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Review

Food waste posing a serious threat to sustainability in the Kingdom of Saudi Arabia – A systematic review

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ABSTRACT

Worldwide, food waste is one of the prime issues threatening food security and the Kingdom of Saudi Arabia (KSA) is not an exception. With 427 kg of food wasted per capita per year, the country ranks among the top food wasters. Ironically, the Kingdom has limited arable lands and scarce water resources to support mass-scale agriculture and to feed its increasing population, KSA relies heavily on imports and subsidized food to meet needs. Yet, food is wasted at restaurants, caterers, cafeterias and, especially, by households such that food waste is the single-largest component of the landfills. The review article is based on the grey and scientific literature published in the English and Arabic languages on the issue of food waste in Saudi Arabia. Information sources like Web of knowledge, online resources and the databases available through the King Saud University, Saudi Arabia were accessed and used to collect information on food waste, its social, cultural, economic and environmental impacts and related topics. Since food items and groceries are abundantly available to all living in KSA and they are highly subsidized, the residents take food for granted. According to a recent survey, about 78% of food purchased in KSA is discarded each week in order to make room for new groceries. The factors responsible for food waste include: lack of awareness; and insufficient and inappropriate planning when shopping. Food waste in restaurants, celebrations, social events and occasions are enormous. Waste is common in festivals and special events where the customs is to provide more food than required. There is a need to change society's food culture, particularly among the women and the youth, as they are largest segment of the society and the prime food wasters. The analysis of the factors responsible for food waste, identified in this article suggests a "Stop Wasting Food" campaign should be launched. It is also recommended to determine and activate the role of extension education to reduce food waste in the KSA through vibrant capacity building programs for youth and women, in particular, and society in general.

Contents

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1. Introduction

Today the earth sustains 7.2 billion people and the population is expected to reach 9.6 billion by 2050 (United Nations, 2014). This means there will be at least three billion extra individuals to feed by the end of the century. Yet, at the global level more than 850 million people already lack access to the food they need for a healthy, productive life. At the same time, approximately one-third of the food produced in the world to feed people every year – approximately 1.3 billion tons – is lost in the waste stream (FAO, 2011). Lipinski et al. (2013) define food waste as the "*food that is of good quality and fit for human consumption but that does not get consumed, because it is discarded – either before or after it spoils*". Food waste is the result of negligence or a conscious decision to throw food away. In the European Union, 89 million tons of food is wasted annually; experts predict it may rise to 126 million tons by 2020 if improvements are not implemented (WRAP, 2011). In 2010, Americans wasted 34 million tons of food, or 115 kg per capita every year (Myers, 2015). The United Nations Food and Agriculture Organization (FAO) reports that the volume of food wasted in industrialized countries is nearly equal to the entire food produced by sub-Saharan Africa.

The Gulf Cooperation Countries (GCC) do stand out as among the world's top food wasters. For example, particularly high quantities of food are wasted during Ramadan (Abu Dhabi Environment Agency, 2013). Understanding food waste issues in the Kingdom of Saudi Arabia (KSA) is important since the country is reflective of other Gulf Cooperation Countries as they also have been placed in the similar ecological conditions, share the same socio-cultural values and are oil-based economies. Most of the Arab region is currently faced with an increasing demand for food because of urbanization and rising standards of living, in a context of scarce agricultural resources.

The KSA is depleting its non-renewable aquifers due to un-sustainable farming (Baig and Straquadine, 2014), yet it still meets up to 80% of its food needs through imports. Furthermore, the government makes food items available to its population at highly subsidized rates. This cheap food might be why Saudi Arabia has recently been ranked among the top 25 countries for food waste with 427 kg of annual food waste per capita (BCFN, 2016). Food waste has dramatic impacts on the environment as the number one contributor to the landfills (Al-Zahrani, 2016). Therefore in early 2016, the government (under the directives of the King) implemented a committee at the Ministry of Environment, Water and Agriculture (MEWA) that included stake-holders from other Ministries to assess the impacts of food waste, identify its main causes, design solutions and take initiatives to reduce food waste and promote sustainability. The Ministry aims at undertaking a national program to minimize food waste embark on a strategic program for food reserves and its storage; adopting an early warning system and providing timely information to agricultural markets (Alshuwaikhat and Mohammed, 2017).

Many economic and cultural factors explain food waste, especially at the consumer level. Economic affluence and welfare policies make food items available at subsidized rates, to the extent that most people can afford to waste. However, the average Saudi citizen spends about 27% of their incomes on food (Gain Report, 2015). Moreover, the KSA's tradition of hospitality, festivals and celebrations imply serving huge quantities of food that are not eaten. Some estimates have been given by Yougov (2017) and UDA Consulting (2017), however, the results of these studies have not been brought to the civil society. The current lack of awareness on the topic continues wasteful practices (Aziz, 2012). The present study is based on the hypotheses that food waste can be reduced significantly by creating awareness; educating the public and changing their attitudes towards food and water consumption in the KSA. Food waste in Saudi Arabia as an issue has only been discussed in the grey literature. The prime goal of this article to highlight the issue and stimulate the interest among the scientific community to conduct scientific studies to gauge the intensity of

the issue, identify the prime waster groups, major food waste items. The present review would provide basic information to the researchers, planners, policy makers and the civil society and seeking their support to ensure food waste in the Kingdom is reduced to the minimum possible level. Present study aims at ensuring the participation of all the stake-holders in the on-going food waste reduction initiatives by the Ministry in the Kingdom. The specific area of contribution is in scoping out the magnitude and causes of food waste caused by people with the aim of policy identifying actions required to reduce it.

2. Methodology

A thorough search of grey and scientific literature published in English and Arabic languages on the issue of food waste was made to determine the extent of the problem as well as identify the factors responsible for it. Secondary data on its social, cultural, economic and environmental impacts and related topics was collected using the web of knowledge, online resources, and the databases accessed through the King Saud University, Saudi Arabia. The information was related to KSA and finally national and international experiences were collected and recommendations formulated how KSA could proceed with food waste prevention measures in order to reduce the huge impact on global sustainability.

3. Background information and agriculture in the KSA

The Kingdom of Saudi Arabia (KSA) spreads over an area of 2.15 km^2 covering as little as 1.6% arable land of the total land area with the lowest per capita arable land (0.11 ha) at the global level (World Bank, 2018). The KSA, with its desert landscape, scarce water resources, high temperatures and low rainfall, is one of the driest countries of the Arabian Peninsula, and presents restricted agricultural growth. As compared to other regions in the world, the Kingdom lacks essential resources like good quality land and sufficient water resources to support mass-scale agriculture (Baig and Straquadine, 2014). Prior to 1970, agriculture was practiced on a rather small scale on scattered pockets. In the 1980s, the KSA started to modernize its agricultural system to attain self-sufficiency, based on public financial support for farmers – free loans and free land – and irrigation.

3.1. Journey towards self-sufficiency

In the 2000s, the KSA made an important strategy shift towards sustainable agriculture by abandoning the previously adopted conventional production systems. The Kingdom achieved self-sufficiency for several commodities like eggs and dates and strong enough to meet most of the demand for vegetables as revealed in Fig. 1. It also became the 6th most important wheat exporter in the world by extracting higher volume of water than the recharge from the non-renewable water resources. The wheat subsidy program that enabled Saudi Arabia to be the wheat exporter, for example, consumed billions of gallons of non-renewable fossil water exported from the country. Saudi Arabia was able to meet only one-fourth of its food demand through local produce in 2014. However, there is still a big gap in meeting the food requirements of the Saudi citizens as shown in Fig. 2, primarily met through heavy import of food items.

3.2. Roll-back policy on mass-scale wheat cultivation to conserve limited agricultural and water resources

High input agricultural production severely damaged limited groundwater resources, with a rate of water extractions greater

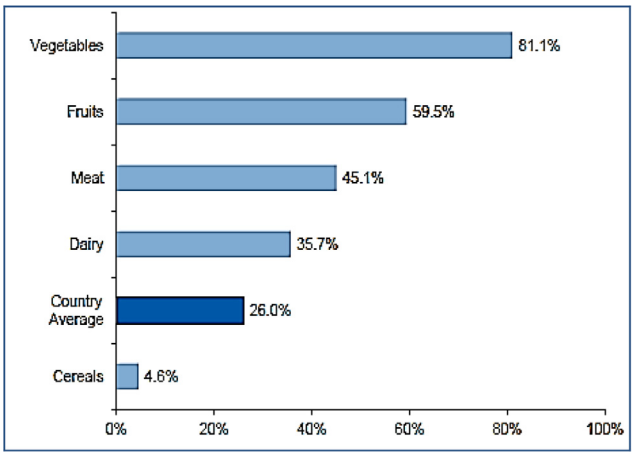

Fig. 1. Self-sufficiency ratio in Saudi Arabia. Source: AOAD 2014, Image Credit: GCC Food Industry Report (2017).

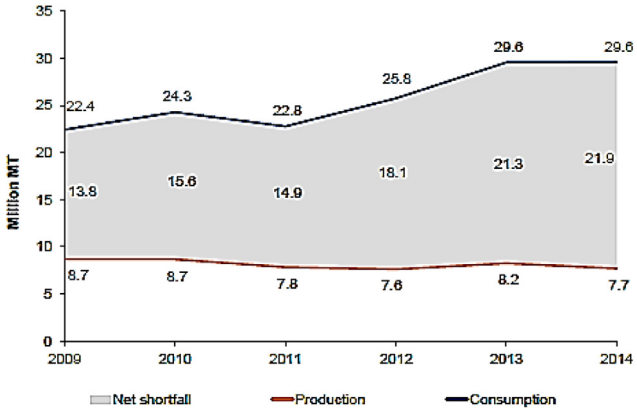

Fig. 2. Food production and consumption in Saudi Arabia. Source: AOAD 2014, Image Credit: GCC Food Industry Report (2017).

than the rate of recharge (Al-Shayaa et al., 2012; Baig and Straquadine, 2014). Intensive farming led to a significant water deficit because of extraction of non-renewable aquifers. To address the issue of depleting water resources, Saudi Arabia has undertaken initiatives to stop cultivation of crops with high water requirements such as wheat, barley and green fodder (GCC Food Industry, 2017). Al-Otaibi (2015) believes that agricultural policies and irrigation methods adopted since the 1980s resulted in the loss of two thirds of ground water supplies in the KSA. In 2008, Saudi Arabia adopted a phase-out of its wheat production program, with an annual reduction of 12.5% starting in 2009 and off-set such reductions with imports. The government has stopped buying wheat from the farmers since 2016 and has instructed them not to plant crops with high water requirements. The implementation of the program has also further reduced the country's food self-sufficiency, making it essential to explore other sustainable development strategies to ensure a continued supply of food commodities in the domestic market. The most recent National Development Plans place greater emphasis on growing crops with less water requirements and importing higher volumes from food surplus countries where water deficiencies are not a notable issue.

After observing the roll-back policy regarding mass-scale agriculture of 2008, Saudi Arabia had to spend US $20-billion on food in 2010 (Chatham House, 2013). It is expected that import dependency of Saudi Arabia will remain high, particularly for strategic commodities such as cereal grains, since it is unable to meet

requirements through domestic production. The situation is currently changing in Saudi Arabia as food prices increase and the country's oil revenues have decreased by 74%. In order to maintain and continue with supplies of food commodities, the KSA adopted an alternative and grabbed the largest acreages of overseas arable lands as a percentage of domestic arable land (BCFN, 2016).

3.3. Increasing reliance on imports

With the scarce agricultural resources, Saudi Arabia imports 80–90% of its food, so that wasting food increases economic dependence and reliance on foreign countries (Grindle et al., 2015), especially in the era when world food prices are on an increase and oil incomes are declining. Saudi Arabia has been spending US $12 billion per year, on average, on importing food and agricultural commodities. The top ranking imports include barley, sheep, rice, chicken and wheat account for 40% of all imports. Many researchers, such as Pradhan (2010), Woertz (2010), Intini et al. (2012) and organizations like USDA (2014) indicate that the KSA could face an increased dependence on food and agricultural imports to meet its domestic food requirements in the future. The heavy dependency of the KSA on food imports and rising international food prices can have significant upward pressure on national and household budgets. However, substantial increases in international prices of a broad range of foods (Global Economic Prospects – World Bank, 2011b) and fast-growing domestic food demand could have an impact on people, as typically they spend anywhere from one-third to two-thirds of their income on food. Despite ample subsidies to consumers, Saudis still spend about 26–27% of their incomes on food (USDA, 2014; Albawaba, 2017).

3.4. Food availability and potential food insecurity

Saudi Arabia's population was about 32.28 million in 2016 (World Bank, 2017) and it is expected to reach 40 million by 2025 (USDA, 2014). The rising trends in population mean more food would be required to meet the food requirements of added masses as well. The increase in population exerts massive pressure on limited agricultural resources forcing KSA to have greater reliance on food imports (Sadik Abdul-Karim, 2014). It is maintained that at least one fifth of the people in the KSA experience food insecurity (Intini et al., 2012).

4. Food waste in Saudi Arabia: significance and impacts

The level of food waste in the KSA is as high as in other rich countries such as the United States or European countries. Food waste has emerged as one of primes issues in the Gulf Countries including Saudi Arabia since this region lacks agricultural resources and water. Food wastes in the restaurants, celebrations, festivals, special occasions and social events are enormous where the customs is to provide more food than required. Food waste is an environmental problem due to unnecessary utilization of scarce national and also imported resources, as the food production processes cause air, water and soil pollution and at the disposal stage, untreated food waste may produce huge amounts of methane due to anaerobic decomposition contributing to further greenhouse gas emissions and thus to global climate change. Thus, food waste contributes to environmental damage not only at the point of wastage but also on a global scale due to food imports and global distribution of pollutants. In addition, an economic problem (Aziz, 2012) is induced by food waste because it takes away the major portion of the national revenues of these countries, leaving them to have an increasing dependence on imports on the one hand. On the other hand, a surplus demand for food which is wasted afterwards increases the global food price which decreases the accessibility to food for developing economies. Furthermore, besides the general ethical issue of wasting food, this food insecurity leads to social problem in several economies. This means that food wastage affects all three categories of sustainability – ecology, economy as well as social issues and therefore is also seen as critical issue within the Sustainable Development Goals (SDGs, sub-goal 12.3) which were released by United Nations in 2015 (United Nations, 2014).

4.1. Levels of food waste in the Middle East including the Kingdom of Saudi Arabia

Data from the Middle East show similar levels of food waste to those reported at the global level. The FAO (2011) claims that one-third of the global food produced, never reaches to the consumers and goes to waste – equivalent to around 1.3 billion tons per year. In Saudi Arabia, the level of food waste is higher than other Arab countries as depicted in Fig. 3 and also higher than the global level. The findings of the survey conducted by YouGov – an internet-based market research firm (Jiwaji, 2014) – indicated that 78% of respondents in the KSA discard food every week to make room for new supply of groceries. According to the Qatar Statistics Authority, the per capita production of solid waste in the KSA is over 1.5 kg per day, placing the KSA among the highest per capita waste producers in the world.

Quoting the report of the seminar on "Reducing Food Waste," held in Riyadh, Whitman (2016) reported that the Saudis waste US $35 million worth of food daily, amounting to US $13 billion per year. Yousef Al-Saif – An Undersecretary at the Ministry for Municipal and Rural Affairs, in a workshop organized by the MEWA titled "Reduction of Food Waste." reported that an average person in the Kingdom possibly wastes 1.2–1.4 kg of food a day; or 511 kg a year. It could be because an ordinary Saudi individual consumes more food that far exceeds his needs, causing more than 50% to household waste (Al-Buainain, 2015) whereas about 70% of food served in the public events goes to waste. With such trends observed in food waste in the KSA, it is expected that food waste may rise to 17.5 million tons by the year 2020 (Whitman, 2016). In another estimate, food worth of Saudi Riyals 70 million goes to trash every day – at the household level. This level of food waste is equivalent to 8 million meals a day or 1.65 million tons of food goes to landfills from domestic kitchens annually (Ismail, 2018).

It is also estimated that almost 4 million meals are being dumped into the landfills only just in the Eastern Province daily (Al-Khan, 2015). Rice is one of the key commodities associated with food security in the KSA strategy (Agricultural and Food Security Committee,

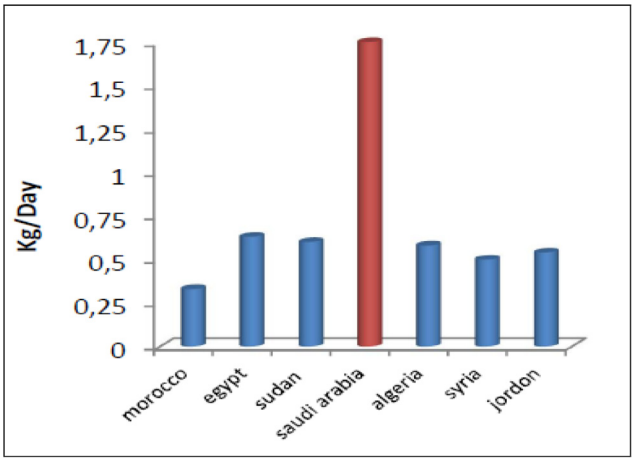

Fig. 3. Per capita solid waste generation in the Kingdom of Saudi Arabia as compared to other Arabian countries. Source: Khan and Kaneesamkandi (2013).

2014). The country imports about 1.3 million tons of rice annually at an estimated cost of SR 4 billion. However, nearly 440 tons of rice, being waste gets dumped into the landfills every year. Saudis may throw away between 35 and 40% of cooked rice a year, amounting to SR 1.6 billion (Saudi Gazette, 2014). Economists estimate that if Saudis reduce this waste by 30%, it would significantly reduce food prices at least by 15% at the national level (Al-Fawaz, 2015). On average, each person's food wastage amounts to around 250 kg, of this 35% consists of baked goods and another 30% of rice.

Food waste contribute to a major squandering of resources, including water, land, energy, labor and capital. Gulf Insider (2017) reported that up to 427 tons of food and eight million meals valued at SR 70 million are squandered daily in the KSA. On the other hand, food waste also produces greenhouse gas emissions, contributing to global warming and climate variation. Khan and Kaneesamkandi (2013) found that food waste constitutes a significant portion of the organic waste generated by major cities because of increasing population and urbanization. Al-Saif (2016) an Undersecretary at the Ministry for Municipal and Rural Affairs is of the opinion that food waste accounts for 28% of all waste in the country. The study of Khan and Kaneesamkandi (2013) revealed that food waste contributes about 50.57% to the constituents of the solid waste (Fig. 4). Therefore, municipal solid waste holds great potential for biological treatment due to the high organic contents and in addition composting is also gaining acceptance in Saudi Arabia in recent years.

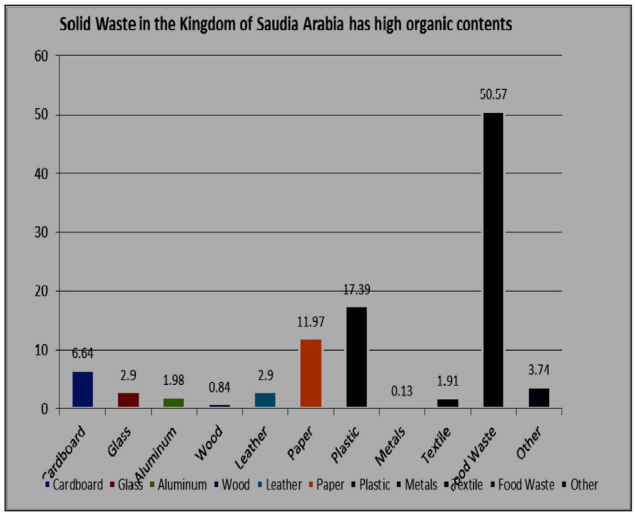

Fig. 4. Food waste is major contributor the solid waste. Source: Khan and Kaneesamkandi (2013).

4.2. Food waste and environmental impact for KSA

Solid waste mismanagement is one of the main reasons for pollution and environmental challenges, issues and deficiencies. Food waste leads to unnecessary use of chemicals such as fertilizers and pesticides during food production. Methane (CH_4) emissions come from industry, agriculture, waste management activities and rotting of food. It is known as one of the most harmful greenhouse gases that contribute to climate variation. Though its lifetime in the atmosphere is much shorter than carbon dioxide (CO_2) yet CH_4 is 25 times more efficient and active at trapping radiation than CO_2 as a greenhouse gas in our atmosphere (EPA, 2017). Huge volumes of food dumped into the landfills release excessive amounts of greenhouse gases such as methane, CO_2 and the present chloroflurocarbons absorb infrared radiation and heat up the earth's atmosphere, causing global warming and climate change (Psomopoulos et al., 2009; Al Ansari, 2012; Dana, 2015).

4.2.1. Food waste and climate change impacts on water availability

The KSA witnessed heavy floods and continued dry spells at frequent intervals primarily due to climate change. Researchers like Darfaoui and Abdu (2010) warned that climate change would have a major impact on agriculture and food production largely as a result of reduced water availability in KSA. Temperatures could rise up to 3°C by 2040 in addition to greater rainfall variability and sea level rises, causing substantial crop yield variability (Darfaoui and Abdu, 2010). In this context, emissions associated with food production and improper food waste management negatively impact national agricultural production in KSA on a middle and long term.

4.2.2. Food waste and impact on water resources

Agriculture accounts for 70% of the water used throughout the world, whereas in Saudi Arabia, agricultural sector is the greatest consumer of good quality water, roughly consuming 87% of total consumption as revealed in Fig. 5. In the past, Saudi Arabia was producing high water requirement crops like wheat, barley and fodder crops (alfalfa) and they severely damaged meager and diminishing non-renewable water resources. According to an estimate made by Dana (2015) that roughly a volume of 50,000 l of water is being used to produce one kilogram of beef; similarly pouring one glass milk into drain means that about 1000 l of water goes to waste (Dana, 2015). Taking into consideration, that water is a scarce resource in KSA and other countries as well, one should decrease unsustainable water utilization needed for the production of food which is wasted afterwards.

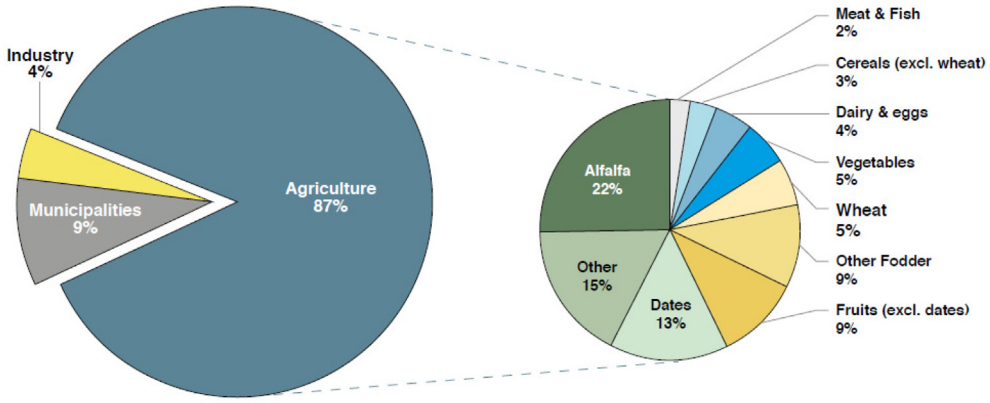

Fig. 5. Water Consumption by different sectors and various agricultural crops. Source: Napoli et al., 2016; Image Credit: KAPSARC 2016.

4.3. Main factors responsible for food waste in Saudi Arabia

What makes Saudi Arabia very different from other industrialized countries is the structure of its "food supply chain", centered on distribution and consumption with very little production. As most food is imported, the main factors behind food waste are related to food distribution (in stores or restaurants) or consumption.

4.3.1. Food waste as a result of economic affluence

Saudi Arabia viewed as a food-secure country, with a strong fiscal balance and large oil reserves that feeds its population and meeting the food commodities requirements through imports. Among others, one factor of food waste is economic affluence, and more cultural traditions of service, harder to change, that could be responsible for a large proportion of food waste. The KSA occupies a very prestigious economic position in the Arab world and globe (Boughanmi et al., 2014). In oil rich Middle Eastern countries, prices hikes and the cost of grain imports may not have much impact on their citizens, because governments often absorb the part of the food-price increases at the country level and regulate prices as seen in the KSA. According to Boughanmi et al. (2014), the Saudi government uses price caps and provides subsidies to food producers and retailers to enable them to provide food to the consumers at low prices. In particular, the government regulates prices of staple foods such as milk and provides supports to food producers and retailers by compensating the private sector for narrow profit margins.

Food waste includes uneaten food items, food preparation scraps and leftovers coming from residences or households, commercial establishments like restaurants, schools, institutions, and cafeterias, making the single-largest component of the waste dumping sites (Aziz, 2012). People prefer to throw away the leftover food as they think it is unhealthy to eat or they do not want to eat the same food twice. The younger generation and children throw away half empty and partially eaten packets of chips, chocolates, burgers, sandwiches and soft drink bottles (Aziz, 2012). Not only do such items litter the roadways, but also provide evidence of wasted food. High consumption, coupled with high waste, is a factor that adversely affects the economy and prevents savings (Al-Buainain, 2015). The luxury is unjustifiable and damaging to the economy and food security.

4.3.2. Food waste in the Saudi Arabian culture

Up to 70% of the food in KSA is lost during special celebrations (Al-Buainain, 2015). Arabs are generous in hospitality; the provision of food is a gesture of welcome to guests. Even if a family might have little food to spare, visitors are often fed with surplus. People in the KSA usually buy food in bulk and prepare more food than they could consume with significant quantities going to waste. As part of the culture, Saudis love setting up lavish food tables during Eid festivals, weddings, parties or informal get-togethers. They love to organize abundant banquets where wasting food is an indispensable feature (Aziz, 2012). Noora bint Abdulaziz Al Ajami, chairperson of Khairat Charity Society, blames that the massive food waste is due to social culture and the food wasted on the daily basis in the KSA is sufficient to feed the whole population of Riyadh (Gulf Insider, 2017). In Arab culture, a person trying to conserve food is viewed as a miser and inhospitable (Ismail, 2018).

4.3.3. Food waste due to lack of awareness and absence of public policies

The lack of measurement and awareness on the topic, at the policy level as well as at the individual level, contributes to high levels of food waste in KSA. So far, international institutions such as the FAO or UNEP have made their food waste assessments on the U.S. and the European Union while ignoring the Middle East and Arab countries (FAO, 2011). They have also not conducted specific studies and taken initiatives in the KSA. At the national level, very few studies help understand the extent, impacts and factors of food waste and at the same time the KSA government also did not dedicate studies on the topic. At the restaurant level, due to lack awareness, the customers do not ask for leftovers to take home resulting food prepared for parties and occasions goes to waste. Saudis believe that fresh food should be standardized and respect strict hygienic criteria to be consumed (Baig, 2016). A significant part of society at the household levels throws their leftover food in the garbage, so the campaign "Do not waste food" which was implemented by.... is a tough challenge in a culture where food is so readily discarded. Beyond the ethical issues, people must learn more about the significance and importance of food and water – including the reduction of food waste.

5. Potential strategies for KSA and remedial measures

5.1. Panel of experts and the committee to reduce food waste

Realizing the gravity of food waste issue, the Ministry of Food and Agriculture in Riyadh has set-up initiatives and established a committee to study ways and means to reduce food waste and address the issue in a sustainable manner (Alshuwaikhat and Mohammed, 2017). The committee has been given the mission to look at the food supply network to see where and how food wastage could be curbed and devise mechanisms for reducing food wastage in society as food waste is a threat to the natural resources of the Kingdom including groundwater. On the face of it, sorting out failures in the food supply chain may be easier than the other part of the ministry's brief. KSA plans to launch a campaign to drive home the need to stop wasting food, not simply in the family but in restaurants, hotels, canteens and cafeterias of the schools and universities (Al-Fuhaid, 2013).

5.2. Regulation and elevating of prices of food commodities and food disposal

Increasing the cost of food would be one of the appropriate solutions to increase its value and reduce waste. Although this is a strong economic incentive for all stakeholders along the food supply chain, the effects on underprivileged groups in KSA have to be considered properly. Finally, a regulation should also introduce an appropriate food waste management strategy for municipalities so that food waste at the landfills could be reduced. One measure could also include a food waste disposal fee which is charged for stakeholders who want to dispose of food waste at landfills. Another measure is to restrict the content of organic carbon in waste destined for landfilling. A corresponding approach was introduced e.g. by the Austrian government in the framework of the Federal waste legislation by limiting organic waste content to a very low value which implies the pre-treatment of waste before landfilling (Austrian landfill ordinance, 2008). This measure positively impacts separate collection of food waste and biological (pre-) treatment of waste and reduces the emission of methane omitted by microbiological processes in landfills.

5.3. Potential role of extension education

One of the most viable options to reduce food waste in the KSA is to increase the public's awareness on food waste and corresponding impact on sustainability with special focus on the water situation in the KSA through the vibrant extension educational program. A large amount of food waste could be attributed to a

culture that fails to emphasize the importance of conserving food and the resulting effect on the global environment and sustainability. However, the solution begins first of all with the family and then society in general, as there should be awareness about wasting food, especially on food products and commodities that are imported in huge volumes, such as rice. The deteriorating situation has created severe and serious implications for the National Extension Service of the Kingdom.

Saudis need to find ways to utilize the surplus food left by ordinary citizens to reduce the food waste stream. Though it is impossible to completely halt the food waste issue yet can be minimized significantly by creating public awareness through by launching a sound campaign and the vibrant extension education programs on food waste. Reducing waste demands a change at both the personal attitudes and commercial viewpoints (Balkhi, 2018). In Saudi Arabia, Islamic teachings pose heavy impact and cause great influence on society. Therefore, it would be of great help if the following verse of the Holy Quran be brought in public "Allah says: "O children of Adam! Beautify yourselves for every act of worship, and eat and drink (freely), but do not waste: verily, he does not love the wasteful!" (7:31).

The KSA needs to launch a national, comprehensive campaign with the goal to save food and use it wisely since a significant proportion of food is imported. In the Kingdom, a campaign needs to be launched to stop the wasting of food, not simply in the family, but in restaurants, hotels, schools, institutions, and universities. Extension Department can achieve this by organizing workshops and conferences for the planners, policy makers, and opinion makers such as civil societies, youth and women groups. The government alone cannot take any measures unless the strategies proposed are supported, accepted and practically implemented by public. In order to change attitudes towards food waste in the Kingdom, a viable option would be to educate every member of society to highlight the importance of food. Such campaigns could be inspired by successful international campaigns such as e.g. Love Food Hate Waste from the UK but should be carefully adapted to the specific conditions in KSA.

5.4. Framing of laws and formulation of policies supporting food surplus redistribution

There is no current regulation in the Kingdom against littering or throwing away food. The government could take action to reduce food waste in the food system by enacting laws or penalties for stakeholders involved in food waste. The government at the Ministry of Food and Agriculture through its unit primarily set-up to reduce food waste in Kingdom needs to frame laws and draft legislation and implement regulations that limit the processing of wasted food and agricultural products in Saudi Arabia and prohibit households throwing out fruits and vegetables by introducing laws for the safe disposal of food items.

As partial blue print for such a legal framework, France could be used where a law against food waste from retailers was adopted in 2016 (Mourad, 2016). Therein, retailers are forced to donate edible surplus food to social organizations to redistribute among the needy. In the USA in 1996, new law namely "Bill Emerson Good Samaritan Food Donation Act" was enforced. It enables the social organizations to redistribute surplus food to the needy people. A similar law to curb food waste namely "La Legge del Buon Samaritano" has also been adopted in Italy since 2003.

5.4.1. Employing extension methods and its tools to create awareness

Roadside billboards and signs in the parks are effective extension tools to create awareness, educate the society and bring behavioral change in the overall society. Launching of anti-food waste awareness campaigns through the print media (i.e. brochures, newspapers, and magazines), traditional electronic media (i.e. TV, Radio, messages through cellular phones) and social networking websites such as Facebook, Twitter and YouTube would help reducing of food wastes. Given that Saudi citizens are mostly Muslims, sermons through Imams at Friday prayers could include a message on not to waste food, complementing lectures at schools, colleges and universities.

5.4.2. Extension education programs organized by private organization like It'aam

It'aam Food Charitable Society through its Extension Education Programs is increasing awareness on the importance of conserving food, and its awareness campaigns could have a positive impact on society and the national economy. It has also signed a number of Memorandums of Understanding with numerous official bodies, such as the Saudi Press Agency and Saudi Aramco. Further it creates awareness through a magazine namely 'Meerah (i.e. provision, supply) and conveys its message i.e. "Do not waste food" to the readers and the general public and food they donate could be used by the needy (Saudi Gazette, 2016).

5.4.3. Planning for groceries, stop over-buying and extra cooking

It is possible for families to reduce wasteful behavior that starts in over-buying and cooking extra or cooking in huge quantities. Families need to develop strategies to plan out meals and make shopping lists to determine what is actually needed for the week, buy food in reasonable quantities. Realistic consumption, avoiding impulse buys by keeping in view the concept of use-by-dates for best quality, and not "safety dates could reduce food waste. Developing the habit of re-using leftovers by eating them for lunch the next day or re-cooking leftover into delicious dishes would help dropping food waste. The need to have food to offer in case friends or other guests drop in should no longer be an excuse, especially since virtually every Saudi's kitchen is well-equipped with freezers and microwaves, so that extra food can be prepared in a few minutes for visitors and guests making friendly visits (Arab News, 2013).

5.4.4. Focus on youth and women

Civil society in the Kingdom is generally traditional, collective, and conservative. Youth are the largest demographic segment of the society. More than 70% of the population is below the age of 30 (GAIN Report, 2015), and two-thirds below the age of 29. Women make up about 49% of the total population (Murphy, 2011). Since youth and women are more in number therefore, remedial measures need to be designed to this segment of the population. The charity organization It'aam is also striving to release animated short films for children. It also works to convey this vision to teachers as well. Women, especially, are an important target as they are often responsible for food management and cooking in the households. Young people spend a lot of time on their cellular phones and women watch TV at home; therefore to create awareness among the youth, extension messages could be released on cellular phones; and to educate women, morning shows on TV could be an effective medium to bring behavioral change.

5.4.5. KSA – the multilingual region

Making more than 10 million expatriates and overseas workers serving in the country the part of awareness and education campaigns would pose significant and positive impact. The KSA has geared to become a multilingual country, so that messages should be broadcasted in different languages.

5.5. Managing left-over at the restaurants

Certainly, it seems difficult to control waste in hotels and restaurants; some argue it is almost unavoidable. Even when much

of an order is freshly cooked, part of the ingredients will have been prepared beforehand. Some of the food that is left over is given to the staff or is repacked into different dishes for the following day for consumption, but waste seems inevitable. Courteous reminders in buffets, cafeterias, restaurants, eating places could help reduce food waste. One restaurant even set an example by charging customers extra who would not finish their plates (Life in Saudi Arabia, 2014). Experiences from other countries show that specific apps for mobile phones which could support young people exploring the options of food waste reduction are very effective tools for that target group. An example of a successful app is "Too good to go" which is available in eight European countries aiming to sell surplus food from restaurants to a cheap price to consumers on time. From the launch of the app in 2015 until mid of May 2018, 4 million meals have already been saved by the users of the app corresponding to approximately 7000 tons of CO_2 (Lienert, 2018).

5.6. Setting up a food charitable society

As opposed to other industrialized countries with high tax incentives for food donations, the Kingdom does not impose taxes on the public, therefore does not offer incentives to donate food.

Given the level of surplus food in a context of social inequality and rampant food insecurity, food redistribution appears to be a good solution to both the issues problems at once, all the more since it fits in with the Islamic tradition of charity. A group of citizens set up an organization named "The It'aam Food Charitable Society" to collect surplus quantities of food. Food bank is establishing its branches in almost all the cities of the KSA and the organization collects food and distributes it among the families (Saudis and non-Saudis) in special packages (Al-Khan, 2015). Some citizens are also making efforts individually to reduce food waste and make food available to the needy, for example a rich person has put a big refrigerator in front of his house in the northern Saudi city of Hail and invited people to donate food to help the needy as seen in Fig. 6. This initiative saves the needy asking for food from any sort of embarrassment. Those examples should be spread across KSA in case food waste could not be reduced at the source in order to meet sustainability to a better extent.

5.7. Developing composting or biogas facilities

When food waste is inevitable, an optional solution is to compost locally the food that spoiled to avoid sending it to the landfill. Developing more composting facilities at the household levels and all the municipalities could also be a viable solution to reduce the impacts of organic waste while making the soil more fertile if the compost is applied to the soil at the end of the process. From governmental side, an incentive system could be introduced in order to encourage separate collection and composting of food waste. As food waste is per se not always suitable for aerobic composting due to the high water content, this measure has to consider a proper mix of different organic wastes in order to achieve a good input quality for the composting process. An alternative to the composting process are small-scale biogas plants for building blocks or small settlements as well as decentralized biogas plants for larger catchment area. With this measure, both energy produced form biogas as well as the solid residues from the treatment process could be achieved from food waste. That technology could be used for food waste only while the residues should undergo a final composting process prior to using as soil improvement agent.

Fig. 6. A Saudi citizen has placed a fridge in front of his house in the City of Hail and invites others to donate food. Image Credit: Mezmez, 2014.

6. Limitations of the present study pave the way for the future research

Among the limitations, the prime one is lack of scientific studies and the non-availability of reliable data on the extent of food waste paving the way for the actual research at the levels of retail, hospitality sector and households. There is a need to conduct scientific studies to assess the extent of food waste and identify the food waster groups more in detail. As it was shown, estimates of food waste amounts vary a lot due to different methods and measuring units. It is important to explore the reasons of food waste, underlying social and individual context and what should be done to bring the food waste levels at the minimum possible. The present study was based on the available scientific and grey literature to pave the way forward and stimulate the interest among the scientific community and seek the support of planners and the policy makers. The present impact and also the potential improvement in relation to sustainability due to food waste prevention could only be calculated on the basis of reliable methodological and data framework which is lacking so far.

7. Conclusions and recommendations

Food waste is a real and serious issue in the KSA. With the 427 kg of annual food waste per capita, it ranks among the top 25 countries causing food waste (BCFN, 2016). About 78% of food purchased in KSA is discarded on a weekly basis. Lack of awareness; insufficient and inappropriate planning when shopping, attitudes of young towards food, cultural norms, high income levels are the principal factors responsible for food waste. The KSA is not in the position to feed its citizens through its domestic agricultural production, therefore heavily depends upon importing food commodities through international markets. This dependency on imports is further expected to rise due to the rapidly growing populations, improving living standards, sustained economic/industrial development and depleting and precious limited non-renewable water resources. Moreover, climate change is also expected to impose a major negative effect on water resources of the country. In past, the KSA has been making abundant food and water resources available to its citizens at the highly subsidized rates. However, today several laws have been framed to regulate water and subsidies to conserve resources and generate revenues.

Food wastage causes economic losses and inflation, environmental damages above all, it is also against the religious teachings of Islam. From an ethical point of view, it is important to project a feeling of solidarity towards millions of people around the world who face hardships in having a single meal each day.

Issues and threats to sustainability of natural resources and food security cannot be addressed through a single solution in the Kingdom of Saudi Arabia (KSA) rather they require an integrated approach throughout society. One way to address food waste is to reduce demand for food items. Consumers can help in

this regard, by adopting a strategic approach to shopping with a few simple measures like: planning while shopping for food and exercising knowledge about storage of food.

Food waste is also one of the prime factors influencing all three pillars of sustainability: financial, environmental and social issues. However, there is a pressing need to develop more scientific studies to reveal accurate estimates about the volume of food wasted in the KSA. Food wastage is reaching alarming proportions, making it necessary to adopt an approach to build resilience and improve sustainability. This will require inter-disciplinary and multi-disciplinary collaboration with all the stakeholders including the representatives of the ministries, educational institutions, food industries, and the civil society; opinion leaders, and change agents. As a result, food waste can be reduced significantly by educating the public and changing people's attitudes towards food and water consumption in the KSA. It is anticipated that Extension Education Programs would make greater impacts if executed in public-private partnership to address this complex issue in the KSA.

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