Food waste: causes and economic losses estimation at household level in Pakistan

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Abstract

Food waste is one of the major sustainability issues that need to be addressed due to its negative impacts on the economy, environment, and food security. To develop food waste reduction policies on regional and global level, it is mandatory to have a clear understanding of the various factors prompting food waste at household level and the extent of the economic losses incurred by food waste. Reducing food waste can decrease household expenditure on food, freeing resources for health, education, and well-being. The current study was aimed to (1) examine the food waste behavior of the respondents and to (2) determine the level of monetary losses from food waste. To address these objectives, a questionnaire survey and sample of food waste generated during 24 h were collected from 51 households in Tehsil Kahror Pakka, District Lodhran, Punjab, Pakistan. The survey focus was on levels of food waste and respondents' knowledge and behaviors about food waste. Economic estimation of food waste was also done. In the survey, respondents from both high- and low-income households revealed that their fruit and vegetables (31%; 32%) and peel and scrap (53%; 48%) losses were higher while egg losses (4%; 4%) were lower among various food waste categories. Wanting to eat fresh food and having no time to save food were the reasons for food waste. Monetary losses from food waste (US$ 12.8/Rs. 3677.01 per capita per annum) were higher in high-income households compared to low-income households.

Keywords Consumer behavior · Economic losses · Food waste · Pakistan

Introduction

The issue of food loss (edible food that is available for human ingestion but is not consumed for any reason) and waste (an element of food loss and happens when an edible item goes uneaten) is gaining attention worldwide due to its negative impacts on economy, environment, and community and is also not acceptable from an ethical point of view (Betz et al. 2014). Food waste is not only the loss of food, but also the wastage of resources which are being used for food production, processing, packaging, distribution, and marketing (Gustavsson et al. 2011). These resources should be used sustainably due to their limited availability (Beretta et al. 2013).

One-third of the food produced for human consumption goes waste every year (Gustavsson et al. 2011), while on the other hand, 1 billion people living in the world are malnourished and food insecured (FAO 2009). In Pakistan, about 36 million tons of food is being wasted every year and according to the World Food Program (WFP) 43pc of the country's population remains food insecure, with 18pc facing a severe shortage (Mughal 2018). The Global Hunger Index 2016 ranks Pakistan as a country with "serious" hunger level (Mughal 2018; Von Grebmer et al. 2016). Decreasing food waste can increase the efficiency of value chains by lowering food prices and increasing food availability to borderline insecured households (Gustavsson et al. 2011) and hence relieving food insecurity through

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redistribution. Lipinski et al. (2013) reported that in developing nations, more food losses and waste happen at farm level, whereas in developed nations, these losses are more at the consumer level. The food loss and waste vary with supply chains, commodities, and countries. In the USA, annual food waste at the consumption stage costs approximately US$ 1600 for a family of four and in the UK £680 (around US$ 842.16) for an average household (Lipinski et al. 2013). The annual expenses of food waste in Finland were estimated at €460 (around US$ 495.27) (Katajajuuri et al. 2014); Sweden, €585 (around US$ 629.86) (Gjerris and Gaiani 2013); Scotland, £430 (around US$ 462.97) (Ventour 2009); New Zealand, US$ 292 million (Reynolds et al. 2016); and Australia, $616 (around US$ 404.72) (Baker et al. 2009) per household. According to Statistics Canada (2010), Canadians waste food worth $27 billion per annum and 50% of that waste arises at the household level (Gooch et al. 2010), and consumers spend worth about $28 per week on wasted food for each Canadian household (Martin 2012).

Mostly economic estimation of household food waste is done in developed nations, yet, limited data about quantitative estimation of household food waste are available in developing countries like Pakistan (Khalid et al. 2019), Iran (Fami et al. 2019), Lebanon (Charbel et al. 2016), Saudi Arabia (Baig et al. 2018), and Lebanon (Chalak et al. 2019). Findings of developed countries may not be translated into the context of developing countries. So, estimating the cost of food waste can help create awareness among the general public and policy makers on the importance of food which is being wasted due to consumer behavior.

Similarly, in many developed countries, several studies have been undertaken to find out the reasons behind the food waste, so that the right strategies can be developed to tackle the issue of food insecurity. The main causes of food waste at household levels were poor-quality food, improper meal planning, food not consumed in time, plate waste, antipathy of eating leftovers, improper storage, and lack of awareness about the impact of food waste (Reich and Foley 2014). However, reasons for household food waste in developing nations with special reference to Pakistan are lacking. So, discovering the reasons of food waste at household level is indispensable to comprehend food-wasting behaviors and to find the options in planning food waste reduction strategies. Policies can be developed at regional and global level to lessen food waste or redirect surplus food to deprived people before it got wasted.

Many researchers reported that besides other factors, socio-economic status of a family positively influenced household food waste (Mallinson et al. 2016; Porpino et al. 2015; Qu et al. 2009; Secondi et al. 2015) whereas Chalak et al. 2019 found negative correlation and some researchers reported no correlation between household income level

and food waste (Koivupuro et al. 2012; Williams et al. 2012). In South Africa, the value of food waste increased with the increase in income level; in high-, middle-, and low-income households, the value of food waste was Rand 1618, Rand 1191, and Rand 777 per month, respectively (Nahman et al. 2012). Less cereal waste was reported in low-income household in Nigeria as compared to high-income household (Akerele et al. 2017). The quantities of food waste produced by Danish and Norwegian homes tend to be correlated with household income (Edjabou et al. 2016; Hanssen et al. 2016), whereas in both Vietnam and Brazil, low-income households waste considerable amount of food (Porpino et al. 2015; Trang et al. 2017). Poor households, being more concerned about the financial instability of food prices in recent past, do overbuying of food substances in bulk, which is not consumed in time and results in food waste, whereas in rich households, people buy and cook more than their actual need which ultimately leads to more food waste (Lahsaeizadeh 2001; Pourghadri 2018).

So, to lessen food waste, there is a need to determine an economic estimation of food waste and to determine the attitude and behavior of consumers which causes food waste.

Keeping in view the above facts, the current study was designed with the objectives to estimate the cost linked with food waste and factors governing this waste in both high- and low-income households in Tehsil Kahror Pakka, District Lodhran, Pakistan.

Materials and methods

This study was planned with the main purpose of determining the knowledge and behavior (planning, shopping, and storage) of respondents regarding food waste and estimating the quantity and value of food waste generated from high and low income at household level. The flow chart of research methodology is given in Fig. 1a.

The study area

The city Kahror Pakka of District (the district is the third-order administrative division below province and division) Lodhran has been selected for the study. Kahror Pakka is situated on the northern side of River Sutlej. It is bounded to the northeast by the district Vehari, to the south by district Bahawalpur, and to the west lies the district Lodhran (Fig. 1b). Its geographical coordinates are 29°37′0″ N, 71°55′0″ E. The Punjab developmental statistics reported that the population of Kahror Pakka was 464,000 during the year 2011. The climate of Kahror Pakka is very hot and dry in summer and cool in winter. The hottest months are May to September.
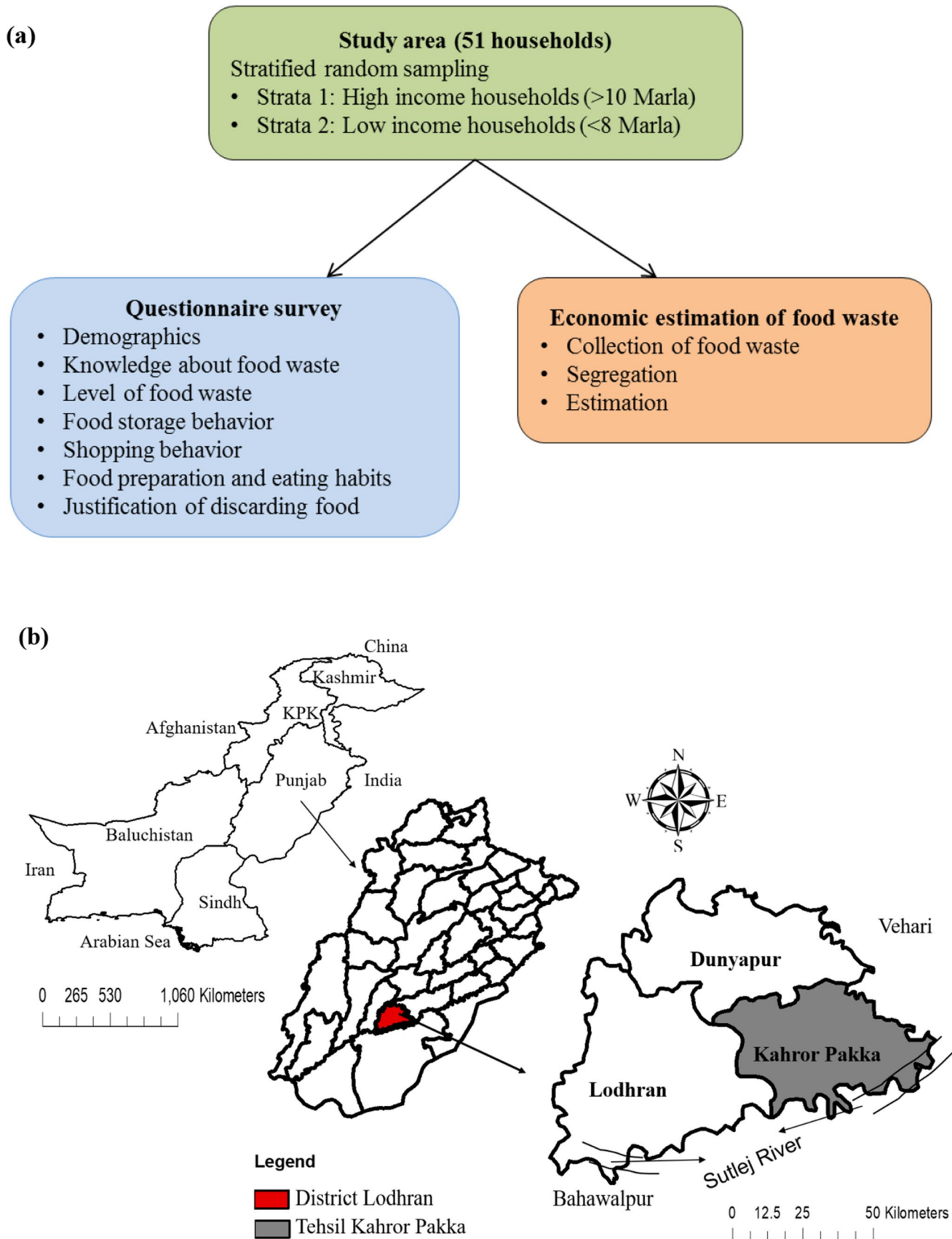
(a)

Study area (51 households)
Stratified random sampling
- Strata 1: High income households (>10 Marla)
- Strata 2: Low income households (<8 Marla)

Questionnaire survey
- Demographics
- Knowledge about food waste
- Level of food waste
- Food storage behavior
- Shopping behavior
- Food preparation and eating habits
- Justification of discarding food

Economic estimation of food waste
- Collection of food waste
- Segregation
- Estimation

(b)

Fig. 1 Flow chart of research methodology (**a**) and map of Tehsil Kahror Pakka, Punjab, Pakistan (Khalid et al. 2019) (**b**)

Data collection

The study was conducted in late 2015 and early 2016 and comprised a questionnaire survey and economic estimation of food waste generated during 24 h from 51 households. A face-to-face questionnaire survey was performed through stratified random sampling, having two strata, i.e., low-income and high-income households. Houses having covered an area of more than 10 Marlas (253 m^2) were considered as high-income household whereas having less than 8 Marlas were considered as low-income household. Twenty-six samples were collected from high-income households and 25 from low-income households. Questionnaire survey and plastic bags to keep their food waste were delivered to each household 1 day before the collection of samples. Data regarding house head/owner name, covered area, number of people in a family, and their addresses were obtained from the TMA and city health workers' official registers.

Economic estimation of food waste

Respondents from each household were provided with six plastic bags for keeping their cooked food, cereals, dairy products, processed food, and fruits and vegetables separately. Economic estimation of food waste was done separately for high- and low-income households.

Each food waste element was weighed separately and its weight was documented. After the food waste accumulation and segregation, for food waste of each type, economic estimation of food waste was done by weighing each component of food waste and multiplied by the market price of each item. The market price of each type of food was obtained from the price list in the main market or retail shops; for cooked food, from the cooked food seller (250 g = 1 plate). The actual amount of food waste was determined as 1000 g (1 kg) and monetary loss for each kilogram of food was estimated. Prices were converted from Pakistani rupees to US dollar according to the currency exchange rate of 2023 (1 USD = 287.26 Pakistani rupees).

Even though respondents in the study area collaborated very well, a small number of respondents think it is a bizarre activity and exhibited a lack of attention due to their busy schedules. Some respondents were unwilling to collaborate due to the additional burden of handling of food waste, spiteful odor, and superstitious belief in using their food waste for doing black magic. Few of them did not provide information without the consent of male members of their family.

Statistical analysis

The questionnaire survey data was analyzed as descriptive statistics using SPSS version 16.

Results and discussion

Questionnaire survey

Household demographics

Demographic data obtained from the surveyed houses is presented in Supplementary data (Table 1). In high-income households, male respondents (56%) and young generation (40%) were high, whereas in low-income households, female respondents (61.5%) and middle-aged generation (50%) were high. Data on literacy rates in the study area and marital status revealed that in low-income households, more respondents have master's degrees and above education (34.6%) and were married (65.4%) as compared to high-income households. For any study, the information related to the area where the study is planned is very important. In this study, most of the respondents were educated (Supplementary Table 1). The majority of the respondents were married as the survey was basically designed for household heads. Female participation was good in the area.

Knowledge about food waste

Respondents were asked general questions to assess their knowledge about food waste (Supplementary Table 2), by exercising Yes/No options. When asked about individual knowledge (Do you understand the term food waste?), most of the respondents' high-income households (100%) were aware of the term food waste as compared to low-income households (88%). The awareness level of all the respondents was good related to food waste. In the study area of low-income households, 88% understand the term food waste, whereas in high-income households, 100% of participants understand the term food waste. In a similar study in the USA as compared to our results, when participants were asked similar questions, only 42% said "Yes" (Neff et al. 2015). It showed that in the study area, people know about food waste, while on the other side, the USA, it can be speculated that people over there have no time or attention to think about food waste. With this, there is a possibility that people in developed countries like the USA are financially strong and do not bother about the food waste issue.

The majority (72%) of the respondents in low-income households think that food waste affects the environment as compared with 57% in higher income households. When respondents were asked (Do you think food waste affects the environment?), most of the respondents in low-income and high-income households (72% and 58%, respectively) said "Yes." Similarly, in another study of UK and US sustainable America survey, 68% of the respondents indicated food waste as an environmental issue (Quested et al. 2013).

When respondents were asked about the monetary loss with food waste, the response was almost similar; 72% said yes in low-income households and 73% marked yes in high-income households. The last question of this section was about individual behavior (Do you waste food?); 68% of respondents in low-income households and 61.5% from high-income households said no to this question. Similarly, McCarthy and Liu (2017) reported that high-income households waste more food. When asked about individual behavior (Do you waste food?), most respondents said "No" in low-income households (68%) compared with high-income households (61.5%). In a previous study in the UK, 69% of the consumers agreed to discard food (WRAP 2007) and in the USA, 56% of the respondents indicated that they discarded 10% of the purchased food (Neff et al. 2015), whereas in a recent study, 95% of US residents reported that they waste food at household level (Ahmed et al. 2021). In Poland, almost half (47%) of the respondents declared that they waste food and only 2% reported that they do not waste food (Jungowska et al. 2021). Similar to our findings, Mason et al. (2011) reported that in New South Wales, Australia, 63% of people threw out "very little" food. So, here it can be concluded that people in developed countries are wasting food and accepting it, while in this study mostly people said no to waste food. The possible reason for this could be that people in the study area were mostly average to low-income group with simple eating routines and habits. So, according to them, they discarded very less food.

Level of food waste

Respondents from both high- and low-income households were asked to rate the various types of food waste from their houses in five levels, i.e., very low, low, moderate, high, and very high (Fig. 2a). In high-income households, 66%, 66%, and 62% of respondents indicated that they waste a very low amount of milk and dairy; fish, meat, and seafood; and poultry and eggs, respectively, whereas in a low-income household, 76%, 60%, and 56% of respondents reported that they waste a very low quantity of eggs, cereals, and cooked food, respectively. In both high- and low-income households, peel and scrap waste (53% and 48%) and fruit and vegetable waste (31% and 32%) respectively were very high; moreover, in low-income households, processed food waste (32%) was also very high. In the study, when respondents were asked to rank their food losses from very low to very high (Fig. 1a), both low-income and high-income households indicated that peel and scrap and fruit and vegetable waste were very high. Parizeau et al. (2015) reported that peel and scrap were the most commonly reported food waste type produced by Canadian households. Higher fruit and vegetable waste among all food waste types at household level was also reported in America (Neff et al. 2015 and ERS 2012), South Africa

(Nahman et al. 2012), Italy (Gaiani et al. 2018), the UK (WRAP 2008), and Poland (Jungowska et al. 2021).

Food preparation and eating habits

Responses of the people regarding food preparation and eating habits in the form of three-point Likert-scale questions are presented in Fig. 2b. In high-income households, people reported that they often save leftovers in the fridge (42%) and discard leftovers (35%); sometimes they forget about food in the fridge (46%), save leftovers in the fridge (46%) and eat at home to use leftovers (46%), and rarely cooked in a careless way (50%). On the other hand, in low-income households, respondents reported that they often save leftovers in the fridge (48%), sometimes eat at home to use leftover (60%) and forget about food in the fridge (52%), and rarely use leftovers in future meals (56%).

Food storage behavior

In this section, respondents were asked to share their food storage habits. In Table 1, food types were given, and major storage options were mentioned as fridge, kitchen, cupboard, garage, and any other. In both low- and high-income households, most of the respondents reported that they store potatoes (52% and 42%) and onion (56% and 54%) in the kitchen, respectively. In both low- and high-income houses, fridge is mostly used to store fruits and vegetables (68% and 67%), eggs (68% and 61%), cooked food (56% and 57%), dairy (92% and 85%), and drinks (44% and 31%), respectively. In low-income households, most of the respondents reported that the kitchen is used to store processed food (60%) and meat, fish, and poultry (36%) while in high-income households, respondents used the fridge (61% and 47%) to store these commodities, respectively. Most of the respondents (92%) in low-income houses store cereals in the cupboard, while in high-income households, 50% marked kitchen and 50% cupboards.

Fruits, vegetables, and bakery products are perishable (Quested et al. 2011) and their shelf life is subjective to how they are stored at ambient or low temperature (fridge/freezer). Suitable food-storing practices lead to lessen food waste (van Gefen et al. 2017). Lack of knowledge of proper storage conditions for various food typologies (Plumb et al. 2013) also leads to food reducing their shelf-life and flavor (Quested et al. 2011) and results in food waste (Waarts et al. 2011).

Food shopping behavior

When asked about food shopping behavior (Table 2), mostly respondents in low-income households reported that they sometimes buy too much due to tempting products (60%), make a shopping list (52%), males do the shopping (44%),

Table 1 Food storage behavior in low-income and high-income households

Type	Low-income houses (%)						High-income houses (%)					
	Fridge	Kitchen	Cupboard	Garage	Other	No answer	Fridge	Kitchen	Cupboard	Garage	Other	No answer
Cereals	0	8	92	0	0	0	0	50	50	0	0	0
Cooked food	44	56	0	0	0	0	31	57	8	0	0	4
Dairy	92	8	0	0	0	0	85	4	11	0	0	0
Drinks	44	8	16	24	8	0	31	15	31	19	4	0
Eggs	4	68	16	12	0	0	61	15	19	4	0	0
Fruits and vegetables	68	16	4	12	0	0	67	21	4	4	0	4
Meat, fish, poultry	32	36	28	4	0	0	47	19	30	4	0	0
Onion	12	56	12	20	0	0	8	54	12	27	0	0
Potatoes	16	52	16	16	0	0	31	42	8	19	0	0
Processed food	20	60	16	4	0	0	61	31	4	4	0	0

and find ways to store food (36%); however, they rarely pick things that they do not need (44%).

In high-income households, most of the respondents reported that they often plan their meal before shopping (42%) and females do the shopping (42%); however, they sometimes pick things from the market that they do not need (32%) and always (39%) check the fridge and cupboard before shopping.

Meal planning and making a shopping list can reduce food waste (Principato 2018) as planning prevents the purchase of surplus food (van Geffen et al. 2020) and increases purchasing precision (Quested et al. 2013). In high-income households, most of the respondents reported that they always plan their meal before shopping, check the fridge and the cupboard before shopping, and make a shopping list as compared to low-income households, but their food waste was higher than low-income households. Similarly, Stefan et al. (2013) reported that a person's intention (planning and shopping) not to waste food does not translate into lesser food waste and that food-related household practices significantly impacts the quantity of wasted food. Contrary to our findings, some researchers reported that meal planning results in less food waste levels (Farr-Wharton et al. 2014; Jorissen et al. 2015; Mallinson et al. 2016; Quested et al. 2013), whereas other researchers have found no relation between meal planning and less food waste levels (Stancu et al. 2016; Visschers et al. 2016). Gender influences food shopping and food waste behavior. In high-income households, females often do the shopping which results in more food waste because females want to provide healthy, fresh, and sufficient food to their family, which might result in more food waste (Koivupuro et al. 2012). McCarthy and Liu (2017) reported that women are mostly responsible for grocery shopping in Australia. People's shopping behavior in stores impacts food waste levels. In high-income households, picking things without

need is also the reason for more food waste. Analogous findings were also reported by Parizeau et al. (2015). In low-income households, people sometimes buy too much due to tempting products which ultimately results in food waste. A study showed that shopping too much food is caused by the temptation from marketing offers inspiring consumers to buy more than actually wanted and thus promotes the wasting of food (Mondejar-Jimenez et al. 2016; WRAP 2007), whereas Jorissen et al. (2015) reported that people who buy discounted products had lower food waste.

In high-income households, people save leftovers in the fridge and later discard these leftovers which results in food waste, whereas in low-income households, people save leftovers in the fridge and forget about the food in the fridge and not use leftover in future meals which eventually results in food waste. In Italy, the top four reasons of food waste given by the respondents were that their food has expired, their food became moldy, food has been in the fridge for too long, and that leftovers were not appealing to them (Gaiani et al. 2018).

Justification of discarding food

In this section, respondents were asked to give justification to waste food (Fig. 3a). In high-income households, 31% and in low-income households 20% of people said they want to eat fresh food. In high-income households, 19% and in low-income households 12% respondents claimed they have no time to save food. When the respondents were asked to justify the basic reason of food waste (Fig. 3a), most of the respondents in both high- and low-income houses (30% and 20%, respectively) of Tehsil Kahror Pakka said "they want to eat fresh food." Similarly, Neff et al. (2015) and Hamilton et al. (2005) reported that the majority of the respondents in their study area described that they only wanted to eat the freshest food.

Fig. 2 Survey results about food waste level in high-income and low-income households (bars showing level of food waste) (**a**); food preparation and eating habits in low-income and high-income households, respectively (**b**)

Table 2 Consumers' shopping behavior in relation to food waste

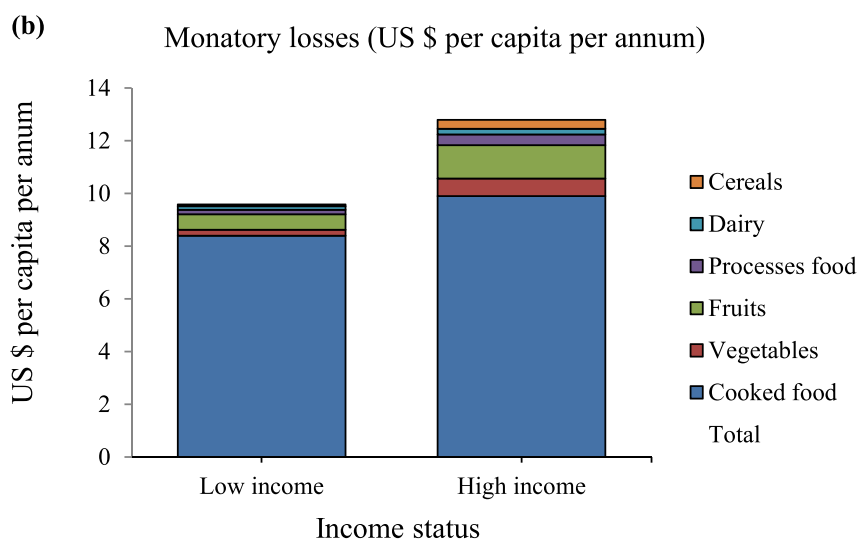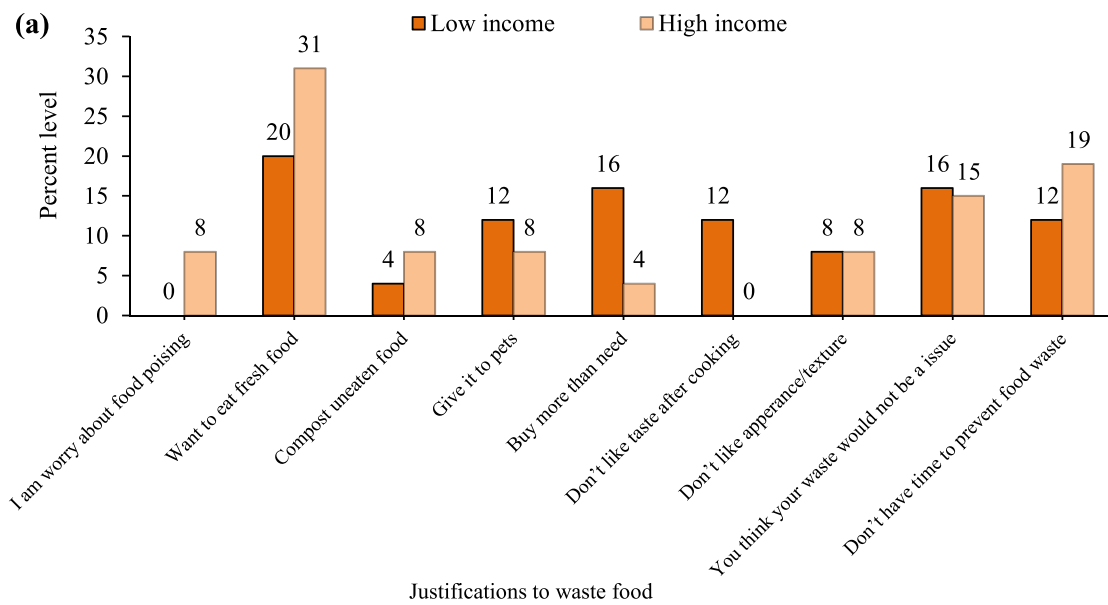| Options	Low-income houses (%)					High-income houses (%)				
	Always	Often	Sometimes	Rarely	Never	Always	Often	Sometimes	Rarely	Never
Buy too much due to tempting products	12	12	60	8	8	4	30	42	12	12
Check fridge and cupboard before shopping	36	32	24	8	0	39	35	23	4	0
Females do the shopping	24	20	36	12	8	31	42	15	8	4
Find ways to store food	8	32	36	20	4	8	31	27	23	11
Make a shopping list	12	16	52	20	0	19	30	46	4	0
Males do the shopping	20	20	44	12	4	19	31	35	11	4
Pick things without need	4	8	12	44	12	19	27	32	11	11
Plan meal before shopping	16	36	20	24	4	23	42	15	15	4

Fig. 3 Justification of discarding food with major reasons in high-income and low-income households. The *x*-axis shows common reasons; *y*-axis, frequency of the respondents (**a**); total monetary losses (Rs. per capita per year) from low- and high-income households in Tehsil Kahror Pakka (**b**)

Economic estimation of food waste

Food waste is contributing to monetary loss too. In high-income households, monetary losses from food waste were higher (USD 12.80 or Rs. 3677.01 per capita per annum) as compared to low-income households (USD 9.58 or Rs. 2754.65 per capita per annum) (Fig. 3b). In the study area, cooked food waste fraction was very high from both low-income (USD 8.40 or Rs. 2411.92 per capita per annum or USD 0.023 or Rs. 6.61 per capita per day) and high-income (USD 9.90 or Rs. 2843.35 per capita per annum or USD 0.027 or Rs. 7.79 per capita per day) households as compared to other food waste types; that is why it is contributing more toward economic loss (Fig. 3b).

In cooked food waste types, rice value is much higher as compared to other types in both low-income (US$ 0.064 or Rs. 1.85 per capita per day) and high-income (US$ 0.0043 or Rs. 1.23 per capita per day) households (Table 3). In this study, cooked food was the major contributor toward food waste; rice was being wasted in high amounts from both low- and high-income households. The main reason for this as observed during sampling and survey was low price as compared to other costly products and more routine consumption patterns. Furthermore, rice is the most favorite and common dish in southern Punjab, so its wastage was more in Tehsil Kahror Pakka. Similarly, Ventour (2008) reported that UK wasted approximately US$ 149.69 million per annum on cooked rice whereas in Sweden cooked rice is wasted less among other cooked food categories (Williams et al. 2020). A number of similar studies were done on food waste estimation in different countries, but rice as such was not included in the list of food waste over there (Quested et al. 2011; Nahman et al. 2012; Venkat 2012). In another study, when the food waste estimation was performed, poultry and its products were the major contributors (41 pounds) at the consumer level (Buzby et al. 2014).

Among vegetable waste, cauliflower waste (US$ 0.00056 or Rs. 0.16 per capita per day) contributed more to money waste in high-income households (Table 3). Among fruits, oranges contribute to more food and money waste (US$ 0.0011 or Rs. 0.33 per capita per day) in high-income households as compared to low-income households where banana waste was high (US$ 0.00066 or Rs. 0.19 per capita per day) (Table 3).

Among processed food types, sandwich waste (US$ 0.00028 or Rs. 0.08 per capita per day) was more in high-income households as compared to low-income households (Table 4). Overall, processed food waste was less observed in the study area. The main reason for this was affordability issues of the people to buy expensive processed food and likes/dislikes too. Similar results were observed in another study, where processed food waste was low as compared to other types, i.e., fruit, vegetables, fish, meat, and poultry

(Kirkendall 2015). But still, this loss was considerably higher in comparison to the value of our processed food.

While taking into account dairy products, yogurt waste was high (US$ 0.00059 or Rs. 0.17 per capita per day) in high-income households (Table 4).

The study showed the fact that food waste is also contributing to significant monetary losses. Food waste and monetary losses from food waste were higher in high-income households. Similarly, a positive correlation between household income and value of food thrown away was reported in Italy (Gaiani et al. 2018), Denmark (Edjabou et al. 2016), Norway (Hanssen et al. 2016), and China (Zhang et al. 2018) and a negative correlation between income and food waste was found in Brazil (Porpino et al. 2015) and Vietnam (Trang et al. 2017). However, some researchers found no influence of income level on household food waste generation (Koivupuro et al. 2012; Williams et al. 2012). According to the study, three food types are strongly contributing to money loss. First, cooked food waste is contributing to maximum money loss, followed by fruit waste and vegetables (Fig. 3b). These three food waste types are more in high-income households, so it can be concluded that high-income or more earning people tend to buy such food types and ultimately it is consumed in such a way that it generates food waste. In a similar study conducted in the USA, Buzby et al. (2014) determined fish, meat followed by poultry (cooked food) and dairy as the major contributors to economic losses.

In this study, economic loss due to the processed food was low while in another study, Buzby et al. (2014) reported that money loss due to processed food waste was very high. Collectively, all food waste types in the study were contributing to the loss of US$ 22.39 or 6431.665 Rs per person per annum. As compared to this, in the USA it was estimated that food waste type (including all types of food) caused a loss of US$ 522 per capita per annum (Lipinski et al. 2013); in New Zealand, NZ$ 131 (US$ 79.24) (Reynolds et al. 2016) in the Netherlands, €270–400 (US$ 288.6–427.64) (Thonissen 2009); and in Australia, AU$ 239 (US$ 156.24) (Baker et al. 2009) per person per year. In Pakistan, food waste value was less than that in developed countries (currency exchange rate during 2023 US$ 1 = approximately NZ$ 1.6; € 0.936 and AU$ 1.525).

Cross-tab analysis

Cross-tab analysis of covered area and food wastage behavior revealed that more (8) respondents from less than 8 Marla houses had very high processed food waste whereas from more than 10 Marla houses, a greater number of respondents (9) reported very less processed food waste (Table 5). Egg storage behavior revealed that more respondents (16) from higher covered area (>10 Marla) store egg in the fridge whereas from lower covered area (<8 Marla),

Table 3 Estimated value of cooked food waste from low-income and high-income households in Tehsil Kahror Pakka

Food items	Price (250 g/plate)	Low income			High income		
		g	Rs	US$	g	Rs	US$
Cooked food							
Beans	70 Rs/plate	0.03	0.008	0.000028	0.1	0.02	0.000070
Cauliflower	50 Rs/plate	0	0	0	0.47	0.09	0.00031
Chick pea	60 Rs/plate	2.18	0.52	0.0018	0.37	0.09	0.00031
Chicken	80 Rs/plate	2.38	0.76	0.0026	5.96	1.9	0.0066
Chicken potatoes	50 Rs/plate	0.85	0.17	0.00059	2.91	0.58	0.0020
Custard	80 Rs/plate	0	0	0	0.59	0.19	0.0066
Split pulses	50 Rs/plate	1.65	0.33	0.0011	2.97	0.05	0.00017
Fenugreek, potato	80 Rs/plate	0	0	0	0.76	0.6	0.0021
Gulab jamun	60 Rs/plate	0.92	0.22	0.00077	0.95	0.22	0.00077
Sweet (halvah)	80 Rs/plate	0.63	0.2	0.00070	0	0	0
Bauhinia pods with mutton	100 Rs/plate	0.63	0.25	0.00087	0	0	0
Carrot dessert	80 Rs/plate	2.78	0.88	0.0031	0	0	0
Meat	140 Rs/plate	1.5	0.24	0.00084	1.46	0.23	0.00080
Mix vegetable	60 Rs/plate	0.83	0.19	0.00066	4.18	1	0.0035
Moringa inflorescence	60 Rs/plate	0.67	0.16	0.00056	1.26	0.3	0.0010
Mustard leaves	50 Rs/plate	0.09	0.01	0.000035	0.63	0.12	0.00042
Naan	30 Rs/plate	0.6	0.07	0.00024	1.21	0.14	0.00049
Omelet egg	40 Rs/plate	0.31	0.04	0.00014	0	0	0
Fried snack made from gram flour and vegetables (pakoras)	40 Rs/plate	0.71	0.11	0.00038	0.68	0.1	0.00035
Potatoes	50 Rs/plate	1.48	0.23	0.00080	1.46	0.29	0.0010
Radish pods (mongra)	50 Rs/plate	0	0	0	1.33	0.27	0.00094
Rice	50 Rs/plate	9.22	1.85	0.0064	6.16	1.23	0.0043
Roti	20 Rs	4.56	0.36	0.0012	3.93	0.31	0.0011
Curry puff (samosa)	30 Rs/plate	0.11	0.01	0.000035	0.52	0.06	0.00021
Total money loss Rs per capita per day		6.61	0.023		7.79	0.033	
Vegetables							
Cabbage	60 Rs/1000 g	2.65	0.016	0.000056	0.29	0.01	0.000035
Carrot	15 Rs/1000 g	2.56	0.02	0.000070	2.96	0.02	0.000070
Cauliflower	50 Rs/1000 g	0.00	0	0	3.13	0.16	0.00056
Cucumber	30 Rs/1000 g	0.69	0.02	0.000070	0.26	0.007	0.000024
Garlic	70 Rs/1000 g	0.19	0.01	0.000035	0.11	0.007	0.000024
Green chili	20 Rs/1000 g	0.16	0.003	0.000010	0.69	0.01	0.000035
Mongra	50 Rs/1000 g	0.40	0.01	0.000035	1.329	0.06	0.00021
Onion	50 Rs/1000 g	1.31	0.06	0.00021	3.84	0.19	0.00066
Radish	40 Rs/1000 g	0.80	0.03	0.00010	1.53	0.06	0.000021
Tomatoes	30 Rs/1000 g	0.37	0.01	0.000035	0	0	0
Total money loss Rs per capita per day		0.179	0.000621		0.524	0.001639	
Fruits							
Apple	120 Rs/1000 g	0.19	0.02	0.000070	0.86	0.1	0.00035
Jujube fruit (bair)	100 Rs/1000 g	0.59	0.05	0.00017	0.41	0.04	0.00014
Bananas	80 Rs/dozen	2.42	0.19	0.00066	2.19	0.17	0.00059
Guava	60 Rs/1000 g	0.86	0.05	0.00017	0.82	0.04	0.00014
Lemons	100 Rs/1000 g	0.24	0.02	0.000070	2.81	0.28	0.00097
Orange	60 Rs/1000 g	2.31	0.13	0.00045	5.56	0.33	0.0011
Pineapple	150 Rs/1000 g	0.00	0		0.28	0.04	0.00014
Total money loss Rs per capita per day		0.46			1		

Table 4 Estimated value of processed food waste, dairy waste, and cereal waste from low-income and high-income households in Tehsil Kahror Pakka

Food items	Price	Low income			High income		
	1000 g	g	Rs	US$	g	Rs	US$
Processed food (g)							
Biscuits	80 Rs/1000 g	0.19	0.02	0.000070	0.28	0.02	0.000070
Bread	80 Rs/1000 g	0.44	0.03	0.00010	0.18	0.01	0.000035
Carrot jam	150 Rs/1000 g	0	0		0.71	0.1	0.00035
Ketchup	120 Rs/1000 g	0.7	0.08	0.00028	0.62	0.07	0.00024
Pickle	120 Rs/1000 g	0.11	0.01	0.000035	0.12	0.01	0.000035
Porridge	80 Rs/1000 g	0	0	0	0.42	0.03	0.00010
Sandwich	150 Rs/1000 g	0	0	0	0.58	0.08	0.00028
Total money loss Rs per capita per day	1.44	0.14	0.00049	2.91	0.32	0.0011	
Dairy waste							
Yogurt	70 Rs/1000 g	1.47	1.47	0.00051	2.49	0.17	0.00059
Cereals							
Flour knead	70 Rs/1000 g	0.99	0.06	0.00021	3.99	0.27	0.00094

Table 5 Cross-tab analysis of covered area and food wastage behavior in Tehsil Kahror Pakka, District Lodhran, Punjab, Pakistan

		Covered area	
		<8 Marla	>10 Marla
Processed food	Very low	7	9
	Low	8	5
	Moderate	1	8
	High	1	2
	Very high	8	1
	No answer	0	1
Chi-square value		**0.022**	
Egg storage	Fridge	1	16
	Kitchen	17	4
	Cupboard	4	5
	Outdoor	3	1
	No answer	0	0
Chi-square value		**0.000**	
Cereal storage	Fridge	0	0
	Kitchen	2	13
	Cupboard	23	13
	Outdoor	0	0
	No answer	0	0
Chi-square value		**0.001**	
Processed food storage	Fridge	5	16
	Kitchen	15	8
	Cupboard	4	1
	Outdoor	1	1
	No answer	0	0
Chi-square value		**0.022**	

Chi-square value is significant at 0.05 level of significance

more respondents (17) store egg in the kitchen. Cereal storage behavior revealed that more respondents (23) from low covered area (<8 Marla) store cereals in the cupboard whereas more respondents from higher covered area (>10 Marla) stored cereals in the kitchen (13) and cupboard (13). Respondents from low covered area stored processed food in the kitchen (15) and high covered area in the fridge (16), as earlier respondents from low covered area revealed that they had very high processed food waste. Wrong choice of processed food storage could be the reason for the higher processed food waste.

Conclusion

This is one of the few studies done on household food waste generated from both low- and high-income households in developing countries. It clearly revealed that irrespective of household type, a considerable amount of food is being wasted in Tehsil Kahror Pakka. The samples of two income levels in the city revealed that high-income holders waste more food compared to the low-income group. Food waste was higher in high-income households (US$ 35.36 or Rs. 3677.01 per capita per annum). Reducing food waste can improve financial performance and free up resources for health, education, and well-being. Attitudes and behavior toward food waste are very critical. The major factors contributing to food waste are that people save food for further consumption but did not consume that food in time and prefer to eat fresh food, lack of interest, mismanagement of meals, lack of time, and eating and storing routines. This loss is posing a serious threat on all resources used in food production and contributing to energy losses. High-income households buy more without

need and do not consume the food in time, causing more food waste. Mostly people are not concerned about food sustainability. It would be right to say that most of the people never think about the food waste issue or any remedial actions for its reduction.

Recommendations

This study was done on a small area during one season (winter) just to get insight into food loss and waste issue at the household level. In the future, deeper studies should be done on a larger area, i.e., from farm to fork, to check the food waste–generating behaviors and motivations that can change these behaviors. Even though respondents in the study area collaborated very well, a small number of respondents think it is a bizarre activity and exhibited a lack of attention due to their busy schedules. Some respondents were unwilling to collaborate due to the additional burden of handling food waste, spiteful odor, and superstitious belief in using their food waste for black magic. Few of them did not provide information without the consent of male members of their family.

The government should introduce environmentally friendly ways to store, transport, and handle food and ensure the availability of low-quality food at cheaper prices to reduce food waste, poverty, and hunger and to improve sustainability. Food waste as an environmental issue can further be highlighted or studied in depth to reduce environmental degradation. With all this, food waste composting and its use as a source of energy can be done to overcome the energy crises. Reducing the amount of food waste could limit pressure on all resources or make them available for other purposes. So, proper actions should be taken from government to a public level for its reduction.

Declarations

Conflict of interest The authors declare no competing interests.

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