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Food Waste in Saudi Arabia: Causes, Consequences, and Combating Measures

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Abstract: The enormous amounts of food going as waste to landfills is of great concern in Saudi Arabia. The issue of food waste is complex, with its numerous social, cultural, economic, and environmental sustainability dimensions warranting further investigations. Food waste is one of the prime issues threatening food security in Saudi Arabia. This article aims to gauge the real issue, to create awareness among those who waste large amounts of food, and to encourage planners and policy makers to implement corrective measures. This article aims to stimulate interest within the scientific community, seek support from different branches of Saudi Arabian government, and engage all major segments of society. A thorough search of the international scientific publications and the grey literature published in English and Arabic was made. It was discovered that the available literature is scarce, and tends to focus on finding knowledge about the problem rather than on generating solutions. Thus, further research should attempt to find ways to form strategies and to test new ideas and interventions that could reduce food waste, particularly in the hospitality sector and within households. Based on the analysis presented in this paper, the recommended course of action for Saudi Arabia is to launch an integrated “Stop Wasting Food” campaign that would include all stakeholders. Raising awareness about the detrimental consequences of food waste and encouraging behavioral changes to reduce this squandering of precious resources is the first step in addressing the issue. There is an urgent need to promote behavioral changes in Saudi Arabian society, particularly among prime food wasters: women and youth.

Keywords: food waste; food security; behavioral change; awareness; Saudi Arabia



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1. Introduction

Saudi Arabia is not a country ideal for agricultural growth. It is not capable of producing enough food to feed its citizens due to its harsh and hot temperatures, low rainfall, limited arable lands, lack of fertile soil, absence of permanent water bodies, and diminishing water resources [1]. Saudi Arabia depends heavily upon exports from other countries to meet its food requirements. Despite the insufficient domestic production of food commodities in this country, food wastes are enormous. Currently, food waste is one of the prime issues threatening food security in Saudi Arabia [2]. No scientific estimates of food waste exist for households, supply chains, and dining places, yet, based on the

most recent report of the Ministry of Environment, Water and Agriculture (MEWA), Saudi Arabia ranks number one in food wasting in the world [3]. According to the Saudi Minister, ref. [4] based on the study conducted by the Saudi Grains Organization (SAGO) [5], around 33 percent of food goes to waste, worth over SR40.4 billion (US\$10.77 billion), annually.

The average food waste per capita is 250 kg per year, whereas the world average is about 115 kg. Many published articles highlight that a large portion of food leftovers are wasted at dinner parties, weddings, restaurants, and hotel buffets. According to Abdullah et al. [6], the major causes of food waste in Saudi Arabia are low awareness of food waste in society, behaviors of dinner hosts, and a tendency to flaunt lavish foods in the presence of guests. Often, restaurants and hotels are poorly organized to curb food waste [7]. Further, at present, Saudi Arabia has no laws in effect that could stop or limit food waste.

Despite its insufficient domestic agricultural production, Saudi Arabia has the highest statistical consumption of grains in the world. The average citizen consumes 158 kg annually, compared to the global average of 145 kg per capita. In 2016, the Saudi Arabian government, under a directive from the King, convened a committee at the MEWA. The committee included stakeholders from different ministries of the government who deal with natural resources in society, especially among youth [8].

Keeping these facts in view, and having no law in place to curb food waste, the apex governing body in 2018, a sort of parliament called the Shoura Council, reviewed a proposal of a law that would combat food waste and squandering. The law would impose penalties on individuals and organizations involved in food waste, such as enforcing a fee on restaurant-goers who leave unfinished plates. The Social Affairs Committee of the Shoura Council also proposed establishing a national center to limit food waste by offering guidance and awareness on this issue [8]. The purpose of the discussions made in the council was to launch programs that could accurately assess the impacts of food waste, identify its main causes, design solutions, and take initiatives to reduce food waste and promote sustainability. The Ministry now aims to undertake a national program to minimize food waste. It is concerned with the important national food security requirements of this proposed program for food reserves and storage, as well as adopting an early warning system and making timely information available to agricultural markets [9].

1.1. Background of the Study

Focusing on chief food wasters, youth and women [2,10], the present article aims to stimulate interest among the scientific community and to seek support from government policymakers to ensure food waste in Saudi Arabia is significantly reduced. The information gathered from various sources and provided here in the form of analyses and discussions supports the ongoing food waste reduction initiatives taken by the Ministry of Environment, Water, and Agriculture in Saudi Arabia. This article is especially concerned with revealing the magnitude of Saudi Arabian food waste, along with the reasons for food waste, with the aim of encouraging government policies identifying actions required to reduce it.

A thorough search of international scientific publications and the grey literature published in English and Arabic was undertaken to identify the social, cultural, economic, and environmental sustainability issues associated with food waste. This search was launched by accessing online resources through King Saud University in Saudi Arabia and Central Queensland University in Australia. The authors identified 20 scientific articles based upon various key words closely relevant to our research topic. To better understand and grasp the concepts of food waste and the purposes of this article, the authors depended upon the most agreed-upon definition:

Food waste is defined as “edible food and drinks fractions from products or meals that are acquired to be consumed by humans remain unconsumed and are discarded” [11].

1.2. Framework for Food Waste in Saudi Arabia

Food waste takes place in the entire food supply chain, starting from its production at the farm level until reaching the dining table. Food waste and losses occur in the postharvest

processes, followed by losses at the storage centers for imported food commodities, through transport and processing, and finally through consumption, poor recycling, and poor reuse. Waste takes place both when Saudi Arabian citizens plan meals to be eaten at one's own home, or when food is eaten outside of one's own home. Individuals tend to decide whether the particular food item is edible or inedible, with the latter disposed of in a waste receptacle. In discussions about individual food waste, the focus is generally on avoidable food waste. Avoidable food waste is defined as edible food that is deemed inedible. This may be due to changes to the food product, such as its no longer being safe or palatable to eat, or to preferences of the individual, such as preferring fresh food products or having eaten enough of that particular food [12]. For example, rice husks have multiple uses in rice-producing countries. A significant amount of rice husk is produced, and it is an entirely organic waste. It is an important byproduct of the biomass and rice milling industries. The cellulose-based fiber in rice husk has an approximate 20% amorphous silica content. In addition, it contains 60–65% volatile matter, 10–15% fixed carbon, and 17–23% ash. About 40% of it is comprised of cellulose, 30% is lignin, and 20% is silica. The unit weight of a rice husk is 83–125 kg/m³, and it can absorb water in the range of 5 to 16% of unit weights. About 90% of the ash from rice husk is silica, which has a large specific surface area, is very porous, and is lightweight [13]. Due to these qualities, it can be used as a supplement in agricultural fields.

Similarly, the peelings of fruits and vegetables can be fed to domestic animals and used in composting. It is important to recognize that, in addition to avoidable food waste, there will always be some food discarded that emerges from components of food products considered to be inedible (e.g., vegetable peelings) or physically impossible for individuals to eat (e.g., bones) [14]. Finally, it is important to note that the food wasted by individuals is not an isolated behavior; it emerges from the interactions of activities associated with food purchasing and provisioning [15,16].

1.3. Food Production in Saudi Arabia

Saudi Arabia lacks the essential natural resources [17], such as fertile soil and sufficient water, to support mass-scale food production. With a low population density of 9.5 persons/sq km [18], its land area is dominated by a desert climate with only 2.1 million km² or 1.6% of its area being suitable for agriculture. This contributes to its having one of the lowest global amounts of arable lands per capita, i.e., 0.11 hectares/person [19].

Prior to 1970, with food production restricted by high temperatures and scarce water resources in the desert landscape, agriculture occurred on a small scale in scattered pockets. In the 1980s, Saudi Arabia began to modernize its agricultural system with the objective of improving its food self-sufficiency, by introducing free loans, free land, and water for irrigation for farmers [20].

This intensive farming led to a significant water deficit [1,17,21], and resulted in the loss of two thirds of the ground water supply in Saudi Arabia [22]. Consequently, in the 2000s, Saudi Arabia made an important strategy shift towards more sustainable agricultural practices. This shift led to the government instructing farmers not to plant crops with high water requirements, such as wheat, barley, and green fodder [1,23].

1.4. Reliance on Imports

Saudi Arabia is highly reliant on food imports, as its overall food self-sufficiency ratio is only 26%. However, the ratios for specific products vary, such as being below 5% for strategic commodities such as cereal grains [24]. Saudi Arabia produces just above 3.2 million tons of fruit and vegetables, 57% of which are vegetables. It thus spends more than 2200 million dollars a year on imports to meet internal demand, the equivalent of 1790 million Euros. This vast imported amount of food per year is why the government is encouraging local producers to invest in other countries with competitive advantages for producing these foods [25].

In recent years, prices for international oil and petroleum products have significantly fallen, causing a decline in the country's per capita income from approximately \$24,000 in 2011 to \$21,784 in 2016. Surprisingly, the resultant reduced per capita income has not significantly altered food consumption patterns. The demand for high-quality fruits and vegetables is growing due to several factors:

1. A booming local and expat population.
2. Healthy eating trends and changing tastes and food preferences supported by a higher income per capita, which enables individuals to choose higher-quality imports rather than local produce.
3. Saudi Arabia's dependency on imports increases as its local fruit and vegetable production is limited, due to its dry climate coupled with a lack of water sources.
4. The continued increase in the country's population, the increased number of pilgrims (religious visitors) coming for Umrah and Hajj rituals, and the relatively high disposable income will continue to increase demand for food imports [26].

In order to increase security of these food commodities in international markets, Saudi Arabia is actively purchasing large areas of arable lands in overseas countries [27]. Being a net food importer increases Saudi Arabia's dependence on foreign countries [28]. This could lead to significant upward pressure on national, community, and even household budgets, in an era where oil incomes are declining in Saudi Arabia and food prices on the world market are volatile and may even increase.

1.5. Domestic Food Demand in Saudi Arabia

Saudi Arabia boasts a population of 32.55 million [18], and projections exist stating that it will reach 39.5 million by 2030—more than four times the total population in 1980 [26]. Despite the generous subsidies offered in Saudi Arabia, its people continue to spend a significant portion (26%) of their income on food [24,29]. Figure 1 shows that households in Saudi Arabia spend around 25% of their income on food.

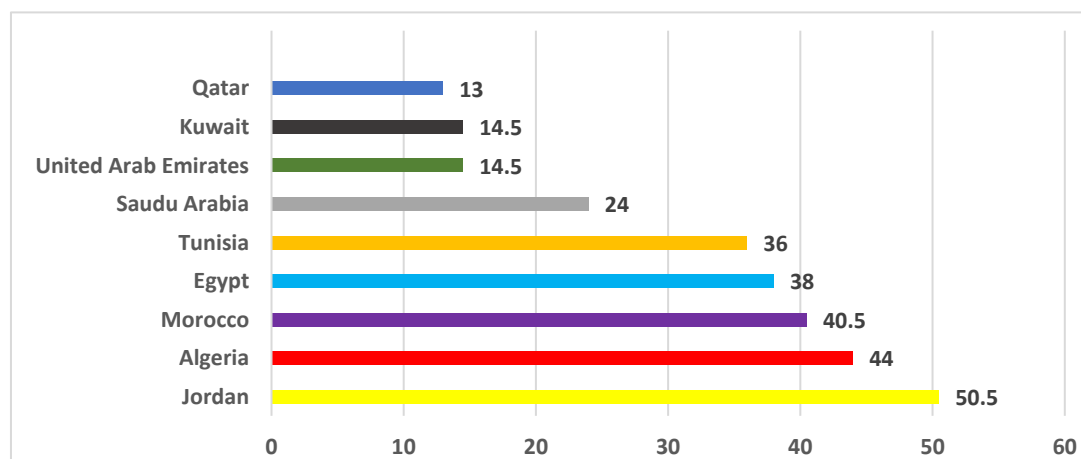


Figure 1. Household expenditures on food in different Arab countries. Source: USDA, 2014 [24].

Interestingly, when demand for food is high, more food goes to waste. According to [26], the demand for food items are increasing for the following reasons:

- Consumers enjoy trying new food products;
- Saudi consumers prefer to eat fast foods and “take-away” restaurants are increasingly popular with the youthful Saudi population;
- The high per capita income and changing lifestyle and diets in Saudi Arabia continue to boost demand for high-quality food products;
- Saudi Arabia sustains more than 13 million expatriates who live and work in Saudi Arabia, creating higher demand for greater diversity and ethnic foods;

- An increased number of religious pilgrims come to Saudi Arabia every year (approximately 8 million pilgrims in 2016), creating higher demand for institutional food services.

2. Generation and Composition of Food Waste in Saudi Arabia

On a global scale, the level of food waste per capita in Saudi Arabia is high. The variety of estimates shown in Table 1 suggest per capita food waste in Saudi Arabia is around 1.3 kg every day, amounting to 470 kg a year. This is \$US 35 million worth of food wasted daily, amounting to \$US 13 billion per year [30]. Approximately half of this waste generation occurs at the household level. In addition, with medium- and high-income countries, the waste moves along the supply chain and chiefly occurs at the retail and individual levels [31].

A recent study conducted by the Saudi Grains Organization (2019) found that food waste costs 40.4 billion riyals (\$10.77 billion) annually based on consumer spending. Additionally, the study indicated that each person contributes roughly 184 kilos of wasted food, or 4.06 million tons yearly. According to the study, about 33.1% of food in SA goes to waste.

Rice is one of the key commodities associated with food security in Saudi Arabia [32]. People in Saudi Arabia waste large amounts of cooked rice, with estimates reaching up to 40 percent (Saudi Gazette [33]). Approximations suggest that around 35% of food waste occurring in the household consists of baked goods and another 30% is cooked rice [29]. However, accurate scientific data on the amount of food waste generated are limited or nonexistent in the Arab world [34].

Table 1. Overview of identified estimates of amounts of wasted food in Saudi Arabia. National kg/capita/year estimates are highlighted in bold/underline.

Source	Estimate	Data Source for Estimate
FAO, G [31]	210 kg/cap/yr (food loss and waste, North Africa, West & Central Asia)	Literature search, info from local FAO offices/universities; assumptions, estimates based on comparable places/commodities/supply chain stages
COMCEC [35]	119 kg/cap/yr (household) 733 kg/establishment/year (food service)	Self-report survey of 111 consumers, 94 food service establishments in Riyadh
GAS [18]	14,220,000 metric tons of household solid waste/yr [Equivalent to 458.5 kg/cap/yr household solid waste]. If this is 36% food, then waste of food = 165.1 kg/cap/yr]	
Saab, Tolba [36]	1.5 kg/cap/day solid waste [equivalent to 547.5 kg/cap/yr solid waste. If this is 36% food, then waste of food = 197.1 kg/cap/yr]	Solid waste analysis in cities such as Riyadh, Doha, and Abu Dhabi
Khan and Kaneesamkandi [37]	5.5 million tons/yr	Solid waste experts reported that solid waste collected in Saudi Arabia could contain 50.57% food
Al-Saif [38]	28% of Saudi waste is food 1.2–1.4 kg food waste/person/day 511 kg/capita/yr	Solid waste data?
Ministry of Environment, Water and Agriculture [39]	250 kg/cap/yr	NA
Gazette [40]	1/3 cooked food	NA
BCFN [27]	427 kg/cap/yr	Estimate from Eta'am (Food Bank) Director
Al-Fawaz, N [41]	Over 50% of food wasted Over 70% of food from public events wasted	NA

Based on the findings presented by these researchers, only a few studies have examined food waste generated by different sectors in Saudi Arabia. They further revealed the absence of reliable data on food waste, particularly on its magnitude, causes, sources,

drivers, and management, as well as the policies, interventions, and initiatives directed to reducing them.

Food waste constitutes a significant portion (around 50.57%) of solid waste collected in municipal areas. As depicted in Figure 2, organic materials were the highest component of landfills. According to research conducted in SA [42,43], the entire amount of Municipal Solid Waste MSW generated in 2014 was predicted to have reached up to 15 million tons (which is expected to quadruple by 2033) and was composed primarily of Food Waste FW, accounting for 37–50.6 percent of that total.

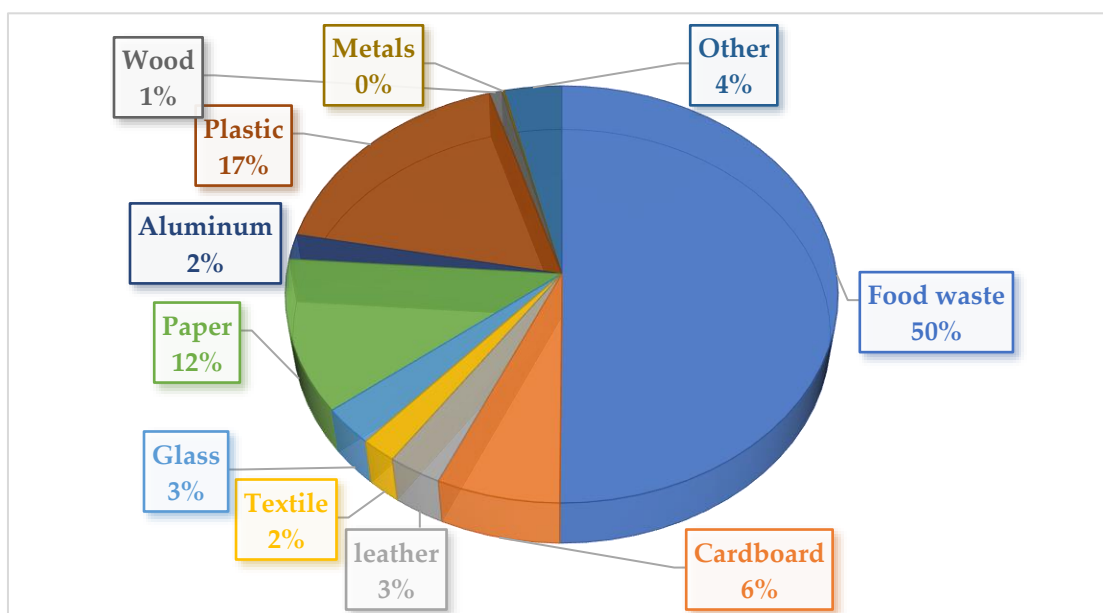


Figure 2. Food waste is the highest contributor to the landfills in Saudi Arabia Source: Khan & Kaneesamkand [37].

Khan & Kaneesamkandi [38] studied the composition of the overall waste produced in Saudi Arabia. They noticed that paper, food, and wood waste comprised about 75% of organic wastes. They further revealed that food waste as a single component contributed approximately 50.57% of all organic waste, whereas the paper waste percentage was 11.97%. Plastic was found to be approximately 17.39%, whereas glass contents were about 3.5% and cardboard pieces made up 6.64% of landfill waste. Figure 2 also presents that textiles, metals, leather, and aluminum make up less than 4–5% of landfill waste.

Consequences of Food Waste

Wasting food has economic, environmental, and social consequences in Saudi Arabia [20,44,45]. It contributes to national economic problems by increasing dependence on imported food while squandering the national revenues and household funds associated with its purchase [2,10,20].

Saudi Arabia has limited land and water needed for food production, and food waste means that scarce resources are expended on food that is not consumed. More Saudi citizens will feel food-insecure in the years to come due to the shrinking of freshwater resources, rising food prices, and uncertainty of transportation of food commodities from abroad [2,10]. Further, unconsumed food taken to dumping sites is decomposed by microorganisms and releases harmful greenhouse gases, including methane (CH_4). Such emissions are exceptionally problematic and are prime contributors to climate change. In addition, social and moral dilemmas arise when huge volumes of edible food are discarded while a significant number of people do not have enough to eat [46]. It is estimated that one out of five Saudi citizens will be experiencing hunger or food insecurity in 2020 [47], as shown in Figure 3.

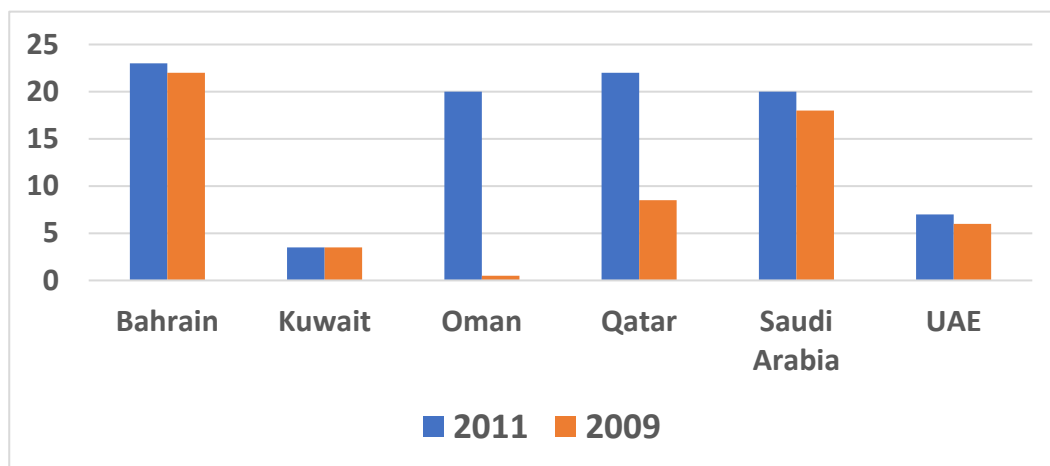


Figure 3. Levels of food insecurity in GCC. Source: Intini et al. [48].

After reviewing the Gallup World Poll data, Intini et al. [48] noted that at least one-fifth of the citizens in Bahrain, Oman, Qatar, and Saudi Arabia viewed themselves as food-insecure. The levels of perceived food insecurity revealed a persistent decline over time. Further analyses of the data indicated that food-insecure people are increasing by 1–3% in Bahrain, Saudi Arabia, and the UAE. In contrast, Qatar witnessed that food insecurity reached levels three times higher in the year 2011 than was observed in 2009. The declining food scenario could be attributed to the combined effects of. Reviewing the rapidly worsening food availability situation, Intini et al. [48] noted that government-supported initiatives have drastically expanded in the wake of the global financial crisis to address the food insecurity issue and other associated problems. To support their reasons, they quoted an example, revealing that Saudi Arabia allocated \$12.3 billion to the agriculture and water sectors, whereas an amount of \$10.4 billion was designated only for its citizens (private investment) to invest in developing its agricultural sector.

3. Causes of Food Waste

With limited capacity to increase domestic food production, this expansion in demand will lead to greater reliance on food imports [2,10]. Mu'azu et al. [44] reported numerous socioeconomic factors that lead to the huge generation of food waste (FW) in Saudi Arabia. The main national influences on the amount of food wasted are associated with economic affluence, cultural traditions associated with an abundance of food at celebrations, and a pervasive lack of awareness of consequences arising when food is wasted. The same authors also identified more structural problems resulting from food waste: absent or inadequate legislation, lack of policy, missing separate collection of different solid waste fractions, traditional waste disposal practices lacking any kind of pretreatment prior to landfilling, public attitudes, lack of awareness, and food waste byproducts not having ready acceptability. The study of Alshabanat et al. [47] reveals that SA produces significant volumes of dates, chicken, and fish; therefore, there is need to enhance the refrigerated storage capacity of Saudi Arabia to accommodate the large volume of these food commodities for the longer periods without compromising their qualities.

3.1. Economic Prosperity

Saudi Arabia enjoys a strong economic standing, a balanced budget, and large oil reserves. Due to its strong economy, the Saudi government protects its people from price rises by using price caps and absorbing price increases. It also extends support to food producers and retailers by giving subsidies to enable them to make food available at affordable prices [49]. This leads to a perceived lower monetary value for the population, followed by a lavish handling of food. There is a strong correlation between a family's economic standing, social position, family income, degree of education, and spending patterns in

SA, according to the [2]. As the greatest oil exporter in the world, SA enjoys a privileged economic position [49,50]. Resultantly, its rising economic growth has accelerated per capita income. However, due to higher income levels and prosperity, people purchase more food than they can consume [51].

Being generous with food is part of a culture of hospitality and celebration in Saudi Arabia. People in Saudi Arabia usually buy food in bulk and prepare more food than they can consume. The provision of food is a gesture of welcome to guests. It is a well-established cultural tradition to provide an abundance even when there is little for the family to eat. Lavish food tables are set up during celebrations such as festivals, weddings, parties, or informal gatherings. These cultural traditions unfortunately result in significant amounts of food waste, accumulating up to 70% during special celebrations [41].

Significant food waste is generated during religious occasions such as the fasting month of Ramadan [52]. During that holy month, food waste is the highest in Saudi Arabia and other Gulf Cooperation Council (GCC) countries [53,54]. Furthermore, during Ramadan, 30 to 50% of the food prepared in Saudi Arabia is discarded [41]. During Ramadan, Muslims prepare excessive quantities of food that far exceed their needs, resulting in increased food waste and leftovers [55]. One important factor in determining how people behave is their adherence to God's laws. This argument's foundation is the idea that all divine faiths, including Christianity and Islam, indicate that the environment was created by God and that as a result, everyone in society should encourage others to preserve it and all its resources, including food [56]. Religion has been identified as one of the fundamental elements of Saudi Arabian life, shaping social behavior and having a direct and indirect impact on society and its citizens. Numerous facets of customers' lifestyles are impacted by their religion, which ultimately changes their behavior. Customers' choices to use or reject specific products or services are influenced by their religious convictions.

3.2. Other Events

Similarly, during social events such as weddings, births, and deaths, food is usually prepared on a mass scale, often turning into lavish shows flaunting wealth and social status [2,10]. For example, the average amount of food wasted at an average wedding in Mecca, Saudi Arabia, can be sufficient to feed 250 hungry people. In 2016, the food wasted in Makkah was enough to feed millions going hungry globally [57].

3.3. Lack of National Data

Reliable information on the generation, characteristics, and reasons for food waste is of great importance, especially for a region where reducing food loss and waste (FLW) is imperative in order to realize a sustainable food system and ensure food security [34]. Food waste is an important driver of pollution and a potential cause of economic losses and should be monitored at several levels. Data are needed to assess hotspots where food is wasted through the food value chain including waste at the farm storage and refrigeration levels, as well as through transport and handling. Data on food waste at consumption should be collected from households, commercial outlets such as hotels and restaurants, public functions, and select cultural activities and gatherings.

3.4. Changing Food Culture Due to Demographic Development

Generating the estimated sales revenues of \$6.9 billion in 2017, more than 13,000 fast food restaurants are currently operational in Saudi Arabia. The foremost attributed factors contributing to the strong demand for such eateries are assumed to be an increase in disposable income, the rising youth population (approximately 70% of citizens are under the age of thirty), changing lifestyle (women entering the workforce and lack of time to prepare foods at home), continued exposure to Western consumer trends (more Saudis are traveling than ever before), and a lack of other socializing venues for youth. Dining at fast food chains and casual dining at Arabian restaurants are becoming very popular, particularly amongst the younger population. Like other nationalities, Saudi youth often

associate dining out with a prime source of entertainment and a place to get together and mingle with friends [58]. The study conducted by Alsawah et al. [59] indicated that female members of the family could significantly help in achieving food waste reduction. However, their research suggests also investigating male attitudes toward food waste and the impacts of different policies on food waste reduction in Saudi Arabia can also help in achieving food waste reduction goals and forming a meaningful food waste policy.

4. Building Awareness

4.1. Lack of Awareness

There is a pervasive lack of understanding about the dramatic extent and overall negative impact of food waste in Saudi Arabia. Recent activities at the national level have influenced the government to begin exploring various methods which can successfully contribute to reducing such waste in the region. This includes exploring policy options and commissioning research studies that accurately measure the extent and detrimental consequences of food waste on a holistic scale. These results will assist in creating evidence-based policies, thus reducing the economic and environmental impact such practices have in the region. The lack of awareness regarding the continuous waste of vast amounts of food extends to not only the general population in Saudi Arabia, but also corporate organizations. Reducing waste produced by such establishments can significantly improve their profitability and contribute to the emerging sought-after goals of Corporate Social Responsibility. When individuals change their behavior and act in a more accountable manner, they can save their own money while simultaneously contributing to the environmental and economic goals of the nation.

4.2. Creating Awareness—Waste against the Teachings of Islam

The acts of food waste do not match with the teachings of Islam, where Muslims are asked to share excess food with the poor. However, altering wasteful behaviors will require a significant cultural shift, as the current traditional perspective on an individual trying to conserve food in Saudi Arabia is likely to be that they are miserly and inhospitable [60]. In Saudi Arabia, Islamic teachings greatly influence government and society. Therefore, to draw attention to the pressing issue of food waste, it would be impactful if the following verses of the Holy Quran were brought to the attention of the people: Allah says: “O children of Adam! Beautify yourselves for every act of worship, and eat and drink (freely), but do not waste: he does not love the wasteful!” (7:31) and “Indeed the wasteful are brothers of the devil . . . ” (17:27).

4.3. Creating Awareness through Extension Services

Another viable option to reduce food waste in Saudi Arabia is through a vibrant national extension educational program to change common attitudes towards food waste.

The recent example in Australia with the announcement of a National Food Waste Strategy [61], followed up with an industry-led Fight Food Waste Cooperative Research Centre [62], provides a relevant example and successful approaches for Saudi Arabia. The National Food Waste Strategy [61] emerged from extensive consultation with industry, government (across all three tiers of federal, state, and local), research communities, and activist organizations. It provides a framework for action across four priority areas of policy support, business improvements, market development, and behavior change. The Fight Food Waste Cooperative Research Centre is a \$A 120 million industry-led, government-supported 10-year research program. It aims to tackle the growing international problem of food waste by reducing food waste throughout the supply chain, transforming unavoidable waste into innovative high-value co-products, and engaging with industry and consumers to deliver and adapt behavioral changes.

A strong and focused campaign encouraging citizens not to waste food would help individuals change their behavior when they are making food-related decisions at their home and when eating out. The Extension Department could facilitate this by organizing

workshops and conferences for all relevant stakeholders. This would include planners, policymakers, opinion leaders, and people from civil society. Creating this broad coalition of support will facilitate acceptance in society and its effective implementation [2,10].

4.4. Target Audience for Behavior Changes When Eating at Home

Target Group: Women and Youth

Women are a key target for behavior change interventions, as they are often responsible for household food management and cooking. Female family members may very likely have a significant role in reducing food waste, according to the study done by [59]. Inclusion of young people will provide the best return on investment from behavior changes achieved from such initiatives. Television programs watched by women and communications accessible by cellular phones for young people may be effective media for distributing messages associated with the “stop wasting food” campaign.

As Saudi Arabia is a hub of job opportunities for expatriates who that number 13 million and comprise 25% of the population, it is important to consider whether it is feasible to include multilingual communications for these overseas workers in this campaign.

4.5. Behavior Changes When Eating Out-of-Home

Reducing food waste in situations where people are eating out-of-home is unique and challenging. Expectations of an abundance of food for celebrations and a wide range of food choices prevailing in restaurants generate undue pressure to provide a surplus of food. However, courteous reminders could help reduce food waste in such social situations. A restaurant has implemented a policy to charge additional dues for customers who do not finish their plates [63]. Encouraging people to take home food ordered but not eaten, such as ‘doggy bags,’ and using smaller plates, are other interventions to reduce food waste when eating away from home [64].

Changing behaviors associated with over-buying is key to reducing food waste caused in households. Those responsible for food provisioning in households must write shopping lists based on planned meals to determine food requirements for the week and avoid the temptation to purchase beyond what is required when shopping.

Behaviors resulting in cooking profligately also need to be addressed and challenged. Developing the habit of re-using leftovers, such as using them for snacks or simple meals, would help reduce the amount of food wasted. For some, this will require educating citizens regarding food safety to help them become versed in storing and reusing leftovers. Further, there is no need to have prepared food available if a guest arrives unexpectedly, as most kitchens have freezers and microwave ovens so extra food may be prepared in a few minutes [65].

4.6. Using Modern ICT to Minimize Food Waste

Advertising on social networking websites (i.e., Facebook, Twitter, YouTube, etc.), print media (i.e., brochures, newspapers, magazines, billboards, etc.), and traditional electronic media (i.e., TV, radio, messages through cellular phones, etc.) would facilitate widespread awareness of the “stop wasting food” campaign. Further discussions in schools, colleges and universities, as well as in Friday sermons and prayers, will increase the reach and impact of the food waste reduction message.

5. Combating Strategies to Reduce Food Waste in Saudi Arabia

5.1. Policy Measures to Reduce Food Waste

Although Saudi Arabia currently has no policy to address the issue of food waste, several proposals have been made and are under consideration by the government, and numerous initiatives have been taken in this direction. According to Abiad and Meho [34], an “Action Plan” to reduce food losses and waste in Saudi Arabia was launched in 2014.

However, reducing food waste in Saudi Arabia will require government and civil society to adopt an integrated set of activities to modify behavior and increase accountability

for both corporate organizations and individuals. This will necessitate shifts in personal attitudes, as well as societal expectations/norms [66]. Saudi Arabia will benefit from the emerging body of international research dedicated to understanding the fundamental factors that stimulate food waste, along with critical interventions that can support overall reductions [67–70].

Currently, no law in place could implement fines and penalties for those who waste food at eateries. However, the Saudi government is considering framing laws to combat thoughtless food waste. The suggested law demands penalties on individuals and organizations causing food waste, such as enforcing a fee on those leaving unfinished plates at restaurants [71]. Some private organizations, like the Saudi Grains Organization, have shown willingness to help prepare legislative frameworks to implement rules regarding wastage [3].

5.2. Sustainable Development Goals Must Include Target 12.3 and the Obligation to Reduce Food Waste

The United Nations Sustainable Development Goals include Target 12.3, which aims to: “By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses” [72]. Many national governments across the globe are actively supporting this goal set forth by the United Nations. Saudi Arabia can learn from numerous global initiatives and implement adaptations suitable for its unique cultural, economic, and geographic landscape.

5.3. Leadership including a Panel of Experts

Influencing behavioral changes associated with reducing food waste requires leadership from credible individuals and organizations in Saudi Arabia. For example, The Ministry of Food and Agriculture in Riyadh established a committee that is dedicated to establishing initiatives focusing on approaches to reduce food waste [9]. This committee was tasked with investigating the food supply network to identify how and where food waste could be diminished, and to devise realistic mechanisms for achieving such goals. This offers a worthy template for action that could be duplicated in other regions.

5.4. Legal Framework

Saudi Arabia’s Shoura Council, a consultative body, has made deliberations regarding the outrageous food waste in the country and has suggested that the consumers and food businesses be penalized for excessive waste, such as fining diners at restaurants who waste food [73]. The Council has also advocated for the creation of a national center to educate individuals about food waste. Though consultative in nature, this Council’s decisions are not binding [74]. The Saudi government has an opportunity to contribute to reducing food waste by using its authority to implement regulations and formal sanctions to mandate the changes necessary to achieve results. Such formal directives should encourage organizations in the food supply chain, along with individuals, to reduce the amount of food they waste and ensure the most appropriate disposal option for the inevitable small portion remaining.

5.5. Legal Framework on Subsidies

Relaxation of government support for food items would increase food prices. Although this would represent a major shift in policy, and hence consequences are likely to emerge in many other areas, such action would draw much-needed attention to food and increase its overall value, with the attractive outcome of reducing each individual’s food waste.

5.6. Legal Framework Needed for Charitable Food Collection and Distribution Organizations

Additionally, encouraging the formation of vibrant charitable food rescue organizations to collect edible food and redistribute it amongst the poor would greatly reduce the amount of food waste in landfills. This process is commonly called food rescue or food

banking [75,76]. The provision of taxation-based incentives for organizations who donate food and appropriate accommodation under safe food handling laws would facilitate this socially beneficial practice. This practice would also correlate with the important and honorable Islamic tradition of charity. Existing examples in Saudi Arabia include the It'aam Food Charitable Society, with its Memorandums of Understanding with official bodies (i.e., Saudi Press Agency and the integrated energy and chemicals company Saudi Aramco) and a magazine titled 'Meerah' (i.e., provision, supply) [40]. Another interesting initiative is installing refrigerators in front of houses and inviting individuals owning a surplus of food to donate it for collection by those in need [77].

5.7. Reducing Loads on Municipalities and Landfills by Turning Left-Over into Compost

Finally, encouraging household food waste management strategies for cities and their people will reduce the overwhelming pressure on landfill sites. Providing facilities to compost food waste offers a viable example. This would lead to food waste being diverted from landfills, and the chemicals in it being recovered and returned to the soil as a fertilizer.

Though different countries have adopted various strategies to combat food waste, some additional strategies that may work for Saudi Arabia have been presented in the Table 2.

Table 2. Some additional strategies that may work for Saudi Arabia.

Strategies to Combat Food Waste	Status	Challenges	Reference
Reduction at the source	It is one of the best valid options to combat food waste, especially in households, wedding halls, and restaurants.	To reduce FW at the source, changing consumers' behavior remains a prime challenge. However, through the creation of awareness, reduction at the source can be realized.	Mu'azu et al. [44]
Feeding needy people through food banks and charitable organizations	Feeding the needy through the Food Banks has been a very successful practice. Recently, Food Preservation Foundation has also been established to secure food, prevent waste, and benefit from surplus food.	Collection of consumable food items from the wedding Halls and Restaurants requires trained human resources. A huge well-trained task force of volunteers would be necessary to capably collect consumable food, packaging, distribution, and identifying the needy people.	Mu'azu et al. [44] Baig, M.B.; Gorski, I.; Neff, R.A. [2]
Composting through anaerobic digestion	Though not very many Saudi citizens prepare compost at the domestic and household levels, KAUST has taken the initiative to prepare composts on a mass scale.	Currently, organic waste is dumped in landfills, where it becomes a pollutant, increases greenhouse gas emissions, and releases hazardous chemicals into the earth and soil. But in desert regions with limited arable area, inadequate water supplies, and poor soil quality, the organic waste contains valuable resources that can aid farmers in growing more food with less water. These conditions make large-scale desert agriculture challenging and ineffective due to a lack of technical know-how on composting techniques.	Ouda et al. [42] Mu'azu et al. [44]

Table 2. Cont.

Strategies to Combat Food Waste	Status	Challenges	Reference
Bioenergy	KSA is an energy-conscious nation that is eager to explore new options and conserve its present energy sources. FW has shown a lot of promise for generating energy in the initial lab studies	No FW separation or recovery system exists in the KSA. Waste food is mixed with other solid wastes. Lack of technical knowledge required for the procedure to run. It is uncertain whether the final product will be accepted.	Ouda et al. [42]; Mu'azu et al. [44]
Aerobic Composting	Not very popular and does not exist on the household levels	FW separation and recovery process would require large facilities. The demand for final products or byproducts may have little or no acceptance of byproducts by the citizens.	Mu'azu et al. [44]
Landfilling and dumping sites	Prevalent in almost every city of the Saudi Arabia	FW dumped in the landfills causes a volume of leachate, which requires a sanitary landfill with an adequate monitoring system. Sanitary landfills are uncommon; work is currently underway on the technical aspects of their design and management. Also, biogas from landfills is an expensive alternative and its demand is unknown.	Mu'azu et al. [44]

A few significant strategies that can effectively combat food waste in Saudi Arabia have been enlisted in Table 3. In addition, Various consequences of food waste, affecting environment, causing pollution and negatively impacting economy are presented in the table as well.

Table 3. Summary of Food Waste in Saudi Arabia: Causes, Consequences, and Combating Measures.

Aspects of Food Waste	Salient Points for Consideration of the Planners in Saudi Arabia
Causes	<ul style="list-style-type: none"> • The state offers high-quality food products at incredibly low prices. • Consumers have low awareness levels and waste food because they take food for granted. • Young Saudi consumers are fascinated by the exotic foods and fast food, and in cases they discard food as it does not taste like their traditional food and likewise, “take-away” is becoming more and more popular among working men and women; they buy more than what they can consume, causing waste. • The high per capita income and changing lifestyle and diets in Saudi Arabia continue to boost demand for high-quality food products that are often wasted. • Saudi Arabia supports more than 13 million expatriates with higher salaries than what they were earning in their native countries. Well-paid foreign employees, with their increasing demand for greater diversity and ethnic foods in large volumes, lead to waste. • There is inadequate legislation, and penalties for food wasters due to lack of policy.

Table 3. Cont.

Aspects of Food Waste	Salient Points for Consideration of the Planners in Saudi Arabia
Consequences	<ul style="list-style-type: none"> Local and domestic food production depends upon meager natural resources i.e., land and water. Food waste would create more pressure on these already weak resources. Food waste causes environmental, economic, and social issues. Food waste causes an undue economic burden and financial stress on middle- and low-income households. Saudi Arabia feeds its population through heavy imports of food commodities. Food waste creates increased pressure for more imports. Landfills cause infiltration of heavy metals into the soils; leachates deteriorate sub-soils, and unpleasant odor bothers the nearby communities, damages the environment, and causes pollution. Unused food dumped in landfills is broken down by microbes and releases methane and other harmful greenhouse gases (CH₄). These emissions are extremely harmful and a major cause of climate change.
Strategies to combat food water	<ul style="list-style-type: none"> In Saudi Arabia, a solution to the problem of food waste continues to be crucial, difficult, and incredibly essential. Its reduction will necessitate an ongoing, comprehensive partnership with stakeholders, including the food sectors, ministries, educational institutions, and change agents from the religious institutions like Masjids, the extension department, and civil society. A strategy must be developed with the cooperation of various agencies/departments/ministries to increase the food system's resilience. A strong "Stop Wasting Food" campaign is suggested. Awareness and educational programs on minimizing food waste must be launched with the help of a coalition of interested parties. Serious and concerted efforts are needed to promote behavioral adjustments among the prime food wasters, i.e., youth and women, to address the complex issue of food waste in Saudi Arabia

Source: Summary is presented by the authors, based on the analyses of the current study.

6. Need for Further Research and Regional Cooperation

Recently, El Bilali et al. [78] published a systematic review on food waste in the GCC countries. They emphasize the need for additional studies on FW in the GCC to identify research gaps, such as causes and drivers, trends, magnitude and extent, and environmental and economic repercussions, along with the implications of food waste in terms of food security. These also suggest that all the GCC countries should have a common shared regional research agenda, since food waste is a problem that affects all GCC nations.

7. Conclusions and Recommendations

In Saudi Arabia, domestic agricultural production is limited due to less per capita fertile/arable land, harsh climate, low rainfall, and scarce water resources. There is a large production-consumption gap; however, the expanding food demands of its affluent population are satisfied through imported food supplies. To fulfill their rising food consumption levels, however, SA heavily depends upon importing food commodities through international markets to feed the increasing population. With a growing population and continued economic development, this reliance on imports will likely continue to rise.

Saudi Arabia is one of the top food wasters in the world. Saudis waste more food per person than many industrialized nations in North America and Europe. Approximately one third of all imported food goes to waste in SA due to lower shelf-life and hot climates requiring to reduce food loss and waste along its entire food supply chain. The volume of food going to waste is quite significant in Saudi Arabia. Without active intervention, it is likely to emerge into an immense problem.

With economic consequences impacting both food security and environmental sustainability, Saudi Arabia might minimize the rising growth of imports of the main eight food items, which would improve food security. Food waste contributes to a direct economic

loss that reduces food security and has a negative impact on environmental sustainability. Above all, it is against the religious teachings of Islam. From this ethical perspective, it is important to reduce food waste as an act of solidarity toward millions of people worldwide who face hardships as they struggle to find enough nutrition for survival.

Food waste remains an extremely important, complex, and vital issue in Saudi Arabia. Present study yields a variety of implications for all sects of society, including policymakers in the government, hospitality industry, and the restaurant business.

Among the combating strategies, first of all, the government officials in SA must focus on society and should start a media campaign to inform the public/society about the value of food conservation from a variety of economic, social and religious perspectives. Most importantly, concerted efforts are needed to create awareness and launch educational programs on food waste.

The society needs to have awareness and education to enable them to stop food waste at the source while eating at home or dining at the other facilities, away from their homes. Awareness, educational and training programs should be organized particularly for the younger members and women groups of the society.

Together with restaurant owners and management, policymakers should work to prevent food waste. To educate and encourage people to limit food waste and conserve food, one might write verses from the Quran or Hadith “sayings” of the Prophet Mohammed (Peace be upon him). It would be a good idea to post these motivational sayings on food delivery boxes and in the eating area.

In Saudi Arabia, Saudis typically prepare food in large quantities to observe their social events like weddings, births, and funerals. These meals frequently become extravagant displays that boast one’s wealth and social standing. Saudi society must understand that Islam forbids waste and ostentation. Society can help combat waste by minimizing it at the source, i.e., in homes, restaurants and other dining places. Restaurants can help educate the society by highlighting positive religious phrases as they have a higher influence on individuals. It is anticipated that adopting such an approach will build resilience in the food system; thus, the recommended course of action is to initiate a “Stop Wasting Food” campaign for civil society.

In order to conserve food and avoid waste, smaller portions of food should be served. For example, a loaf of bread weighing 550 g is sold for one Saudi Riyal. The authorities should try to sell it at a half weight of 250 g. Similarly, the restaurants should avoid slogans like “All you can eat for Saudi Riyals 50” and buffets providing too many dishes; rather, they must try serving smaller portions and fewer dishes to save food.

Society needs encouraging policies, internalized awareness, and creative commitment to food to combat waste at the business and household levels in Saudi Arabia. Training courses on how to convert wasted food into useful compost will reduce the overwhelming pressure on landfill sites. Plant nutrients can be returned to the soil as a fertilizer by using composts.

Similarly, policy makers and planners are equally important in developing strategies, framing laws, suggesting penalties for food wasters and implementing rules and regulations at the household level and food industry sector to combat food waste in Saudi society.

The social affairs committee of the Shoura Council proposed the establishment of a national center to offer guidance and awareness on food waste to the public. Policy makers should make it more functional and operational and responsive to the needs of the society. It should pursue its goals more efficiently and effectively.

The Saudi government needs to reevaluate the generous subsidies given for various food items to bring a balance between the prices of food items and their relationship with the food waste.

Saudi Arabia is in serious need of a national strategy to combat food waste to address the food waste issue, as FLW is posing a serious threat to the sustainability of its already stressed natural resources and resulting in food security challenges. The workable and viable strategy will require an enduring, integrated collaboration with stakeholders rep-

representing the ministries, educational institutions, food industries, opinion leaders, and change agents from civil society. The active participation and the coalition of stakeholders will help to build momentum to raise awareness about the consequences of food waste and encourage behavioral changes required to reduce it.

Since not enough studies have been conducted to document the actual and real FLW, Saudi Arabia must undertake scientific studies to gauge the substantial losses and waste volumes (starting from field to fork) to launch evidence-based interventions to minimize food waste. This will need to identify the amount of food being wasted and what products are in this waste stream, and design immediate interventions to reduce it. Moreover, it is extremely important to prompt the researchers and scientists to undertake field studies along the whole food supply chain, including households and restaurants. These facts make our study an applied one and not an empirical one.

Countries in the Gulf Cooperation Council (GCC) share similar environmental, economic, and social frameworks related to the food supply, demand, and wastage. Thus, Saudi Arabia has an opportunity to provide leadership for the region in understanding, addressing, and reducing food waste in efficient ways. This is not only due to optional knowledge-sharing between governments, official decision-makers, or academic researchers, but also to the relevant group of pilgrims from other countries who could take food waste prevention knowledge from SA back into their home countries.

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References

1. Baig, M.B.; Straquadine, G.S.; Aldosari, F. Revisiting extension systems in Saudi Arabia: Emerging reasons and realities. *J. Exp. Biol. Agric. Sci.* **2017**, *5*, S160–S164. [CrossRef]
2. Baig, M.B.; Gorski, I.; Neff, R.A. Understanding and addressing waste of food in the Kingdom of Saudi Arabia. *Saudi J. Biol. Sci.* **2019**, *26*, 1633–1648. [CrossRef] [PubMed]
3. Gazette, S. National Initiative to Reduce Food Waste Launched. An article appeared in the Daily Saudi Gazette. 2018. Available online: <https://saudigazette.com.sa/article/528769> (accessed on 11 June 2018).
4. AlFadley, A.A.A. Food Waste Costs Saudi Arabia SR40 Billion Annually. Available online: <https://mewa.gov.sa/en/MediaCenter/News/Pages/News242020.aspx> (accessed on 4 February 2020).
5. SAGO. *Saudi FLW Baseline: Food Loss and Waste Index in Kingdom of Saudi Arabia*; Saudi Grains Organization Riyadh: Riyadh, Saudi Arabia, 2019.
6. Abdullah, N.; Al-Wesabi, O.A.; Mohammed, B.A.; Al-Mekhlafi, Z.G.; Alazmi, M.; Alsaffar, M.; Anbar, M.; Sumari, P. Integrated Approach to Achieve a Sustainable Organic Waste Management System in Saudi Arabia. *Foods* **2022**, *11*, 1214. [CrossRef] [PubMed]
7. Ameen, M. Saudi Arabia Top Food Wasting Country. Available online: <https://ksaexpats.com/saudi-arabia-top-food-wasting-country/> (accessed on 11 June 2018).
8. International Desk. Saudi Arabia Ranks Number One in Food Waste. Available online: <https://www.jagonews24.com/en/international/news/39712> (accessed on 11 June 2018).

9. Alshuwaikhat, H.M.; Mohammed, I. Sustainability matters in national development visions—Evidence from Saudi Arabia's Vision for 2030. *Sustainability* **2017**, *9*, 408. [CrossRef]
10. Baig, M.; Al-Zahrani, K.; Schneider, F.; Straquadine, G.; Mourad, M. Food waste posing a serious threat to sustainability in the Kingdom of Saudi Arabia—A systematic review. *Saudi J. Biol. Sci.* **2018**, *26*, 1743–1752. [CrossRef]
11. van Geffen, E.; van Herpen, H.; van Trijp, J. Causes & Determinants of Consumers Food Waste: Project Report, EU Horizon 2020 REFRESH Wagening. Wageningen University and Research. 2016. Available online: <https://library.wur.nl/WebQuery/wurpubs/589779> (accessed on 20 May 2022).
12. Roodhuyzen, D.M.; Luning, P.A.; Fogliano, V.; Steenbekkers, L. Putting together the puzzle of consumer food waste: Towards an integral perspective. *Trends Food Sci. Technol.* **2017**, *68*, 37–50. [CrossRef]
13. Phonphuak, N.; Chindaprasirt, P. Types of waste, properties, and durability of pore-forming waste-based fired masonry bricks. *Eco-Effic. Mason. Bricks Blocks* **2015**, 103–127. [CrossRef]
14. Evans, D. *Food Waste: Home Consumption, Material Culture and Everyday Life*; Bloomsbury: London, UK, 2014.
15. Stancu, V.; Haugaard, P.; Lähteenmäki, L. Determinants of consumer food waste behaviour: Two routes to food waste. *Appetite* **2016**, *96*, 7–17. [CrossRef]
16. Pearson, D.; Perera, A. Reducing food waste: A practitioner guide identifying requirements for an integrated social marketing communication campaign. *Soc. Mark. Q.* **2018**, *24*, 45–57. [CrossRef]
17. Baig, M.B.; Straquadine, G.S. Sustainable agriculture and rural development in the Kingdom of Saudi Arabia: Implications for agricultural extension and education. In *Vulnerability of Agriculture, Water and Fisheries to Climate Change*; Springer: Heidelberg, Germany, 2014; pp. 101–116.
18. GAS. *Demographics of Saudi Arabia*; General Authority for Statistics: Riyadh, Saudi Arabia, 2018.
19. Bank, W. Databank Home: World Development Indicators Database. Available online: http://databank.worldbank.org/data/views/reports/reportwidget.aspx?Report_Name=CountryProfile&Id=b450fd57&tbar=y&dd=y&inf=n&zm=n&country=SAU (accessed on 20 May 2022).
20. Al-Zahrani, K.H.; Baig, M.B.; Straquadine, G.S. Food Waste in the Kingdom of Saudi Arabia: Implications for Extension Education. In *Climate Change, Food Security and Natural Resource Management*; Springer: Heidelberg, Germany, 2019; pp. 73–101. [CrossRef]
21. Al-Shayaa, M.S.; Baig, M.B.; Straquadine, G.S. Agricultural extension in the Kingdom of Saudi Arabia: Difficult present and demanding future. *J. Anim. Plant Sci.* **2012**, *22*, 239–246.
22. Al-Otaibi, G. By the Numbers: Facts about Water Crisis in the Arab World. Submitted by Ghanimah Al-Otaibi on the Blog Set Up by the World Bank on Thu. 2015. Available online: <https://blogs.worldbank.org/arabvoices/numbers-facts-about-water-crisis-arab-world> (accessed on 20 May 2022).
23. Capital, A. GCC Food Industry Report. 2017. Available online: http://www.alpen-capital.com/gcc-food-industry-report_february-22-2017.pdf (accessed on 20 May 2022).
24. USDA Foreign Agricultural Service. Global Agricultural Information Network GAIN 12/15/2014. 2014. Available online: <https://gain.fas.usda.gov/> (accessed on 20 May 2022).
25. Attraction, F. Fruit Attraction: Reconnecting the World Fresh Produce Community 2018. Available online: <https://www.fao.org/platform-food-loss-waste/events/detail/en/c/1411704/> (accessed on 20 May 2022).
26. Food Export Midwest USA. Saudi Arabia Country Profile. Available online: <https://www.foodexport.org/get-started/country-market-profiles/middle-east/saudi-arabia-country-profile> (accessed on 20 May 2022).
27. Barilla Center for Food and Nutrition (BCFN). Food Sustainability Index. 2016. Available online: <https://foodsustainability-cms.eiu.com/> (accessed on 20 May 2022).
28. Grindle, A.K.; Siddiqi, A.; Anadon, L.D. Food security amidst water scarcity: Insights on sustainable food production from Saudi Arabia. *Sustain. Prod. Consum.* **2015**, *2*, 67–78. [CrossRef]
29. Albawaba. Waste Not Want Not, 8 Million Meals Wasted Daily in Saudi Arabia. Available online: <https://www.albawaba.com/loop/waste-not-want-not-8-million-meals-wasted-daily-saudi-arabia-960702> (accessed on 20 May 2022).
30. Whitman, E. Oil-Rich Saudi Arabia Wastes Astounding \$35 Million in Food Every Day. 2016. Available online: <http://www.ibtimes.com/oil-rich-saudi-arabia-wastes-astounding-35-million-food-every-day-2282137> (accessed on 20 May 2022).
31. FAO. Global Food Losses and Food Waste—Extent, Causes and Prevention. SAVE FOOD: An Initiative on Food Loss and Waste Reduction 2011. Available online: https://www.fao.org/fileadmin/user_upload/sustainability/pdf/Global_Food_Losses_and_Food_Waste.pdf (accessed on 20 May 2022).
32. Ministry of Food and Agriculture. Riyadh, Saudi Arabia. 2014. Available online: <https://www.mewa.gov.sa/ar/Pages/default.aspx> (accessed on 20 May 2022).
33. Gazette, S. Saudis Throw away 440 tons of Rice Annually. Saudi Gazette Report. 2014. Available online: <https://saudigazette.com.sa/article/89553> (accessed on 20 May 2022).
34. Abiad, M.G.; Meho, L.I. Food loss and food waste research in the Arab world: A systematic review. *Food Secur.* **2018**, *10*, 311–322. [CrossRef]
35. COMCEC. Reducing Food Waste in the OIC Countries. In Proceedings of the Committee for Economic and Commercial Cooperation of the Organization of Islamic Cooperation (COMCEC) Coordination Office, Ankara, Turkey, 2017. Available online: <http://www.comcec.org> (accessed on 20 May 2022).

36. Saab, N.; Tolba, K. Arab environment: Future challenges. In Proceedings of the Report of the Arab Forum for Environment and Development, Beirut, Lebanon, 2008. Available online: <http://www.afedonline.org> (accessed on 20 May 2022).
37. Khan, M.S.M.; Kaneesamkandi, Z. Biodegradable waste to biogas: Renewable energy option for the Kingdom of Saudi Arabia. *Int. J. Innov. Appl. Stud.* **2013**, *4*, 101–113.
38. Arab News. Food-Saving Panels Soon. Statement Issued and Published in the Daily Arab News on Jan 23, 2016 Regarding the Orders of Royal Courts on the Formation of Committees to Reduce Food Waste to Conserve Natural Resources Including Water. Available online: <http://www.arabnews.com/saudi-arabia/news/869191> (accessed on 20 May 2022).
39. Ministry of Environment, Water and Agriculture; Ministry of Municipal and Rural Affairs and Housing. Plans Launched to Reduce SR40 Billion (\$10.66 billion) in Food Waste through A National Program. Riyadh—The Kingdom of Saudi Arabia. 2018. Available online: <https://www.arabnews.com/node/2064986/saudi-arabia> (accessed on 20 May 2022).
40. Gazette, S. Eta'am's Ramadan drives in full swing. Saudi Gazette. 2016. Available online: <https://www.saudigazette.com.sa/article/156647> (accessed on 20 May 2022).
41. Al-Fawaz, N. Need to Reduce Food Waste: Experts. Available online: <https://www.arabnews.com/saudi-arabia/news/722026> (accessed on 23 March 2015).
42. Ouda, O.K.; Raza, S.; Nizami, A.; Rehan, M.; Al-Waked, R.; Korres, N. Waste to energy potential: A case study of Saudi Arabia. *Renew. Sustain. Energy Rev.* **2016**, *61*, 328–340. [CrossRef]
43. Miandad, R.; Rehan, M.; Ouda, O.; Khan, M.; Shahzad, K.; Ismail, I.; Nizami, A. Waste-to-hydrogen energy in Saudi Arabia: Challenges and perspectives. *Biohydrogen Prod. Sustain. Curr. Technol. Future Perspect.* **2017**, *61*, 237–252.
44. Mu'azu, N.D.; Blaisi, N.I.; Naji, A.A.; Abdel-Magid, I.M.; AlQahtany, A. Food waste management current practices and sustainable future approaches: A Saudi Arabian perspectives. *J. Mater. Cycles Waste Manag.* **2019**, *21*, 678–690. [CrossRef]
45. Al-Khateeb, S.A.; Hussain, A.; Lange, S.; Almutari, M.M.; Schneider, F. Battling Food Losses and Waste in Saudi Arabia: Mobilizing Regional Efforts and Blending Indigenous Knowledge to Address Global Food Security Challenges. *Sustainability* **2021**, *13*, 8402. [CrossRef]
46. Miroso, M.; Pearson, D.; Pearson, R. Ethics of food waste. In *The Routledge Handbook of Food Ethics*; Routledge: Oxfordshire, UK, 2016; pp. 416–424.
47. Alshabanat, Z.; Alkhorayef, A.; Ben Haddad, H.; Mezghani, I.; Gouider, A.; Tlili, A.; Allouche, M.A.; Gannouni, K.A. Quantifying Food Loss and Waste in Saudi Arabia. *Sustainability* **2021**, *13*, 9444. [CrossRef]
48. Intini, V.; Clemens, B.; Ivana, B.; Fidele, B.; Olivier, E.; Kenneth, I. Food Security Strategies in the GCC countries. Economic and Social Commission for Western Asia ESCWA. Strengthening Development Coordination among Regional Actors in ESCWA Region; 2012. Available online: <https://www.unescwa.org/file/31400/download?token=KtpKcmt> (accessed on 20 May 2022).
49. Boughanmi, H.; Kodithuwakku, S.; Weerahewa, J. Food and Agricultural Trade in the GCC: An Opportunity for South Asia. Available online: https://www.unescap.org/sites/default/files/Food%20and%20Agricultural%20Trade%20in%20the%20GCC_Jeevika_Sept2014.pdf (accessed on 20 May 2022).
50. UNDP. Annual Report. United Nations Development Program. Available online: <https://www.undp.org/content/undp/en/home/librarypage/corporate/annual-report-2011-2012--the-sustainable-future-we-want.html> (accessed on 19 April 2021).
51. Al-Thani, M.; Al-Thani, A.-A.; Al-Mahdi, N.; Al-Kareem, H.; Barakat, D.; Al-Chetachi, W.; Tawfik, A.; Akram, H. An overview of food patterns and diet quality in Qatar: Findings from the National Household Income Expenditure Survey. *Cureus* **2017**, *9*, e1249. [CrossRef]
52. Elmenofi, A.; Capone, R.; Waked, S.; Debs, P.; Bottalico, F.; El Bilali, H. An exploratory survey on household food waste in Egypt. In Proceedings of the VI international scientific agriculture symposium “Agrosym 2015”, Lukavica, Bosnia and Herzegovina, 15–18 October 2015; pp. 15–18.
53. Etaam; Saudi Food Bank. Available online: <http://saudifoodbank.com/> (accessed on 15 May 2017).
54. FAO. Mediterra 2016: Zero waste in the Mediterranean. In *Natural Resources, Food and Knowledge*; International Center for advanced Mediterranean Agronomic Studies and Food and Agriculture Organization of the United Nations-Paris Presses de Sciences Po: Nancy, Paris, 2016.
55. Zayat, I. Arab Countries Face Problem of Food Waste during Ramadan. The Arab Weekly 2017. Available online: <https://the arabweekly.com/arab-countries-face-problem-food-waste-during-ramadan> (accessed on 20 May 2022).
56. Elshaer, I.; Sobaih, A.E.E.; Alyahya, M.; Abu Elnasr, A. The impact of religiosity and food consumption culture on food waste intention in Saudi Arabia. *Sustainability* **2021**, *13*, 6473. [CrossRef]
57. News, A. Food-Saving Panels Soon; ARAB NEWS: Riyadh, Saudi Arabia, 2016.
58. Report, G. Saudi Arabia Food Service—Hotel Restaurant Institutional. USDA Foreign Agriculture Servic. Global Agricultural Information Network. 2015. Available online: https://apps.fas.usda.gov/newgainapi/api/Report/DownloadReportByFileName?fileName=Food%20Service%20-%20Hotel%20Restaurant%20Institutional_Riyadh_Saudi%20Arabia_09-30-2020 (accessed on 20 May 2022).
59. Alsawah, G.; Saleh, W.; Malibari, A.; Lashin, M.M.; AlGhamdi, T. Food Waste, Attitudes and Preferences of Young Females: A Case Study in Saudi Arabia. *Sustainability* **2022**, *14*, 1961. [CrossRef]
60. Ismail, T. Executive director of Savola Group—A leading Saudi food conglomerate. Ideas to chew on: How to end food waste in Saudi Arabia. The National. 2018. Available online: <https://www.thenationalnews.com/business/ideas-to-chew-on-how-to-end-food-waste-in-saudi-arabia-1.705509> (accessed on 20 May 2022).

61. Australian Government. National Food Waste Strategy: Halving Australia's Food Waste by 2030. Commonwealth of Australia Canberra, Australia: 2017. Available online: <https://www.dcceew.gov.au/sites/default/files/documents/national-food-waste-strategy.pdf> (accessed on 20 May 2022).
62. FFWCRC (Fight Food Waste Cooperative Research Centre). Director's Elections 2022. Available online: <https://www.fightfoodwastecrc.com.au/> (accessed on 20 May 2022).
63. Arabia, L.i.S. Extra Charges for Leftover Food in Saudi Restaurant. 2014. Available online: <http://life-in-saudiarabia.blogspot.com/2014/10/extra-charges-for-leftover-food-in.html> (accessed on 20 May 2022).
64. Miroso, M.; Munro, H.; Mangan-Walker, E.; Pearson, D. Reducing waste of food left on plates: Interventions based on means-end chain analysis of customers in foodservice sector. *Br. Food J.* **2016**, *118*, 2326–2343. [CrossRef]
65. Arab News. Need to Check Wastage of Food. Editorial Published Friday 13 September 2013. Available online: <https://www.arabnews.pk/news/464416> (accessed on 20 May 2022).
66. Ebrary. Food Waste in Saudi Arabia. 2014–2018. Available online: https://ebrary.net/212435/environment/food_waste_within_saudi_arabia (accessed on 20 May 2022).
67. Aschemann-Witzel, J.; De Hooge, I.; Amani, P.; Bech-Larsen, T.; Oostindjer, M. Consumer-related food waste: Causes and potential for action. *Sustainability* **2015**, *7*, 6457–6477. [CrossRef]
68. Graham-Rowe, E.; Jessop, D.C.; Sparks, P. Identifying motivations and barriers to minimising household food waste. *Resour. Conserv. Recycl.* **2014**, *84*, 15–23. [CrossRef]
69. Hoek, A.; Pearson, D.; James, S.; Lawrence, M.; Friel, S. Shrinking the food-print: A qualitative study into consumer perceptions, experiences and attitudes towards healthy and environmentally friendly food behaviours. *Appetite* **2017**, *108*, 117–131. [CrossRef]
70. Pearson, D.; Miroso, M.; Andrews, L.; Kerr, G. Reframing communications that encourage individuals to reduce food waste. *Commun. Res. Pract.* **2017**, *3*, 137–154. [CrossRef]
71. DhakaTribune. Saudi Arabia Number One in Wasting Food Worldwide. Available online: <https://www.dhakatribune.com/world/2018/06/12/saudi-arabia-number-one-in-wasting-food-worldwide> (accessed on 12 June 2018).
72. ESCAP, U. Sustainable Development Goal 12: Ensure Sustainable Consumption and Production Patterns. 2016. Available online: <https://repository.unescap.org/handle/20.500.12870/4180> (accessed on 20 May 2022).
73. Business, G. Saudi could Fine Restaurant Goers under Food Waste Law. Available online: <https://gulfbusiness.com/saudi-could-fine-restaurant-goers-under-food-waste-law/> (accessed on 11 June 2018).
74. Alzahrani, M. Potential of Waste-to-Energy Technologies in Saudi Arabia—Impact of Increased Population, Hajj And Umrah, and Global Waste Reduction Trends in 2030. 2019. Available online: <https://dalspace.library.dal.ca/handle/10222/76660> (accessed on 20 May 2022).
75. Booth, S.; Whelan, J. Hungry for change: The food banking industry in Australia. *Br. Food J.* **2014**, *116*, 1392–1404. [CrossRef]
76. Nair, D.J.; Rashidi, T.H.; Dixit, V.V. Estimating surplus food supply for food rescue and delivery operations. *Socio-Econ. Plan. Sci.* **2017**, *57*, 73–83. [CrossRef]
77. Toumi, H. Man Installs 'Charity Fridge' Outside His House. Available online: <http://gulfnnews.com/news/gulf/saudi-arabia/man-installs-charity-fridge-outside-his-house-1.1328931> (accessed on 20 May 2022).
78. El Bilali, H.; Ben Hassen, T. Food waste in the countries of the gulf cooperation council: A systematic review. *Foods* **2020**, *9*, 463. [CrossRef]