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Food Waste within South Africa and Saudi Arabia

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Abstract

The food waste reduction potential within the countries of Middle East and Africa is large and understudied. Countries in the region are faced with food security and sovereignty issues, with over 50% of food imported in some countries. Due to the many differences between these countries, this chapter highlights the state of food waste in two prominent countries: South Africa and Saudi Arabia. Both South Africa and Saudi Arabia have their own food waste challenges and solutions. This chapter summarises the current state of food waste research in each country, and reports the estimated volumes of food waste in South Africa and Saudi Arabia along with any notable policy developments.

Introduction

The food waste reduction potential within the counties of Middle East and Africa is vast. The FAO estimate that over 20% of most food supply chains are wasted leading to over 210 kg/capita/year wasted across the region (Gustavsson et al 2011). This equates to over \$60 Billion USD a year in wasted food (FAO, 2014).

Countries in the Middle East and Africa (ME&A) region are faced with food security and sovereignty issues with over 50% of food imported in some countries. This leads to any reductions in food supply through losses and waste being even more impactful. Likewise there are rapid structural and dynamic changes occurring throughout countries in the ME&A region that are leading to additional increases in food waste. Depending on the country within ME&A, these rapid changes include high population growth and increasing urbanisation, a scarce and fragile natural resource base, limited capacity to expand food production, high exposure to climate change impact (drought, flood etc.), changing food preferences (which can be linked to), rising incomes, the effects of the double burden of malnutrition, sudden food price volatility, and conflicts and political instability.

As can be seen from these many generalisations it would be impossible to do justice to the food waste situations for the many countries inside the ME&A region within the space offered by this chapter. Instead, this chapter will now focus on two prominent countries in ME&A: South Africa and Saudi Arabia. Each of them with their own food waste challenges and solutions as outlined below.

Food waste within South Africa

South Africa is an interesting case study when considering food waste. It is listed as a developing country with high unemployment and poverty rates despite having an abundance of goods and natural resources and being recognised as one of the largest industrialised countries in Africa in both wealth and GDP (Bakari, 2017). South Africa is also an exception in the sub-Saharan African region in terms of the central role that modern food supply chains play in provisioning the cities (Crush and Frayne, 2011).

When comparing the average municipal solid waste composition of a sample of South African municipalities with that of sub-Saharan Africa and other countries with different income traits (Figure 1), it is quite clear that South Africa has a somewhat unique municipal solid waste composition. When focussing on the organic component of the municipal waste stream (garden and food waste), this comparison suggests that post-consumer food waste in South Africa is likely to be closer aligned with that in high income countries, despite being geographically located in sub-Saharan Africa.

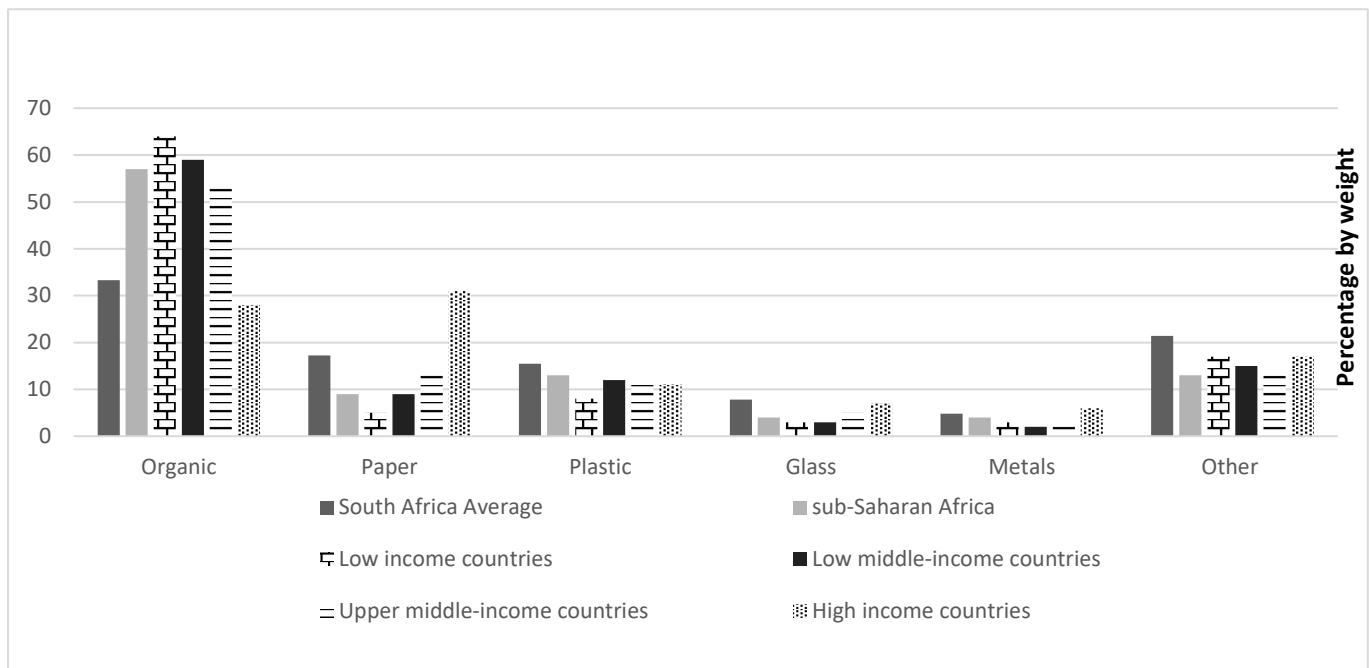


Figure 13.1: Comparing South African municipal solid waste composition with the rest of the world, values provided as Percentage by weight (adapted from Hoornweg and Bhada-Tata, 2012)

South Africa is a net exporter of food (DAFF, 2017), resulting in pre-consumer food waste generation in South Africa, while post-consumer food waste will be generated in the importing country. Global estimates of food waste generation in sub-Saharan Africa are based on the assumption that food is mainly produced by small scale farmers with inefficient farming, storage, processing and distribution systems (Gustavsson et al., 2013). The case of South Africa is however somewhat different. Food production in South Africa is dominated by a few powerful corporations specifically in inputs, processing and retail, and to a lesser degree in primary production (Hall and Cousins, 2015). Agriculture is dominated by large-scale commercial farming (World Bank, 2011) while food processing is dominated by four South African food giants – Tiger Brands, Pioneer, Premier and FoodCorp (Hall and Cousins, 2015). It is therefore likely that food losses and waste in the early stages of the value chain in South Africa may be closer aligned with that of developed economies where sophisticated harvesting, storage and processing systems are in place.

This section is therefore a first attempt to collate the available research on food waste in South Africa with the aim to inform future research, estimates and decision making relating to food waste in South Africa. The purpose of this section is to provide an overview of food waste related research undertaken in South Africa to date, covering the entire food value chain from agricultural production through packaging, processing, distribution and consumption.

Harvest and post-harvest losses

Research on food losses and waste in South Africa have traditionally focussed on reducing harvest and post-harvest losses of various crops. The main causes for post-harvest losses are physiological (wilting, shrivelling and chilling injury, etc.), pathological (decay due to bacterial or fungal infestations) and

physical (mechanical injury) (Mashau et al., 2012). Mechanical or physiological damage typically leads to bacterial or fungal infestations which causes decay.

A study of the post-harvest losses of fruit at the Tshakhuma fruit market in Limpopo (Mashau et al., 2012) reported no losses during transportation due to the short distance between the farm and the market (5km). It is further reported that the produce is sourced from the commercial farms in the area and to a limited extent from subsistence farmers. The vendors buy stock on a weekly basis due to a lack of appropriate technology to keep fruits fresh at the market. The storage facilities at the market is in corrugated stores with no refrigerated storage containers. Vendors selling guava, avocado and pawpaw self-reported 50% losses as a result of over-ripening due to a lack of measures to control the ripening processes of the fruits. Sellers of macadamia reported no losses as dried nuts have a longer shelf life than fresh fruit and vegetables. Post-harvest fruit losses at the Thsakhuma market was 43.3% (Mashau et al., 2012). Reasons for the high losses include knowledge gaps in the use of proper packaging materials, poor procurement planning (some sellers managed to sell all their weekly stocks) and the lack of understanding of the link between transport and fruit rotting, alongside the self-reported lack of refrigeration (Mashau et al., 2012).

Munhuweyi (2012) investigated vegetable losses at retail level in Stellenbosch. The study covered tomato, cabbage and carrots and assed post-harvest quality and losses at the retail level and during consumer simulated storage. The environmental conditions in the supermarkets were cooler and with higher humidity than the outdoor market, but none of the outlets in this study kept the produce at the recommended optimum conditions (Munhuweyi, 2012). The losses for tomatoes at retail level averaged at 14.46%, cabbage at 21.21%, carrots at 17.93%, and apples at 10-20% but sometimes as high as 30-50%. The national loss of tomatoes at retail level is estimated at 37,207 tonnes at a value of R61.65 million (in 2012); cabbage at national level is 24 470 tonnes valued at R17.74 million; and carrots 15250 tonnes of fresh carrots valued at R21.71 million.

Losses and waste in food supply chains

A study that investigated the motivational factors driving South African food processors to reduce food waste through recovery systems (Hayes, 2011) uncovered the following:

- Most South African retailers have policies in place to return expired and damaged stock to the suppliers for disposal. The result of this policy is that branded product is returned to the processors contributing to the waste. The data records kept by the processors are not retailer specific but facility specific.
- The extent of knowledge on the waste quantities was limited and less than 50% of respondents provided quantitative data on the waste generated.
- The majority of this waste (29%) is disposed of at landfill, 28% by feeding of stock, 18% is removed by third party collections, 14% is reported to be composted, 8% is used for product recovery and 3% is donated to charities.
- Waste disposal to landfill by the meat industry, is often the only option due to possible toxicity. This may occur as a result of production process failures, safety issues with raw materials and packaging or due to stock being expired.
- A change in regulation resulted in a declined market for carcass meal as it can now only be used as fertiliser due to the potential risk of spreading disease. It is reported that selling carcass meal as fertiliser is not cost effective.

- Other uses of food waste that is noted in this study is generation of biogas, grease interceptor waste is used for the manufacture of biodiesel. Apricot kernels are being exported for the production of persipan, outer hard apricot kernel shells is being used to clean jet engines and peach kernels are used as replacement fuel for coal in the boilers.
- The reported reasons for processors to address food waste proactively are:
 - Cost of disposal is higher than handing the waste to a third party user or even selling it to a downstream user.
 - Brand protection – if damaged or expired goods is not disposed of properly, it can damage the brand’s reputation

In 2017, Le Roux et al. estimated the wastage of carrots, cabbage, beetroot, broccoli and lettuce at each stage of the supply chain from farm to consumer as part of a water footprint determination of vegetables produced on the Steenkoppies Aquifer in Gauteng. Lettuce has higher average wastage percentages (38%) as compared to cabbage (14%) and broccoli (13%). The wastage varies depending on the season and it is noted that some of the waste is used for beneficial purposes including animal feed and composting (Le Roux et al., 2017). A summary of their findings by commodity group along the supply chain by is provided in Table 1.

Table 13.2 Summary of the wastage estimated for vegetables from the Steenkoppies aquifer (adapted from Le Roux et al., 2017)

Commodity groups	Production (T/a)	Total wastage as a % of input				
		Farm	Market	Retail	Consumer	Total
Root & Tubers	49022.9	24.3	0.7	2.3	1.5	28.8
Vegetables	47976.6	17.9	4.6	5.5	3.6	31.6

The results found that 70% of the food wastage occurred on-farm at the packhouse. The results was obtained “from a large commercial farm that uses advanced technologies” (Le Roux et al., 2017). The average calculated wastage of the mentioned five vegetables along the supply chain is lower than previous estimates by Oelofse and Nahman (2013). The reasons for the high wastage at the pack house include damage as a result of pests and disease and unmarketable properties. The amount of wastage is highly variable between different vegetables types, with the highest wastage occurring in perishable crops (lettuce) and lower wastage in less perishable crops (cabbage) (Le Roux et al., 2017).

Food waste in municipal solid waste

Adhikari et al. (2006) found a correlation between gross domestic product, percentage urban population, municipal solid waste generation and food waste production on a per capita level. Municipal solid waste (MSW) generation is well correlated with Gross Domestic Product (GDP) (R2=0.94) whereas food waste generation demonstrated a lower (correlation coefficient R2 = 0.86), but still a valid correlation. Using these correlations, Adhikari et al. (2006) calculated the urban food waste in South Africa as 5.05 million tonnes in 2005 or 48% of MSW and this is expected to increase to 7.83 million tonnes in 2025 or 45% of the total MSW fraction in 2025 if current waste management practices are maintained. (Adhikari et al., 2006).

In 2012, Nahman et al. estimated the cost of household food waste in South Africa at 1.4 million tonnes per annum, at a cost to society of R21.7 billion (approximately US\$2.7 billion at 2012 exchange

rates¹) per annum (Nahman et al. 2012). More recently, there have been an increasing number of waste characterisation studies undertaken by municipalities in South Africa. Unfortunately, few of these waste characterisation studies are comparable, and food waste is still not reported as a separate waste category in most of these studies. The studies that reported food waste as a separate waste category are listed in Table 2. The food waste component in these studies varied between 3% in Ekurhuleni and 33% in Nelson Mandela Metropolitan municipality.

Table 13.3: Food waste percentages reported in waste characterisation studies in South Africa

Municipality	% food waste	Comment	Source
City of Cape Town	8	2011 study covering households only	CoCT IWMP, 2015
City of Tshwane	17	Kitchen waste from households reported as organic fraction	Komen et al., 2016
Nelson Mandela Metropolitan Municipality	33	Random sampling of trucks entering the landfill site. Includes household and commercial waste	Pilusa J. 2017
Polokwane	31		
Ethekwini	31		
Msunduzi	22	Percentage of MSW	McCarthy, 2016
Mbombela	16		
Mangaung	15		
Rustenburg	16		
Mhlatuze	23		
Emfuleni	12		
City of Johannesburg	7	Percentage of Household waste.	Oelofse et al., 2018.
Ekurhuleni Metropolitan Municipality	3		

Oelofse et al. (2018) published the food waste results of comparable waste characterisation studies from two of the big metropolitan municipalities in the Gauteng province of South Africa (Oelofse et al., 2018). The results provide an indication of the food waste disposed of to the municipal bin rather than the food waste generated at household level. These results indicated an average weekly food waste disposal rate of 0.69kg per household in Johannesburg and 0.48kg per household in Ekurhuleni. The household food waste disposed to landfill in these two municipalities, which are home to 25% of the South African population and contribute 34% to the country's GDP, amounts to 76 661 tonnes per annum. Since these two studies are not a representative sample of metropolitan municipalities in South Africa, it is not possible to use these results for extrapolation purposes. It is however interesting to note that the food waste component of household waste (excluding garden waste) in these two municipalities was 3% in Ekurhuleni and 7% in Johannesburg (Oelofse et al., 2018) in contrast to the predicted 45% of MSW in 2025 (Adhikari et al., 2006).

Oelofse and Muswema (2018) estimated the food waste from domestic sources in municipal solid waste at 2.38 million tonnes per annum in 2011. They have used the food waste generation per

¹ Note that the US \$ equivalents in these early papers was based on an exchange rate at that time of around R8 to the \$. The rate now is closer to R14 to the \$.

income group from Nahman et al. (2012) and applied these to the provincial distribution of the adult population per income group in 2010.

Food waste in informal settlements

Mollatt (2014) investigated food waste flows and food production in Enkanini informal settlement in Stellenbosch using mixed method approach including transdisciplinary, action research and participatory action research. Food waste collected from participating households was measured as on average 9.6kg per household per week (Mollatt, 2014).

National estimates of food waste and cost

The first attempts to quantify food waste in South Africa beyond MSW was done in 2012. Oelofse and Nahman followed a similar approach as used in the global assessment by Gustavsson et al. (2011), but using the estimated/assumed waste percentages for each commodity group in each step of the food value chain for sub-Saharan Africa and applying this to the South African production figures (Oelofse and Nahman, 2013). The calculated average per annum food waste generation figures for South Africa is reported as a preliminary finding of approximately 9.04 million tonnes per annum (Oelofse and Nahman, 2013). The authors caution that this is a highly aggregated result that needs to be verified through primary data collection (Oelofse and Nahman, 2013).

In 2013, Nahman and De Lange estimated the cost of edible food waste along the entire food value chain from agricultural production, post-harvest handling and storage, processing and packaging, distribution (including wholesalers, supermarkets and retailers) and consumption (waste at household level) (Nahman and De Lange, 2013). During their research, the food waste estimates of Oelofse and Nahman (2013) were updated by also accounting for food imports and exports. The new updated estimated of food waste (edible portion) generation in South Africa was 10.2 million tonnes per annum (Nahman and De Lange, 2013). Since the focus of this estimate was on the edible portion of food waste, it can be assumed that this food waste is avoidable. The total cost of the edible portion of food waste throughout the value chain amounts to R61.5 billion per annum (approximately US\$ 7.7 billion at 2013 exchange rates), or 2.1% of the national annual GDP of South Africa (Nahman and De Lange, 2013).

However, there are also costs associated with the inedible portion of food waste, namely opportunity costs that are lost if the waste is not used as input material into other processes, such as composting, bio-energy generation, or the production of animal feed (De Lange and Nahman, 2015). De Lange and Nahman (2015) therefore developed a methodology for the estimation of opportunity costs associated with the inedible portion of food waste.

A first step in determining the opportunity costs of inedible food waste, was to quantify the inedible food waste. Assuming that 81% of food waste is avoidable (based on Ventour, 2008), De Lange and Nahman (2015) calculated the total food waste in South Africa as 12.6 million tonnes per annum, of which 2.4 million tonnes (19%) are inedible. The full cost of disposing food waste to landfill (including opportunity cost and disposal costs) is estimated as a weighted average cost of R5922 (US\$592 at 2015 exchange rates) per tonne. These costs should be compared to the full cost of alternative treatment options to inform decisions regarding waste management options for food waste (De Lange and Nahman, 2015).

Households food waste behaviour

Research on household food wastage and behaviour in South Africa is limited to a few small studies in the City of Tshwane, the broader Gauteng province and one in Kimberley in the Northern Cape. Ramukhwatho et al. (2014) reported on a survey covering 50 households in the Mamelodi Township located in the City of Tshwane Metropolitan municipality. The types of food most wasted by the respondents included pap (maize porridge, 58% of respondents), rice (26%) and bread (16%). An electronic survey covering 301 households in the broader City of Tshwane indicated that fruit and vegetables are the most wasted commodities followed by cereals and bread (including pasta, rice cakes and pastries). Dairy products (milk, yogurt and cheese) were rated in the third place followed by meat, poultry, fish and eggs (Oelofse and Marx Pienaar, 2016).. The self-reported wastage (as a percentage of purchase) was more than 30% of fruit and vegetables (31% of respondents), more than 20% of cereals and breads (34% of respondents) and more than 20% of dairy products (27% of respondents) (Oelofse and Marx-Pienaar, 2016).

The finding from the Mamelodi study is interesting from a cultural perspective as the majority Mamelodi residents are black Africans preparing porridge as a daily staple meal and 90% of respondents indicated that they do not eat fresh fruit and vegetables (Ramukhwatho et al., 2014). An important finding from this study is the ignorance of respondents about their own household's food wastage. At the start of the interviews, 82% of respondents indicated that they do not waste food (Ramukhwatho et al., 2014).

The reported reasons for wasting food are: sell by date indicated that the product has expired ; I was concerned for the health and safety of my family , and I always prepare too much , food residues and falling for special offers (Ramukhwatho et al., 2014; Oelofse and Marx-Pienaar, 2016 . This result suggest that household food waste behaviour may be very similar to that of households in developing countries (Oelofse and Marx-Pienaar, 2016).

Marx-Pienaar and Erasmus (2014) found that bulk packs of fresh produce is preferred by nearly 70% of the 560 respondents. This preference transpired as one of the prominent causes of food waste (Marx-Pienaar and Erasmus, 2014). It is reported that 45% of respondents who purchased smaller quantities did so to avoid unnecessary wastage. Despite planning fresh produce purchases in advance (66.54%), 44.05% of respondents are reported to waste fresh produce due to slow consumption while nearly 40% of admitted over purchasing when the prices are low. Attractive displays are also identified as temptations that result in over purchasing (33.77%) which in turn increase wastage. This study also reported a general ignorance about sustainable disposal practices for food waste, with less than 25% of respondents recycling food waste through composting. (Marx-Pienaar and Erasmus, 2014).

The consumer demand for visually appealing produce result in fresh produce with slight blemishes, but perfectly suitable to use in cooked dishes, to be discarded as waste by retailers (Marx-Pienaar and Erasmus, 2014). The consumer's perceived entitlement to superior quality produce is a critical area of concern that requires intervention if food waste is to be reduced. Another concerning finding by Marx-Pienaar and Erasmus (2014) is that almost 60% of respondents were ignorant about the climate change impacts of food wastage not realising that food waste also generate greenhouse gasses during decomposition.

Ramukhwatho (2016) conducted face-to-face interviews with of 210 households in the City of Tshwane from five suburbs targeting different socio-economic groups. Participating household were

requested to separate their food waste and weigh on a weekly basis over a three week period in order to measure actual food waste generation at household level. On average, respondents wasted 6kg of food per week. A statistical significant difference was reported between income groups, with low income households wasting more food than the middle income households and high income households wasting the least food by weight (Ramukhwatho et al., 2016). Disposal to the municipal bin is the main waste management option used by 83% of respondents, 14% of respondents feed their food waste to pets and the remaining 3% disposed of their food waste through home composting (Ramukhwatho, 2016).

A study in Kimberley (Cronje et al., 2018) revealed that 30% of respondents plan meals in advance and only 54% of those planning their meals in advance, stick to their planning. More than half (52%) of respondents indicated that they bought more food than what they need. The reported reasons for buying in excess (in order of importance) are: food was marked down or on special offer (68%); impulsive purchases (15%); incomplete shopping lists (14%); and influenced by a co-shopper (3%). Further findings from this study indicate that 61% of respondents discard excess food, 25% freeze surplus food, 12% donate the food, 1% dispose of the food to home composting and another 1% store the food in the fridge for consumption on the following day. Only 21% of respondents reported that they use leftover food in additional meals. It is encouraging that 43% of respondents indicated that it bothered them a great deal when food is thrown away. The most wasted food as reported in this study is indicated in Table 3 (Cronje et al., 2018).

Table 13.4: Most wasted food items by households (% respondents) in Kimberley (Adapted from Cronje et al. 2018)

Fruit	%	Vegetables	%	Other food	%
Bananas	42	Tomatoes	27	Leftovers	34
Apples	20	Potatoes	17	Milk and dairy products	30
Avocado	8	Cabbage	13	Bread	25
Oranges	5	Lettuce	12	Condiments	3
Pears	4%	Carrots	9	Convenience food	3

In a provincial study in the Gauteng Province, covering 1250 households through an electronic survey respondents rated their food wastage as more than 20% of their monthly fresh produce purchases (Marx-Pienaar et al., 2016). The reported drivers for food wastage were similar to those reported in the UK (Marx-Pienaar et al., 2016).

Chakona and Shackleton (2017) quantified food waste along a rural-urban continuum in Richards Bay, Dundee and Harrismith. A total of 554 households (183 in Richards Bay, 173 in Dundee and 198 in Harrismith participated in the study through interviews. The majority of households are reported to eat meals as a family together at home. The findings of this study suggest that more households discard prepared food than uncooked food and drinks, but the quantities of discarded uncooked foods are significantly higher than cooked food. The estimated food waste in this study is reported to be 5-10kg per person per annum. (Chakona and Shackleton, 2017).

Venter (2017) investigated Gauteng consumer's fresh produce waste practices with a view of determining the reasons for household food wastage. The commodities wasted in order from most-to least wasted are vegetables, fruit, bread, dairy products, cakes and pastries, desserts, condiments,

cereals, meat, oils, beverages and sweets. The self-reported wastage as a percentage of purchase are summarised in Table 4. It should however be noted that the results are not representative of the demographics of the population in Gauteng (Venter, 2017).

Table 13.5: Self-reported food waste as a percentage of purchase (N=1154) (adapted from Venter, 2017)

Food category	% of purchase that is wasted
Vegetables	21.10
Fruit	20.14
Bread	19.22
Dairy	14.22
Cakes and pastries	13.70
Desserts	12.64
Condiments	10.55
Cereals	10.24
Meat	9.58
Oils	8.93
Beverages	8.23
Sweets	7.80

The vegetables that are most likely to be wasted are reported as green leafy vegetables (Spinach, lettuce, salad greens) followed by cucumbers, tomatoes, cabbage (cauliflower, broccoli, kale), peppers, stem and cap vegetables (mushrooms, asparagus), roots, pumpkin, peas and beans, and lastly mielie/sweetcorn on the cob in order from most to least. The fruit that are reportedly most likely to be wasted in order from most to least are soft tropical fruits (bananas, papaya, figs, guavas), hard fruit (apples and pears), avocado, melons, (spanspek, watermelon), stone fruit (peaches and plums), citrus fruit, pineapple, berries and grapes. (Venter, 2017).

Universities

Food waste composition, alongside student views and behaviours have been measured at three of South Africa's universities: Stellenbosch University (Marais et al., 2017), University of Johannesburg (Sebola et al., 2014), and Rhodes University (Painter et al., 2016)

Food wastage in hospitals

Nemathaga et al. (2008) did a study on waste management practises at two hospitals in the Limpopo Province of South Africa. At the time of measurement, Tshilindzini hospital had 450 admitted patients and Elim hospital 250. The leftover food recorded at the two facilities were 70 and 48kg/day respectively (Nemathaga et al., 2008). This equates to 0.192 and 0.156 kg/patient per day. The reported waste management practice for leftover food is reuse or recycling, but no further detail is provided.

Food waste management in the hospitality sector

Mabaso (2017) conducted research on the current status of food waste management in the hospitality sector with a specific focus on an international Hotel group. The research objectives of Mabaso (2017) covered the food waste behaviour and perceptions of hotel staff linked to food waste, and an analysis of the food waste management practices. Food waste production was measured over a six week period. Plate waste was identified as the most common food waste followed by production waste and

serving waste. The buffet service style was identified as the service style creating the most food waste followed by staff meals, functions, a la carte, and the hotel room service.

Marx-Pienaar et al. (2018) found that production, distribution and packaging, specifically secondary packaging used in distribution, in the quick service restaurant supply chain in South Africa warrants attention to reduce food waste. The specific concern regarding the secondary packaging is that even good quality secondary packaging does not provide the required protection to the food products, especially bakery products, during transport and distribution.

Biomass waste from food production

Oelofse and Muswema (2018) estimated the waste biomass from food processing for a number of commodities as summarised in Table 5. The assumptions used in the calculations were sourced from international literature and applied to available statistics on production and processing of the different commodities (Oelofse and Muswema, 2018).

Table 5. Summary of waste biomass from food processing identified in South Africa (adapted from Oelofse and Muswema, in press).

Source	Assumptions	Tonnes (2012/13)
Malting barley	14 to 20kg of spent grain is produced per hectolitre of beer	584 125 to 607 490
Deciduous fruit	40% of input by weight - juice production 17.5% of input by weight – processing for preservation	184 290
Subtropical fruit	17.5% of input by weight – processing for preservation	22 980
Citrus fruit	Peels (50% of wet juiced fruit)	224 182
Vegetables (excl. Potatoes)	17.5% of input by weight - processing	32 278
Potatoes	90kg per tonne of input (56% of this is potato skins, 33% starch and 11% inert material)	33 427

Environmental footprint of food waste

Mekonnen and Hoekstra determined the South African water footprint and agriculture contributed 76% of the total footprint (Mekonnen and Hoekstra, 2011). In 2014, Oelofse calculated the water footprint of food waste (excluding fish) in South Africa using the food waste estimate of Nahman and De Lange (2013). The calculated water footprint of food waste is in the order of 12 854Mm³ or the equivalent of nearly 22% of the total water footprint of agricultural production in South Africa (Oelofse, 2014).

Notten et al. (2014) estimated a ballpark figure for the cost of embedded energy wasted when food is wasted as R1 billion. The magnitude of this wasted energy is estimated to be enough to power the City of Johannesburg for 16 years. Fruit and vegetables account for 44% of the food waste but only 15% of the cost of wasted energy. The water (ground and surface water) used to produce food that is not consumed is estimated as 1.7km³ (Notten et al., 2014). This is equivalent to about 20% of the total water abstraction in South Africa at a cost of R260 million, with fruit and vegetables accounting for the largest portion. Food wastage therefore comes at a very high cost when considering the cost of energy, water, and waste disposal. In addition, disposal of food waste to landfill adds opportunity

cost that is lost when the valuable resources (energy, enzymes etc.) locked in food waste are not utilised (Notten et al., 2014).

Governance issues

Harduth (2017) identified the need for legal protection for donors of surplus food in South Africa. She argues that surplus food is wasted due to the fear of potential donors that they may be held liable if the donated food cause harm to beneficiaries of the donated food. It is therefore proposed that South African legislation, inline with international best practice as seen in Panama, Canada, France, Italy and the United States of America, should be developed to support and encourage surplus food donations while providing the requisite protection to the donors.

Food waste within Saudi Arabia

Research on food loss and waste (FLW) in the Arab world is scant and there is dearth of reliable data, particularly on their magnitude, causes, sources, drivers, and management, as well as the policies, interventions and initiatives directed at reducing them. This information is vital especially in a region where reducing FLW is imperative for a sustainable food system and key for the region's food security. Three recent review papers, one by Abiad, and Meho (2018) and two by Baig et al., (2018a; 2018b), have attempted to fill this literature gap. This lack of data and research is carried through to the Saudi Arabian context, with Abiad, and Meho (2018) only finding 4 studies which examine food waste generated by different sectors in Saudi Arabia (see table 6). This chapter-section summaries recent reviews as well as new developments.

The investigation made by Abiad, and Meho (2018) shows interesting trends in food wastage and suggests areas of interest to be further elucidated. For example, significant waste is generated during social and religious occasions in Saudi Arabia, especially during the fasting month of Ramadan (Elmenofi et al. 2015). In that holy month, food waste is the highest in Saudi Arabia, and other Gulf Cooperation Council countries (Etaam-Saudi Food Bank 2012; CIHEAM and FAO 2016). Furthermore, during Ramadan, 30 to 50% of the food prepared in Saudi Arabia is thrown away (Al-Fawaz 2015).

The increase in food waste during Ramadan is attributed to the preparation of extravagant meals that far exceed the needs of families, and leftovers are thrown away (Zayat 2017), although such acts do not conform with the teachings of Islam, where Muslims are asked to share excess food with the poor.

In fact, Islam prohibits wastage in every aspect of one's life, whether it is in time, energy, or food, as clarified in the following verses of the Holy Quran:

“It is He Who has brought into being gardens, the cultivated and the wild, and date-palms, and fields with produce of all kinds, and olives and pomegranates, similar (in kind) and variegated. Eat of their

fruit in season, but give (the poor) their due on harvest day. And do not waste, for God does not love the wasteful.” [Quran 6:141]

“O you who believe! Do not make unlawful the wholesome things which God has made lawful for you, but commit no excess for God does not love those given to excess.” [Quran 5:87]

During social events, such as weddings, births, and deaths, food is usually prepared on a large scale, in many cases turning into lavish shows flaunting wealth and social status (Baig et al., 2018a; Baig et al., 2018b). For example, food wasted at an average wedding in Mecca, Saudi Arabia, can be sufficient to feed 250 hungry people. In 2016, the amount of food wasted in Makkah is enough to feed millions going hungry globally (Arab News 2016). **However, there is no available data on the amount of food waste generated during such occasions across the Arab world.**

Table 13.7 Published scientific research on FWL distributed across the Arab countries (adapted from Abiad, and Meho (2018))

Country	Number of studies
Iraq	9
Saudi Arabia	4
Egypt	3
Lebanon	2
Morocco	2
UAE	2
Algeria	1
Jordan	1
Kuwait	1
Oman	1
Palestine	1
Tunisia	1

The population of Saudi Arabia is expecting to reach 34.4 million by 2020. Scarce arable land and limited and diminishing natural water resources limit Riyadh's ability to meet demand through domestic production; increasing food imports and expanding the development of alternative water resources will therefore prove critical in ensuring the country's long-term food and water sustainability and security (Baig et al., 2018b).

With the generation of heavy oil revenues in the Kingdom, rising per capita domestic incomes and globalization have changed dietary patterns of the Saudis in the Kingdom. A 'nutrition transition' has emerged associated with changes in diet and lifestyle; Saudis have transitioned to the consumption of more energy-dense diets. Wheat, rice, yoghurt and chicken are staple items for Saudis, yet many are opting for a more diversified diet with greater Western influence. Changes in lifestyle and Western-style diets are causing growing obesity issues, with 33.7 per cent of the adult population considered obese in 2014.

In Saudi Arabia 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 (Baig et al., 2018a; Baig et al., 2018b).

According to a report by the country's Ministry of Environment, Water and Agriculture (2106), the Saudi citizens waste 30% of their food (around 8.3 million tons of food annually) causing the loss of over SR49 billion annually to national economy (DhakaTribune, 2018). Abdul Fatah (2018) reports that unfortunately offering excessive amounts of food to guests at dinner parties is becoming a social custom where left-over ends up in the landfills. The guests do leave the significant volume of food as leftovers in the dinner parties, weddings, restaurants, and hotel buffets making the Kingdom number

one in the world in wasting food (Baig et al., 2018a; Baig et al., 2018b). An average Saudi wastes 250 kg of food annually compared to the global average of 115kg. Similarly, Saudi Arabia has the highest consumption of grains in the world where the average citizen consumes 158 kg annually compared to the global average of 145 kg per person. Around 33.5 million people live in Saudi Arabia (Worldometer, 2018); with an average wastage of 250kg per head, the country wastes about 8.3 million tons of food every year. "It's mainly due to low awareness in appreciating food, although it is embedded in our religious values,"

Food Waste Policy

Though at the moment, no policy exists to address the issue of food waste yet 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 (2018), an Action plan to reduce food losses and waste in Kingdom of Saudi Arabia was launched in 2014. FAO has also been asked to help combating the issue by the Kingdom of Saudi Arabia.

Currently, there is no similar law in place that could implement fines and penalties to the food wasters at the eating places (DhakaTribune, 2018). However, Saudi government is considering framing laws to combat the thoughtless issue of food waste. The law would comprise penalties on individuals and organizations with regards to food waste, such as enforcing a fee on those leaving unfinished plates at the restaurant (DhakaTribune, 2018). Some private organizations like the Saudi Grains Organization plans to help preparing legislative framework to implement rules regarding wastage (Saudi Gazette, 2018). Saudi Arabia's Shoura Council (apex body that runs the country) has been discussing a potential legislation that will see the implementation of fines on individuals and businesses involved in waste food. The law would primarily address the issues of food wastage in Saudi Arabia, causing nearly a loss \$35 million in the form of food every day. Shoura Council members desired to frame a law to fine organizations serving food in public and private places 38 percent of the total bill per serving as punishments should they waste food (Alarabia, 2017). Additionally, the proposed legislation looks to fine three percent of the total bill on individuals and companies who organize private or public events without the proper license to do so.

Other food waste reduction actions

Other initiatives taken to minimize food waste in Saudi Arabia include those in the wider food industry and the restaurant and hospitality sector.

A food bank under the name of It'aam, the Arabic word of 'feeding', was established in 2010 to help feed the underprivileged by distributing excess food from hotels, banquets and wedding parties. It offers a service at 48-hour notice to individuals and organizations by either collecting leftovers in meal

boxes in a hygienic manner or recycling food. It's estimated that this programme saves nearly 9,000 meals per day (6 million meals a year). In 2017, approximately 49 tons of leftover food (i.e, 144,000 meals) were collected from one site.

The General Sports Authority, represented by the Saudi Community Sports Union, signed an agreement with the Saudi Food Bank at the authority's headquarters in Riyadh. The agreement aims to promote the conservation of food and the avoidance of food waste through the activities and programs of the SCSU (Arab News, 2018). The agreement also includes training for those participating in the Grace Conservation program, in addition to teaching them the basics of food conservation and delivery. The signatories also agreed to launch a food conservation prize, in the name of the SCSU and the It'aam Association for Grace Conservation, which will target more than 100 hotels and restaurants in the Kingdom (Arab News, 2018).

Other restaurant and hospitality operators have engaged their own policy and programmes. Al-Bugamy (2015) reported that Jeddah municipality had obliged all restaurants and ceremony services to contract with the charity organizations for food distributions in order to redistribute the leftovers to the poor and needy. The municipality of Jeddah has also placed 900 containers as the second initiative for food leftovers throughout the city to preserve the blessing of food (Arab News, 2018).

Many individuals are not used to fill their plate in reasonable portions (Saudi Gazette, 2018) so in order to minimize food waste the restaurants have started using small portions. The press have reported that this action has been taken one step further by some restaurant owners, with the establishment of a rule that people who leave food on their plates will be charged extra for wasting food (Saudi Gazette, 2018). The possibility of taking home a parcel made of the leftover food (i.e. a "doggy bag") is also becoming more commonplace.

Measurement of food loss and waste

Estimates of wasted food in Saudi Arabia are listed in table 7. A local university in partnership with Saudi Grains Organization (SAGO) have undertaken a pilot project to reduce food waste and measure the levels of food waste in the society. In order to quantify and identify the major food waster groups, the initiative was implemented in five phases. The first phase of the project was to carry out a field study to measure the levels of food waste in society in 27 cities (Saudi Gazette, 2018). The project involved stakeholder engagement activities from various organisations: Food and Agriculture Organization and World Resources Institute, and private companies. The initiative aims at reducing food waste, especially of wheat, rice, dates, fruits, vegetables, red and white meat. The study aims at determining the volume of food waste and measure the economic losses resulting from it. The study aims to focus on the economic, social and cultural aspects of food waste in the Kingdom and will apply

behavioural economics methods to curb this practice and educate the public about the best practices to minimize waste (Saudi Gazette, 2018). The study will also determine the food waste baseline in the Kingdom and that will enable the researchers to make comparisons it with the other countries in the region and around the world. The study will help the team build KPIs to measure the level of food waste up to 2020 (Saudi Gazette, 2018).

Table 13.8: 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
UN FAO	<u>210 kg/cap/year</u> (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	<u>119 kg/cap/yr (household)</u> 733 kg/establishment/year (food service)	Self-report survey of 111 consumers, 94 food service establishments in Riyadh
Saudi General Authority for Statistics	14,220,000 metric tons household solid waste/year [equivalent to 458.5 kg/cap/year household solid waste. If this is 36% food, then waste of food= <u>165.1 kg/cap/year</u>]	
Tolba and Saab, 2008	1.5 kg/cap/day solid waste [equivalent to 547.5 kg/cap/year solid waste. If this is 36% food, then waste of food= <u>197.1 kg/cap/year</u>]	Solid waste analysis in cities such as Riyadh, Doha and Abu Dhabi
Khan & Kaneesamkandi, 2013	5.5 million tons/year	Solid waste experts est based on idea that KSA solid waste may be 36% food
Undersecretary of Saudi Arabia Ministry for Municipal and Rural Affairs	28% of Saudi waste is food 1.2 – 1.4 kg food waste/person/day <u>511 kg/capita /year</u>	Solid waste data?
Saudi Ministry of Agriculture, unverified	<u>250 kg/cap/year</u>	NA
Eta'am (Food Bank) Director, 2016	1/3 cooked food	NA
Barilla	<u>427 kg/cap/yr</u>	Estimate from Eta'am (food bank) director
Fadal Al-Buainain, 2016	Over 50% of food wasted Over 70% of food from public events wasted	NA

Source: Baig et al., 2018b

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