													
Beer													
Soft Drinks													
Soft Drink (Post-mix)													
Orange Juice													
Apple Juice													
Orange Juice (Post-mix)													
Apple Juice (Post-mix)													
Other Juices													

Other Products	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Olive Oil (L)													
Cooking Oil (L)													
Sugars (kg)													
Coffee (kg)													

APPENDIX 2:
TOURIST SURVEY

Section 1: General Information

1 Gender*

- [ ] Male
- [ ] Female
- [ ] Other

2 Age

_____

3 Education Level*

- [ ] Secondary school
- [ ] Technical/vocational training
- [ ] Bachelor’s degree
- [ ] Master or Doctorate degree
- [ ] Prefer not to say

4 Country of Usual Residence *

- [ ] UK
- [ ] Sweden
- [ ] Norway
- [ ] Germany
- [ ] Poland
- [ ] Greece
- [ ] Israel
- [ ] Russia

5 Which of the following broad categories best describes your current approximate annual income before taxes (€)?*

- [ ] <15.000
- [ ] 15.000 - 30.000
- [ ] 30.000 - 60.000
- [ ] >60.000
- [ ] Prefer not to say

Section 2: Trip-related Information

6 Please specify your **accommodation type** for your holiday in Cyprus *

- [ ] 2 star
- [ ] 3 star
- [ ] 4 star
- [ ] 5 star
- [ ] Hotel Apartment

7 Terms of Stay*

- [ ] Accommodation Only
- [ ] Bed & Breakfast
- [ ] Half Board (two meals)
- [ ] Full Board (three meals)
- [ ] All Inclusive

8 Is this your first visit to Cyprus?*

Yes Y No N

9 If no, how many **times** have you visited Cyprus?

Times

10 In which **district** of Cyprus did you stay during your vacations?

- [ ] Ayia Napa
- [ ] Protaras
- [ ] Paphos
- [ ] Larnaca
- [ ] Limassol
- [ ] Nicosia
- [ ] Other (Please Specify)

11 Whom do you travel with?*

- [ ] Solo traveller
- [ ] Couple
- [ ] Family
- [ ] Group of Friends

12 If applicable, please specify the number of **adults**

adults

13 If applicable, please specify the number of **children (0-18)**

children

14 Number of **nights** stayed in Cyprus?*

nights

15 **Total cost** of your trip to Cyprus

€ .00

16 What percentage (**%**) of the total trip cost was spent on **food and dining**?

%

17 What percentage (**%**) of the total trip cost was spent on **transport**?

%

Section 3: Food Preferences

18 Do you have any **dietary preferences** or restrictions that influence your food choices while traveling?*


Yes Y No N

19 If yes, please specify

- [ ] Food Allergies
- [ ] Religious dietary laws (e.g. kosher/halah)
- [ ] Vegetarian
- [ ] Vegan

20 Would you be interested in knowing know about the **origin of the food** you consumed during your stay in Cyprus?*


Yes Y No N

21 Were **local food products** more expensive than imported options?*

Yes Y No N

22 If yes, how much **more** are you willing to pay for local food products?

- [ ] Up to 10%
- [ ] 10-20%
- [ ] 20-30%
- [ ] More than 30%

23 Were **certified/eco-labeled** food products (e.g., Fair Trade, Organic, Rainforest Alliance etc.) more expensive than non-certified products?*

Yes Y No N

24 If yes, how much are you willing to pay for **certified/eco-labeled** food products?

- [ ] Up to 10%
- [ ] 10-20%
- [ ] 20-30%
- [ ] More than 30%

25 How much more likely are you to **revisit** Cyprus if there were more **local/eco-labelled food** options available?*

1	2	3	4	5	6	7	8	9	10

Unlikely Very Likely

26 Would you support having **meat-free days** (e.g., 2 days per week) in the hotel's buffet?*

Yes Y

No N

27 How much **leftovers** you usually have during meals?*

- ☐ A lot (>30%)
- ☐ A significant amount (10-30%)
- ☐ A reasonable amount (10%)
- ☐ Very Little (<10%)
- ☐ None

28 What is your usual approach to **leftovers**?*

- [ ] Leave any leftovers on the plate to be thrown away
- [ ] Take the leftovers home (doggy bag)
- [ ] Share any leftovers with my dining companion
- [ ] Other (Please Specify) _____

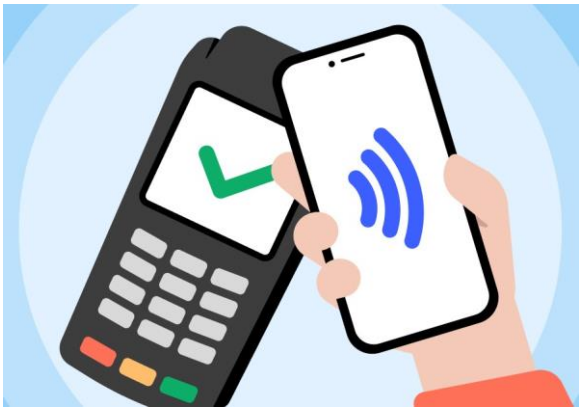
Section 4: Environmental Behaviour

29 How frequently you have participated in the following activities in the past six(6) months

	Never	Rarely	Occasionally	Sometimes	Often	Very often	As often as possible
Purchased environmentally friendly and/or energy efficient products	1	2	3	4	5	6	7
Preferred purchasing items without excessive packaging	1	2	3	4	5	6	7
Reused or mended items rather than dispose them	1	2	3	4	5	6	7
Purchased Organic Food	1	2	3	4	5	6	7
Reused ingredients from home cooking	1	2	3	4	5	6	7
Composted food waste at home	1	2	3	4	5	6	7
Discusses with others in your community about environmental issues	1	2	3	4	5	6	7
Worked with others to address an environmental problem or issue	1	2	3	4	5	6	7
Chose not to purchase a food item due to its negative environmental impact	1	2	3	4	5	6	7

Section 5: Interaction Technologies

30 Which of the following technologies you know how to use?

- [ ] 
NFC

- [ ] 

RFID

- [ ] 
QR Code

- [ ] 

Blockchain

31 How easy the following technologies are to understand?

	Not Easy	Slightly Easy	Somewhat Easy	Moderately Easy	Very Easy	Very Much Easy	Extremely Easy
NFC	1	2	3	4	5	6	7
RFID	1	2	3	4	5	6	7
QR code	1	2	3	4	5	6	7
Blockchain	1	2	3	4	5	6	7

32 Rate to what extent the following technologies

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Useful	1	2	3	4	5
Save time	1	2	3	4	5
Make deriving information easier	1	2	3	4	5