



Household food wastes in Morocco: extent of, drivers of and environmental policy integration for sustainable consumption

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Abstract

Food waste reduction is an essential solution to guarantee food security and to achieve sustainable development goals, especially promoting sustainable consumption and production patterns that lead to attainment of the twelfth Sustainable Development Goal. Although a number of quantitative studies have explored food wastage, few have focused on analysing the main factors contributing to the issue. Given that Morocco, as a member of the United Nations, is committed to halving the per capita food waste at the consumer level by 2030, designing a lever for action to reduce food waste at the household level is crucial and is a top priority. So, many questions, such as the following, need to be answered: What are drivers of food waste generation? How could they influence food habits? Does being aware of the importance of sustainable consumption influence households to change their behaviour? The aim of this study is to analyse food waste rates associated with seven commodity groups among 256 Moroccan households. Results indicated that the most influential food waste generation driver was social class. Moreover, it was noted that consumers wasted food even if they were aware of the problem, and even if they mentioned adopting good eating habits. We therefore proposed an innovative environmental policy integration, named “Culture of Personal Food Governance”, that was based on three levels of action: regulating, raising awareness and monitoring. The results obtained will guide the scientific community, decision-makers and civil society to establish training and awareness protocols adapted to the Mediterranean context, or even to devise an international multi-stakeholder strategy against household food wastage.

Keywords Sustainable consumption · Food wastes · Analysis of drivers · Environmental policy integration · Moroccan households

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Introduction

Considering that the projected global population could reach 9.7 billion in 2050 (United Nations 2019), our food consumption patterns face several challenges related to food security in terms of both quantity and quality, environmental and natural resource preservation and concerns about land and energy use (Agapios et al. 2020; Tsangas et al. 2020; Spratt et al. 2021; Elhamdouni et al. 2022; Shouket et al. 2023). Without advancements in technology and changes in behaviour within our food supply chain, and with projected population and income growth, the environmental impacts of the global food system could rise by 50–90% from 2010 to 2050 (Springmann et al. 2018). After the publication of a study conducted by the Food and Agriculture Organization (FAO) which estimates that one-third of all food produced for human consumption in the world is either lost or wasted,

amounting to 1.3 billion tons per year (Gustavsson 2011), the issue of food loss and waste (FLW) has assumed increasing importance among political debates, and in the international scientific research literature. Moreover, reducing FLW is crucial for advancing several United Nations (UN) Sustainable Development Goals, as it addresses significant social, economic and environmental challenges that threaten the sustainability of our planet (Principato et al. 2019). Taking this into consideration, all 193 member states of the UN have incorporated “Responsible Production and Consumption” into their 2030 agenda under Sustainable Development Goal (SDG) 12 (Carlsen and Bruggemann 2022). Transitioning to this objective requires sustainable agricultural production (Tsangas et al. 2020), through pursuing circular economic growth while simultaneously avoiding the unsustainable use of natural resources and the unsustainable production of waste and emissions (Chan et al. 2018a, b). Therefore, the UN is urging governments, producers and consumers to reconsider the environmental and social impacts of their products throughout the entire value chain, and to halve their FLW by 2030 (Ardra and Barua 2022). As a result, studying and managing FLW has become an obligation, especially for United Nations member countries that must honour the aforementioned commitment. Furthermore, recent studies consider FLW management to be an essential solution to guarantee food security and to achieve environmental objectives (Springmann et al. 2018; FAO 2019; Kuiper and Cui 2020; Jribi et al. 2020; Cattaneo et al. 2021).

The Food and Agriculture Organization (FAO) defines food loss and waste (FLW) as the decrease in quantity or quality of food along the food supply chain (FAO 2019). Otherwise, FLW is frequently employed to categorize materials initially intended for human consumption but ultimately lost, discharged, contaminated or degraded (Zorpas et al. 2018). Food loss is a segment of FLW which is a result of unintentional rejection or an unavoidable decrease in perceived quality concerning nutritional, economic or food safety value (Vilariño et al. 2017). In contrast, food waste is a part of FLW which is caused either by choice or after proliferation or expiration due to negligence or oversupply (Principato et al. 2019; FAO 2019).

The main barrier faced by food waste management is a lack of comprehensive and exhaustive studies on the extent of FLW in several UN member countries, such as Morocco, despite their commitment to achieve SDG 12.3 by 2030. And this may be due to the difficulties related to conducting integrated studies across all food categories and identifying the factors influencing FLW, rather than simply carrying out quantitative studies that give no indication of how to design solutions. Nevertheless, Zorpas et al. (2021) has highlighted another kind of barrier called “crisis in leadership”, which is associated with the deficiency of educational initiatives and awareness activities, coupled with inadequate waste

infrastructure and strategy, alongside misguided political decisions regarding waste management strategies.

As demonstrated by Rodrigues and Bortoleto (2022), it is essential to understand the key factors influencing the food waste rate to act appropriately and to develop strategies and programs adapted to each context and therefore alleviate environmental impacts caused by human activities. Thus, quantifying the food waste rate is not enough to reduce this issue. Morocco, as a middle-income emerging country (African Development Bank Group 2019), may have a significant rate of food waste (FW) at the household level; this hypothesis is based on the FAO’s study which has demonstrated that in middle- and high-income countries and industrialized countries, food waste occurs mainly at the consumption stage (Gustavsson 2011). Nevertheless, to the best of our knowledge, no previous study has investigated the link between food wastage and its potential drivers at the consumption stage in the Moroccan context. This research project aims, firstly, to explain food wastage rates according to household characteristics and in relation to other potential drivers such as food habits and, secondly, to measure food waste within all food groups (cereals, roots and tubers, oilseeds and pulses, fruits and vegetables, meat, fish and seafood and milk and dairy) at a household level, and thirdly, to propose an effective solution for the environmental integration of considerations related to food waste reduction at an individual scale, that of households and consumers.

Material and methods

Data collection

The study is based on a randomly sampled questionnaire survey in Morocco using a free online platform Google Forms. We developed a structured questionnaire which begins with a pre-announcement message and which consists of two parts. Firstly, our survey was expected to identify the potential drivers of food wastage, using eight sections with 25 questions, as outlined in Fig. 1. The responses about food habit adoption were collected using a Likert scale ranging from 1 to 5 (Sullivan and Artino 2013). Secondly, our questionnaire is designed to quantify food waste rates generated by households for seven food groups using the multiple-choice grid options proposed by Google Forms, putting the commodity groups (cereals, roots and tubers, oilseeds and pulses, fruits and vegetables, meat, fish and seafood and milk and dairy group) in the rows and, in the columns, the households’ estimations of their food waste by percentage (0%, 5%, 10%, 15%, 20% and 25%). The choice of this percentage scale and these food groups was based on the results found by the FAO regarding the estimated food waste percentages in the context of consumption for North Africa and West

Fig. 1 Graphical presentation of the questionnaire survey designed by the authors

First part: Identification of the potential drivers of food waste

Section 1: Socio-Demographic Characteristics

Gender

Age

Habitat type (urban or rural)

Average monthly income (in Moroccan Dirham (MAD))

Number of household members

Section 2: Awareness level

Could you describe your awareness level about Responsible Consumption?

Section 3: Training level

Could you describe your training level about Responsible Consumption?

What is the duration of this training?

Section 4: Culture and shopping habits

Do you purchase food products using a shopping list?

Do you evaluate the contents of your pantry or refrigerator before going to buy food products?

Can the "promotion" make you buy a product that you don't need?

In your opinion, the Best Before Date corresponds to What ?

Do you only buy a food product if you are certain that you can consume it before its Use-By Date?

Shopping in state of hunger can drive you to buy products that do not match your needs or your tastes?

Section 5: Preparation habits

Do you exactly assess your needs before preparing your meals / food products?

Did you prepare food products properly to prevent spoilage?

Section 6: Consumption habits

Do you prioritize the consumption of opened /started products?

Do you prioritize the consumption of products with the closest Use-By Date?

Can you consume a food product in the Best Before Date is outdated?

In which case, do you find that there is more food waste?

Section 7: Food waste management

In the case of eating out, do you take the leftover of your products to consume it later?

If no, why not?

What happens to the leftover of your food products ?

Section 8: Knowledge and motivations

In your opinion, at what stage of the food supply chain there is more food loss and waste?

In your opinion, why we should not waste the food?

Second part: Quantification of Food Waste Rates

What is your estimated Food Waste Percentage for each food group?

Cereals

Roots and tubers

Oilseeds and pulses

Fruits and vegetables

Meat

Fish and seafood

Milk and dairy group

and Central Asia for each product group: cereals, roots and tubers, oilseeds and pulses, fruits and vegetables, meat, fish and seafood and milk and dairy, which are, respectfully, 12%, 6%, 2%, 12%, 8%, 4% and 2% (FAO 2011).

Data analysis

Statistical analyses were performed in open source R software (Field et al. 2012; Team 2015). Principal component analysis (PCA) of food waste (FW) drivers and respondents, either classified by their gender or by their income, were performed using the Factoextra (Kassambara and Mundt 2017) and Factominer (Husson et al. 2013) packages. The circles of correlation were also obtained using the Psy (Falissard and Falissard 2022) and Corrplot (Wei et al. 2017) packages.

Grouped boxplots with jitter were generated using Dplyr package (Wickham and Wickham 2020)

Results

General characteristics of respondents

The random sample studied was 256 Moroccan households. Figure 2 shows that the group of respondents in our survey was approximately gender balanced, with 58.2% (149) male and 41.8% (107) female. The most common age groups among the participants in our survey were individuals aged 20–30 years old and 31–40 years old, representing 43.4% and 24.2% respectively. This distribution can be explained by the fact that the questionnaire was administered online

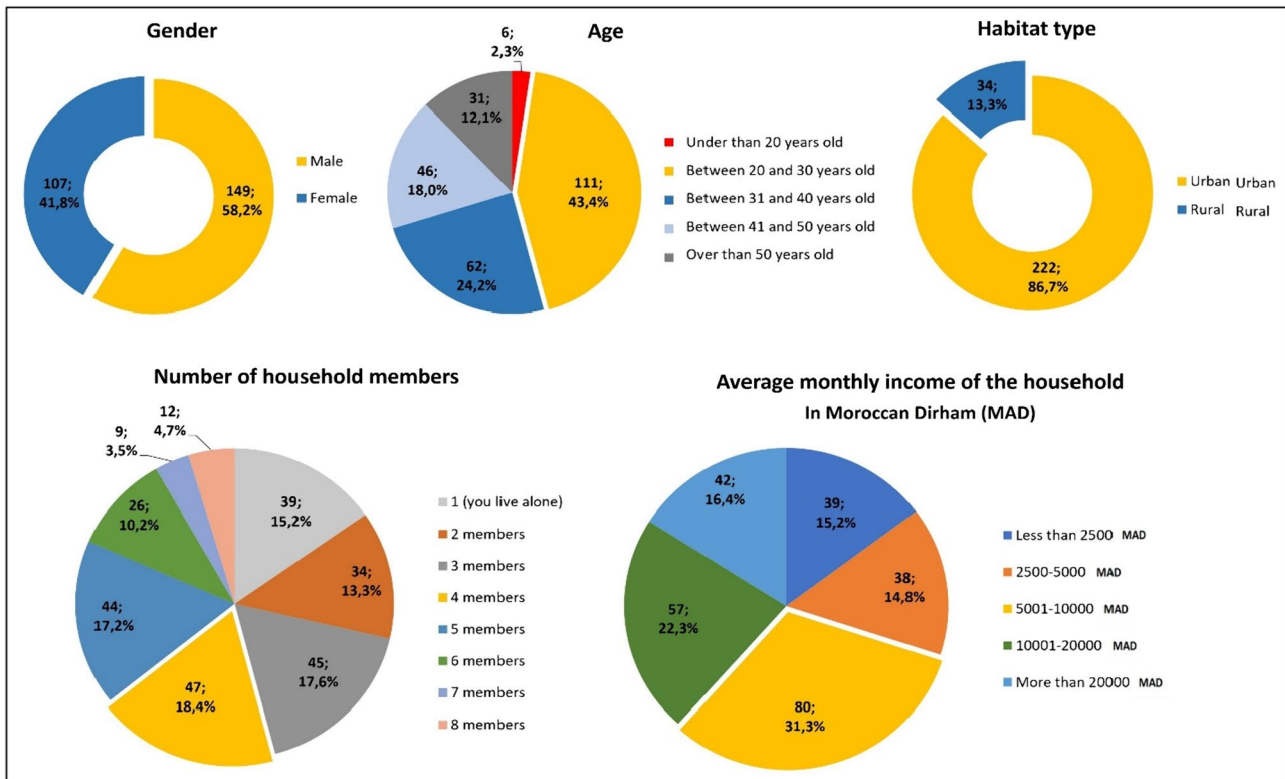


Fig. 2 Results of the general characteristics observed in the studied population

and by these two age groups' significant use of computer tools and the Internet. In addition, more than a half of respondents lived in households with 4, 3 or 5 members – 18.4%, 17.6% and 17.2%, respectively. These results are similar to the official data published by the Moroccan Ministry, which revealed that the most frequent household compositions are 4, 5 and 3 members, with, respectively, 19.9%, 17.9% and 15.2% (Ministry of National Territorial Planning, Urban Planning, Housing and City Policy 2014). Additionally, almost a third of the households (31.3%) have a total monthly income ranging from 5001 to 10,000 Moroccan Dirham (MAD). The average monthly income of Moroccan households is 7661 MAD (High Commission for Planning of Morocco 2022). Furthermore, about 86.7% (222) of the households were located in an urban area, compared with 13.3% (34) in a rural area. The low representation of the rural population is due to their limited access to Internet resources and the online mode of administration of the questionnaire.

Variations in food habits according to gender

In general, gender had no effect on food habits. Men and women had almost the same cultural and shopping habits, preparation and consumption habits and food waste management habits. Figure 3 shows that both genders frequently

adopted (median is 4) good habits such as: “Evaluating the content of the pantry or refrigerator before going to buy food” (Fig. 3 – Boxplot 2), “Buying food products only if they were sure to consume them before their use-by date” (Fig. 3 – Boxplot 3), “Assessing needs before preparing food” (Fig. 3 – Boxplot 5), “Prioritizing opened/started products” (Fig. 3 – Boxplot 7) and “Prioritizing products with the closest use-by date” (Fig. 3 – Boxplot 8). We observe that these habits were prevalent among households regardless of gender. Additionally, shopping while hungry (Fig. 3 – Boxplot 4) could moderately lead both genders to purchase food products that do not meet their needs. Likewise, individuals typically prepared their food in a random manner (Fig. 3 – Boxplot 6), they were unable to consume food products with outdated best use dates (Fig. 3 – Boxplot 9) and they did not take leftovers of their food when eating out (Fig. 3 – Boxplot 10). Women in particular tended to use a shopping list more than men (Fig. 3 – Boxplot 1).

Variation in food habits according to social class

Income did not have an overall effect on household food habits. All social classes had nearly the same food habits. Figure 4 demonstrates, firstly, that the most frequent food habits among households regardless of their social class were “Evaluating the content of the pantry or refrigerator

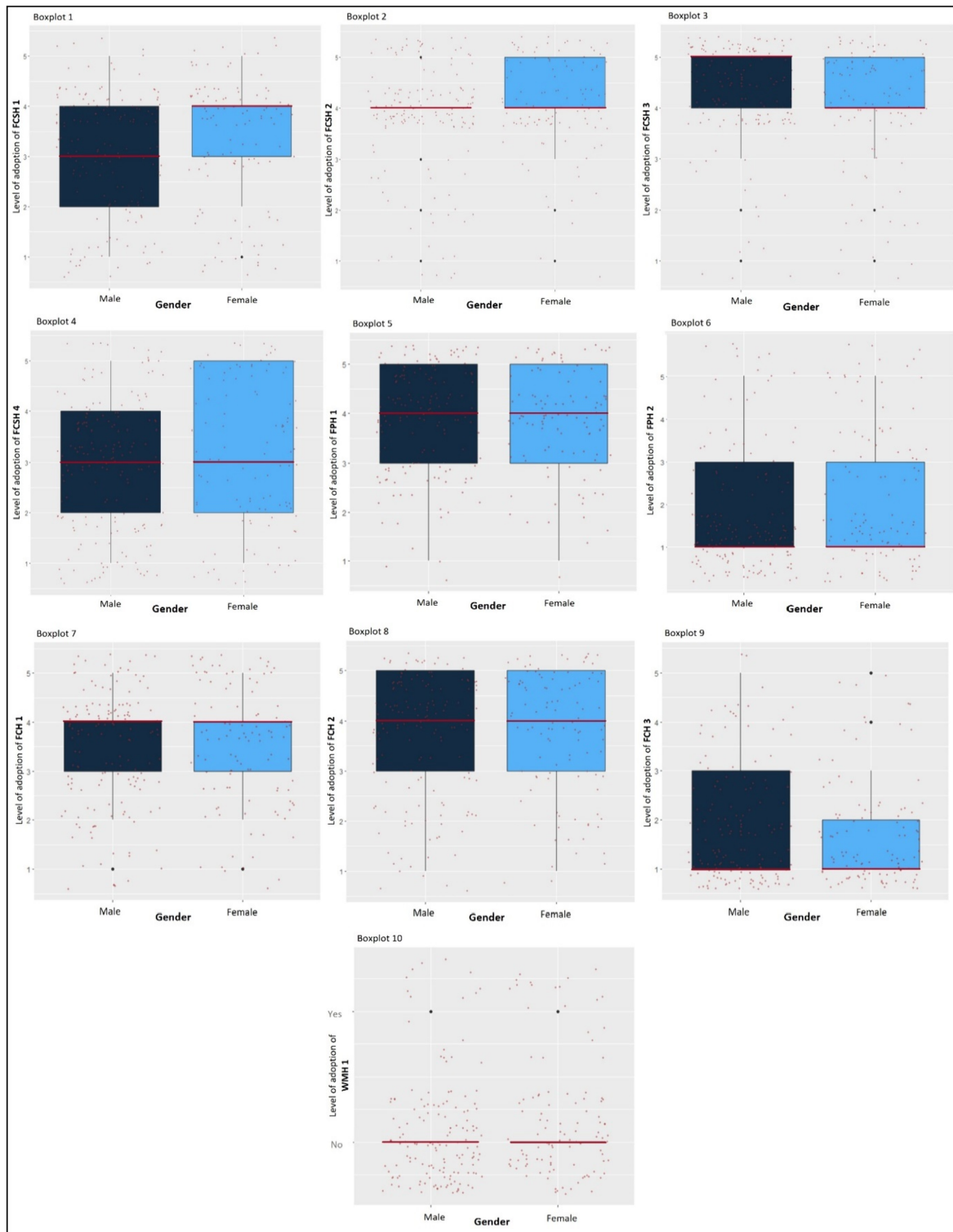
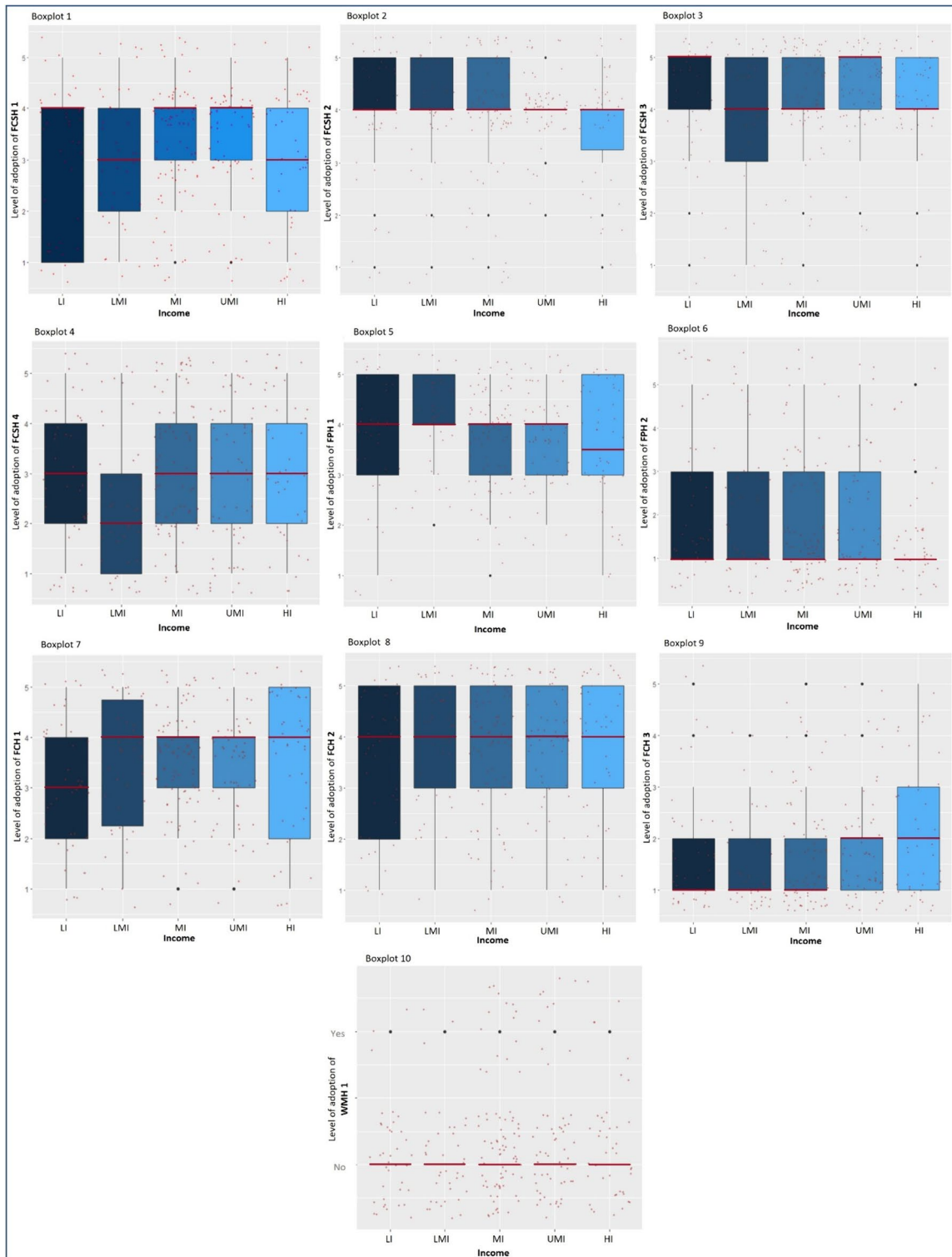


Fig. 3 Boxplots of households' food habit adoption according to gender. Food habits are represented along the *x*-axis and were previously classified into categories as follows: culture and shopping habits (FCSH; FCSH 1: purchasing food products using a shopping list; FCSH 2: evaluating the content of the pantry or refrigerator before going to buy food; FCSH 3: buying food products only if they were sure to consume them before their use-by date; FCSH 4: shopping while hungry), food prepara-

tion habits (FPH; FPH 1: assessing needs before preparing food; FPH 2: preparing food products properly to prevent spoilage), food consumption habits (FCH 1: prioritizing opened/started products; FCH 2: prioritizing products with the closest use-by date; FCH 3: consuming products with outdated best-before dates) and waste management habits (WMH; WMH 1: taking the leftovers of products when eating out) using a Likert scale (1: Never; 2: Rarely; 3: Sometimes; 4: Often; 5: Always).



before going to buy food” (Fig. 4 – Boxplot 2), “Buying food products only if they were sure to consume them before their use-by date” (Fig. 4 – Boxplot 3), “Assessing needs before preparing food” (Fig. 4 – Boxplot 5) and “Prioritizing products with the closest use-by date” (Fig. 4

– Boxplot 8). Secondly, all social classes usually prepared their food at random (Fig. 4 – Boxplot 6); also, individuals were unable to consume food products with outdated best-before dates (Fig. 4 – Boxplot 9). The higher social class stood as an exception, as they might occasionally consume

Fig. 4 Boxplots of households' food habit adoption according to income. Food habits are represented along the x-axis and were previously classified into categories as follows: culture and shopping habits (FCSH 1: purchasing food products using a shopping list; FCSH 2: evaluating the content of the pantry or refrigerator before going to buy food; FCSH 3: buying food products only if they are sure to consume them before their use-by date; FCSH 4: shopping while hungry), food preparation habits (FPH 1: assessing needs before preparing food; FPH 2: preparing food products properly to prevent spoilage), food consumption habits (FCH 1: prioritizing opened/started products; FCH 2: prioritizing products with the closest use-by date; FCH 3: consuming products with outdated best-before dates) and waste management habits (WMH 1: taking the leftovers of products when eating out) using a Likert scale (1: Never; 2: Rarely; 3: Sometimes; 4: Often; 5: Always), with income varying from LI to HI [low income (LI), lower-middle income (LMI), middle income (MI), upper-middle income (UMI), high income (HI)]

these kinds of products. Our data indicated that rich individuals typically possessed a higher level of awareness and education. Finally, people in all social classes did not take the leftovers of their food products when eating out (Fig. 4 – Boxplot 10). Furthermore, “Purchasing food products using a shopping list” (Fig. 4 – Boxplot 1), “buying products that do not match the needs when shopping while hungry” (Fig. 4 – Boxplot 4) and “Prioritizing opened/started products” (Fig. 4 – Boxplot 7) were moderately frequent food habits in all social classes, with small fluctuations.

Influence of food waste drivers on the food waste rates at the household level

Identification of the key factors influencing the food waste rate

PCA (Fig. 5A) revealed that the food waste rate was strongly affected by income and age and partially related to the number of household members, awareness and training levels about responsible consumption and training duration. In other words, rich and older people tended to waste more food, and individuals wasted food even when they had some awareness or training about responsible consumption. This waste rate is most important in large households with many members. However, gender and habitat type had some negative effect (low) on the FW rate. Men and people in urban areas wasted more food. Additionally, the two preparation habits negatively influenced the FW rate, although this impact remained minor. According to our data, 16% of households that plan their preparation of food, and 8% of those, the ones that assessed their needs before preparing food, had lower FW rates. Despite being good food habits, all cultural and shopping habits, consumption habits and food waste management habits had no influence on the FW rate. In the beginning of this study, our team assumed that those habits (drivers) could strongly

influence FW; however, the results obtained revealed the opposite.

Classification of data

To highlight the influence of gender and habitat type on the distribution of our data, the individuals in the PCA were classified according to those two factors. The first classification (Fig. 5B) showed that gender had no significant effect on data distribution. Men wasted more food even if they had higher awareness and training levels as well as training duration than women. In contrast, women had more good food habits such as planning food preparation and assessing needs before preparing meals. However, the second classification (Fig. 5C) revealed a clear impact of habitat on data distribution. Households from urban areas wasted more food than those from rural areas. In fact, urban people had more income, which is the main driver influencing FW. In addition, people from urban areas do not have good food preparation habits, despite their higher awareness and training level regarding responsible consumption. Generally, rural households have less income, and they plan their food preparation, which explains the low FW rate in the rural area.

Concerning the effect of habitat and gender, the PCA confirmed the results obtained by the first analysis using boxplots.

Correlation between food waste drivers and food waste rates

To illustrate how FW factors influence FW generation with respect to each commodity group, we studied the correlation between each driver and the FW rate using correlation circles (Fig. 6). The results obtained demonstrated a strong positive correlation between the income and waste rate for all food commodity groups. The food wastage of a household was more significant when its income was higher. This correlation exceeded 91% for the following commodities: fruits and vegetables (91.4%), cereals (92.8%), fish and seafood (93.8%) and meat (94.4%). Concerning milk and dairy, the impact of income on FW was up to 85.7%, while it was 77.9% for roots and tubers and only 64.4% for oilseeds and pulses. In general, the income strongly affected the overall food waste rate, with 94.7% regardless the commodity group. This is related to its significant influence on all of the food groups.

Influence of household average monthly income (in MAD) on the food waste rates

To understand the relationship between the social class of households and their FW rate, an analysis based on boxplots was performed (Fig. 7). The results obtained demonstrated

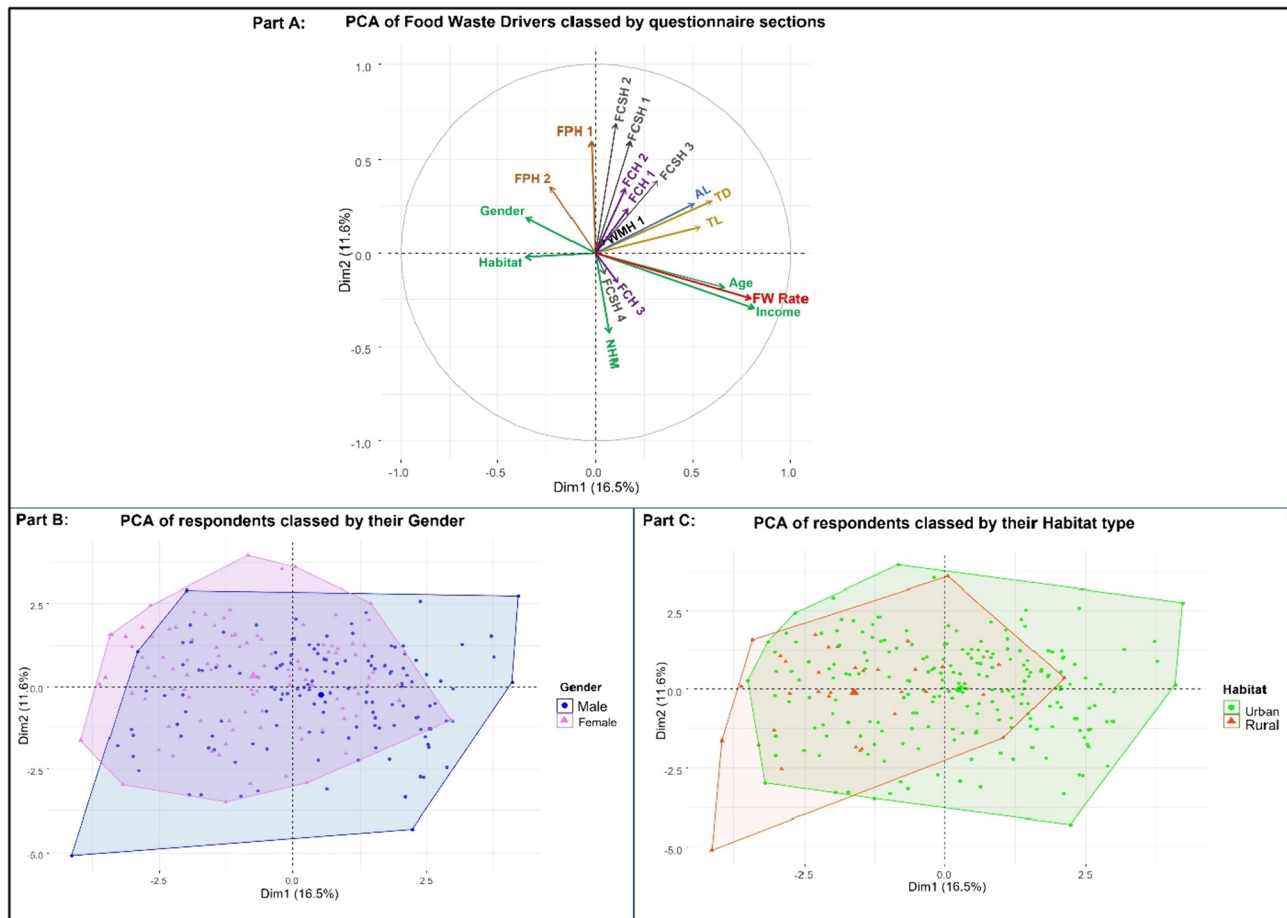


Fig. 5 PCA of the relationship between food waste drivers and food waste rate and classification of respondents by gender and habitat type. Food habits were previously classified into categories as follows: culture and shopping habits (FCSH 1: purchasing food products using a shopping list; FCSH 2: evaluating the content of the pantry or refrigerator before going to buy food; FCSH 3: buying food products only if they are sure to consume them before their use-by date; FCSH 4: shopping while

hungry), food preparation habits (FPH 1: assessing needs before preparing food; FPH 2: preparing food products properly to prevent spoilage), food consumption habits (FCH 1: prioritizing opened/started products; FCH 2: prioritizing products with the closest use-by date; FCH 3: consuming products with outdated best-before date) and waste management habits (WMH 1: taking the leftovers of products when eating out). *TD* Training Duration, *TL* Training Level and *AL* Awareness Level

a strong variation of FW rates according to income. In general, people from higher social class had more food waste rate regardless the food category. Correspondingly, the high income (HI) and upper-middle income (UMI) groups wasted more food, with an average of 15%. In contrast, the low-income (LI) and lower-middle income (LMI) groups wasted only about 5% of their food. Concerning “cereals” and “fruits and vegetables”, the social classes HI and UMI wasted about 25% from both of these two categories. On the contrary, poor people wasted less cereals and fruits and vegetables, about 5% for the LI group and 10% for the LMI group. For “oilseeds and pulses” and “milk and dairy”, the food waste rate was generally low for all social classes. In contrast, people from middle and high social classes still had higher waste rates, about 10% on average. Regarding “roots and tubers” and “fish and seafood”, there was a sort of gradual evolution of food waste according the social class.

Though the LI group wasted only 5%, this rate exceeded 15% starting from the third social class category. However, the last category of food (meat) showed a clear gradual influence of income on the food waste rate. The higher FW rate of meat is 25% for the HI group, 20% for the UMI group, 15% for the MI group, 10% for the LMI group and only 5% for LI group.

Discussion

Food waste typically correlates with individual ethics, quality of life, level of education, daily routines, income, behaviour, and attitudes (Zorpas 2020). Partially, this research highlights that household food waste in Morocco depends mainly on income. Similar results were found by other studies in the world (Parfitt et al. 2010; Aschemann-Witzel

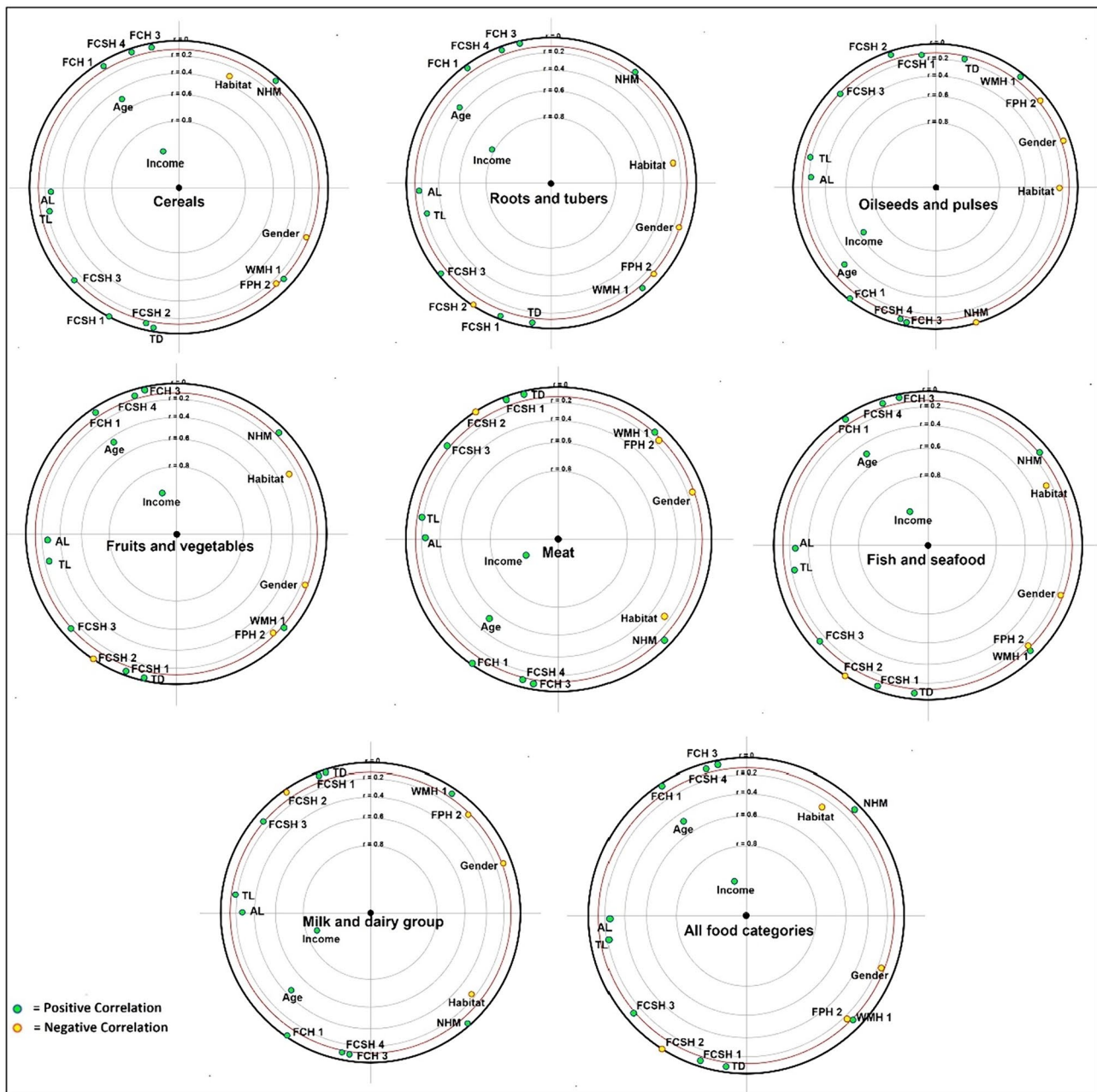


Fig. 6 Correlation of the food waste drivers and food waste rate in each commodity group. Food habits were previously classified into categories as follows: culture and shopping habits (FCSH 1: purchasing food products using a shopping list; FCSH 2: evaluating the content of the pantry or refrigerator before going to buy food; FCSH 3: buying food products only if they are sure to consume them before their use-by date; FCSH 4: shopping while hungry), food prepara-

tion habits (FPH 1: assessing needs before preparing food; FPH 2: preparing food products properly to prevent spoilage), food consumption habits (FCH 1: prioritizing opened/started products; FCH 2: prioritizing products with the closest use-by date; FCH 3: consuming products with outdated best-before date) and waste management habits (WMH 1: taking the leftovers of products when eating out). TD Training Duration, TL Training Level and AL Awareness Level

et al. 2015). However, other researchers find no correlation between income and food waste (Koivupuro et al. 2012; Visschers et al. 2016). According to the World Bank's 2020–2021 classification, Morocco is considered a low-middle-income country. Nevertheless, studies have shown that the average income of a country is not the only factor

responsible for the level of food waste observed at the consumption stage (Parfitt et al. 2010; Reich and Foley 2014). Melbye et al. (2017) revealed that there is no significant relationship between household income and attitudes towards food waste. Although, Hirvonen et al. (2021) argue that the extent of food consumption is very closely related to

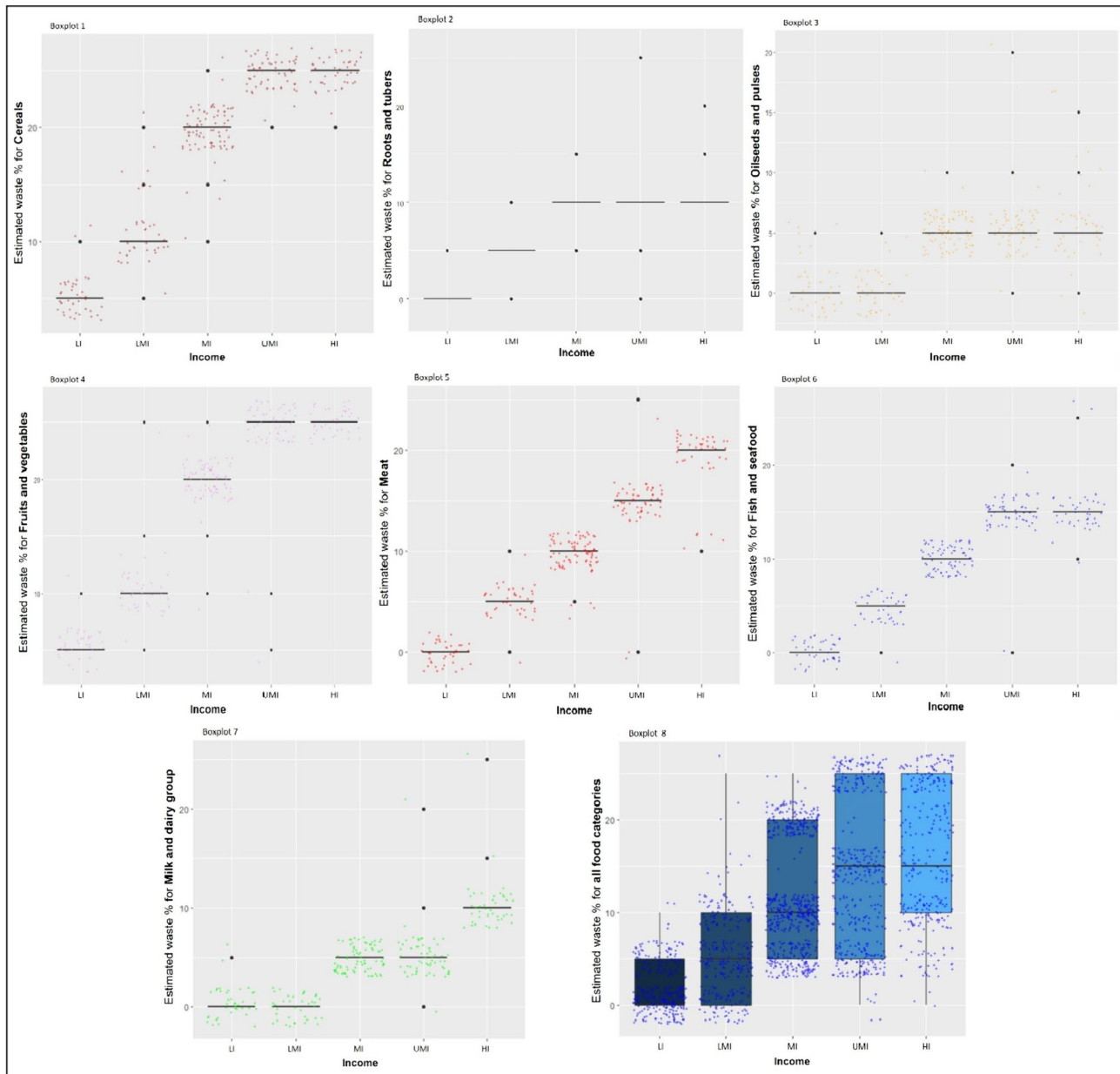


Fig. 7 Estimated food waste percentages for each commodity group in relation to monthly income, with income varying from LI to HI [low income(LI), lower-middle income (LMI), middle income (MI), upper-middle income (UMI), high income (HI)]

household social class, and reduced income may lead to less purchasing power for food. The second factor that strongly affects the FW rate, according to our research, is age. Older people tend to waste more food than younger ones. However, Quedsted et al. (2013) found the opposite in their research carried out in the UK context. Moreover, men waste more food than women do. This can be explained by the feeling that comes from wasting food. Women often feel guilty when wasting food because they feel that they are not doing a good job managing the household and providing for the family (Hebrok and Boks 2017). Also, this paper highlights

that the FW rate is most significant in large households with many members. Households with more than three members generally have a higher percentage of FW than those with two or one member (Brook et al. 2007). Furthermore, people in urban areas often waste more food than rural people do. The growth of urbanization can also exacerbate issues of the food wastage at the consumer level (Liu 2014; Song et al. 2018). In the current global context, social modernization and economic inclusivity have catalysed an unprecedented increase in population density in urban areas, creating an

increase in waste generation, consequently, causing waste management pressures (Xulu et al. 2022).

In our context, FW generation rate is significant at the household level even if individuals have some awareness or training about sustainability. Nevertheless, Grandhi and Appaiah Singh (2016) state that raising consumer awareness about food waste will cause a sense of responsibility and guilt, which can influence practices in a way that reduces food waste. Meanwhile, Watson and Meah (2012) find that raising awareness does not sufficiently reduce food waste, because it is caused by complex processes, and that increasing awareness does not change these processes in practice. In other words, even if people have a high intention to reduce food waste, this volition does often not translate into action (Stefan et al. 2013).

Changing food habits as a result of demographic changes in emerging countries leads to these countries also facing an increase in food waste at the household level (High-level Panel of Experts 2014). Nonetheless, good planning when it comes to shopping leads to having a better overview of stock and thus avoiding overbuying and, consequently, minimizing food wastage (Farr-Wharton et al. 2014; Parizeau et al. 2015; Secondi et al. 2015). However, this study showed that shopping habits have no effect on FW rate. On the contrary, the role of food preparation habits in reducing FW have been emphasized by this study. Households that plan their preparation of food could often reduce amount of food they waste. Several studies revealed a strong relationship between preparing too much food and food wastage prevention (Graham-Rowe et al. 2014; Silvennoinen et al. 2014; Porpino et al. 2015). Khan et al. (2022) observe a growing trend towards consuming and making meals that require little preparation time in recent years. In fact, various studies highlight that the presence of children in households can decrease the effectiveness of meal planning (Comber et al. 2013; Hebrok and Boks 2017). In addition, other research pointed out the unpredictability of eating patterns and preferences of children (Cappellini & Parsons 2012) and variations in adults' appetite (Ganglbauer et al. 2013). Further studies have showed that the material property of food itself and the material infrastructure in terms of living situation, available space for storing food, geographical access to stores and means of transportation can strongly affect the rate of food waste (Hebrok and Boks 2017; Waitt & Phillips 2016). Only a few studies investigate the role of food consumption habits in food waste prevention (Schanes et al. 2018). Our results demonstrate that food consumption habits have no significant effect on the amount of food wasted by households. Nevertheless, there are wrong eating practices that were highlighted by this article which are generally a result of a lack of information about food labelling or just of hesitations. Firstly, people hesitate to consume outdated food products, owing to their misunderstanding of

Table 1 Answers of multiple-choice question about the meaning of a best-before date

The BBD is a date beyond which the product ...	Type of answer	Number of respondents	Percentage
1 – Is unsafe to eat	False	110	36.9
2 – May lose its organoleptic and nutritional qualities	Correct	116	38.9
3 – Is not unsafe to eat	Correct	46	15.5
4 – I don't know	False	26	8.7
Total		298	100.0

Table 2 Reasons for not taking the leftovers of food when eating out

Reasons	Number of respondents	Percentage
1 – You consider it simply waste	23	10.5
2 – You think it will be reused by the restaurant	12	5.5
3 – You do not find the packaging adequate	37	17
4 – It embarrasses you	146	67
Total	218	100.0

the term “best-before date (BBD)”. To prove this hypothesis, we asked households what the BBD meant (Table 1) using a multiple-choice question with two right choices. About 38.9% of responses indicated that products with outdated BBD might lose their organoleptic and nutritional qualities, while only 15.5% agreed that an expired best-before date does not mean that something is not unsafe to eat. The right answer combines these two definitions. Correspondingly, only 8.98% of respondents got this answer. Secondly, this research revealed that, when eating out, individuals typically did not take their leftovers. To understand this behaviour, we requested that households give their reasons for not taking the leftovers of their food. The results obtained (Table 2) demonstrated that 67% of people are embarrassed to take the leftovers, 17% did not think the food packaging was adequate, 10.5% considered the leftover to be simply waste, and 5.5% thought that their food leftovers would be reused by the restaurant. In the context of south Australian households, laziness and safety issues were the main reasons for leftovers not being eaten (Vicki Mavrakis 2014). In addition to that, Watson and Meah (2012) highlight a feeling of disgust towards leftovers being another problem why leftovers are thrown away.

Other tools are used in the framework of agricultural strategic development planning in the Balkan region, in particular the life cycle analysis (Tsangas et al. 2020). However, in spite of its advantages in enhancing food sustainability, this

tool has limitations for its application at a consumption level because it is better suited to agriculture and food production and is generally applied to a limited number of product categories; furthermore, it cannot provide an exhaustive analysis based on all food categories, as was done in this study.

Environmental policy integration

Analysing and understanding food waste generation at the household level became an emerging research area for environmental scientists to implement awareness and training programs and develop strategies to alleviate this environmental issue. Several initiatives have been implemented at an international level; however, no exhaustive analytic study has been carried out at the Moroccan level. The only similar Moroccan study represented the ratio of food thrown away per group using only descriptive statistics (Abouabdillah et al. 2015). To sum up, this paper aims to identify all drivers that could have a significant effect on reducing food wastes, to enable effective and appropriate action through developing an integrated policy. In particular, this study carried out at a consumption level identified several weaknesses in our national food wastage policy, as it was noted that consumers waste food even if they have some awareness of or training in sustainable consumption, and even if they mention adopting good eating habits. Therefore, we believe that the best food policy to combat food wastage at the household level should focus on implementing a culture of “personal food governance”. To inculcate this new concept, we propose a multi-stakeholder policy based on three levels of action: regulating, raising awareness and monitoring (as shown in Fig. 8).

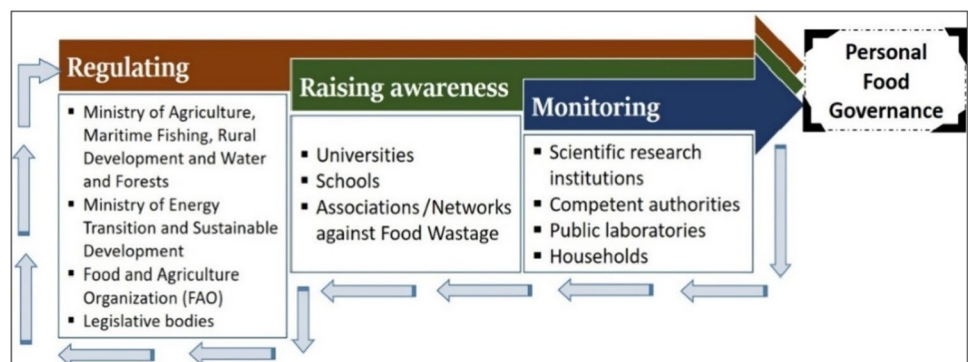
Based on the results presented in this work and in similar international studies, policy-makers need to design a regulatory framework for FW reduction through FW prevention, food donation, and standardized knowledge of date labelling. Moreover, we analysed answers to the question “Why should we not waste food/contribute to food loss?” to better understand anti-food wastage motivators

that could drive consumers to reduce their FW, and to help people who raise awareness and training designers in their programs. Correspondingly, understanding consumer’s perception of FW could help us avoid designing or implementing inappropriate awareness/training programs. Additionally, that could ensure the growth of our new concept, “personal food governance”. According to the Pareto chart “80/20” (Fig. 9), the most important reasons for not wasting food are, in order of importance: avoiding wasting money; the belief that is unethical, which is tied to the principles of religion; and avoiding greenhouse gas (GHG) emissions. Any awareness-raising program must therefore focus on these three ranked reasons to achieve the desired results. As a result, the outcomes of this study could provide input that can help specialists design quantification methods that will give detailed estimations about this scourge. Furthermore, after this assessment, we need to review our policies and re-regulate to be part of a continuous improvement loop.

Conclusion

As food waste management becomes increasingly recognized as an effective solution for achieving sustainable development goals and promoting a circular economy, discussions and debates surrounding the drivers of food waste are gaining momentum. This study contributes to a better understanding of how socio-demographic characteristics, training and awareness level, culture and shopping habits, preparation and consumption habits, food waste management habits, and knowledge and motivations affect the food waste rate. The most important driver behind food wastage at the level of Moroccan household is the average monthly income of households. In fact, people from higher social classes have higher food waste rates than those who are in the lower social classes. In general, the income strongly affects the overall food waste rate, 94.7% regardless the

Fig. 8 New proposed food waste policy based on personal food governance



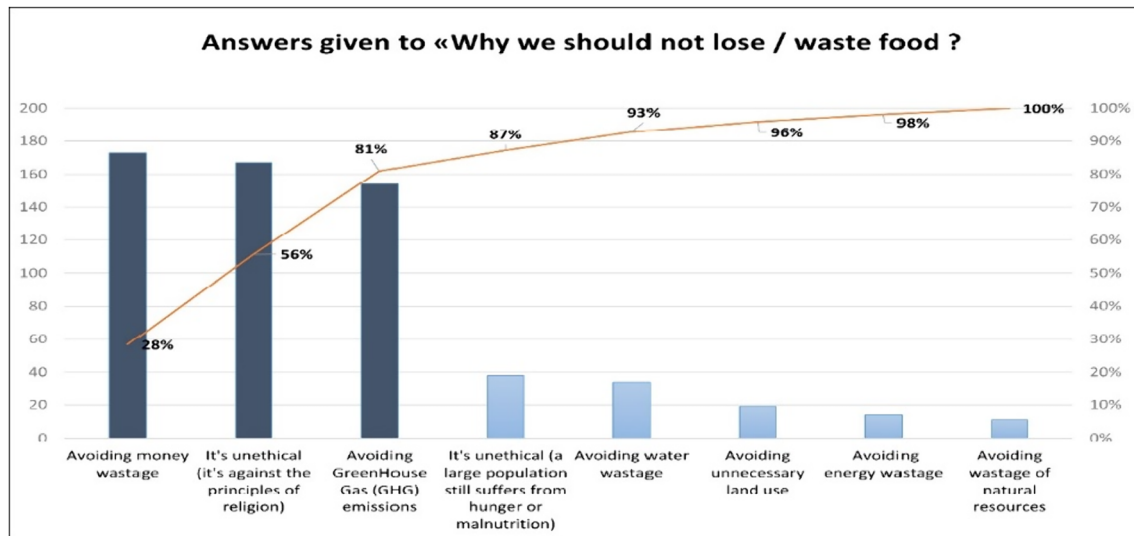


Fig. 9 How the studied population perceives reducing food waste using a Pareto chart

commodity group. This is related to its significant influence on the whole food groups.

Based on the fact that consumers waste food even if they have some awareness of or training in sustainable consumption, and even if they mention adopting good eating habits, this study has proposed a new approach to environmental integration policy. This new concept, named “personal food governance”, creates a starting point from which the scientific community, decision-makers and civil society can establish training and awareness protocols adapted to the Mediterranean context, or even to devise an international strategy to fight food wastage at the household level.

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Data availability All data supporting the findings of this study are fully available upon request. Please, feel free to contact the corresponding author for any data.

Declarations

Conflict of interest The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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