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# HOUSEHOLD FOOD WASTE GENERATION, DISPOSAL AND MINIMISATION IN TWO SOUTH AFRICAN TOWNS

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by

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# DECLARATION

I, Sinako Mtakati, hereby declare that this thesis represents my original work (except where indicated) and that none of this work has been submitted for another degree, or any purpose at Rhodes University or other institutions of higher learning.

**Signature:** *Signed by Miss. Sinako Mtakati*

**Date:** 19 September 2021

# ABSTRACT

Food waste is becoming an important issue considering greenhouse gas emissions from landfills. However, data on the quantities of food disposed remains limited, especially for developing, countries including South Africa. Global food waste estimates suggest that households in developed countries waste more food than those in developing countries. Further, research shows that lack of food waste management impacts negatively on the global efforts to combat food waste generation. I therefore set out to present primary data relating to household food waste generation and minimisation within a South African context. The case study covers two towns in the Eastern Cape province, namely Cradock and Middelburg, with a combined population of 55 352 people. Household food waste assessment and quantification was undertaken using two methods, 1) questionnaires to explore quantities of different types of food wasted by households, and 2) kitchen scales to measure the amounts of food discarded by households. Participating households in each suburb were selected randomly.

Differences in shopping and household food waste behaviour in households from different income suburbs is vital to understand as it sets an effective approach to food waste interventions that might have a positive impact in minimising food waste generation. In this thesis, differences in shopping and household food waste behaviour across households in the affluent, middle and low-income suburbs is uncovered. A questionnaire was conducted and households in the affluent suburbs purchased food more frequently and had the highest percentage of respondents that used shopping list when buying food than those in the middle and low-income suburbs. The thesis also indicates that households in the low-income suburbs were more attracted to food special offers and had a higher proportion of respondents who could not distinguish between “Use by” and “Best before” dates than those in the affluent and middle-income suburbs. The reasons to food waste generation overlap between the towns. However, between the suburbs, the respondents from households in the affluent suburbs pointed that they were mainly generating and disposing food waste because they did not think it is an issue. Excessive cooking and food expiring before being consumed were found to be the most common reasons for food waste generation and disposal among households in the low and middle-income suburbs. The times which households are likely to generate more food waste were investigated. Nonetheless, only a few households indicated that there were times that they generated and disposed more food in the bins. The most cited times in the affluent suburbs were during Christmas (54%) and in summer (41%). Festive season (65%) and traditional

ceremonies (37%) were the most cited times in the middle-income suburbs, while festive season (46%) and the summer season (36%) were the most cites among households in the low-income suburbs.

The dimensions of shopping and household food waste behaviour is reflected in the types and quantities of food waste generated. The results reveal that vegetables were the most wasted food type in Cradock (26%) and in Middelburg (30%), while tinned food and dairy were the least discarded food types in both study towns with no significant differences in proportions of households discarding all six food types. One of the key results is that the average self-reported and weighed food waste generated per capita per annum for the two towns was 23.40±47.20 and 202.60±128.30 kg/capita/year, respectively as compared to the estimated 6-11 kg per annum in sub-Saharan Africa and South and Southeast Asia.

Between the towns, Cradock generated more food waste (5.05±2.68 kg) than those in Middleburg (3.84±2.59 kg) in the previous 48 hours. It was also evident that each household and each person in Cradock generated more food waste at breakfast and the least at lunch, while in Middelburg the highest average amount of food waste generated was observed at supper and the least at lunch. The results indicate that household size and employment status were negatively correlated to food waste generation, while wealth status and gender were positively correlated to food waste generation.

Majority of households (74% in Cradock and 73% in Middelburg) had no household food waste minimisation strategies implemented. The most cited strategies in place were cooking less frequently, cooking small portions and chopping and freezing vegetables as an anti-food waste strategy. Worth noting is that the small proportion of households with strategies in place are faced with a challenge of some household members showing unwillingness to effectively implement the strategies. The results also reveal that children wasted more food than adults, particularly girls.

**Keywords**: Food waste; food waste minimisation strategies; greenhouse gas emissions; income suburbs; socio-economic status.

# CHAPTER 1

# GENERAL INTRODUCTION

Image 1: Taken from Wrap (2011).

# 1.1. INTRODUCTION

Globally, about 30%, i.e. 1.3 billion tons of the food produced is wasted (Ananno *et al.,* 2020; Nunkoo *et al.,* 2021), most of which is landfilled in developing countries (Masud *et al.,* 2019a). An early study conducted by Lipinski *et al.* (2013) pointed that about 44% of the total food waste occurs in the developing world, whereas the developed world accounts for 56% of food waste globally, despite the markedly lower human populations. In 2006, it was predicted that global food waste generation would increase by 44% between 2005 and 2015 as a result of changing diets and growing populations (Adhikari *et al.,* 2006). Asia was predicted to experience the largest increase in food waste generation, from 278 to 416 G kg (Adhikari *et al.,* 2006). In the United Kingdom, for example, 15 million tonnes of food and drinks are thrown away annually, with households disposing almost seven million tonnes to landfills (WRAP, 2013).

Gas emissions from decomposing food waste contribute to climate change and are one of the major anthropogenic sources of methane gas (Adhikari *et al.,* 2006; Friedrich, 2013; Ananno *et al.,* 2020; Redlingshöfer *et al.,* 2020; Ritchie, 2020). This is because food chains generate greenhouse gas (GHG) emissions at all phases of the chain, from farming inputs and processes, through to manufacturing processes, distribution, refrigeration, retailing, food preparation by households, and waste disposal at landfills (Masud *et al.,* 2019a). The disposal of food waste in landfills leads to methane gas emissions (DEA, 2011; Redlingshöfer *et al.,* 2020; Ritchie, 2020). Further, food waste contributes approximately 6-10% of human-generated greenhouse gases, including methane (Ritchie, 2020). The above-mentioned gas contributes about 18% (which is estimated about 500 million tonnes per year) towards global warming, of which 8-15% (40-75 million tonnes) is the result of emissions from landfills (El-Fadel *et al.*, 1997). For example, about 3.7 million metric tons of food is wasted (Shams *et al.,* 2017). Resulting from this amount of discarded food, the potential of methane gas emission from landfilling is 2.8 million tons per year (Ananno *et al.,* 2020).

Although there is no evidence of the exact amounts of methane gas emitted from landfills between the years 2006 and 2015; Adhikari *et al.* (2006) predicted that if food waste generation is maintained, landfilled food waste would increase the world's methane gas emissions by 8-10% (Adhikari *et al.,* 2006). In South Africa, 4.3% of the contribution to greenhouse gas

emissions is attributed to the waste sector (DEA, 2011). As a result, studies emphasise the urgent need to minimise food waste to landfills in order to minimise methane gas emissions (Adhikari *et al.,* 2006; DEA, 2011; Ritchie, 2020).

Adhikari *et al.* (2006) estimated that Asia will have the highest growth in food waste generation and disposal to landfills between 2005 and 2025 (Table 1). Predictions reveal that China and India alone, will generate 25-27% of the global food waste by 2025 (an increase from 142 to 213 G kg of food waste) (Adhikari *et al.,* 2006). Following this will be the United States of America whose food waste generation will increase from 125 to 174 G kg. Adhikari *et al.* (2006) argued that Brazil, Mexico and the United States are the major generators of food waste in the Americas, followed by Canada and Argentina (Table 1). Additionally, the United States and Brazil are predicted to produce 85 and 117 G kg food waste (representing 15% of the global food waste generation yet are home to only 10% of the global population).

For the same period from 2005 and 2025, food waste generation in European countries such as France, Italy, Germany, United Kingdom and Russia will increase from 58 to 68 G kg. In comparison to these economically developed countries, food waste in African countries will increase from 51 to 87 G kg, representing 9-11% of the global food waste generated. Moreover, Nigeria will generate 13 G kg food waste, whilst South Africa is predicted to generate 22 G kg food waste annually (Adhikari *et al.,* 2006). This will be followed by Egypt, Morocco and Sudan (Table 1).

Table 1:Predicted food waste production for selected world countries from different continents (Adapted from Adhikari *et al.* (2006))

| **Continent** | **Country** | **Food Waste (G kg) 2005** | **Food Waste (G kg) 2025** |
|---|---|---|---|
| Africa | Egypt | 5.76 | 8.09 |
| | Morocco | 2.30 | 3.20 |
| | Nigeria | 7.71 | 14.16 |
| | South Africa | 5.05 | 7.83 |
| | Sudan | 1.63 | 2.40 |
| Americans | Argentina | 4.56 | 6.42 |
| | Brazil | 16.31 | 23.23 |
| | Canada | 5.97 | 7.94 |
| | Chile | 1.62 | 2.25 |
| | Mexico | 11.25 | 15.94 |
| | Peru | 2.19 | 3.12 |
| | United States | 68.74 | 94.65 |
| Asia | China | 86.12 | 126.73 |
| | India | 55.69 | 86 |
| | Indonesia | 13.69 | 20.45 |
| | Nepal | 1.04 | 2.05 |
| | Vietnam | 4.24 | 6.81 |
| Europe | France | 10.68 | 13.30 |
| | Germany | 15.06 | 18.13 |
| | Italy | 9.31 | 10.30 |
| | Russia | 11.34 | 12.16 |
| | United Kingdom | 11.12 | 14.02 |

For accurate and comparative global food waste inventories it is crucial that food waste is defined from both a global and national context. There are various definitions for food waste (Table 2), even though the FAO (2009) and FAO (2013) argue that there is not internationally accepted one. They argue that this allows researchers to define food waste to best suit their respective contexts and studies. However, this undermines attempts to compare statistics across studies and countries. Early on the FAO (1981) defined food waste as edible food intended for

human consumption, which ends up as waste or consumed by pests. However, FAO (2013) redefined food waste as food products appropriate for human consumption which are instead thrown away (generally at consumer and retail stages). Ramukhwatho (2016), Oelofse *et al*. (2018) and Oelofse *et al*. (2020) defined food waste as raw or cooked, edible or inedible material (e.g. eggshells, bones, fruit and vegetable peelings) generated either during the preparation or consumption of meals that instead ends up wasted. The definitions and those presented in Table 2 are widely used. However, for the purpose of defining food waste in the context of (1) South Africa and (2) small South African towns, household food waste refers to edible food material that is produced for human consumption and ends up being wasted by the consumer for various reasons (Chakona and Shackleton, 2017).

Table 2: A selection of food waste definitions

| **Definition** | **Author (s)** |
|---|---|
| Any food and inedible food material, removed from the food supply chain to be disposed or recovered | FUSIONS (2016) |
| Edible food material that is intentionally diverted away from human and fed to animals | Stuart (2009) |
| Edible food intended for human consumption, which ends up as waste or consumed by pests | FAO (1981) |
| Raw, cooked, edible or inedible material (e.g. eggshells, bones, fruit and vegetable peelings) generated either during the preparation or consumption of meals produced to be consumed by human and instead ends up wasted | Ramukhwatho (2016), Oelofse *et al.* (2018) and Oelofse *et al.* (2020) |
| Food lost at consumer level which include edible food material that is produced for human consumption and ends up as waste for various reasons | Chakona and Shackleton (2017) |
| Any edible food material that is lost during any of the phases of the food system | Gustavsson *et al*. (2013) |
| Edible food material that goes unconsumed because of human actions, often a result of decisions made by government, businesses or consumers | Bloom (2010) |
| All food material discarded from the food chain while they still preserve their nutritional value and complying with the national food safety standards | Falasconi *et al.* (2015) |
| Food lost from the food chain supply, which excludes food diverted to uses such as animal feed, bio-based products, or sent for redistribution | European Commission (2014) |
| Food products appropriate for human consumption that are thrown away (generally at consumption and retail stages) | FAO (2013) |

It is generally accepted that food waste is a significant global environmental issue (Parfitt *et al.,* 2010; Ananno *et al.,* 2020). Nevertheless, there remains little knowledge and quantification of household food waste generation and practices in Sub-Saharan African countries, including South Africa (Oelofse and Nahman, 2013; Oelofse *et al.,* 2020) and household food waste minimisation thereof. Although studies such as that of Oelofse and Nahman (2013), Ramukhwatho *et al*. (2014), Chakona and Shackleton (2017), Cronjé *et al.* (2018) and Phasha *et al.* (2020) focused on household food waste, the drivers, patterns and behaviours in respect to food waste generation remains poorly understood in developing countries, including the Eastern Cape province of South Africa.

### *1.1.1. Drivers of food waste*

There are several drivers to food waste production by households, although information on what causes food waste is inadequate (Lebersorger and Schneider, 2011). In many developed countries, such as the United States and the United Kingdom, food waste is attributed to high food accessibility, widespread availability (Rozin, 2005; Preka *et al.,* 2020), reasonable affordability (Blair and Sobal, 2006). In addition, lack of knowledge about food, such as where food comes from, what food production entails, and the implications of food waste, is identified as one of the main drivers (Stuart *et al.,* 2009; Masud *et al.,* 2019b). Thyberg and Tonjes (2016) found that personal choice, socio-demographic, and cultural characteristics are correlated with food waste generation. Further, Phasha *et al.* (2020) emphasised the influence of cultural practices on food waste generation. Different attitudes such as not placing a financial value on food and disregarding negative impacts associated with food waste have also been found to be the drivers of food waste across different nations (Stuart, 2009).

Many studies on food waste reveal that in many developing countries, such as South Africa, some food waste is attributed to lack of proper storage, excessive food purchasing, shopping frequency and household food shopping habits (Lyndhurst *et al.,* 2007; Cronjé *et al.*, 2018; Ramukhwatho *et al.,* 2018; Oelofse *et al.,* 2020). Therefore, one can conclude that food waste generation is a function of socio-demographic, policy, cultural, and economic factors that affect personal and household behaviour in various ways (Pearson *et al.,* 2013).

#### *1.1.1.1. Socio-demographic factors*

Surveys of behaviour and attitudes towards food waste have shown a correlation between food waste generation and socio-demographic factors such as age (Pearson *et al.,* 2013; Kambo and

Osmani, 2018; Grasso *et al.,* 2019; Annunziata *et al.,*2020). For example, younger people generally waste more than elders (Hamilton *et al.*, 2005; Cox and Downing, 2007; Quested and Johnson, 2009; Annunziata *et al.,*2020; Sorokowska *et al.,* 2020). In Denmark and Spain, for example, food waste decreases as age increases (Grasso *et al.,* 2019). Hamilton *et al.* (2005) found that 38% of respondents between the ages of 18-24 years wasted more than $30 purchasing food over a period of two weeks, compared to 7% of people who are 70 years and above. In the United Kingdom, people above the age of 65 waste less food, compared to younger people (Quested *et al.,* 2013; Thyberg and Tonjes, 2016). This was interpreted as older people believing that food waste is wrong, and their belief may be associated with their age group having experienced difficult economic conditions during World War II, causing them to be more cautious against wasting resources (Quested *et al.,* 2013).

Household size is another attribute that is commonly correlated with the amount of food wasted per capita (Jörissen *et al.,* 2015; Grasso *et al.,* 2019; Li *et al.,* 2020). Smaller households generate more food waste per capita than larger households (Jörissen *et al.*, 2015). For example, single person households in Karlsruhe (Germany) and Ispra (Italy) were found to waste more food per capita than those with more than four persons (about 243 g of food wasted per person/week in Karlsruhe and 205 g in Ispra) (Jörissen *et al.*, 2015). While households with more than four persons wasted about 115 g per person/ week in Karlruhe and about 57 g per person/week in Ispra. To explain this phenomenon, Quested and Johnson (2009) argue that food is often available (or affordable) in larger packages, and this usually caters for larger groups of people than for individuals. So, households of one person often find themselves stuck with more food than they need, thus resulting to higher amount of food wasted. In contrast, in terms of household size and food waste generation, there was no correlation detected amongst households in Italy (Annunziata *et al.,* 2020).

Family composition is another factor that can influence food waste generation. For example, households with children waste more than those that do not have children (Hamilton *et al.*, 2005; Cox and Downing, 2007; Parizeau *et al.,* 2015; Thyberg and Tonjes, 2016). For example, in Swedish households, children's tendency to refuse to finish their food has been the leading cause of food waste (Parizeau *et al.,* 2015). Evans (2012) points out that this is associated with children's tendency to not finish their food and the fact that they are mostly selective when it comes to food.

Households with retired people are also argued to contribute the most to food waste generation (Ventour, 2008). This is because they are usually small households, and as previously mentioned, small households waste the most per capita. Additionally, retired people spend most of their time at home and non-working groups tend to cook more often, leading to more food waste. However, there is no study which clearly present figures to support this phenomenon. Therefore, this study will aim to provide figures to support or argue against the claim made by Ventour (2008).

Gender of the household head has also been seen in some studies to influence the amounts of food wasted, in particular male-headed households are likely to generate more when factors such as wealth and household size are accounted for (Lyndhurst *et al.,* 2007). In the United Kingdom, males throw away about 33% of the food that is meant to be consumed, whilst females throw away about 26% (Figure 1) (Lyndhurst *et al.,* 2007). The reasons for the observed difference could easily be mistaken with the global assumption that women-headed households are generally 'poorer' than their male-headed counterparts. They are mostly assumed as low-income groups and that this feature as a cause of "male absence" and low-income households are correlated with low food waste generation due to lack of money for food storage facilities (Cronjé *et al.*, 2018).

A body of literature argues that poor households waste less (Cox and Downing, 2007; Gustavsson *et al.,* 2013; Pearson *et al.,* 2013; Ramukhwatho *et al.,* 2014). This means that the explanation is rather a misleading stereotype. A reasonable explanation could be that male respondents interviewed in the United Kingdom live by themselves, which then explains the higher food waste rates because smaller households waste more than larger households (Jörissen *et al.,* 2015).

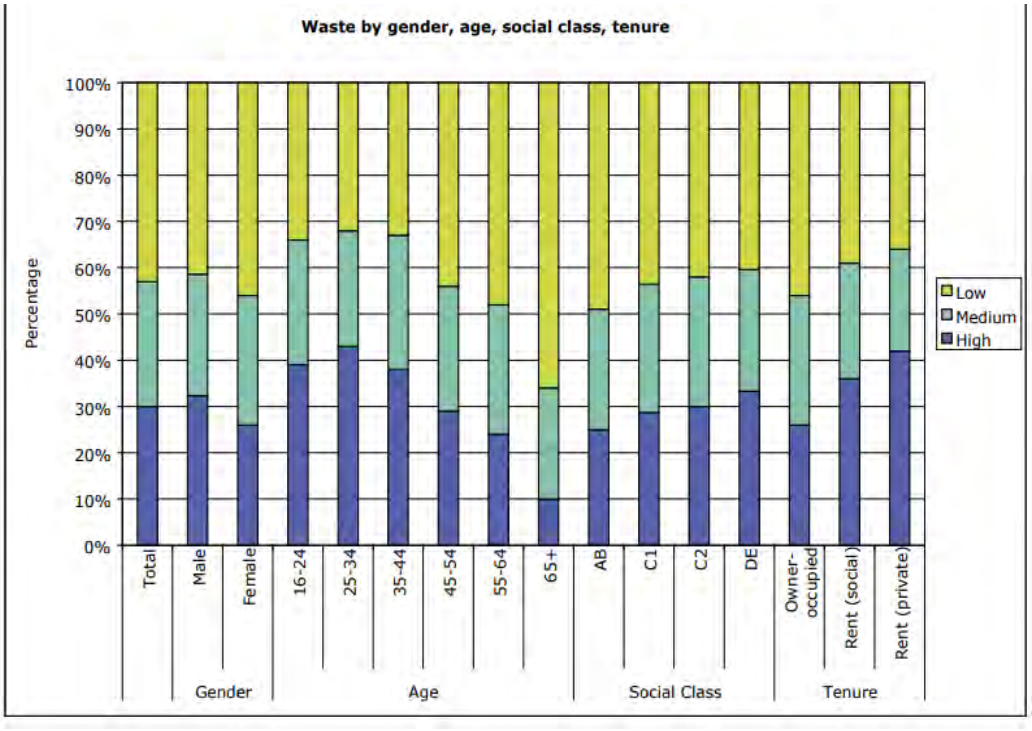



Figure 1: Variations in food waste by gender, age, social class, and tenure amongst households the United Kingdom (Taken from Lyndhurst *et al.* (2007)).

#### *1.1.1.2.Cultural factors*

Cultural factors affect shopping habits, nutrition, and food waste generation (Sobal, 1998; Rozin, 2014; Grasso *et al.,* 2019). The quantities of food wasted depend on attitudes and cultural habits (Rozin, 2014; Phasha *et al.,* 2020). People from distinct cultures consider different food parts and food types as consumable and throw away those they do not consider consumable (Strasser, 1999). Pollan (2007) highlight that countries like Australia and the United States have delicate food traditions and values, meaning that there are no rules or values guiding what food to consume and when to consume it. In addition, Bloom (2010) argues that the United States has no strong relationship with food, i.e. their culture places limited value on food, which contributes to high rates of food waste. In contrast, countries which have solid food cultures, such as France, foster the placing of value on food (Gatley *et al.,* 2014). Countries with solid food cultures are more resistant to change, they have strong values around how food is grown and prepared, leading to less food wasted.

Shopping habits and accessibility also have an impact on food waste generation. For example, the amount of food thrown away increases when people shop at larger supermarkets and decreases when shopping occurs at smaller outlets (Figure 2) (Jörissen *et al.*, 2015; Preka *et*

*al.,* 2020). For example, in Karlsruhe (Germany) and Ispra (Italy) people mostly purchase from large supermarkets (about 49% respondents in Karlsruhe and 35% in Ispra. Jorissen *et al.* (2015) argue that household food waste in these two areas is high when people shop at larger supermarkets as compared to smaller outlets (about 162 g food waste per person/week in Karlsruhe and about 148 per person/week in Ispra), while the amount of food is less when food is purchased from smaller outlets (about 121 g food waste per person/week in Karlsruhe and about 105 g per person/week in Ispra).

An explanation for this is that people who buy food from small shops place more value on food than those who prefer convenient supermarkets (Jörissen *et al.*, 2015). This could also be because larger supermarkets are often some distance away and sell large food packages and require that people take a mode of transport. So, most people avoid untimely trips to shops by buying in bulk (Graham-Rowe *et al.,* 2014), not realising that in their attempt to minimise inconveniences; they are increasing chances for food spoilage and waste.

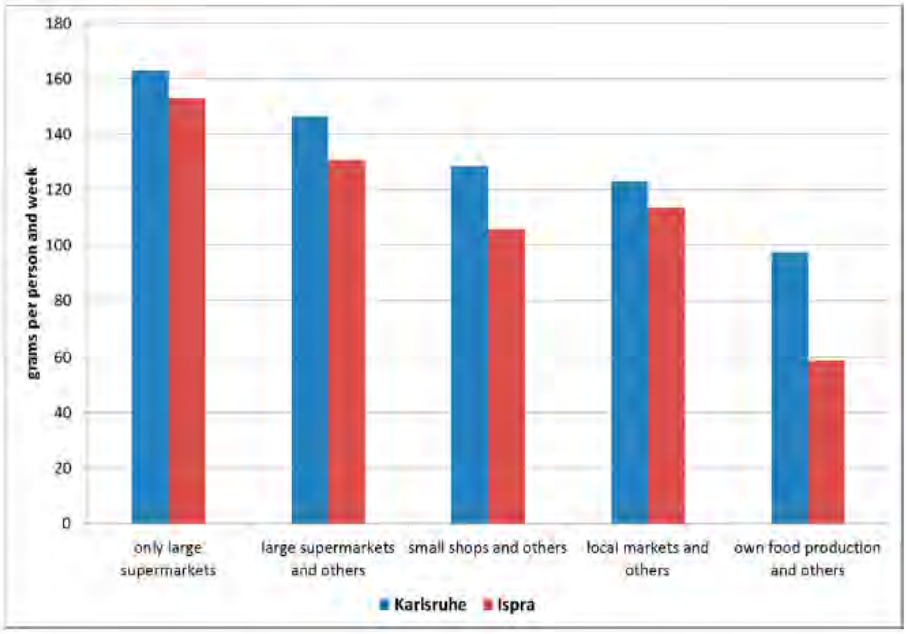



Figure 2: Per capita amount of food discarded (per person/week) in relation to different shopping facilities in Karlsruhe (Germany) and Ispra (Italy) (Taken from Jörissen *et al.* (2015)).

Shopping frequency is also correlated with food waste generation (Jörissen *et al.*, 2015). Households who purchase food more often generate less food waste (Pearson *et al.,* 2013).

While this may be the case, Jörissen *et al.* (2015) reveals contrary trends between two towns: in Karlsruhe there is less food waste with an increased shopping frequency, but the opposite was observed for Ispra (Figure 3). In Karlsruhe, households who purchase every second day waste about 12 g of food per person/week and about 165 g per person/week in Ispra. Whereas, households who purchase food once a week in Karlsruhe discard about 145 g food per person/week and about 119 g per person/week in Ispra.

An explanation to the observed trend of less food wasted for increased frequency of shopping is that it allows for a better matching with the household's daily needs for food. In contrast, the decreased frequency for shopping increasing the likelihood of food spoilage, especially foods with short shelf-lives such as bread, vegetables, and dairy which are perishable (Graham-Rowe *et al.,* 2014; Jörissen *et al.*, 2015). However, Lyndhurst *et al.* (2007) and Graham-Rowe *et al.* (2014) argue that while an increased frequency of shopping allows for a better day-to-day food management, it may trigger over-purchasing of food and thus, increasing the amount of food discarded.

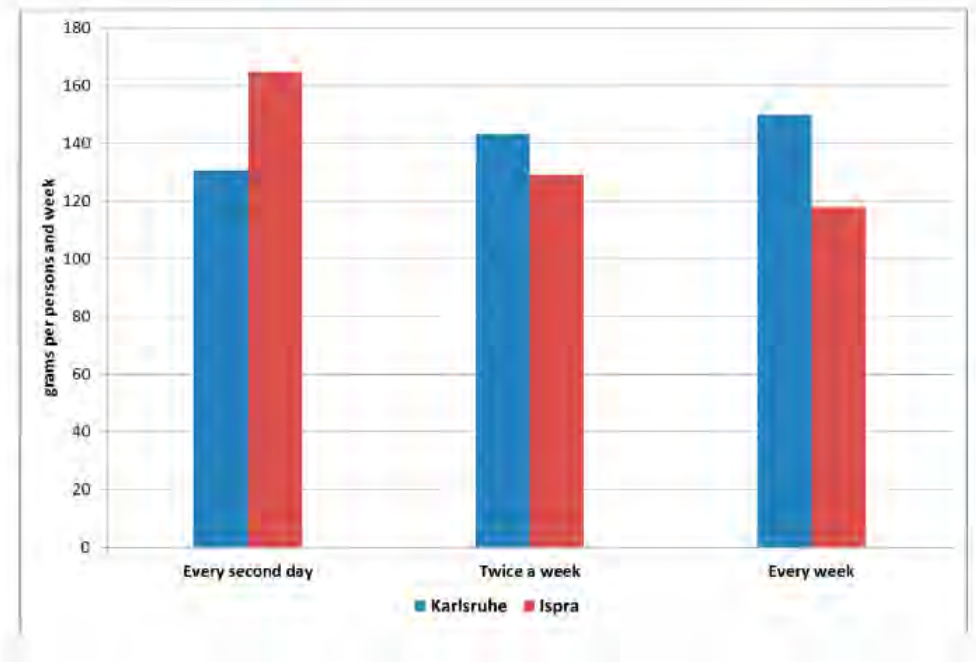



Figure 3: Per capita amount of food discarded (per person/week) in relation to frequency of shopping in Karlsruhe (Germany) and Ispra (Italy) (Taken from Jörissen *et al.* (2015)).

The culture of shopping lists is also correlated to food waste minimisation (Quested *et al.,* 2013). Jörissen *et al.* (2015) reveal that making a shopping list reduces the amounts of food thrown away. For example, in Ispra 70% of the households make use of shopping lists for purchasing groceries. The authors argue that when using a shopping list, the amount of food discarded per capita is reduced by 25% in Ispra and 20% in Karlsruhe. The results presented by Jörissen *et al.* (2015) are consistent with the findings of Lyndhurst *et al.* (2007) who also concluded that the use of shopping lists reduce food waste generation.

#### *1.1.1.3. Policy factors*

In all countries there are various food policies which influence food waste generation (Thyberg and Tonjes, 2016). These authors assert that policies influence food waste generation by authorising food waste disposal under specified conditions. For example, some policies aim to achieve food safety, which in many instances mandates food disposal (Thyberg and Tonjes, 2016). A typical example is that of the 2010 Healthy, Hunger-Free Kids Act signed into law by Barak Obama, with the aim to promote overall student wellness (Jalonick, 2014). According to Jalonick (2014) the policy required an update of the nutrition standards of the food offered for lunch and breakfast at schools. The policy emphasised food quality improvements. However, it has been criticised for leading to increased food waste because learners throw away newly introduced food types, arguing that they dislike them (Jalonick, 2014). For example, Byker *et al.* (2014) found that at one school, 45% of the food and beverages served were thrown away by students.

The impact of this policy on food wastage is sensitive and complicated. This is because while the policy advocates for food safety strategies, it seems to compromise food waste minimisation goals. According to Chalak *et al.* (2016), for a food safety policy to be effective it needs to be flexible and comprehensive. On a more practical level, food policies need to incorporate both food safety and food waste minimisation strategies so to avoid a compromising situation.

Nonetheless, it appears that countries that have enacted food waste minimisation strategies and legislation have relatively low quantities of food waste (Chalak *et al.,* 2016). For example, in 2001 Japan issued the Law for the Promotion of Recycling and Related Activities for the Treatment of Food Resources, which specifically targets the minimisation of food waste generation. This action was monitored across the food manufacturing, retail, wholesale sectors as well as households, whereby they are required to produce reports of how much food was

wasted and recycled (Chalak *et al.,* 2016). While there are no documented figures of how much food waste has been minimised as the result of this policy, Herszenhorn *et al.* (2014) and Chalak *et al.* (2016) assert that this legislation has been directed to lower food wastage.

#### *1.1.1.4.Economic factors*

Typically, growth in household income is associated with increasing food waste (Gustavsson *et al.,* 2013). According Cox and Downing (2007), low-income households waste less food than high-income households. Additionally, Jörissen *et al.* (2015) assert that households that earn higher than €60 000 in Italy (Ispra) and Germany (Karlsruhe) waste more food than those earning less than €48 000.

For developing countries such as South Africa, the observation seems to be explained by low-income households not being able to afford storage facilities for preserving food (Cronjé *et al.,* 2018; Jeswani *et al.,* 2021). However, other studies have found no association between food waste and income (Wenlock *et al.,* 1980; Van Garde and Woodburn, 1987; Koivupuro *et al.,* 2012). For developed countries such as Italy, Germany and United States as income increases, people waste more food because their food expenditure is only a small portion of their total income (e.g. only approximately 6% in the United States of America) (Pearson *et al.*, 2013) and thus the effect of wasting food which has been bought does not affect their disposable finances to any significant degree (Pearson *et al.,* 2013).

In developed countries, food is not expensive compared to other personal expenses, such as housing and cars, as the result people feel little effects from discarding food whenever they want to (Pearson *et al.*, 2013). In contrast, some developing countries are shown to also have high expenditures on food. For example, in 2012 households in Pakistan spent 48% of their net income on food; while in the same year households in Cameroon spent 46% (Pearson *et al.,* 2013). It is this careless attitude and behaviour of consumers that lead to household food waste (Gustavsson *et al.,* 2013).

Some research suggests that employment status has an influence on food waste generation (Secondi *et al.,* 2015; Grasso *et al.,* 2019). Lyndhurst *et al.* (2007) reveal that in the United Kingdom, people who are not working (parents/maternity) generate more food waste than those who are full-time or part-time workers (Figure 4). The results show that people in the United Kingdom who are not working throw away about 45% food, while those who work full-time throw away about 32% and those who work part-time 35%. An explanation for this is that people who work do not spend most of their time at home, therefore are unlikely to waste food.

Whereas people who do not work spend more time at home doing house chores and preparing more food than they need. Worth noting is that other studies report different findings. For example, Secondi *et al.* (2015); Grasso *et al.* (2019) reported that in their studies people who were unemployed wasted less food than those who were employed full-time.

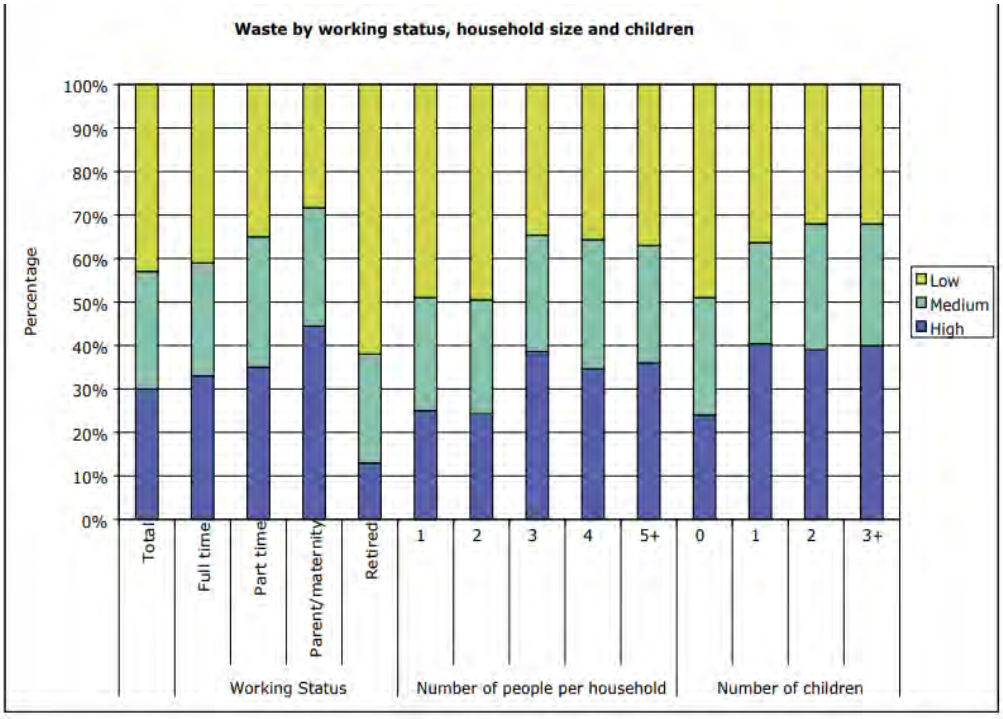



Figure 4: Variations of household food waste by working status, household size and children in the United Kingdom (Taken from Lyndhurst *et al.* (2007)).

Food prices may also affect household food waste generation. This is because consumers are drawn to food special offers, such as "buy one get one free" marketing strategies (Jörissen *et al.*, 2015). For example, households that tend to buy discounted food products waste less compared to those who do not (about 145 g per person/week food is wasted in Karlsruhe and about 140 g per person/week in Ispra). However, this phenomenon is different across countries, with the discount in food prices often leading to increased amounts of food thrown away (Quested *et al.,* 2013). The latter can be explained by the association between 'discounted food' and 'close expiring date' which tends to increase the chances for food spoilage if not used on the day of purchase.

### *1.1.2. Types of food wasted*

Although there are multiple, complex and interacting drivers of food waste, there are also specific types of food that are more likely to be wasted than others at the household level. For example, Beretta *et al.* (2013) highlight that in Swedish households, the food types with the highest losses include eggs (64%), unprocessed vegetables (40%), and pastries and bread (32%). Meanwhile, amongst Norwegian households, fruits and vegetables contribute 24% of edible food waste, bakery products (mostly bread) 27%, fish and meat 8%, prepared food wasted 22%, and the rest of the food wasted 22% (Hansen *et al.,* 2004).

While the types of food wasted vary from one county to the other, and between households, most studies reveal that perishable food items such as bread, vegetables, and leftovers of prepared food appear to be the most commonly wasted food types between developed and developing countries (Pekcan *et al.,* 2006; Quested *et al.,* 2013; Langley *et al.,* 2010; Ventour, 2008). For example, Chakona and Shackleton (2017) found that in mid-sized South African towns, households waste 27% of prepared food. Cronjé *et al.* (2018) found that in Kimberly, in the Northern Cape province of South Africa, respondents mostly discard bananas (42%), followed by leftovers (34%), dairy products (30%), tomatoes (27%), and bread (25%) (Table 3).

The observed differences in the figures of the different types of food wasted can be associated with several reasons, each specific to a country and between developed and developing countries. For example, Cronjé *et al.* (2018) reported that households in Kimberly, throw away leftovers and bread because they require to be refrigerated or properly stored, and many low-income households do not have refrigerators or lack the ability to create alternative meals out of leftovers.

This coincides with findings of Ramukhwatho *et al.* (2014), who reported that low income contributes to food waste; households who received less than R5 000 per month wasted more than those with a higher income. In an essence, the living conditions of the poor make it difficult for them to preserve the different types of food that require good storage or food preservation facilities. Cronjé *et al.* (2018) state that low-income households often buy in bulk, including vegetables and fruits which require proper storage facilities, which some low-income households lack.

The type of household food waste is associated with emotional judgement and morals. This is supported by Rozin (2014) who argue that people's value for different food types is influenced by their distinct cultures. Meaning that, people are most likely to discard food types that are of less importance to their culture. For example, in a country like Australia with limited food traditions, the amount of food wasted is high (Strasser, 1999) because people have relatively few food types that they place value on.

Evans (2012) argue that socio-demographic factors affect not only the quantity of food wasted, but also the types and their relative contributions. For example, households with more children present, are likely to waste more vegetables and fruits because children are selective with regards to consuming vegetables and fruits, subsequently increasing the amounts of vegetables and fruits discarded (Evans, 2012). One can, therefore, argue that the types of food discarded in households between and within countries will always vary due to cultural, socio-demographic, policies and economic differences.

Table 3: Types of food products wasted by 10% or more in Kimberly households in descending order (Adapted from Cronjé *et al.* (2018)

| **Fruit** | **(%)** | **Vegetables (%)** | **(%)** | **Other food products** | **(%)** |
|---|---|---|---|---|---|
| Bananas | 42% | Tomatoes | 27% | Leftovers | 34% |
| Apples | 20% | Potatoes | 17% | Milk and dairy products | 30% |
| Avocado | 8% | Cabbage | 12% | Bread | 25% |
| | | Lettuce | 5% | | |

### *1.1.3. Food waste in South Africa*

Food waste is becoming a significant issue in South Africa (Nahman *et al.,* 2012; Oelofse *et al.,* 2020; Phasha *et al.,* 2020). This is attributed to consumer behaviour (Chakona and Shackleton, 2017; Ponis *et al.,* 2017). According to Ramukhwatho *et al.* (2018) and Oelofse *et al.* (2020) the common drivers influencing food waste, specifically household food waste, generation in South Africa include poor storage, cooking too much food, buying too many food items, poor purchasing, and buying food items 'on special'. The reasons mentioned by Ramukhwatho *et al.* (2018) are like those identified in developed countries. For example, WRAP (2013) shows that in the United Kingdom, household food waste was attributed to shopping frequency, which resulted in buying too many items.

Ramukhwatho *et al.* (2018) and WRAP (2013) found that while larger households waste more food in terms of volume in South Africa, single-person households waste more food per capita. The reasons for this phenomenon are single-person households tend to waste more food per person because they cooked or bought more food than they need. Furthermore, Chakona and Shackleton (2017) specifically identified financial status, storage and cooling facilities to be the driving forces behind food waste in the rural areas of South Africa.

Nahman *et al.* (2012) concluded that the total amount of food waste generated by South African households is 1.4 million tonnes per annum (Table 4). Meanwhile, Oelofse and Nahman (2013) concluded that the amount of food waste in South Africa is 177 kg/capita/year. In contrast, Chakona and Shackleton (2017) reported that the average per capita food wasted at household level is approximately 32-66 kg/capita/year. Ramukhwatho *et al.* (2014) found that on average, South African households dispose about 24 kg food on a weekly basis. This shows that South Africa has a food waste challenge and that estimates are subject to methodological variations within ongoing research.

Ramukhwatho *et al.* (2018) argue that the average amount of food wasted per capita by South African households is less than households in the United Kingdom. This is supported by WRAP (2009) which reveal that households in the United Kingdom discard more than 62 kg of food on a weekly basis. This difference is likely to be because South Africa is a developing country, and the United Kingdom a developed country, and the people in the latter generally throw away more food because (1) it is not expensive and (2) they can afford to purchase more food whenever they need (Pearson *et al.,* 2013).

Given the extent of household food waste in South Africa, the country is experiencing substantial negative consequences from the waste stream in landfills (Friedrich, 2013). Chakona and Shackleton (2017) highlight that the cost of household food disposal to landfills is estimated to amount to R505 million per annum. While this is an alarming cost, it is not the only cost associated with household food disposal to landfills, because there are also climate-related costs. These include the release of methane, from decomposing food in landfills, which in turn affects climate systems. For example, in South Africa, the disposal of waste (including food waste) to landfills contributes about 4.3% to South Africa's greenhouse gas emissions (DEA, 2011). Further, food waste increases the environmental effects of agriculture on climate, biodiversity, soils, atmosphere and water bodies (Garske *et al.,* 2020).

Although some studies such as those of Nahman *et al.* (2012), Ramukhwatho *et al.* (2014), Oelofse and Marx-Pienaar (2016), Chakona and Shackleton (2017) and Ramukhwatho *et al.* (2018) have critically investigated food waste in South Africa, they are pitifully few. Consequently, there is still little critical and predictive insight into the amounts of food waste and the drivers of food waste among South African households. Additionally, there is no insight on household food waste minimisation strategies. Therefore, it is in this regard that this study will seek to understand the drivers of food waste, types and quantities of food wasted, and food minimisation strategies in a South African context.

Table 4: Estimated total amounts of household food waste generated annually in South Africa (Adapted from Nahman *et al.* (2012))

| **Income level** | **Food wasted (%)** | **Annual food wasted (tonnes)** |
|---|---|---|
| Low | 18.1 | 1,012,688 |
| Middle | 11.0 | 321,0577 |
| High | 9.6 | 104,0713 |
| Total | | 1,438,977 |

### *1.1.4. Food waste minimisation*

Food waste is a waste stream that is important in terms of its minimisation potential (Abeliotis *et al.,* 2015; Abeliotis *et al.,* 2016), especially with regards to climate change mitigation potential. Further, food waste ranks the highest in terms of waste prevention potential. This is because food waste minimisation can be implemented at various stages of a food chain, such as in industry, retail and households (Salhofer *et al.,* 2008). Focusing specifically on households, there are plenty of waste minimisation initiatives that may be implemented.

Following Abeliotis *et al.* (2016), food waste minimisation refers to a strict reduction in the amount of food wasted at source (i.e., reuse of food material). Minimising the quantities of household food waste is key to sustainable food systems and minimising greenhouse gas contributions. For example, in the United Kingdom, the greatest contribution to food waste is from households; 8.3 million tonnes per annum, contributing 3% of the United Kingdom's greenhouse gas emissions (Quested *et al.,* 2013).

For this reason, minimising the amount of food discarded has greater environmental benefits than food waste treatment at landfills. In addition, each tonne of food waste minimised leads

to 4.2 tonnes of greenhouse gas emissions avoided (WRAP, 2009). Therefore, household food waste minimisation is necessary in limiting methane gas emissions and thus, mitigating climate change.

#### *1.1.4.1.Consumer engagement in minimising food waste in households*

Quested *et al.* (2013) state that in 2007, Waste and Resources Action Programme (WRAP) established the Love Food Hate Waste campaign to allow for consumers to engage with the challenge of food waste. The aim of the campaign was to raise awareness regarding food waste as a problem and the benefits associated with minimising the quantity of food discarded. This was done to create conviction among consumers and to allow them to make suggestions on methods for minimising food waste. Today, the campaign functions across all four nations of the United Kingdom, engaging with consumers, local authorities, grocery retailers, food manufacturers and local communities (Quested *et al.,* 2013).

An example of activities the campaign conducts includes (Table 5) extensive media coverage of food waste in the United Kingdom where consumers are taught about food waste and provided with general advice and tips to minimise food waste. For example, advice is given around date labels and catering for large numbers of people during events, such as Christmas (Quested *et al.,* 2013). In addition, grocery retailers run large campaigns to their customers around issues such as support for food minimisation through in-store and online communications. Local authorities run Love Food Hate Waste programmes that provide local communities with skills to minimise food waste through recipe competitions and cookery demonstrations. The campaign also includes a partnership between the Women's Institute and Love Food Hate Waste, which has been helping communities develop confidence around food, and be aware of the consequences of wasting more and the benefits of wasting less (Quested *et al.,* 2013).

Such campaigns may be effective in any context, including South Africa because people need to learn to prepare enough food for the day and be alerted to food labelling. This will help avoid unnecessary food waste, which is often a result of buying food products which are close to the expiry date. Additionally, when people are made aware of the consequences of wasting food, they voluntarily change their food waste behaviours.

Table 5: Summary of household food waste minimisation strategies through engagement with consumers (Adapted from Quested *et al.* (2013))

| **Strategies** | **Activities** |
|---|---|
| Extensive media coverage | Providing tips and advice around food waste |
| Grocery retailers running large campaigns to customers | Providing in-store and online educational activities to customers |
| Local authorities running Love Food Hate Waste programmes | Recipe competitions and cookery demonstrations |
| Partnership between Women's Institute and Love Food Hate Waste | Assist with community engagement and help customers build confidence regarding food waste consequences and benefits of wasting less |

#### *1.1.4.2.Minimising food waste through collaboration with manufacturers and retailers*

WRAP also works with a number of stakeholders to make changes to retail environments (Table 6) (Quested *et al.,* 2013).This approach supports both manufacturers and retailers in helping consumers purchase what they need, and consume all of the food they buy and therefore waste less. According to WRAP (2011), informative changes made to food packaging, labelling and promotion can reinforce the need for behaviour change regarding food waste.

According to WRAP (2011) this approach seeks to help consumers purchase the right amounts of food. For example, customers are offered reasonable food product sizes and advised on different techniques that minimise the risk of food being discarded (e.g. checking for expiry dates). Moreover, customers are advised by retailers on ways to keep what they buy at its best. For instance, retailers ensure that the product clearly contains storage guidelines. Customers are also advised to use what they purchase, for example, stick to date marks and avoid extending the shelf life of products with the intention to later consume the product (Quested *et al.,* 2013).

Increasing the use of freezers for food materials that are not eaten as planned, but are still within their shelf life, results in less food wastage. WRAP (2010) state that freezing food on the day of purchase before the expiry date leads to less food being thrown away. In addition, consumers are taught the distinction between 'best before' and 'use by' dates. For example, WRAP worked with industries to give clear product guidance on food product date labels. The United Kingdom is the first country to have these recommendations implemented (Quested *et al.,* 2013).

Considering that households in developing countries, such as South Africa, often lack proper storage facilities to keep their food, it may be strategic for manufacturers to educate customers

on different ways to avoid food spoilage. This can be done through their choice of packaging and labelling. Customers mostly have confidence in their retailers and are likely to practice what is included as an "awareness message" on food packages.

Table 6: Summary of household food waste minimisation strategies through engagement with retailers and consumers (Adapted from Quested *et al*. (2013))

| **Strategies** | **Activities** |
|---|---|
| Buying the right food amounts | Offering right food product sizes and using various promotional techniques that minimise food waste |
| Keeping what is bought at its best | Improving food storage labelling guidelines |
| Keeping food that is not going to be eaten as planned in the freezer | Freezing food products on the day of purchase |
| Assisting consumers make a distinction between 'best before' and 'use by' dates | Properly labelling food products and clearly stating the difference between the two to customers |

### *1.1.5. Impact of household food waste minimisation*

According to Quested *et al.* (2013) there is strong evidence that the household food waste minimisation strategies have successfully minimised food wasted in the United Kingdom households. The quantities of food waste collected by local municipalities in the United Kingdom have been reduced by at least 380 000 tonnes between 2006 and 2009 (WRAP, 2010).

Additionally, White *et al.* (2018) suggest that under global warming, a household food waste minimisation is necessary. For example, the previously mentioned estimated 18% methane gas contribution towards global warming per annum (with 8-15% attributed to food waste in landfills), could be significantly reduced if household food waste is minimised. The minimisation of household food waste to avoid food going to landfills is therefore becoming a significant contributor to reducing global warming caused by greenhouse gas emissions (e.g. methane gas emissions) (El-Fadel *et al.,* 1997; DEA, 2011).

### *1.1.6. Methods for quantifying household food waste*

Several studies reveal that there is lack of standardised food waste quantification methodologies (Youngs *et al.,* 1983; Quested *et al.,* 2013; Friedrich, 2013; Cronjé *et al.*, 2018). This lack gives rise to the problem of comparability and inconsistencies in the overall quantities of food wasted on international and national scales (Youngs *et al.,* 1983; Thyberg and Tonjes, 2015). This highlights the need for standardised methodologies to quantify food waste to avoid contradictions and improve comparability between studies on food waste. According to

Thyberg and Tonjes (2015) there are many methods for quantifying food wastage at household level, all of which have both advantages and disadvantages (Figure 5). Methods used to measure food waste are categorised into two groups, namely direct and indirect methods (Lebersorger and Schneider, 2011). Direct measurements involve the direct capturing of the actual quantity of food material wasted. For example, Lebersorger and Schneider (2011) state that the most common direct measuring method is weighing. Elimelech *et al.* (2018) used this method to assess the correlation between self-reports with physical surveys in measuring food waste. Elimelech *et al.* (2018) validated this method by weighing food wasted daily in 192 households in the eastern Haifa (Israel). The results show that household food waste accounted for 45% of the overall waste (573 g/day per capita). However, this method may not give reasons for household food waste.

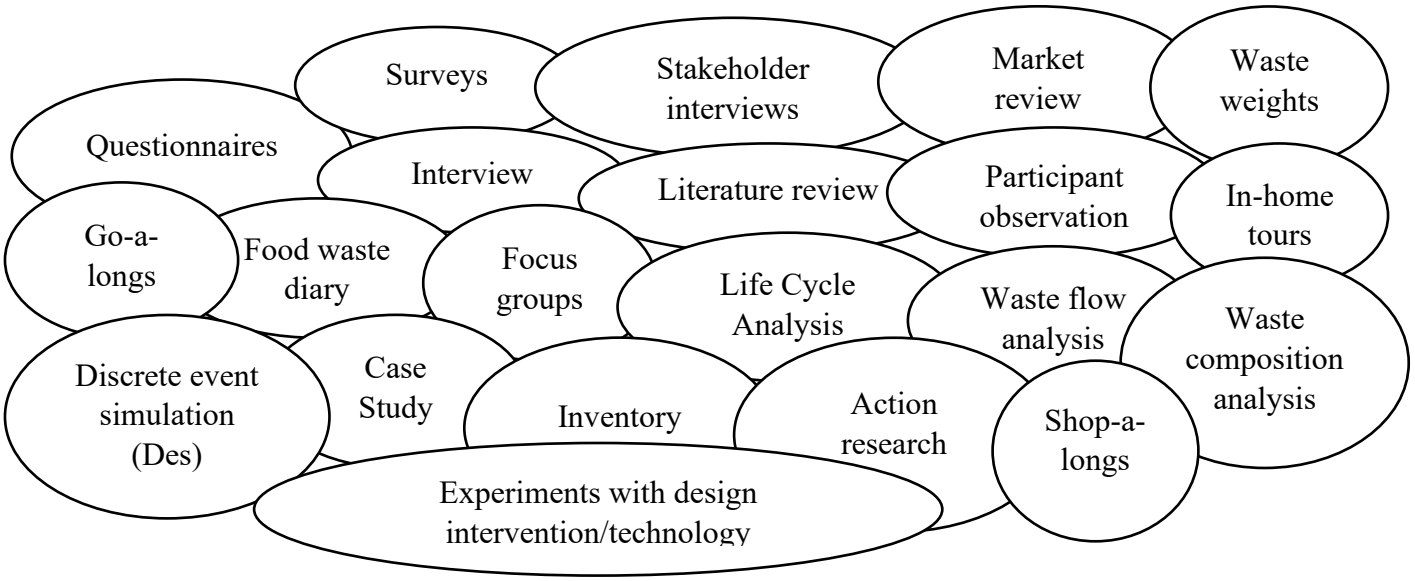



Figure 5: The variety of methods used for quantifying food waste (Adapted from Hebrok and Boks (2017)).

Indirect methods for estimating food waste entail visual estimation and self-estimation (Lebersorger and Schneider, 2011). According to Elimelech *et al.* (2018) self-estimation include diaries, interviews and questionnaire responses. Comstock *et al.* (1979) explain that these indirect measuring methods involve consumers recalling the amount of edible food material they consumed and the amount of food they discarded. Visual estimation involves collecting data using trained waste investigators to evaluate the amount of food wasted by way of observation (Comstock *et al.*, 1979). While this method is able to elicit the reasons for discarding food and tracing the food waste source, it lacks objectivity when it comes to giving

unbiased results because the results are not necessarily based on what participants waste, but what they recall they waste.

Many studies in South Africa have used indirect methods (Nahman *et al.,* 2012; Oelofse and Nahman, 2013; Ramukhwatho *et al.,* 2014; Chakona and Shackleton, 2017; Cronjé *et al.,* 2018; Ramukhwatho *et al.,* 2018). However, Elimelech *et al.* (2018) and Thyberg *et al.* (2016) argue that quantifying household food waste is essential for informing waste policies and setting food waste minimisation goals. Therefore, using more direct methods for quantifying food wasted is vital.

Moreover, the lack of standardised methods for measuring food wasted at household level leaves significant data gaps and people's reluctance to change in many countries. For example, in South Africa estimates reveal that the financial implication of household food waste is approximately R21.7 billion per year (0.82% of South Africa's GDP) (Nahman *et al.,* 2012). Yet people remain reluctant to change. For example, questionnaires can provide a deeper understanding of how people's shopping habits and behaviours are interconnected and result in either food waste at household level than a survey will. Hebrok and Boks (2017) state that surveys give a general idea of whether people waste food or not. Whereas, questionnaires give answers to the specific causes behind wasting or not wasting food at all.

In addition, shop-a-longs and in-home tours may provide answers to the specific behaviours behind household food waste. Hebrok and Boks (2017) argues that assessing household food waste alone is not enough to understand why people actually waste food; and to assist them minimise their waste, what they waste and how much of it is as important in order to develop action plans. Therefore, methods such as food waste weights, experiments with design intervention/ technology, food waste diary and action research (Figure 5) become a necessity.

## 1.2. RESEARCH PROBLEM STATEMENT AND OBJECTIVES

Studies from developed countries reveal that food waste undermines efforts to combat climate-change related issues (El-Fadel *et al.*, 1997; Adhikari *et al.,* 2006; Quested *et al.,* 2013). However, there are relatively few studies with empirical information on food waste in Global South countries, particularly in relation to household food waste (Chakona and Shackleton, 2017). Moreover, there remains few studies from the Global South that have investigated food

waste minimisation strategies, including in South Africa. Thus, there is a need for more empirical studies and understanding of the dynamics of household food waste in terms of quantities and types, drivers of food waste behaviours, and food waste minimisation strategies.

This implies that the contribution of household food waste to national and global GHG emissions is under-considered in South Africa. Therefore, it is of paramount importance that food waste is minimised at source (the focus of this research) to ensure that people are aware of what food waste is and how landfilled food impacts negatively to climate systems. According to Alooh (2015) food waste source minimisation includes strategies and plans that minimise food waste generated during food preparation and consumption in households. The author further asserts that the successful implementation of these strategies requires accurate data on the quantity of food wasted in households, which is echoed by Chakona and Shackleton (2017) who examined the quantity of household food waste in three mid-sized South African towns and Oelofse *et al.* (2018) who looked at household food waste disposal in South Africa (using Johannesburg and Ekurhuleni as points of reference). Therefore, this research will contribute to household food waste estimates in South Africa and consider the strategies for household food waste minimisation.

The aim of this study was to examine the types and quantities of food wasted at households and to investigate the extent to which households implement anti-waste strategies to attempt to fight against food waste generation. The following three objectives were considered:

- To assess and quantify household food waste.
- To assess to the drivers of household food waste generation.
- To investigate household food waste minimisation strategies.
-

## 1.3. STRUCTURE OF THE THESIS

The thesis is divided into four chapters. The first chapter is presenting a general introduction on global and national food waste, and a specific focus on household food waste drivers, minimisation and the potential for methane gas emissions from household food waste. Firstly, this chapter presents empirical information from literature on the drivers, and quantities of food waste generated and disposed. In addition, the chapter presents information on the specific methods used in literature to assess and quantify household food waste. This chapter also provides a review of anti-food waste strategies, and general implications of food waste on the

global climate systems. A review of methods for assessing and quantifying food waste are also presented. Lastly, problem statement, research aims and objectives, and significance of the study are also covered in this chapter.

The second chapter deals with an overview of shopping and household food waste behaviour between and within two towns. Further, the chapter reflects on the significant differences in shopping and household food waste behaviour between households from the affluent, middle and low-income suburbs. The times that households are most likely to discard food and the points of interventions are presented further in the chapter. The chapter then introduces the reasons households from different income suburbs waste food. This chapter then presents the details in respect to the aims and objectives.

The third chapter deals with the types and quantities of food waste generated and disposed between and within the two towns. The different income suburbs are used to assess whether there are any significant differences in the amounts of food wasted between households from the affluent, middle and low-income suburbs. The chapter further presents the differences in the self-reported and weighed food waste quantities. This chapter then presents details on the state of anti-food waste strategies between and within the two towns and the challenges that hinder effective implementation.

Chapter 4 combines the findings from chapter 2 and 3. The chapter also provides a summary and an integrated conclusion. Recommendations for future research are also presented in chapter 4.

## 1.4. STUDY AREA

This study was conducted in Cradock and Middelburg, which are two small towns located in the Eastern Cape province of South Africa (Figure 6).

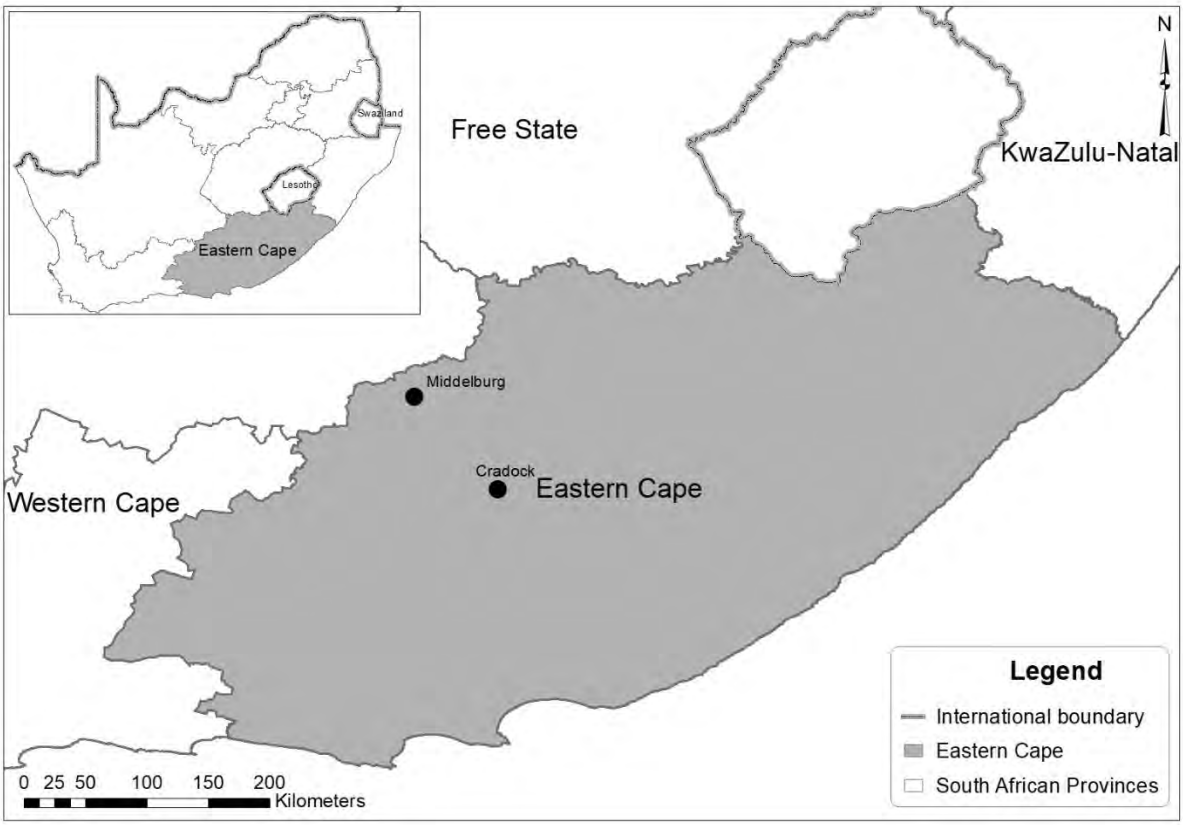



Figure 6: Location of Cradock and Middelburg in the Eastern Cape province, South Africa (Made using ArcGIS).

In addition to the two towns falling under the same municipality, Cradock and Middelburg are both known as poorly developed towns in the Eastern Cape province of South Africa. As such, the two towns were selected for a comparative study, and to present a case of each town when it comes to household food waste quantities, reasons for food waste, and contextual factors such as socio-demographic and economic dynamics affecting household food waste. Cradock and Middelburg also present a perfect example of typical Eastern Cape towns, with reported lack of household refuse removal and general lack of solid waste management by local authorities (IDP, 2017-2022; CHDM, 2018).

Littering and illegal dumping of household waste within urban open spaces is fast becoming a norm in both towns (CHDM, 2018). The landfill sites of both towns are poorly managed and lack proper machinery to compact waste (IDP, 2017-2022). Moreover, landfills from both towns are not compliant with the license terms and conditions, i.e. lack of effective plans to prevent pollution from the landfills (IDP, 2017-2022; CHDM, 2018). This has been declared a

serious concern because it has negative impacts on the environment and to the health of residents (CHDM, 2018).

### 1.4.1. Cradock

Cradock lies 259 km by road northeast of Port Elizabeth (CHDM, 2018), and is located (32.1615 S, 25.6481 E) in the upper valley of the Great Fish river. According to Jebe (2018) the town is an agrarian town, formally established in 1814. It has been the centre of agriculture for the Karoo region for over 200 years, with the economy of the town heavily reliant on commercial farming such as the production of wool and livestock, and mohair, to name a few.

Cradock is under the administration of Inxuba Yethemba Local Municipality in the Chris Hani District Municipality (IDP, 2017). The town is made up of three neighbourhood, i.e. Cradock, Lingelihle and Michausdal (all of which have been sampled in this study). The mean annual precipitation is 379 mm, with most occurring during the autumn season. According to IDP (2017) In 2020, the town had a population of 36 671, with the number of females exceeding that of males (Table 8). The town consists of 10 559 households, of which 46% are female headed and 54% are male headed (Stats SA, 2020).

The racial makeup includes Black African (62%), Coloured (25%), White (12%), Indian/ Asian (0.5%), and other (0.5%). Just over half (56%) are isiXhosa speaking, 38% Afrikaans speaking, 4% English speaking, and 2% residents who speak other languages (Stats SA, 2020). Cradock has a high dependency ratio (Table 7) meaning that majority of its population is either depending on the younger generation, or social grants. According to Stats SA (2020) Cradock has more young people compared to elderly people, with 28% young people (0-14 years), 65% working age (15-64 years) and 7% elderly people (65+ years) (Stats SA, 2020). Eleven percent of residents never went to school, only 10% have received higher education and only 24% passed their matric (Stats SA, 2020).

### 1.4.2. Middleburg

Middleburg is located (31.4988 S, 24.9994 E) in the Great Karoo, 279 m above sea level (IDP, 2017-2022). It falls under the same local municipality as Cradock. According to IDP (2017) Middleburg also consists of three neighbourhoods, i.e. Middleburg, KwaNonzame Lusaka and Midros (all of which have been sampled). According to IDP (2017-2020) the town receives a

mean annual precipitation of 372 mm, with a maximum rainfall of 178 mm in summer and 93 mm in autumn. According to Stats SA (2020) in 2020, there were 18 681 persons who live within Middleburg, with more females than males (Table 7).

The town has a total of 5 337 households, of which 45% are female-headed and 55% male-headed (Stats SA, 2020). Black Africans dominated with 49%, followed by Coloureds with 44%, 6% White, 0.5% Indians/ Asians, and 0.5% other races. Almost half (44%) of the residents speak isiXhosa, 52% Afrikaans, 2% English, and 2% speak other languages (Stats SA, 2020). The town has a high dependency ratio (Table 7), with young people (0-14 years) making up 31%, working age (15-64 years) making up 62%, and elderly people (65+ years) making up 6% of the overall population (Stats SA, 2020). Only 6% have received higher education, 20% passed their matric, and 11% of the population never went to school (Stats SA, 2020).

Table 7: Socio-economic characteristics of Cradock and Middelburg

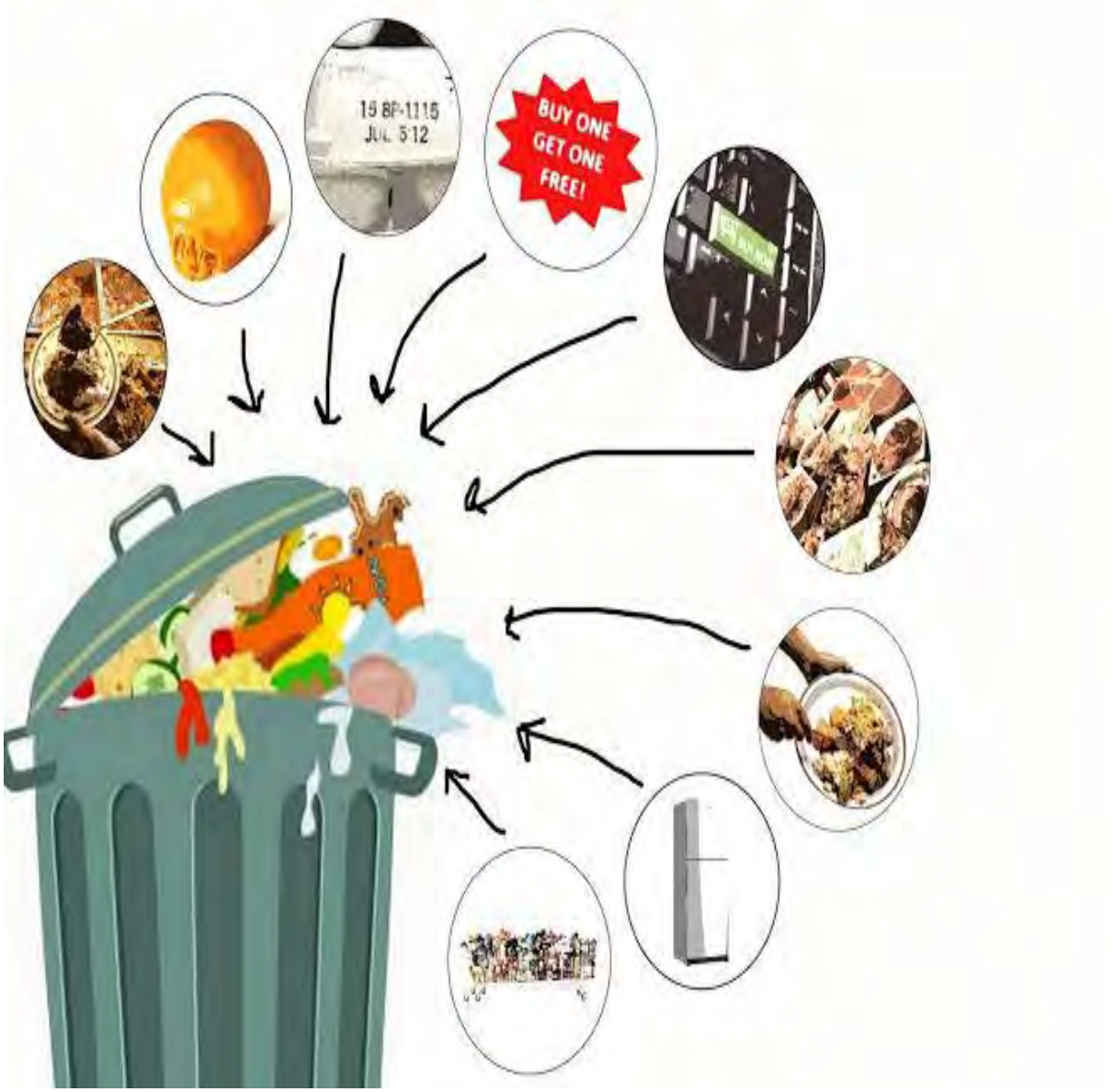
| **Characteristics** | **Cradock** | **Middleburg** |
|---|---|---|
| Population density (persons/ km²) | 291 | 417 |
| Males | 47.5% | 46.8% |
| Females | 52.5% | 53.2% |
| Male headed households | 54% | 55% |
| Female headed households | 46% | 45% |
| % with low household income (≤ R4 800) per month | 4.0% | 5.7% |
| Dependency ratio | 54.5 | 60.7 |
| Average household size (no. of persons) | 3.4 | 3.4 |
| Formal dwellings | 98.2% | 95.4% |
| Weekly refuse removal | 97.4% | 92.2% |

# CHAPTER 2

# DRIVERS OF HOUSEHOLD FOOD WASTE

Image 2: taken from Fusions (2016).

## 2.1. INTRODUCTION




A general concern pertaining to sustainability globally, is the rapidly increasing amounts of edible food wasted at household level (Quested *et al.,* 2013; WRAP, 2011). Subsequently, the Food and Agriculture Organization, among other institutions addressing the issue of food waste, reported that the world will be faced with food scarcity by the year 2050. Therefore, the

United Nations, through the implementation of the Sustainable Development Goals (goal 12.3) aimed to reduce the current global food waste by 2030 (UN, 2013; UN, 2015). In 2011, the FAO reported that about one-third of all food that is produced for human consumption is discarded annually (Steinfeld *et al.,* 2006; Gustavsson *et al.,* 2013). Food waste refers to food that is thrown away at the last stages of the food supply chain, such as at the household level (Gustavsson *et al.,* 2013). This clearly shows that food waste is also linked to human behaviour (Jörissen *et al.,* 2015; Cronjé *et al.,* 2018; Ramukhwatho *et al.,* 2018).

Various studies have investigated the drivers of household food waste in an attempt to work together with the United Nations in developing context-based interventions, such as in Germany and Italy (Jörissen *et al.,* 2015), Denmark (Stancu *et al.,* 2016), Greece (Ponis *et al.,* 2017), Israel (Elimelech *et al.,* 2018), and South Africa (Oelofse and Pienaar, 2016; Chakona and Shackleton, 2017; Venter, 2017; Cronjé *et al.,* 2018; Ramukhwatho *et al.,* 2018). However, despite the growing interest in food waste globally, there remains a gap in understanding the nature and magnitude of the drivers of household food waste. An examination of these drivers in various contexts is necessary to provide insight into the variation and thereby effective and flexible policies for minimising household food waste (Thyberg and Tonjes, 2016).

According to Diaz-Ruiz *et al.* (2018), household food waste drivers are divided into five categories, namely (1) unnecessary food purchasing; (2) lack of food storage; (3) over-preparation of food; (4) less food consumption which leads to leftover food, and (5) careless lifestyle of household members in relation to food. Some studies further grouped the afore-mentioned into two categories; i.e. consumer wasting behaviours when shopping, and those at home (Jörissen *et al.,* 2015; Ramukhwatho *et al.,* 2016; Chakona and Shackleton, 2017; Aschemann-Witzel *et al.,* 2018). The behaviours related to shopping include not using shopping lists (Ramukhwatho *et al.,* 2014), increased shopping frequency, buying more food than needed because of special offers, the inability to distinguish between "Use by" and "Best before" dates (Graham-Rowe *et al.*, 2014; Jörissen *et al.*, 2015) and excessive food purchasing (WRAP 2007; Parfitt *et al.,* 2010; Diaz-Ruiz *et al.,* 2018).

In terms of consumer behaviour at home, poor meal planning and food dislikes are the most identified drivers (Stefen *et al.,* 2013; HLPE, 2014; Parizeau *et al.,* 2015; Mallinson *et al.,* 2016). Porpino *et al.* (2015) also identified over-preparation of food and avoidance of use of leftover foods as antecedents of food waste in low-income households in Brazil. This is because some view leftover food as "psychologically contaminated" (Rozin, 2014), so many people

often avoid eating leftovers. Additionally, Porpino *et al.* (2015) and Mallinson *et al.* (2016) revealed that leaving food too long in the fridge or in the cupboard is also a behaviour that counteracts efforts to minimise the amounts of food wasted.

In South Africa several drivers of household food waste have been identified. One is a lack of proper storage to preserve food from spoiling (Chakona and Shackleton, 2017; Ramukhwatho *et al.,* 2018). Additionally, Ramukhwatho *et al.* (2018) reported that some households in Pretoria threw away food because of misaligned shopping behaviours, such as falling for special offers or buying more food than they need. This culture has led to many households discarding large amounts of food, especially vegetables and fruits, because they generally have a short shelf-life and require proper storage, which many households in South Africa lack (Cronjé *et al.,* 2018). Cronjé *et al.* (2018) also determined purchasing in bulk, purchasing incorrect food items, and the tendency to not eat leftovers as common drivers of food waste.

In terms of consumer behaviours at home, Cronjé *et al.* (2018) found that a lack of meal planning among households in Kimberly, South Africa, was prevalent (70%) and this behaviour contributed significantly to food waste generation. The behaviours contributing to food waste among mid-sized towns in KwaZulu-Natal were either cooking too much food or being unable to save leftovers (Chakona and Shackleton, 2017), with similar behaviours reported in urban middle to high-income households in Tshwane (Oelofse and Pienaar, 2016). Furthermore, Oelofse and Pienaar (2016) reported avoidance of unappealing food; consumers' concerns about the safety of family members regarding certain purchased food products and lack of information about the perishability of certain food products, were also among the behaviours at home, which have influenced food waste generation in South African households.

While the above-mentioned South African studies investigated the drivers of food waste, they are mostly from large cities and none from the Eastern Cape. Taking account of the evident limitation in primary household food waste data within South Africa, and a need to ensure the development of effective interventions for households, Cronjé *et al.* (2018) argue that more research is required on the drivers of household food waste across the country (Cronjé *et al.,* 2018).

### *2.1.1. Aims and Objectives*

Centred on the reviewed food waste literature, the aim of this study is to assess household food waste in urban households in the Eastern Cape province. To fulfil this aim, the study addressed the following objectives:

- Explore whether there are any significant differences in food shopping behaviours between towns and within the suburbs.
- Explore whether there are any significant differences in household food waste behaviours between towns and within the suburbs.
- Explore the relationship between the explored food shopping and household food waste behaviours and household characteristics such as gender, age, number of children, employment status, number of people employed, wealth status, household size, social grants.

As such, the focus of this study was to investigate the drivers of and the reasons for food waste among low-income, middle-income and the affluent suburbs in the Eastern Cape province of South Africa. Shopping patterns, household food waste behaviours were also investigated. It was hypothesised that:

- Households in the affluent suburbs would purchase food more frequently compared to their counterparts, in the low-income suburbs.
- Households in the affluent suburbs would have a higher proportion of people using shopping lists when buying food.
- Households in the low-income suburbs would have a higher number of people growing some food because of limited cash resources.
- A larger proportion of households buying discounted food would be from the low-income suburbs.
- A larger proportion of households with people who are knowledgeable about the distinction between “Use by” and “Best before’ date would be from the affluent suburbs.

## 2.2. METHODS

This study made use of household questionnaires to collect data on the drivers of and reasons for household food waste in suburbs of different socio-economic status. The study design and questionnaire received ethics clearance by Rhodes University Ethics Committee (RUESC), with the following ethics code:1047.

### *2.2.1. Sampling*

Data was collected in two secondary towns, Cradock, and Middelburg. Using aerial photos and Google Earth, each residential suburb was delineated into one of the three income categories. Thereafter, a 100 X 100 m grid was superimposed using ArcGIS. Grid squares were then numbered, and a random selection was drawn per suburb.

The target minimum sample size to represent Cradock was 371 households and for Middelburg was 358, based on a 95% confidence level and 5% margin of error. However, not all randomly selected households agreed to participate in the survey in both towns, leaving a total of 285 and 249 participant households in Cradock and Middelburg, respectively.

Within Cradock, 91 households were from the affluent suburb (town area), 98 from the middle-income suburb (Michausdal), and 96 from the low-income suburb (Lingelihle). In Middelburg, a total of 83 households were sampled per suburb, the affluent suburb (town area), middle-income suburb (Midros), and low-income suburbs (KwaNonzame and Lusaka). However, for the ease of reporting in this study, the low-income suburb in Middelburg is referred to as "KwaNonzame".

### *2.2.2. Data collection*

Household questionnaires (Appendix A) were administered to the randomly selected households between January and February 2020. The sample households were individually approached and requested to participate. At each household, the researcher began with a greeting and requested permission to enter the household. This was followed by seeking for consent, a statement clearly explaining the purpose of the visit, and that personal details of respondents (i.e., names, contact details, etc) would not be gathered. Studies reveal that people who purchase food and those who are responsible for preparing meals at home generally have enough knowledge of the amounts of food consumed or discarded within households (Chakona

and Shackleton, 2017; Cronjé *et al.,* 2018). Therefore, a request to speak with someone who was either responsible for purchasing food, or preparing it, was made.

The administered questionnaires were written in English. However, participants were interviewed in their preferred language, which was mostly isiXhosa or Afrikaans in the poor and middle-income suburbs, and Afrikaans or English in the affluent suburbs. The questionnaire consisted of three sections. The first section investigated household shopping patterns. The second section investigated the causes of food waste, types of food wasted and the quantities of wasted food. The last section captured the socio-demographic and socio-economic attributes of the household.

To calculate household wealth status, the number of selected household assets were summed to give the total number of assets per household, including television, fridge, cell phone, vehicle, water tank, and the Hi-Fi system. The sum of the assets owned per household was divided by the highest sum of assets for a given household. Any value <0.4 was classified as poor, 0.4-0.6 (middle), and >0.6 (wealthy). For example, there were six assets included in this study. Therefore, if a household had two of the six assets, the wealth index was 0.33 and the household would be classified as poor.

### *2.2.3. Data analysis*

Microsoft Excel was used to capture and clean the raw data, and statistical analyses were performed using STATISTICA version 13 (StatSoft Inc). Descriptive data are presented as means and standard deviations, and statistical significance was at $p < 0.05$ for all tests. Proportional data was analysed using Chi-square analysis. After testing for normality of data, differences in continuous variables between and within the investigated towns were analysed using Friedman's test.

In cases where differences in continuous variables were detected, a Dunn's post-hoc analysis was conducted to identify which were statistically different from one another. A Cluster Analysis was used to identify different groups regarding shopping habits and household habits regarding household food waste. Wards minimum variance method was used to group clusters according to the shortest distance to the next cluster. The rationale for choosing this method is that it could identify the strongest clustering structure. Variables that fell within the same cluster were considered more related to one another than in different clusters.

## 2.3. RESULTS

### *2.3.1. Sample description*

The demographic profiles of respondents from Cradock and Middelburg are presented in Table 8. In both towns, the total number of female respondents surpassed that of male respondents, accounting for an average of 77% and 23%, respectively. The respondents' mean age ranged from 42±13 to 48±13 years. In both towns, respondents had mostly secondary education (grade 9-11) as their highest level of education. In terms of employment status, 42% of the respondents were unemployed. Overall, about 65% of the respondent households were poor, with Middelburg having a higher percentage of poor households compared to Cradock. Household size ranged from 3±1.5 to 5±2.3 persons across the study sites.

Table 8: Profile of respondents in Cradock and Middelburg per income level suburb (n= 534)

| **Variable** | | **Cradock (n= 285)** | | | **Middelburg (n=249)** | | | **Mean** |
|---|---|---|---|---|---|---|---|---|
| | | **Low** | **Middle** | **Affluent** | **Low** | **Middle** | **Affluent** | |
| Gender (%) | Male | 30 | 37 | 21 | 8 | 23 | 20 | 23 |
| | Female | 70 | 63 | 79 | 92 | 77 | 80 | 77 |
| Age | (mean± SD) (year) | 45±17.7 | 46±14. | 48±1 | 47±12.6 | 43±15.6 | 42±13 | 45±14.7 |
| Education level (%) | None | 4 | 1 | 0 | 1 | 12 | 0 | 3 |
| | Primary | 24 | 12 | 0 | 18 | 24 | 30 | 18 |
| | Secondary | 44 | 60 | 22 | 46 | 44 | 51 | 45 |
| | Matric | 25 | 20 | 69 | 29 | 19 | 17 | 29 |
| | Tertiary | 3 | 7 | 9 | 6 | 1 | 2 | 5 |
| Employment status (%) | Full-time | 6 | 20 | 62 | 49 | 23 | 43 | 34 |
| | Part-time | 7 | 14 | 2 | 10 | 24 | 21 | 13 |
| | Retired | 3 | 14 | 14 | 2 | 12 | 12 | 10 |
| | Unemployed | 83 | 51 | 22 | 39 | 37 | 23 | 42 |
| | Scholar | 1 | 0 | 0 | 0 | 4 | 1 | 1 |
| People employed | (mean± SD) (No. per household) | 1±1 | 1±1 | 1±1 | 1±0.7 | 1±1 | 1±0.9 | 1±1 |
| Wealth status (%) | Poor | 83 | 56 | 35 | 93 | 75 | 45 | 65 |
| | Middle | 14 | 33 | 20 | 7 | 24 | 8 | 17 |
| | Wealthy | 3 | 11 | 45 | 0 | 1 | 47 | 18 |
| Household size | (mean± SD) (No. per household) | 4±2.36 | 5±2.3 | 3±1.5 | 4±3.7 | 4±2.2 | 5±2.1 | 4±2.5 |
| No. of children | (mean± SD) | 2±1.7 | 2±1.6 | 1±0.8 | 1±1.3 | 1±1.6 | 2±1.5 | 1±1.5 |
| Social grants | (mean± SD) (no. per household) | 1.9±1.71 | 1.8±1.7 | 0.5±0.7 | 1.6±1.6 | 1.6±1.9 | 0.2±0.7 | 1.6±1.7 |

### *2.3.2. Household shopping patterns*

Most respondents in both towns purchased food once a month. Whereas, within the towns, it was observed that the respondents in the affluent suburb in Cradock mostly purchased food weekly, while the respondents in the affluent suburb in Middelburg purchased food fortnightly (Table 9). Significant differences were found in the frequency of shopping between ($\mathcal{X}^2$= 5.56; p<0.05= 41.0; p<0.05) and within the towns ($\mathcal{X}^2$= 55.2; p<0.05). Post-hoc comparison showed that Cradock households bought food more frequently than Middelburg. Within towns, households in the affluent suburbs bought food more frequently than in middle and low-income areas (p<0.05).

Table 9: The frequency of food purchasing in three wealth classes in two towns (n=534) *(Note: All the values in the table above are indicated as % of households. The different subscripts show significant differences in the frequency of food shopping within towns)*

| **Town** | **Suburb income** | **Daily** | **Biweekly** | **Weekly** | **Fortnightly** | **Monthly** |
|---|---|---|---|---|---|---|
| Cradock | Overall | 9 | 8 | 15 [a] | 16 | 52 |
| | Affluent | 21 | 18 | 36 | 13 | 12 [b] |
| | Middle | 1 | 2 | 6 | 20 | 71 [a] |
| | Low | 4 | 3 | 4 | 14 | 75 [a] |
| Middelburg | Overall | 2 | 1 | 1 [b] | 21 | 75 |
| | Affluent | 0 | 1 | 2 | 44 | 53 |
| | Middle | 7 | 1 | 0 | 8 | 84 [a] |
| | Low | 0 | 0 | 0 | 10 | 90 [a] |
| Mean | | 5.5 | 4.5 | 8 | 18.5 | 63.5 |

A minority (16% of the respondents in Cradock and 41% in Middelburg) declared that they used a shopping list whenever they purchased food. The results showed that a larger proportion (60%) of the respondents in Cradock and 47% in Middelburg did not use it, while the rest of the respondents (24% in Cradock and 12% in Middelburg) indicated that they used a shopping list "sometimes". Altogether, there were significant differences in the percentage of households that made use of shopping lists between towns ($\mathcal{X}^2$= 13.7; p<0.05). and between the suburbs ($\mathcal{X}^2$= 21.4; p<0.05); where households in the affluent suburbs in Cradock and Middelburg had the highest percentages (59% and 40%) for the use of a shopping list compared to those in the low-income suburbs (19% and 36%) and the middle-income suburbs (14% and 24%) (p<0.05).

Similar trends were observed regarding the purchasing of discounted food products between the towns; with more than 60% of respondents in all suburbs indicating that they bought food because of special offers. Households in Middelburg had the highest percentage for purchasing discounted food (85%) compared to Cradock (75%) ($\mathcal{X}^2$= 13.1; p<0.05). Significant differences were also observed between the suburbs ($\mathcal{X}^2$= 14.5; p<0.05); where the low-income suburb in Middelburg had a significantly higher percentage (92%) of households that purchased food that was on special offers; and the low-income suburb in Cradock having the least percentage (65%).

More than 80% of the respondents from the low-income suburbs in both towns were unable to distinguish between "Use by" and "Best before" dates. In contrast, more than 70% of respondents from the affluent suburbs were knowledgeable about these terms. However, no significant differences in the proportions of respondents that could distinguish the above-mentioned terms ($\mathcal{X}^2$= 1.2; p<0.05) were detectable between Cradock (54%) and Middelburg (58%). Between the suburbs, the results revealed that households in the affluent suburbs in Cradock (76%) and in Middelburg (72%) had significantly higher percentages compared to those in the low-income suburbs (9% and 19%) and in the middle-income suburb in Middelburg (35%) ($\mathcal{X}^2$= 5.4; p<0.05)

More than 50% of the respondents who declared that they checked for the "Use by" and "Best before" dates when purchasing food products were from the affluent suburb in Middelburg and from the middle-income suburbs of both towns. Significant differences were observed between the percentages of households that checked the expiry dates between the towns ($\mathcal{X}^2$= 26.4; p<0.05), as well as between the suburbs within the towns ($\mathcal{X}^2$= 52; 2, p<0.05). The post-hoc analysis showed that Middelburg had a significantly higher percentage (56%) of households that checked for expiry dates than those in Cradock (47%). Within the towns, the middle-income suburb of Cradock had a relatively higher proportion (65%) as compared to those from the low-income (33%) and the affluent suburbs (43%).

However, expiry dates were checked depending on the type of food products. For example, 40% of respondents in all six suburbs claimed that they mostly checked the "Use by" or "Best before" dates for tinned food, followed by dairy products (Figure 7). Considering the differences between the suburbs, the post-hoc analysis showed that the proportions of households in all suburbs were significantly different ($\mathcal{X}^2$= 8. 5; p<0.05) from one another,

with the middle-income suburb in Cradock having the highest proportion (65%) and the low-income suburb in Middelburg having the least (36%).

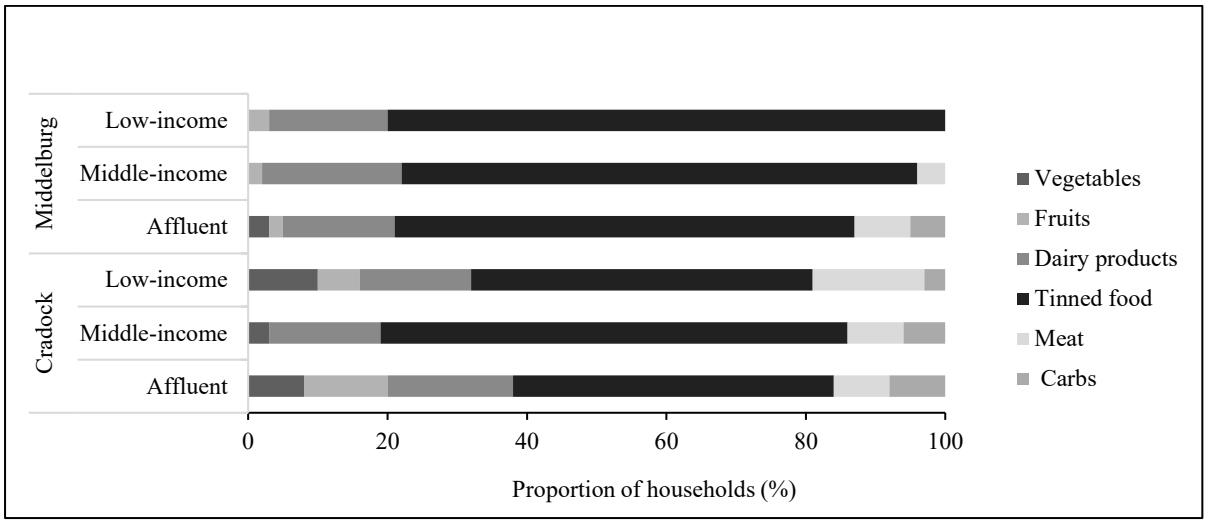



Figure 7: The proportion of households of varying socio-economic classes checking for expiry dates when buying different types of food.

### *2.3.3. Household food waste behaviours*

More than 70% of respondents in all suburbs reported that they concerned themselves with food waste and avoided wasting food whenever possible (Table 10). The post-hoc analysis showed a significant differences in respondents' attitude towards food waste between ($X^2$= 19.0; $p<0.05$) and within the towns ($X^2$= 23.3; $p<0.05$), with the households from the affluent suburbs in both towns having the highest proportions of respondents who demonstrated a positive attitude towards avoiding food waste generation.

Table 10: Comparison of the respondents' description regarding food waste in two towns (% of households)

| **Response option** | **Cradock (n= 285)** | | | **Middelburg (n= 249)** | | | **Mean** |
|---|---|---|---|---|---|---|---|
| | **Low** | **Middle** | **Affluent** | **Low** | **Middle** | **Affluent** | |
| Avoid wasting food | 92 | 90 | 90 | 82 | 70 | 78 | 83 |
| Unwilling to change behaviour | 0 | 1 | 3 | 0 | 12 | 0 | 3 |
| Not concerned with food waste | 8 | 9 | 7 | 18 | 18 | 22 | 13 |

Just over half of the respondents (55%) from the middle-income and the affluent suburb in Cradock indicated that they grew some food for consumption (Table 11). Most (more than 52%) were specifically growing vegetables. The percentage of households that grew food was markedly different between towns ($\chi^2$= 17.5; $p<0.05$), with Cradock showing a higher

percentage (58%) compared to Middelburg (23%). The results also showed a significant difference between suburbs ($\mathcal{X}^2$= 19.0; p<0.05), with households in the affluent suburb of Cradock having the highest percentage of households that grew food, and households in the low-income suburb in Middelburg the least (12%).

Table 11: The proportion of households (n= 534) growing different types of food across six suburbs of different socio-economic classes (% of households)

| **Town** | **Suburb** | **% growing food** | **Vegetables (%)** | **Fruits (%)** | **Both vegetables and fruits (%)** |
|---|---|---|---|---|---|
| Cradock | Affluent | 75 | 92 | 0 | 8 |
| | Middle | 57 | 53 | 13 | 34 |
| | Low | 41 | 88 | 3 | 9 |
| Middelburg | Affluent | 27 | 73 | 0 | 27 |
| | Middle | 29 | 79 | 0 | 21 |
| | Low | 12 | 60 | 10 | 30 |
| Mean | | 40 | 74 | 4 | 22 |

Table 12 shows results for the different ways in which households deal with different types of uneaten food. The most common strategy for dealing with uneaten vegetables was to discard them in waste bins. However, for the other food types the results showed an overlap, and no significant differences were observed between ($\mathcal{X}^2$= 5.6, p>0.05) and within the towns ($\mathcal{X}^2$= 7.8, p>0.05). Some respondents indicated that they had ways of dealing with uneaten food, other than the options presented to them (Table 12) including 1) Froze food such as vegetables and some fruits, 2) Salvaged stale bread; 3) Made soup out of uneaten vegetables, and 4) Reheated and ate uneaten food at a different mealtime.

Table 12: Different ways in which households of three different socio-economic suburbs deal with different types of uneaten food in two towns (n= 534)

| Response options | Town | Suburb | Vegetables (%) | Fruits (%) | Dairy (%) | Tinned food (%) | Meat (%) | Carbs (%) | Mean (%) |
|---|---|---|---|---|---|---|---|---|---|
| Throw in waste bin | Cradock | Affluent | 27 | 35 | 23 | 41 | 25 | 30 | 30 |
| | | Middle | 42 | 20 | 35 | 25 | 12 | 12 | 24 |
| | | Low | 43 | 43 | 44 | 44 | 40 | 36 | 42 |
| | Middelburg | Affluent | 60 | 7 | 14 | 72 | 54 | 12 | 37 |
| | | Middle | 69 | 7 | 0 | 100 | 71 | 0 | 42 |
| | | Low | 51 | 4 | 5 | 41 | 87 | 21 | 35 |
| Donate to the needy | Cradock | Affluent | 18 | 18 | 20 | 10 | 18 | 17 | 17 |
| | | Middle | 33 | 34 | 28 | 36 | 46 | 42 | 37 |
| | | Low | 15 | 15 | 18 | 18 | 18 | 16 | 17 |
| | Middelburg | Affluent | 11 | 49 | 59 | 11 | 4 | 77 | 35 |
| | | Middle | 1 | 80 | 100 | 0 | 17 | 65 | 44 |
| | | Low | 8 | 90 | 95 | 2 | 10 | 1 | 34 |
| Throw in composting bins | Cradock | Affluent | 5 | 5 | 3 | 4 | 3 | 7 | 4.5 |
| | | Middle | 0 | 0 | 0 | 0 | 0 | 2 | 0 |
| | | Low | 5 | 4 | 0 | 1 | 1 | 1 | 2 |
| | Middelburg | Affluent | 8 | 28 | 0 | 0 | 0 | 48 | 14 |
| | | Middle | 12 | 13 | 0 | 0 | 0 | 0 | 4 |
| | | Low | 12 | 6 | 0 | 0 | 0 | 0 | 3 |
| Feed to animals | Cradock | Affluent | 21 | 15 | 32 | 16 | 25 | 19 | 21 |
| | | Middle | 24 | 46 | 37 | 38 | 41 | 43 | 38 |
| | | Low | 36 | 36 | 37 | 36 | 40 | 45 | 38 |
| | Middelburg | Affluent | 21 | 16 | 27 | 17 | 42 | 11 | 22 |
| | | Middle | 18 | 0 | 0 | 0 | 12 | 35 | 11 |
| | | Low | 29 | 0 | 0 | 57 | 3 | 78 | 18 |
| Other | Cradock | Affluent | 29 | 27 | 22 | 29 | 29 | 27 | 27 |
| | | Middle | 1 | 0 | 0 | 1 | 1 | 1 | 0 |
| | | Low | 1 | 2 | 1 | 1 | 1 | 2 | 1 |
| | | | | | | Middelburg | 0% for all suburbs | | |

With respect to reuse of leftover food, the results revealed similar trends between suburbs of the same socio-economic classes in the two towns, with more than 40% respondents from the low-income suburbs indicating that they ate leftover food more than twice a week (Table 13), almost double that in the middle-income suburbs. The number of times the respondents ate leftovers in the two towns were notably different ($\mathcal{X}^2$= 3.9; p<0.05). As were the results for the differences within the towns ($\mathcal{X}^2$= 7.5; p<0.05). Post-hoc comparisons showed that Middelburg had relatively higher proportions of households that ate leftover food frequently. Within towns the highest proportions for eating leftover food was greatest in the low-income suburbs (p<0.05).

Table 13: Frequency of eating of leftovers in households of different socio-economic suburbs (%) (n= 534)

| Town | Suburb | >Biweekly | Biweekly | Weekly | Do not eat leftovers |
|---|---|---|---|---|---|
| Cradock | Affluent | 31 | 20 | 14 | 35 |
| | Middle | 19 | 3 | 57 | 21 |
| | Low | 46 | 20 | 13 | 21 |
| Middelburg | Affluent | 32 | 29 | 23 | 16 |
| | Middle | 24 | 23 | 40 | 13 |
| | Low | 44 | 10 | 24 | 22 |
| Mean | | 33 | 18 | 18 | 21 |

Table 14 shows the proportions of households that ate out or ordered takeaways as their main meals. More than 50% respondents from the low-income and the affluent suburbs in Cradock said they ate out more than twice a week, whereas respondents from the middle-income respondents did so mostly once a month. Respondents in Cradock ate takeaways more often than in Middelburg, although not significantly so ($\mathcal{X}^2$= 0.0; p>0.05). However, a significant difference was noted in the frequencies between the suburbs ($\mathcal{X}^2$= 2.3; p<0.05), with the affluent suburb in Cradock having the highest frequency compared to the low-income and the middle-income suburbs in Middelburg (p<0.05).

Table 14: Frequency of households in different socio-economic suburbs eating takeaways as the main meal (%) (n= 534)

| Town | Suburb income | Times per month | | | | | | | Never |
|---|---|---|---|---|---|---|---|---|---|
| | | >8 | 8 | 4 | 2-3 | 2 | 1 | <1 | |
| Cradock | Affluent | 53 | 5 | 8 | 6 | 2 | 15 | 2 | 9 |
| | Middle | 27 | 1 | 4 | 2 | 10 | 40 | 2 | 14 |
| | Low | 50 | 1 | 3 | 4 | 10 | 10 | 1 | 21 |
| Middelburg | Affluent | 12 | 7 | 0 | 2 | 5 | 67 | 0 | 7 |
| | Middle | 6 | 5 | 1 | 5 | 18 | 40 | 0 | 25 |
| | Low | 15 | 2 | 1 | 36 | 12 | 29 | 0 | 5 |
| Mean | | 27 | 3 | 3 | 9 | 10 | 34 | 0 | 14 |

To understand household food waste behaviour, respondents were asked whether there were any times of the week, month, or year when their households wasted more food than usual (respondents in the affluent suburb of Cradock wasted more food at different times). Most respondents said that there were no other times, except no significant differences were observed in respondents' responses between town ($\chi^2$= 0.00, p>0.05), nor between the suburbs ($\chi^2$= 0.00; p>0.05). Of those saying there were specific times with greater food waste, the most cited times in the affluent suburbs were Christmas (54%) and summer season (41%) (Table 15). Festive season (65%) and traditional ceremonies (37%) were the most cited times in the middle suburbs. In low-income suburbs, the festive season (46%) and the summer season (36%) were the most cited times.

Table 15: Percentage of households wasting more food than usual at different times of the week, month, or year in two towns (% of households)

| Times | Cradock (n=285) | | | Middelburg (n=249) | | | Mean |
|---|---|---|---|---|---|---|---|
| | Low | Middle | Affluent | Low | Middle | Affluent | |
| Weekends | 4 | 10 | 15 | 0 | 10 | 13 | 9 |
| Easter | 30 | 4 | 23 | 20 | 0 | 6 | 14 |
| Christmas | 4 | 0 | 54 | 16 | 0 | 0 | 12 |
| Summer | 8 | 4 | 8 | 36 | 16 | 41 | 19 |
| Festive | 46 | 65 | 0 | 4 | 21 | 25 | 27 |
| Month-end | 4 | 15 | 0 | 4 | 0 | 5 | 5 |
| School holidays | 4 | 2 | 0 | 0 | 0 | 0 | 1 |
| Load shedding | 0 | 0 | 0 | 8 | 0 | 10 | 3 |
| Funerals | 0 | 0 | 0 | 8 | 16 | 0 | 4 |
| Traditional ceremonies | 0 | 0 | 0 | 4 | 37 | 0 | 7 |

Respondents provided varied and sometimes multiple reasons for discarding the types of food, particularly the affluent suburb of Middelburg (Table 16). There were few households (less than 8% for all food types) that declared that they threw away food because they: 1) lacked the desire to eat it, 2) household members did not like the food, 3) households could afford to purchase more food, and 4) because they bought more food than needed.

Table 16: Common reasons for discarding the different types of food in two towns (n= 534)

| Response options | Town | Suburb income | Vegetables (%) | Fruits (%) | Dairy (%) | Tinned food (%) | Meat (%) | Carbs (%) |
|---|---|---|---|---|---|---|---|---|
| More than one option | Cradock | All suburbs | 0% for the different types of food | | | | | |
| | Middelburg | Affluent | 73 | 58 | 43 | 58 | 68 | 53 |
| | | Middle | 25 | 28 | 28 | 28 | 28 | 28 |
| | | Low | 0% for the different types of food | | | | | |
| Food expired | Cradock | Affluent | 7 | 18 | 20 | 19 | 11 | 7 |
| | | Middle | 78 | 82 | 84 | 83 | 65 | 65 |
| | | Low | 49 | 59 | 58 | 57 | 54 | 58 |
| | Middelburg | Affluent | 6 | 2 | 12 | 32 | 1 | 0 |
| | | Middle | 34 | 34 | 34 | 34 | 34 | 34 |
| | | Low | 51 | 4 | 5 | 41 | 87 | 21 |
| Poor food labelling | Cradock | Affluent | 0% for the different types of food | | | | | |
| | | Middle | 0 | 0 | 0 | 4 | 4 | 4 |
| | | Low | 0 | 0 | 1 | 0 | 1 | 0 |
| | Middelburg | Affluent | 1 | 1 | 2 | 4 | 4 | 1 |
| | | Middle | 0% for the different types of food | | | | | |
| | | Low | 8 | 90 | 95 | 2 | 10 | 1 |
| Lack of cooling facilities | Cradock | Affluent | 1 | 2 | 21 | 1 | 1 | 1 |
| | | Middle | 0% for the different types of food | | | | | |
| | | Low | 3 | 4 | 4 | 1 | 2 | 1 |
| | Middelburg | Affluent | 12 | 34 | 38 | 5 | 13 | 3 |
| | | Middle | 4 | 3 | 3 | 3 | 3 | 3 |
| | | Low | 12 | 6 | 0 | 0 | 0 | 0 |
| Excessive cooking (excess food) | Cradock | Affluent | 21 | 14 | 15 | 16 | 24 | 28 |
| | | Middle | 10 | 6 | 6 | 6 | 22 | 23 |
| | | Low | 19 | 11 | 12 | 12 | 13 | 8 |
| | Middelburg | Affluent | 8 | 0 | 0 | 1 | 13 | 35 |
| | | Middle | 34 | 34 | 34 | 34 | 34 | 34 |
| | | Low | 29 | 0 | 0 | 57 | 3 | 78 |
| Did not think food waste is an issue | Cradock | Affluent | 72 | 68 | 65 | 65 | 65 | 65 |
| | | Middle | 6 | 6 | 5 | 5 | 5 | 5 |
| | | Low | 31 | 28 | 28 | 29 | 30 | 30 |
| | Middelburg | Affluent | 0% for the different types of food | | | | | |
| | | Middle | 0 | 1 | 1 | 1 | 1 | 1 |
| | | Low | 0% for the different food types | | | | | |
| No desire to eat leftovers | Cradock Middelburg | <2% in all sites for the different types of food in both towns | | | | | | |
| Not liking the food | Cradock Middelburg | <5% in all sites for the different food types food in both towns | | | | | | |
| Afford to buy more food | Cradock Middelburg | <1% in all sites for the different food types food in both towns | | | | | | |
| More food than needed | Cradock Middelburg | <8% in all sites for the different food types in both towns | | | | | | |

# 2.4. DISCUSSION

### *2.4.1. Household shopping patterns*

Over half of the respondents from households in Cradock and Middelburg went to shop for food monthly, echoing findings from Tshwane (Ramukhwatho *et al.*, 2018). The results also showed that there were differences between the suburbs, where most of the respondents from households in the affluent suburbs tended to purchase food weekly and fortnightly. This can be attributed to three factors: (1) employment status, where most respondents from households in the affluent suburbs are employed, (2) wealth status, where most households in the affluent suburbs are classified as wealthy, and (3) during data collection it was observed that the affluent suburbs are located at close proximity to the grocery stores. As such, it is likely that the respondents from the low-income and the middle-income suburbs purchased food less frequently because their suburbs were further away from the grocery stores, and that transport was expensive. Research suggests that affluent households can afford to purchase food more frequently compared to the low-income households (Stuart, 2009; Parfitt *et al.*, 2010; Kambo and Osmani, 2018) and that low-income groups tend to buy in bulk (Grover and Singh, 2014).

It has been questioned whether households use shopping lists when purchasing food. Ramukhwatho *et al.* (2014) reported that 84% of the respondents in Tshwane (South Africa) used shopping lists, while Jörissen *et al.* (2015) found that about 70% of the households in Ispra (Italy) and Karlsruhe (Germany) also used shopping lists when they went to buy food. In this study, a considerable proportion of households in Cradock (60%) and in Middelburg (47%) indicated that they never used shopping lists. A further breakdown of the results indicated that within towns, the proportions of households that used shopping lists was positively related to household wealth. This is not surprising because the issue of diet among households of different socio-economic groups has been documented in other studies, with the low-income suburbs often having less food products to buy because of affordability challenges (Hendrickson *et al.,* 2006; Monsivais *et al.,* 2012; Wertheim-Heck *et al.,* 2019). As discussed earlier, a majority (>56%) of households in the low-income suburbs are poor and relying on social grants. Therefore, although the respondents from the low-income suburbs acknowledged that shopping lists are effective at discouraging consumers from either purchasing more food than they

needed, or purchasing food that is in their cupboards; they declared that due to financial barriers, they purchased food hampers and did not see the need to use shopping lists.

Food waste generation is also influenced food special offers (Koivupuro *et al.,* 2012; Jörissen *et al.,* 2015). Furthermore, the authors argued that buying discounted food is associated with availability of money, meaning that people who have money tend to be more attracted to special offers compared to those who do not have money. Purchasing discounted food was found to be prevalent in both towns (>60%) and higher than the 26% reported by Ramukhwatho *et al.* (2014).The highest proportion (92%) of the respondents who reported that they purchased discounted food was observed in the low-income suburb in Middelburg, and the least (65%) in the low-income suburb in Cradock. This finding suggests that, of all possible factors influencing the purchasing of discounted food among households from low-income suburbs, the complexity of food quantity verses quality results in low-income households buying more food on specials to optimise the likelihood that they have enough food to last them until the next paycheque. Further, most of the respondents from the low-income suburbs understood food special offers as a "treat" because they rarely afford purchasing many food products when they are sold at normal prices.

Monier *et al.* (2010), Gunders (2012) and Jörissen *et al.* (2015) suggested that the inability of consumers to distinguish between "Use by" and "Best before" dates influences food waste generation. However, these studies have not presented how this behaviour varies across households from low-income to affluent suburbs. The results of this study showed that most of respondents (54%) were unable to distinguish, and that the majority (>70%) in the affluent suburbs were knowledgeable about these terms (as was hypothesised). It appears that the culture of reading food labels is lacking among most households. As such, some people even go as far as purchasing incorrect food products.

There is a considerable lack of research as to what types of food households from different income suburbs are most likely to check expiry dates for. In this study it was found that although a significant number of households in Cradock (47%) and Middelburg (56%) indicated that they always checked expiry dates when purchasing food; this behaviour was most prevalent (65%) among households in the middle-income suburbs, and lest prevalent among low-income suburbs. The results are consistent with the notion that food purchasing is centred around food affordability (Golan *et al.,* 2008; Drewnowski and Eichelsdoerfer, 2010). For example, data from this study suggested that within the suburbs, checking expiry dates for

tinned food was most prevalent among households in the low-income and the middle-income suburbs. Meanwhile, households in the affluent suburbs mostly checked expiry dates for meat and dairy products. Combining these findings, the study suggests that households in the low-income suburbs were less likely to check for expiry dates for food because they mostly bought non-perishable foods with a long shelf life; and according to Chakona and Shackleton (2017) these types of food are cheaper in South Africa

### *2.5.2. Household food waste behaviours*

The respondents generally considered discarding food an unethical behaviour. Like findings among households in Brazil (Porpino *et al.,* 2015). Consequently, they were somewhat concerned with food waste generation, and over 70% of the respondents across all suburbs declared that they avoided food waste however possible. This finding was consistent with Chakona and Shackleton (2017), whose results showed that 80% of the households in their study in KwaZulu-Natal consumed their meals and rarely had leftovers. This may be attributed to poverty rates that have not changed significantly in South Africa. However, many households that lived in poverty during the apartheid era, have sunk deeper into poverty than before (ECSECC, 2020; StatsSA, 2020). Thus, on balance, with the maintenance of the status quo, especially in the Eastern Cape province where approximately 64.3% of people are living below the poverty line (ECSECC, 2020), it would be unlikely for most to discard food by choice.

The results also provided insights into the proportion of households that grew some of the food they consumed. In general, over 40% of the respondents in this study were growing some food. Although Ganglbauer *et al.* (2013) revealed that in Australia, growing food influenced people's behaviours regarding food, the authors did not consider how this varies among households from different income suburbs. The results revealed that the affluent suburbs had the highest percentages of households that grew food compared to households in the low-income and the middle-income suburbs. This difference may be accounted for by two factors. First, the availability of land, where most households in affluent suburbs have enough land to grow food (McConnachie and Shackleton, 2010). Second, the issue of access to water, where the households that had enough land in the low-income suburbs complained about intermittent access to water due to water cuts.

Much of the current literature on household food waste pays attention to ways in which households deal with general leftovers (Ramukhwatho *et al.,* 2014; Chakona and Shackleton,

2017; Cronjé et *al.,* 2018). In general, although the majority of households in a study by Chakona and Shackleton (2017) claimed that they mostly kept leftovers and consumed them within a day or two, the findings of this study show that households in different suburbs had unique ways of dealing with different types of uneaten food. These included throwing foods such as vegetables in waste bins instead of reusing it to make other meals as suggested.

This behaviour could be accounted for by lack of proper food storage facilities. Further, the respondents also declared that they sometimes donated uneaten food to the needy and that this behaviour helped them avoid discarding food. It was also interesting to find that even though the respondents advocated for giving to the needy, some were afraid to do so because they would be accused of food poisoning should the recipient become ill after consuming the food. Interestingly, some of the respondents said that they used food such as vegetables and fruits for compost, and food wasted for composting and feeding animals. The results also revealed that some respondents had other various ways of dealing with uneaten food. Some of these included freezing fruit and vegetable leftovers, salvaging stale bread, and reheating and consuming food such as meat and carbs within a day or two.

Generally, a person's desire to eat food is often influenced by the value they place in certain food products (Vicki Mavrakis, 2014), subsequently eating leftover food reduces food waste generation (Ramukhwatho *et al.,* 2014; Cronjé *et al.,* 2018). In this study an average of 26% of the respondents in Cradock and 17% in Middelburg indicated that they did not eat leftover food. This finding is inconsistent with Ramukhwatho *et al.* (2014) whose study revealed a greater percentage (80%) of informants that did not eat leftovers in Gauteng. Perhaps this inconsistency between the results of this study and those from Gauteng could be explained by the differences in socio-economic status. As discussed earlier, with the Eastern Cape being the most affected province in terms of poverty, it is likely that leftovers are of significant expenditure. Additionally, leftover food tends to be a huge convenience for those who do not work and have limited access to food because they get to have something to sustain them throughout the day.

Consistent with the findings of Parfitt *et al.* (2010), Evans (2012), Grainger *et al.* (2018), Ramukhwatho *et al.* (2018) and do Carmo Stangherlin and de Barcellos (2018) it was also found that although households in the low-income suburbs ate leftover food, they also discarded some food. The most mentioned reasons for discarding food was centred around

excessive cooking and food expiring before being consumed. Further, households in the affluent suburbs were discarding food because they did not think food waste is an issue.

The low-income and the affluent suburbs in Cradock ordered takeaways more often than households in the middle-income suburbs. There are two explanations for this. The first one being the availability of money in the affluent suburbs. The second could be because poor households are generally afraid of being perceived as poor by other people (Porpino *et al.*, 2015). So, instead of embracing that they cannot afford to order takeaways; they may go as far as using limited funds to portray a better version of their situation.

To meet the Sustainable Development Goal (SDG) 12 and the global target to reduce food waste at consumer level by at least 50% in 2030, a holistic approach is required. With this said, it is necessary to understand the times consumers are likely to waste more food. Moreover, Schmidt (2016) points out that it is essential to personalise data regarding food waste generation behaviours to allow for more effective and context-based interventions. The results revealed that households in the affluent suburbs wasted more food during Christmas because most people in these suburbs received big bonus compensations, which could encourage over-purchasing of food than needed because there would be more than enough money to spend. Meanwhile the households in the low-income and the middle-income suburbs identified the festive season as the time their households are most likely to generate more food waste. In the low-income suburbs, most people mentioned that they joined grocery stokvels but food wasting rests solely on the issue of lack of cooling storages. Considering the weather conditions in summer; most people end up having to discard some of the food from the stokvels because it spoiled before they could consume it.

## 2.5. CONCLUSIONS

This chapter aimed at assessing food waste in urban households in the Eastern Cape province. To fulfil this aim, the study addressed four objectives and hypothesis.

Objective one and two focused on exploring consumer behaviour and how they vary across income groups.

- The study showed that the respondents in the three income groups behaved differently as was hypothesised. As such, the first and the second hypothesis were proven to be

correct; because households in the affluent suburbs purchased food more frequently and had the highest percentage of the respondents that used shopping lists when buying food compared to their counterparts.

- Third hypothesis was not correct as households in the low-income suburbs had the least proportion of households that grew some of the food they consumed.
- Moreover, the fourth and the firth hypothesis were correct as there was a higher number of respondents that were attracted to food special offers in the low-income suburbs than there were in other income suburbs. The study also showed that there were more respondents that could not distinguish between "Use by" and "Best before" dates as was hypothesised.

Objective three and four focused on identifying the reasons for households to discard different types of food, and whether these varied in households across different income suburbs. The results show that there was an overlap between the towns. Within the towns, the respondents from households in the affluent pointed that they discarded food because they did not think food waste is an issue. Meanwhile excessive cooking and food expiring before being consumed were found to be the most common reasons for food waste among households in the low-income and the Middle-income suburbs.

# CHAPTER 3

# TYPES AND QUANTITIES OF FOOD WASTE GENERATED, DISPOSED AND MINIMISATION STRATEGIES

Image 3: Taken from Wrap (2011).

# 3.1. INTRODUCTION

Food waste generated at household level has been identified as one of the biggest challenges faced by the world in the 21st century (Djekic *et al.,* 2019; Ananno *et al.,* 2021). This is because (1) land, water and resources are consumed to produce the food, which is wasted, and (2) decomposing food waste results in the generation of greenhouse gases, particularly methane in landfills across the globe (Gustavsson *et al.,* 2011; Gustavsson *et al.,* 2013). Estimates of food waste show that the quantities of food thrown away at household level have significantly increased over the years (Ananno *et al.,* 2021), with households in developed countries generating greater amounts compared to their counterparts in less developed countries (Secondi *et al.,* 2015; Oelofse and Nahman, 2019; Ananno *et al.,* 2021; Jeswani *et al.,* 2021). Chakona and Shackleton (2017) found that the average quantities of all food types wasted in rural and urban households in South African mid-sized towns was 12.4 kg/person/year, which was lower than the estimated amount of 95-115 kg/person/year reported in Europe and North America and marginally higher than the 6-11 kg/capita/year reported for sub-Saharan Africa and South/southeast Asia (Gustavsson *et al.,* 2013).

According to Chakona and Shackleton (2017) food waste is defined as food lost at consumer level, which includes edible food material that is produced for human consumption and ends up as waste for various reasons. Approximately 1.3 billion tonnes of food produced globally for human consumption is lost annually (Oelofse and Nahman, 2019; Ananno *et al.,* 2021; Nunkoo *et al.,* 2021). This is a tragedy to humanity considering that food waste makes it impossible to effectively feed the world, thereby exacerbating global hunger (Nahman *et al.,* 2012; Oelofse *et al.,* 2020; Nunkoo *et al.,* 2021). For example, food wasted in an average week in Mecca, Saudi Arabia, could be enough to feed approximately 250 hungry people (Oelofse *et al.,* 2020). Furthermore, food waste increases the demand for food production, which in turn influences a repeated cycle of food waste generation.

In response to this global challenge, countries must acknowledge the need for establishing effective, context-based strategies to minimise household food waste. This is crucial for tackling poverty and for reducing methane gas emissions from decomposing food in landfills (Redlingshöfer *et al.,* 2020). Many studies have suggested that household food waste minimisation can be achieved through various strategies such as making use of shopping lists when buying food (Jörissen *et al.,* 2015; Ponis *et al.,* 2017; Schmidt and Matthies, 2018), using

proper food storage practices and facilities (Romani *et al.,* 2018), and freezing food (Jörissen *et al.,* 2015; Martindale and Schiebel, 2017), to name a few.

Unfortunately, whilst the Food and Agriculture Organisation of United Nations has proposed a number of food waste minimisation strategies, including but not limited to the aforementioned, the world continues to face an increase in the quantities of food thrown away (Hebrok and Boks, 2017; Schmidt and Matthies, 2018). This pattern is also observed across households of varying income groups (low, middle and high-income), with some studies such as that of Parfitt *et al.* (2010), Ramukhwatho *et al.* (2018), Hebrok and Boks (2017) and Cronjé *et al.* (2018) claiming that high-income households waste more than low-income households as they can afford to purchase more food than low-income households. This claim is also true for households in developing countries, for examples in a South African context, where income gaps are a norm between and within the nine provinces (ECSECC, 2020). Moreover, Kambo and Osmani (2018) also identified age, household size, wealth status, gender, and culture, as other factors affecting household food waste generation. For example, Jörissen *et al.* (2015), Canali *et al.* (2017) and Preka *et al.* (2020) argue that adults waste more food in absolute terms compared to children. However, households with children waste greater amounts of food than those without children (Parfitt *et al.*, 2010; Quested *et al.*, 2013); Stancu *et al.*, 2016). Canali *et al.* (2017) also claimed that females tend to generate more food waste compared to males because they are mostly responsible for preparing food than males.

Several studies, such as that of Nahman *et al.* (2012), Ramukhwatho *et al. (*2014), Chakona and Shackleton (2017), Venter (2017) and Cronjé *et al.* (2018), have reported on the types and quantities of food wasted, and behaviours associated with this phenomenon in South Africa. Yet, there is little information on the quantities and types of food commonly discarded types during breakfast, lunch and supper across households of varying economic spectrums within the Eastern Cape province. Additionally, none of these studies had focused on investigating whether households had any food waste minimisation practices or strategies for food waste and if so, whether household members practiced these strategies. Furthermore, the few household food waste studies conducted in South Africa were mostly in Gauteng province (Nahman e*t al.,* 2012; Ramukhwatho *et al.,* 2018; Oelofse *et al.,* 2018) with one in KwaZulu-Natal and Free State provinces (Chakona and Shackleton, 2017) and Northern Cape Province (Cronjé *et al.,* 2018), and none from the Eastern Cape province.

This lack of primary data on household food waste for the Eastern Cape province may have led to a generalised conclusion regarding the quantities of food wasted; causes of food waste, and the status quo for household food waste minimisation. This is particularly a challenge considering that the Eastern Cape is less developed than the other eight provinces; making it questionable to assume that households in this province waste relatively similar quantities of food as households from other provinces.

### *3.1.1. Aims and objectives*

The aims of this study were to 1. identify the commonly wasted types of food; 2. quantify food wasted; 3. investigate the implementation of food waste minimisation strategies, and 4. identify effective and context-based food waste minimisation strategies in urban households in the Eastern Cape province. To fulfil the above-mentioned aims, the study addressed the following objectives

1. ***Identifying the commonly wasted types of food:***
    - Explored whether there are any significant differences in the types of food wasted between and within the suburbs;
2. ***Quantifying food waste:***
    - Explored whether there are any significant differences in the amounts of food wasted between and within the towns;
3. ***Investigating the implementation of food waste minimisation strategies:***
    - Identified the different strategies implemented by households;
    - Explored whether there are any significant differences in the implementation of food waste minimisation strategies between and within the towns;
4. ***Investigating the socio-demographic factors affecting food waste:***
    - Explored the relationship between the quantities of food wasted and socio-demographic factors between and within suburbs

As such, the focus of this study was to identify the most wasted food types and quantify the amounts wasted among low-income, middle and affluent suburbs in the Eastern Cape province. Food waste minimisation strategies were also investigated. It was hypothesised that: (1) Vegetables and meat would be the most wasted food types, and (2) the quantities of food wasted would decrease in accordance to household income for all food types. Further, it was hypothesised that (3) households in the affluent suburbs would generate more food waste, and that food waste would generally be greater from supper. It was also hypothesised that (4)

weighed food waste quantities would be greater compared to self-reported food waste quantities. Moreover, it was hypothesised that (5) there would be an association between age, household size, number of children, gender, employment status, wealth status, and the quantities of food waste generated. Lastly, it was hypothesised that (6) the number of households with existing household food waste minimisation strategies would increase with increasing household affluence.

## 3.2. METHODS

Food waste quantification followed a quantitative approach using two different methods, 1) questionnaires to explore the recalled quantities of different types of food wasted by households, and 2) direct weighing of the amounts of food discarded by households. The rationale for using the second method was to allow for direct measurements following Elimelech *et al.* (2018) who argued that questionnaires are prone to biases regarding quantifying food discarded. Additionally, the two methods were used for comparing self-reported food waste quantities to the directly measured food waste quantities. The sampling methods used in this chapter are the same as that in Chapter 2 (refer to 2.2.1).

### *3.2.1. Data collection*

The method used for quantifying food waste using questionnaires was explained in detail in Chapter 2 (refer to 2.2.2). In this method, participants were asked to estimate the amounts they discarded for each food type during breakfast, lunch, and supper and any inter-meal snacks, in the previous 48 hours. The estimations were done using cups and the standard for estimation was adopted from the 2013 Food and Agriculture Organization of the United Nation's conversion standard of one cup = 250 g. The grams were then converted into kilograms.

#### *3.2.1.1. Weights of food waste*

To directly quantify food wasted, 10% of the households that were selected to participate in the food waste questionnaires were sampled randomly in each town, i.e. 36 from Cradock and 36 from Middelburg. To weigh discarded food amounts, the study adopted three of the four steps provided by Elimelech *et al.* (2018), which include doorstep collection, sample sorting,

and weighing the amounts of food waste generated. The six different types of food were measured in grams and converted to kilograms.

#### *3.2.1.2. Doorstep collection*

Each selected household was provided with 42 coded, biodegradable plastic bags. This was to allow each household to dispose food waste according to the six types of food during breakfast, lunch, and supper in the previous 48 hours (i.e. 7 x 3 x 2 days (48 hours) = 42). Essentially, quantitative data was collected over a week (7 days) and the food waste collected was food waste generated during breakfast, lunch and supper over two days in each household (48 hours). Food waste was not categorised into prepared and unprepared. The food waste bags were further sorted and measured at each selected household in the morning for two days. The researcher and the field assistants were responsible for sorting and weighing of the bags (Figure 7). The measured wasted food included vegetables, fruits, dairy (including liquids), tinned food, meat, carbohydrates, and other (which was later eliminated as the participants mentioned bread, which for the ease of reporting was considered as part of carbohydrates).

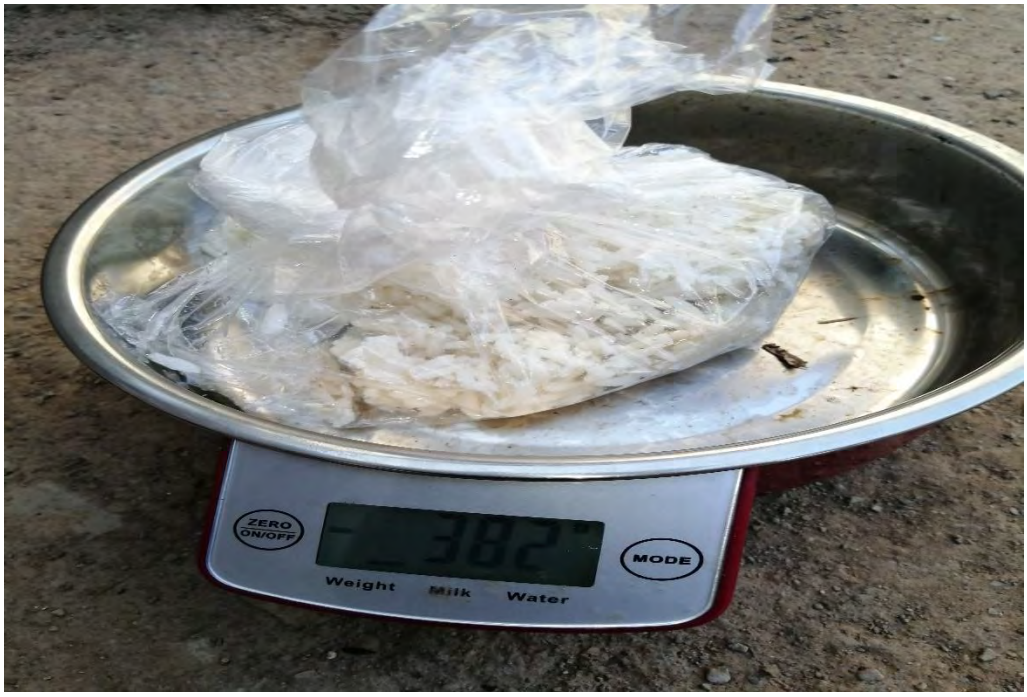



Figure 8: The weighing of household food waste.

### *3.2.1. Data analysis*

Data was captured and cleaned following the same method presented in Chapter 2 (refer to 2.2.3). Descriptive data was presented as means and standard deviations to show the mean amounts of food discarded, as well as per person over 48 hours and annually. The estimated mean amount of food thrown away per household per year was calculated by multiplying the amount of food thrown away in the previous 48 hours by the number of days in a year (365), divided by two days (48 hours). To calculate the amount of food waste generated by each household member, the amount of food discarded per household was divided by the number of people for each household and then the average values were used as estimated quantities of food waste generated and disposed by each household member. The value was three for Cradock and four for Middelburg. Statistical analyses were performed using STATISTICA version 13 (StatSoft Inc) and methods presented earlier in Chapter 2.

## 3.3. RESULTS

### *3.3.1. Self-reported household food waste*

#### *3.3.1.1. Types of food wasted*

Household food waste in the previous 48 hours in Cradock and Middelburg included all the different types of food. Vegetables were the most widespread food type, thrown away by 33% of households in Cradock and 32% in Middelburg (Figure 9A); followed by meat, which was discarded by 24% of households in Cradock and 23% in Middelburg. Furthermore, dairy products and tinned food were the least discarded types of food.

In general, the proportions of households that discarded vegetables and meat slightly increased with increasing affluence in Middelburg, while the proportion of households throwing away carbohydrates decreased with decreasing affluence (Figure 9C). Significant differences were observed in the proportion of households that discarded carbohydrates, with households in Cradock throwing away more carbohydrates than in Middelburg ($\chi^2$= 8.40; p<0.05).

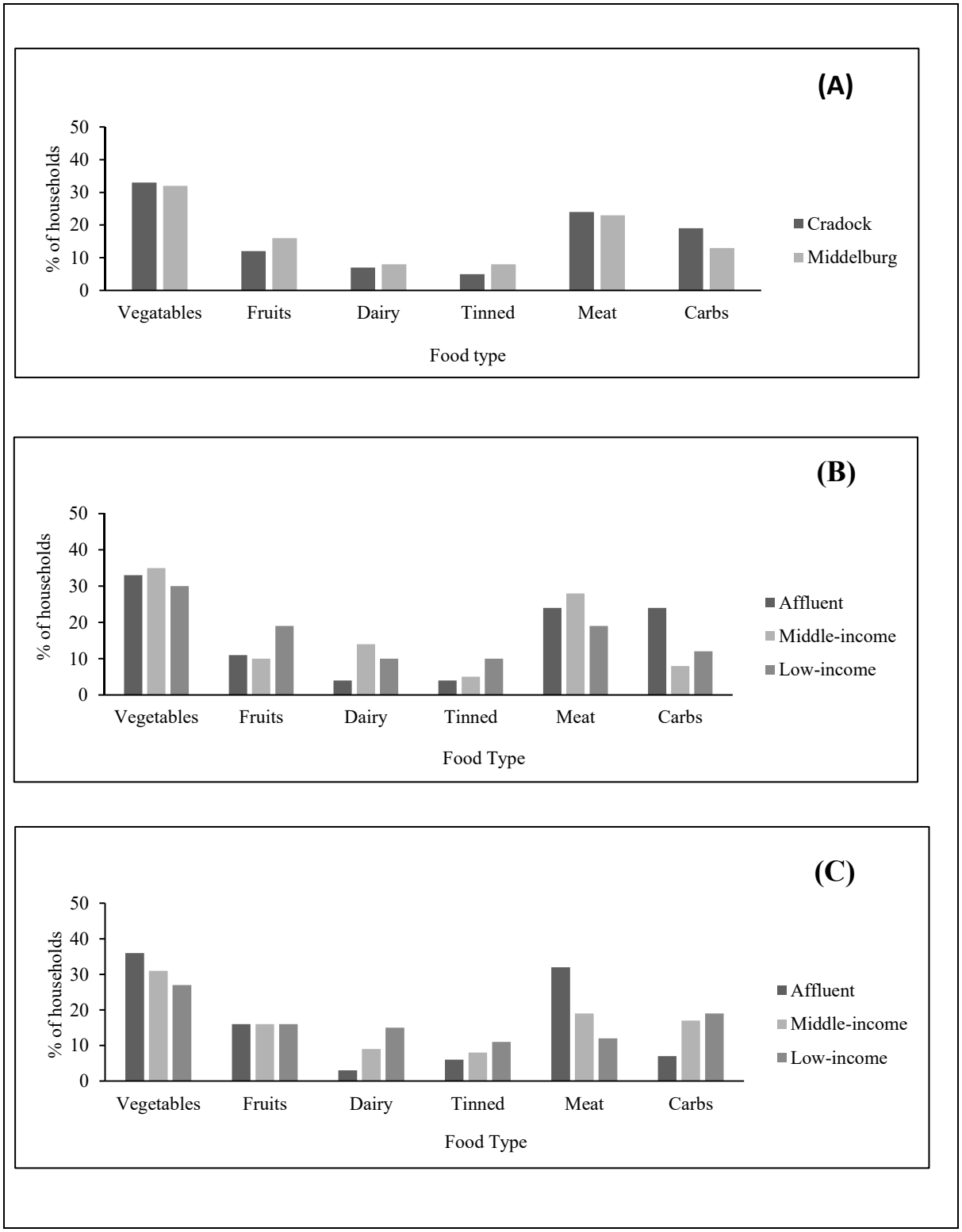



Figure 9: Common type of food wasted by households between the rowns (a) and per suburb in Cradock (b) and Middelburg (c) in the previous 48 hours.

Within the towns, there were significant differences in the proportions of households that threw away vegetables ($\mathcal{X}^2$= 60.75; p<0.05). Comparison of the proportions of households across the suburbs revealed that there were significantly more households wasting vegetables in the affluent suburbs compared to those in the other income suburbs in both towns. Further analysis has shown that the affluent suburb in Middelburg had the greatest proportion of households discarding vegetables (36%). Regarding the proportions of households discarding fruits, the results revealed a statistically significant difference between suburbs in Cradock ($\mathcal{X}^2$=18.19; p<0.05), with households in the low-income suburbs having the highest proportion compared to its counterparts.

Significant differences were also observed between the proportions of households discarding dairy products between the suburbs ($\mathcal{X}^2$= 6.84; p<.05), with the low-income suburb in Middelburg having the most households that discarded dairy; and those in the affluent suburb in Middelburg the least. The proportions of households that discarded tinned food were significantly different between the suburbs ($\mathcal{X}^2$= 2.85; p>0.05). The post-hoc comparison results showed that the low-income suburb in Middelburg had the highest proportion, and the affluent suburb in Cradock the least.

Within the suburbs, a significant difference was detected ($\mathcal{X}^2$= 32.19; p<0.05) in the proportions of households that discarded meat. The post-hoc comparison revealed that households in the affluent suburb in Middelburg had the highest proportion and those in the low-income suburb in Middelburg the lowest proportion. Considering the amounts of carbohydrates thrown away, the results revealed that there was a significant difference in the proportions between the suburbs ($\mathcal{X}^2$= 7.23; p<0.05). The highest proportion for households that discarded carbohydrates was recorded for households in the affluent suburb in Cradock, and the least in the affluent suburb in Middelburg.

#### *3.3.1.2. Self-reported estimates of food wasted by households*

The average, self-reported amount of food waste generated by households in the two study towns at breakfast, lunch and supper in the previous 48 hours is presented in Table 17. In Cradock, the average amount of food waste was estimated at 0.31±0.54 kg at breakfast, 0.18±0.38 kg at lunch and 0.04±0.16 kg at supper. Whereas in Middelburg, households estimated to generate 0.23±0.41 kg of edible food waste at breakfast, 0.20±0.40 kg at lunch, and 0.07±0.18 kg at supper. Generally, the total estimated quantities of edible food discarded

in the two towns was greatest during breakfast (0.27±0.48 kg); and almost five times less during supper (0.05±0.17 kg). Comparison of the quantities of food discarded between the two towns showed significant differences between breakfast and supper ($\mathcal{X}^2$= 43.36; p<0.05) with Cradock having higher estimated quantities than Middelburg.

Considering the differences between the suburbs, the post-hoc analysis revealed that the amounts of food waste generated by households across all suburbs at breakfast were significantly different ($\mathcal{X}^2$= 52.97; p<0.05) from one another for both towns, with the affluent suburb in Cradock discarding the highest average amount and the low-income suburb in Cradock the least. A significant difference was also observed between the quantities of food waste generated at lunchtime between the suburbs ($\mathcal{X}^2$= 53.13; p<0.05). The post-hoc results revealed that households in the affluent suburb in Middelburg discarded more food (0.35±0.43 kg) at lunch than those in the low-income suburb in Cradock (0.12±0.27 kg) (p<0.05). Differences in the amounts of food wasted between all suburbs at supper were also significant ($\mathcal{X}^2$= 12.42; p<0.029), with the middle-income suburb in Middelburg showing the highest average amount of 0.08±0.18 kg of food thrown away and the low-income suburb in Cradock the lowest amount (0.02±0.09 kg). In general, the reported food waste quantities between the suburbs reveal an increase in the amounts of food waste generated at breakfast and lunch with decreasing affluence in both towns.

Table 17: The mean amounts of self-reported food wasted at breakfast, lunch, and supper in two towns in the previous 48 hours *(Bold values indicate the mean estimated amount per town and overall, the superscripts denote significant differences between the quantities of waste discarded between and within the two towns at breakfast, lunch and supper)*

| **Town and Suburb** | **N** | **Breakfast (kg)** | **Lunch (kg)** | **Supper (kg)** | **Total 48 hr (kg)** |
|---|---|---|---|---|---|
| **Cradock** | **285** | **0.31±0.54[a]** | **0.18±0.38[a]** | **0.04±0.16[a]** | 0.53±1.08 |
| Affluent | 91 | 0.66±0.67 | 0.32±0.47 | 0.04±0.17 | 1.02±1.31 |
| Middle | 98 | 0.21±0.46 | 0.12±0.33 | 0.06±0.19 | 0.39±0.98 |
| Low | 96 | 0.08±0.16 | 0.12±0.27[b] | 0.02±0.09 | 0.22±0.52 |
| **Middelburg** | **249** | **0.23±0.41[b]** | **0.20±0.40[b]** | **0.07±0.18[b]** | 0.50±0.99 |
| Affluent | 83 | 0.30±0.41 | 0.35±0.43[a] | 0.05±0.15 | 0.70±0.99 |
| Middle | 83 | 0.21±0.37 | 0.14±0.41 | 0.08±0.18 | 0.43±0.96 |
| Low- | 83 | 0.19±0.42 | 0.12±0.33 | 0.08±0.21 | 0.39±0.96 |

| | | | | | |
|---|---|---|---|---|---|
| **Overall Mean** | **534** | **0.27±0.48** | **0.19±0.39** | **0.05±0.17** | 0.51±1.04 |

### *3.3.1.3. Total amount of food waste produced per household and per person annually*

Table 18 shows that the overall estimated amount of food discarded per household per year is 93.72±188.91 kg (equivalent to 23.40±47.20 kg per person per year). Households discarded more food from breakfast (49.73±87.31 kg) and the least amount of food from supper (9.75±30.84 kg).

Further, the average self-reported amount of food waste generated per households per year in Cradock is 55.86±98.20 kg at breakfast, lunch (32.14±68.88 kg) and 75.19±28.82 kg at supper. Whereas in Middelburg, individual households generated 42.67±72.43 kg of edible food waste at breakfast, 36.83±403.1 kg at lunch, and 12.28±32.90 kg at supper annually.

Table 18: Average amount of food waste generated at breakfast, lunch, and supper per household and person per year

| **Cradock** | **Food waste generation time frame** | **Breakfast (kg)** | **Lunch (kg)** | **Supper (kg)** | **Total (kg)** |
|---|---|---|---|---|---|
| | 48 hrs | 0.31±0.54 | 0.18±0.38 | 0.04±0.16 | 0.53±1.08 |
| | Per household/year | 55.86±98.20 | 32.14±68.88 | 75.19±28.82 | 95.54±195.90 |
| | Per person/year | 18.60±32.7 | 10.70±23.0 | 2.50±9.60 | 31.80±65.30 |
| **Middelburg** | 48 hrs (g) | 0.23±0.41 | 0.20±0.40 | 0.07±0.18 | 0.50±0.99 |
| | Per household/year (g) | 42.67±72.43 | 36.83±73.57 | 12.28±32.90 | 91.78±178.90 |
| | Per person/year in kg | 10.70±18.20 | 9.20±18.40 | 3.10±8.20 | 23.00±44.80 |
| **Mean** | 48 hrs | 0.27±0.48 | 0.19±0.39 | 0.05±0.17 | 0.51±1.04 |
| | Per household/year | 49.73±87.31 | 34.24±70.76 | 9.75±30.84 | 93.72±188.91 |
| | Per person/year | 12.40±21.80 | 8.60±17.70 | 2.40±7.70 | 23.40±47.20 |

### 3.3.2. Directly weighed household food waste

#### *3.3.2.1. Types of food wasted*

With respect to directly weighed food waste, the results show that in both Cradock and Middelburg vegetables (26% and 30%, respectively) were the most common food waste type (Figure 10). Meat was also discarded by more households than other types of food by 24% in both towns. Tinned food and dairy products were the least discarded food types in both study towns. There were no significant differences observed in the proportions of households that discarded all six food types ($p>0.05$).

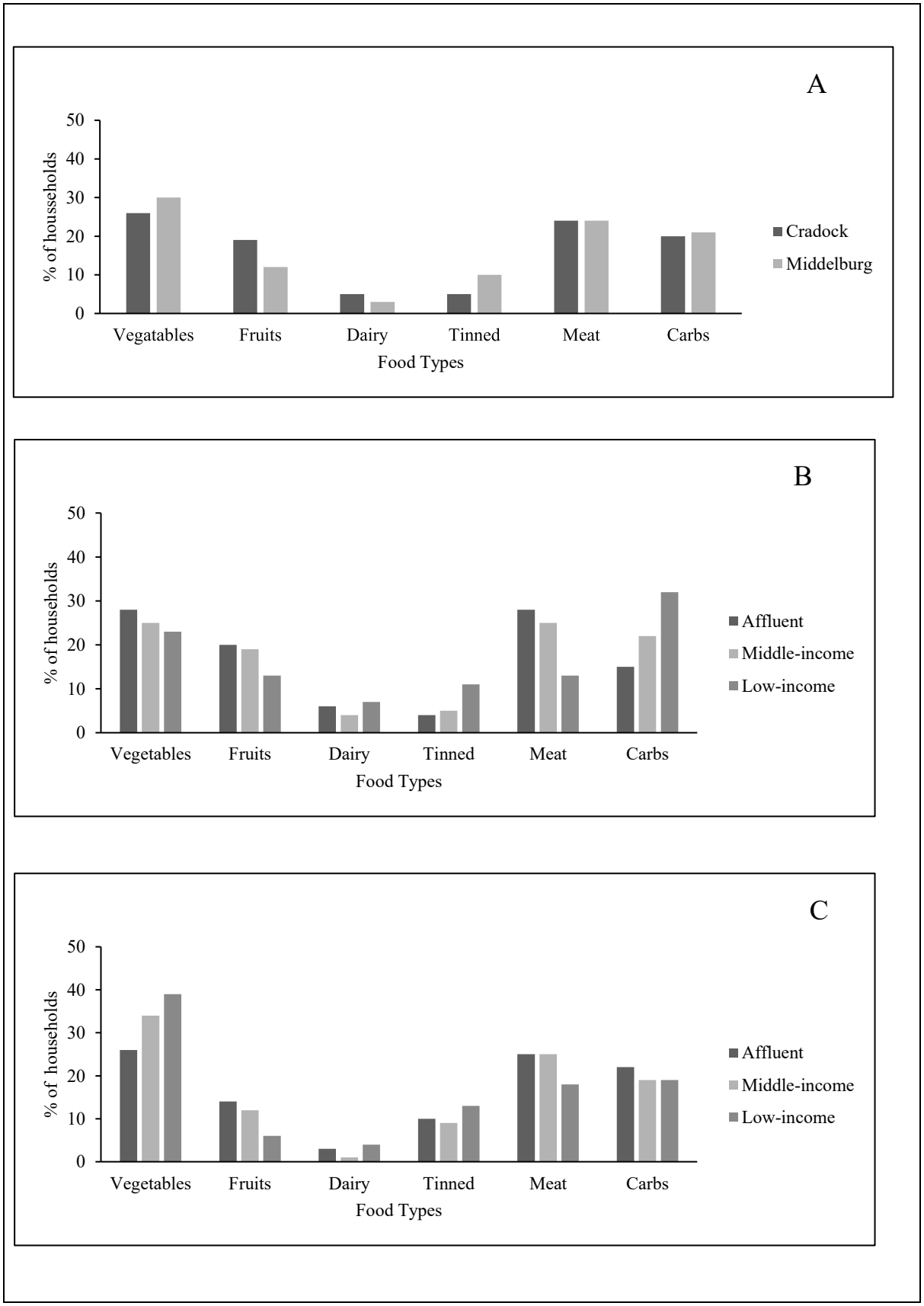



Figure 10: Common types of food wasted by households in different socio-economic groups for both towns (A) and per suburb in Cradock (B) and Middelburg (C) in the previous 48 hours.

There was a significant difference between the proportions of households that generated vegetable waste ($\mathcal{X}^2$= 44. 67; p<0.05) across all suburbs, with households in the low-income suburb in Middelburg having the greatest proportion (39%) and the low-income suburb in Cradock the lowest proportion (23%). Figure 3.4 also shows that the middle-income suburb in Middelburg had the second largest proportion (34%) of households that generated vegetable waste. A significant difference was also observed in the proportions of households that threw away fruits in all suburbs ($\mathcal{X}^2$= 58.00; p<0.05), with the highest proportion in affluent suburb in Cradock (20%) whilst the low-income suburb in Middelburg had the least proportion (6%).

No significant differences were detected in the percentages of households that generated dairy waste between the suburbs ($\mathcal{X}^2$= 9.95; p>0.05). Nevertheless, Figure 3.3 shows that the low-income suburb in Cradock had a higher proportion (7%) and the middle-income suburb in Middelburg had the least proportion (1%). Regarding the percentages of households that discarded tinned food, the results revealed that the percentages were significantly different across all suburbs ($\mathcal{X}^2$= 11.33; p<0.05), with households in the low-income suburb in Middelburg having a significantly higher proportion (13%) and the affluent suburb in Cradock having the lowest (3%).

A significant difference in the proportions of households that discarded meat was apparent in all the suburbs within towns ($\mathcal{X}^2$= 43.33; p<0.05). The affluent suburbs in Cradock and Middelburg had the highest percentage (25% and 25%), whilst the low-income suburb in Cradock had the lowest proportion (13%). For the proportions of households that discarded carbohydrates between the suburbs, the results showed a significant difference ($\mathcal{X}^2$= 25.33; p<0.05). The post-hoc results revealed that more households in the low-income suburb in Cradock were discarding carbohydrates (32%) than those in the affluent suburb in Cradock (15%) (p<0.05).

#### *3.3.2.2. Average quantities of food wasted in two towns in the previous 48 hours*

Households in Cradock were wasting more food than those in Middelburg. The highest average amount of food wasted in Cradock was 2.57± 1.23 kg, which was recorded at breakfast (Table 19). In Middelburg, the highest average amount of food discarded was 1.55±1.07 kg, which was at supper. The quantities of food waste generated decreased from breakfast to lunch, with lunch time having the least quantity. There was a significant difference between the quantities of food waste generated during breakfast between the two towns ($Z$= 0.4; p<0.05) The post-

hoc results showed that households in Cradock wasted more food (2.57±1.23 kg) during breakfast compared to those in Middelburg (1.43±0.93 kg) ($p<0.05$). The differences in the amounts of food thrown away by households at lunch were also significant ($Z= 0.5$; $p<0.05$), with households in Cradock generating significantly higher amounts (1.17± 0.67 kg) of food waste compared to those in Middelburg (0.86±0.59 kg). No notable differences were apparent in the amounts of food discarded at supper between the towns ($Z= 0.3$; $p>0.05$).

Table 19: The mean amounts of weighed food waste at breakfast, lunch, and supper in two towns in the previous 48 hours *(Bold values indicate the mean estimated amount per town and overall, the superscripts denote significant differences between the quantities of meals discarded between and within the two towns at breakfast, lunch and supper).*

| **Town and Suburb** | **N** | **Breakfast (kg)** | **Lunch (kg)** | **Supper (kg)** | **Total (kg)** |
|---|---|---|---|---|---|
| **Cradock** | **36** | **2.57±1.23[a]** | **1.17±0.67[a]** | **1.31±0.78** | **5.05±2.68** |
| Affluent | 12 | 3.51±0.93 | 1.86±0.57 | 1.96±0.64 | 7.33±2.14 |
| Middle-income | 12 | 2.96±0.84 | 0.98±0.46 | 1.23±0.67 | 5.17±1.97 |
| Low-income | 12 | 1.25±0.46 | 0.69±0.26 | 0.71±0.48 | 2.65±1.20 |
| **Middelburg** | **36** | **1.43±0.93[b]** | **0.86±0.59[b]** | **1.55±1.11** | **3.84±2.59** |
| Affluent | 12 | 2.35±0.82 | 1.52±0.41 | 2.76±0.65[a] | 6.63±1.88 |
| Middle-income | 12 | 1.41±0.49 | 0.72±0.36 | 1.44±0.35 | 3.57±1.20 |
| Low-income | 12 | 0.53±0.21 | 0.33±0.12 | 0.46±0.39[b] | 1.32±0.72 |
| **Mean** | **72** | **2.00±0.12** | **1.02±0.65** | **1.43±0.94** | 4.45±1.71 |

Table 20 also shows that the affluent suburbs in both towns generated the most food waste and the low-income suburbs the least. Comparison between the amounts of food waste generated at breakfast was significantly different across all suburbs ($Z = 0.2$; $p<0.05$), with a higher amount of food waste generated in the affluent suburb in Cradock (3.51±0.93 kg) whilst the least average amount of food waste was recorded in the low-income suburb in Middelburg (0.46±0.39 kg). Considering the differences between the quantities of food wasted at lunch between the suburbs, the results showed that the amounts of food discarded in all suburbs were significantly different from one another ($Z = 0.4$; $p<0.0$), with the affluent suburb in Cradock having the highest average amount ( 1.86±0.57 kg) and the low-income suburb in Middelburg having the least average amount (0.33±0.12 kg).

Significant differences in the quantities of food thrown away at supper were also observed between the suburbs ($Z = 0.3$; $p<0.05$), where the affluent suburb in Middelburg discarded a significantly higher average amounts (2.76±065 kg) of food, and the low-income suburb in Middelburg the least average amount of 0.46±0.39 kg. Generally, the low-income suburb in Middelburg generated less food waste compared to other suburbs within Middelburg and those in Cradock.

### 3.3.3. Total quantity of weighed food waste produced per household and per person annually

The amount of food waste generated per household per year is 810.84±5.13 kg (equivalent to 202.60±128.30 kg per person per year) across both towns. Annually, households in Cradock and Middelburg discarded approximately 921.46±489.05 kg and 700.27±473.31 kg, respectively. Further, the results reveal that households in Cradock wasted more of food than those from Middelburg. It is also evident that each household and each person in Cradock generated more food waste at breakfast as the results show highly elevated quantities from breakfast compared to lunch and supper. In Middelburg, the highest average amount of food waste generated was recorded from supper and the least from lunch.

Table 20: Overall amount of weighed food waste generated during breakfast, lunch, and supper by each household and each person per year

| **Town** | **Food waste generation time frame** | **Breakfast (kg)** | **Lunch (kg)** | **Supper (kg)** | **Total (kg)** |
|---|---|---|---|---|---|
| **Cradock** | Per household in 48hrs | 2.58±1.23 | 1.17± 0.67 | 1.31±0.78 | 5.05±2.68 |
| | Per household/year | 470.07±224.89 | 214.33±121.71 | 237.07±142.44 | 921.46±489.05 |
| | Per person/year | 156.70±75.0 | 71.40±40.60 | 79.0±47.50 | 307.20±163.0 |
| **Middelburg** | Per household in 48hrs | 1.43±0.93 | 0.86±0.59 | 1.55±1.07 | 3.84±2.59 |
| | Per household/year | 260.72±170.49 | 156.35±108.15 | 283.20±194.67 | 700.27±473.31 |
| | Per person/year | 65.20±42.60 | 39.10±27.0 | 70.80±48.70 | 175.10±118.30 |
| **Mean** | Per household in 48hrs | 2.00±1.23 | 1.02±0.65 | 1.43±0.94 | 4.44±2.81 |
| | Per household/year | 365.38±224.44 | 185.33±117.99 | 260.14±170.95 | 810.84±513.00 |
| | Per person/year | 91.30±56.1 | 46.30±29.5 | 65.00±42.7 | 202.60±128.30 |

### 3.3.4. Comparison of the self-reported and weighed amounts of food wasted

The mean amounts of food waste from self-reported and weighed data are presented in Table 21. The results show that the respondents underestimated food waste quantities as the weighed data showed that households wasted seven to ten times more food in the previous 48 hours than they reported.

Table 21: Comparison of the overall self-reported and weighed amounts of wasted food in study towns

| **Cradock** | **Food waste generation timeframe** | **Self-reported amount (kg)** | **Weighed amount (kg)** | **Ratio** |
|---|---|---|---|---|
| | 48hrs | 0.52±1.07 | 5.05±2.68 | 9:6 |
| | Per household/year | 95.54±195.90 | 921.46±489.05 | |
| | Per person/year | 31.80±65.30 | 307.2±163.0 | |
| Middelburg | 48hrs | 0.50±0.99 | 3.84±2.59 | 7.6 |
| | Per household/year | 91.78±178.90 | 700.27±473.31 | |
| | Per person/year | 23.0±44.80 | 175.1±118.3 | |
| Overall | 48hrs | 0.51±1.04 | 4.44±2.81 | 8.7 |
| | Per household/year | 93.72±188.91 | 810.85±5.13 | |
| | Per person/year | 23.40±47.20 | 202.60±128.30 | |

### 3.3.5. Correlation of estimated food waste quantities with socio-demographic and socio-economic factors between the towns

Weak significant negative associations were found between the amounts of food wasted and household size, employment and wealth status in both towns. Meanwhile, a negative association between the quantities of food thrown away and the number of children per household was only observed in Cradock (Table 22).

In Cradock, a significant positive correlation between the quantities of food wasted per household and per person and the household size as well as the number of children was observed in the low-income suburb. Whereas, a negative correlation between quantities of food discarded per household/person and wealth status was observed in the affluent suburb.

In Middelburg, a significant positive correlation between the quantities of food wasted per household and per person and household wealth status was observed in the low-income suburb. A significant positive relationship between food waste and household size was also apparent

in the middle-income suburb in Middelburg. In the affluent suburb, the results reveal a significant negative association between the quantities of food discarded and respondents' education level. In all suburbs, there were no correlation between the quantities of food wasted per mean age per household as well as the number of people employed.

Table 22: Spearman correlations between the quantities of food wasted per household and socio-demographic and economic factors in the last 48 hours between the two towns *(Bold numbers indicate significant correlations between the amounts of food wasted and the socio-demographic and economic factors ($p<0.05$)).*

| **Socio-demographic and economic factors** | **Cradock (n= 285)** | | | | **Middelburg (n= 249)** | | | |
|---|---|---|---|---|---|---|---|---|
| | **Town** | **Low** | **Middle** | **Affluent** | **Town** | **Low** | **Middle** | **Affluent** |
| Age of household head | 0.09 | 0.07 | 0.04 | 0.09 | 0.04 | 0.04 | 0.02 | 0.03 |
| Household size | **-0.19** | **0.16** | -0.03 | 0.05 | **0.15** | 0.05 | **0.31** | 0.02 |
| Number of children | **-0.15** | **0.24** | 0.05 | 0.06 | 0.01 | 0.08 | 0.04 | 0.03 |
| Education level | 0.07 | 0.06 | 0.01 | 0.24 | 0.00 | 0.00 | 0.05 | **-0.26** |
| Employment status | **-0.19** | 0.08 | 0.03 | **-0.16** | **0.15** | 0.05 | 0.09 | 0.02 |
| Number of people employed, or self employed | 0.02 | 0.02 | 0.05 | 0.04 | 0.03 | 0.03 | 0.07 | 0.06 |
| Wealth status | **-0.16** | -0.06 | 0.07 | **-0.19** | **0.22** | **0.22** | 0.05 | 0.09 |

### 3.3.6. Household food waste minimisation

Respondents in the sample households were asked whether they had any food waste minimisation strategies. About 74% of the respondents in Cradock and 73% in Middelburg said that they had no minimisation strategies. However, the affluent suburbs in both Cradock and Middelburg had the largest proportions (79% and 75%, respectively) of households with no strategies for tackling food waste. No significant differences were apparent in the percentage of respondents that did not have pre-existing strategies between the towns ($\mathcal{X}^2$= 13.12.0, p>0.05) and between the suburbs ($\mathcal{X}^2$= 15.13; p>0.05).

Respondents from households who reported pre-existing strategies to minimise food waste were asked about the different strategies they implemented. The most mentioned strategies in Cradock were donating leftover food to the less fortunate and cooking less frequently. In Middelburg, just over a half (52%) of the respondents from the affluent suburb (52%) declared that they chopped and froze vegetables to minimise food waste generation; whilst the respondents in the low-income suburb mostly cited the use of shopping lists (24%), and those in the middle-income suburb mostly cited cooking small food portions (31%) (Table 23). It should be noted that the respondents reported that whilst feeding food to animals, donating to the needy, and composting vegetables does not minimise food waste- the strategies reduce the amounts of food thrown into municipal waste bins. Consequently, reducing the quantities of food waste in landfills.

Table 23: Strategies implemented by households to minimise household food waste in two towns and per suburb (n= 534), values are percentages of households

| **Strategies** | **Cradock (n= 285)** | | | | **Middelburg (n= 249)** | | | |
|---|---|---|---|---|---|---|---|---|
| | **Overall** | **Affluent** | **Middle** | **Low** | **Overall** | **Affluent** | **Middle** | **Low** |
| None | 74 | 79 | 73 | 70 | 73 | 75 | 74 | 71 |
| Freeze leftovers | 3.3 | 10 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cook small portions | 7 | 10 | 12 | 0 | 12 | 5 | 31 | 0 |
| Feed leftovers to animals | 16 | 10 | 0 | 38 | 15 | 26 | 0 | 19 |
| Buy food weekly | 13 | 20 | 20 | 0 | 12 | 5 | 31 | 0 |
| Compost vegetables | 7 | 10 | 12 | 0 | 0 | 0 | 0 | 0 |
| Donate to the needy | 15 | 20 | 12 | 14 | 5 | 0 | 0 | 14 |
| Cook less frequently | 23 | 10 | 34 | 24 | 4 | 11 | 0 | 0 |
| Use shopping lists | 7 | 10 | 12 | 0 | 16 | 0 | 23 | 24 |
| Check expiry dates | 3 | 0 | 0 | 10 | 11 | 0 | 0 | 33 |
| Chop and freeze vegetables | 5 | 0 | 0 | 14 | 26 | 52 | 15 | 10 |

When respondents were asked whether all members of their households adhered to the implemented food waste minimisation strategies, about 72% of the respondents from Cradock and 85% from Middelburg declared that not all members of their households adhered to the mentioned strategies. The results revealed that there were no significant differences in proportions between the towns ($X2=16.1$; $p>0.05$) nor between the suburbs ($X2=18.4$; $p>0.05$). The results revealed that the low-income suburb in Middelburg had the largest proportion (86%) of household members who did not adhere to strategies implemented, and the affluent suburb in Cradock had the smallest proportion (71%).

The respondents mentioned that some household members wasted more food than others. The results showed that Cradock had the highest proportion of household members who wasted food (87%) and Middelburg had the lowest (71%), but there were no significant differences in percentages between the towns ($X2= 14.0$; $p<0.05$). Within the suburbs, there were significantly more respondents from the affluent suburbs in both Cradock (80%) and Middelburg (81%) who declared that some members of their households discarded more food, compared to the low-income suburbs (50% and 55%, respectively) and the middle-income suburbs (73% and 70%, respectively) ($X2= 16.5$; $p<0.05$).

In terms of food waste between children and adults, the participants in both towns and within the suburbs (more than 50%) perceived that children wasted more food (food that is already in the house) than adults and most of them were females (more than 50%) (Figure 10). No significant differences were observed in the proportions of respondents who declared that children wasted more food than adults between the towns ($\mathcal{X}^2$=9.5; p<0.05). However, the results showed that between the suburbs; the low-income suburb in Middelburg had a significantly higher proportion (94%) of the respondents who reported that children were the greatest food wasters ($\mathcal{X}^2$=12.5; p<0.05).

In general, between the suburbs, the perception was that children wasted more food than adults, except in low-income suburbs of both towns where the percentages of respondents regarding members that wasted more food was relatively the same for children and adults (50% and 50%). Furthermore, respondents across all suburbs perceived that females waste more food than their male counterparts with more than 50% of respondents agreeing to this. The low-income suburb in Middelburg had a significantly higher percentage (83%) of the respondents who reported that females wasted more food than males ($\mathcal{X}^2$=16.7; p<0.05).

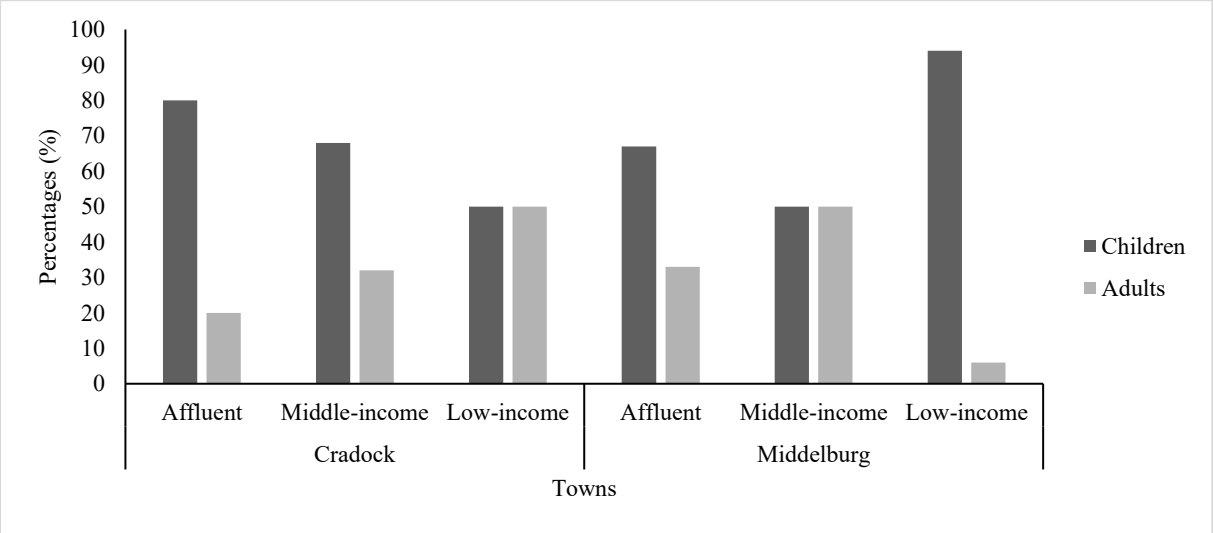



Figure 11: Reported proportions of household members who wasted more food in the study towns.

When respondents were asked what could be done to help households discard less food (Table 24), about 36% of the respondents in Cradock said that households are likely to waste less food if they had proper food storage opportunities. Meanwhile, in Middelburg a large proportion of

the respondents declared that they would likely generate less food waste if they could learn more about the negative impacts of food waste on climate systems. Similarly, within the suburbs, the results show that a significant proportion (more than 30%) of respondents from the affluent and low-income suburbs in Middelburg as well as the affluent suburb in Cradock cited the same. Whilst, a larger proportion of their counterparts, particularly the low-income suburb declared that all the listed options were relevant and would influence them to generate less food waste (Table 24).

Table 24: Most cited interventions to minimise household food waste among two study towns (n=534)

| **Response options** | **Town/Suburb** | **Cradock (%)** | **Middelburg (%)** |
|---|---|---|---|
| Awareness about the negative impacts of food waste on climate systems | Overall | 25 | 47 |
| | Affluent | 34 | 17 |
| | Middle-income | 9 | 31 |
| | Low-income | 31 | 92 |
| Clearer food labels for all household groups | Overall | 1 | 4 |
| | Affluent | 0 | 5 |
| | Middle-income | 1 | 7 |
| | Low-income | 3 | 0 |
| Tax all households that discard higher quantities of food | Overall | 7 | 4 |
| | Affluent | 4 | 6 |
| | Middle-income | 0 | 6 |
| | Low-income | 18 | 0 |
| Donate proper food storage to less fortunate homes | Overall | 35 | 7 |
| | Affluent | 10 | 14 |
| | Middle-income | 85 | 7 |
| | Low-income | 4 | 4 |
| Establish proper institutions to collect excessive consumable food for animal feeding | Overall | 16 | 2 |
| | Affluent | 42 | 5 |
| | Middle-income | 5 | 1 |
| | Low-income | 4 | 1 |
| All of the above | Overall | 16 | 36 |
| | Affluent | 10 | 53 |
| | Middle-income | 0 | 48 |
| | Low-income | 40 | 7 |

## 3.4. Discussion

### *3.4.1. Types of food wasted*

Several studies that have sought to report on the types of food wasted at household level indicate that perishable food accounts for the highest percentage of food waste (Wrap, 2009; Ilakovac *et al.*, 2020). For example, Ilakovac *et al.* (2020) found that in Croatia almost half (46%) of the food waste consisted of vegetables. In South Africa, Cronjé *et al*. (2018) found that a greater proportion (about 42%) of households disposed vegetables. The findings of this study show that the types of food wasted amongst households in Cradock and Middelburg include vegetables, fruits, dairy, tinned, meat, and carbohydrates. When analysing the proportions of households discarding the above-mentioned food types, a greater proportion (26% in Cradock and 30% in Middelburg) of households discarded vegetables compared to other food types. The second highest proportion was observed for meat, with 24% households in both towns. In contrast, Ramukhwatho *et al.* (2014) and Chakona and Shackleton (2017) found that in South Africa, a higher proportion of households (58% and 20%), respectively, discarded maize porridge. A plausible explanation could be that majority of households in South Africa, particularly black communities prepare and eat carbohydrates (i.e. pap and porridge) as a staple food (Chakona and Shackleton, 2017; Oelofse *et al.,* 2020).

When assessing types of food wasted, it is important to investigate the different socio-economic settings. A focus on the types of food wasted by affluent, low and middle-income households is critical. As expected, the proportions of households discarding vegetables was highest amongst households in the affluent suburbs. Further, the proportions of households discarding vegetables increased with affluence in Middelburg, while the proportion of households discarding carbohydrates and meat decreased with decreasing affluence with no significant differences observed between the proportions of households across all suburbs.

The reasons for this difference have not yet been fully established in literature. However, a plausible explanation for this finding could be that out of the 58% of households growing food in Cradock, 92% of the households growing vegetables were observed in the affluent and out of the 23% households in Middelburg, 73% were growing vegetables. As such, vegetables may not absorb a large amount of their expenditure. This is supported by Pearson *et al.* (2013) whose

study claims that people are likely to feel little effects from discarding food when it is of low expenditure to them.

It is worth highlighting that this may not be a consistent finding throughout developing countries. For example, another study undertaken in South Africa indicated that 62% of households in high-income areas purchased vegetables daily, or weekly basis. Yet, only 38% consumed the vegetables that are readily available (Okop *et al.*, 2019). Therefore, these findings would be worth taken into consideration when developing anti-waste strategies at household level.

### *3.4.2. Quantities of food wasted*

Considering that food waste is a pressing topic on food waste management policy agenda (Diaz-Ruiz *et al.,* 2018), urgent strategies need to be developed and implemented to minimise food waste, the purpose of this study was to investigate the types and estimated quantities of food waste generated in Cradock and Middelburg and explore the concept of food waste minimisation amongst local households. This study presents self-reported and weighed food waste quantities across households in different income suburbs as an entry point for food waste minimisation interventions in South Africa, particularly in the Eastern Cape province.

According to self-reported quantities, households in Cradock and Middelburg altogether generated 93.72±188.91 kg per household per year. While, the average weighed food waste generated per household per year is almost nine times greater (810.84±513.00 kg). For comparative reasons, these results were converted into food waste generated per person per year. The findings reveal that the average self-reported food waste quantities of 23.40±47.20 kg/capita/year and the average weighed quantities of 202.60±128.30 kg/capita/year were generated. The average self-reported quantity generated per person per year is far below the global average of 145 kg/capita/annum (Preka *et al.,* 2020), 95-115 kg/capita/year in Czech Republic (Sosna *et al.,* 2019) and 28 kg/capita/year reported in South Africa (Nahman *et al.*, 2012).

However, worth noting is that an opposite situation is observed for the average weighed quantity. Further, both the average, self-reported and the weighed food waste quantities are far above the 6.9 kg/capita/year recorded in Albania in Europe (Preka *et al.,* 2020), 6-11 kg/capita/year in sub-Saharan Africa as well as South-eastern Asia (Gustavsson *et al.,* 2013), 9.68 kg/capita/year (Nahman *et al.,* 2012) and 12.35 kg/capita/year (Chakona and Shackleton,

2017) reported in South Africa. The variability between self-reported and weighed could be explained by the different food waste quantification methodologies. For example, it is possible that the respondents reported lower food waste quantities intentionally because they were ashamed that they would be judged for discarding food when there are millions of people who go to bed hungry daily, or they simply forgot certain waste streams, or they were unable to estimate quantities of food wasted.

Studies which focused on waste characterisation found that affluent households generally discard larger amounts of food than those in low-income areas (Jeswani *et al.,* 2021). Likewise, the results of this study reveal that food waste generation increased with affluence (Table 19). Generally, the connection between food waste generation and high-income has been to an extent established in South Africa. For example, Oelofse *et al.* (2018) revealed the same sequence where high-income households in Ekurhuleni Metropolitan Municipality disposed of higher quantities of food (0.53 kg/household/week) compared to middle-income (0.45 kg/household/week) and low-income (0.38 kg/household/week). A plausible explanation for this difference could be extrapolated from the existing knowledge on poverty rates in the Eastern Cape province of South Africa. According to Stats SA (2020) most people in the Eastern Cape are unemployed and live under difficult financial conditions. Further, South Africa's unemployment rate has jumped from 30.8% in the third quarter of 2020 to a new record high of approximately 32.5% in the fourth quarter of the same year. Therefore, this points that the reported reality in the Eastern Cape could be influencing the lower food waste quantities amongst households in the low-income suburbs compared to their counterparts whose financial capabilities are better.

Moreover, on a per capita per annum basis, households in Cradock mostly generate food waste at breakfast (156.70±75.0 kg/capita/year) and the least at lunch (71.40±40.60 kg/capita/year), while in Middelburg a greater quantity of food waste is generated at supper (70.80±48.70 kg/capita/year) and the least at lunch (39.10±27.0 kg/capita/year). Interestingly, between the suburbs, the quantities of food waste generated at different mealtimes overlap. For example, households in the affluent and middle-income suburbs in Middelburg generated greater quantities of food waste at supper, while those in the affluent and middle-income suburbs in Cradock and low-income suburbs in Middelburg generated greater quantities at breakfast. Considering that there is lack of research in respect to these findings, the observed variation could be attributed to food availability (Aschemann-Witzel *et al.*, 2015; Hebrok and Boks, 2017; Schmidt and Matthies, 2018). For example, in South Africa, disproportion of income

distribution result in several households having limited food for daily consumption (Ramukhwatho *et al.,* 2018). As such, it is unsurprising that there is variation in the quantities of food wasted at different mealtimes as some households could only be preparing food at breakfast, lunch or supper; with a few preparing foods at all mealtimes.

### *3.4.3. Relationship between the amounts of food wasted and socio-economic factors*

The results of this study show that household size significantly affected food waste generation: with Cradock showing a negative association, with smaller households wasting more and larger households wasting less. These findings corroborate with those reported by Chakona and Shackleton (2017), South Africa; Kambo and Osmani (2018) in Albania; and Li *et al.* (2020) in Canada where a negative correlation was observed between household size and the quantities of food wasted. The underlying explanation found in the literature for this trend is that smaller households waste less food because they tend to prepare more than they need (Chakona and Shackleton, 2017; Nunkoo *et al.,* 2021). In this context, most households with relatively smaller household size were from the affluent suburbs. This means that food availability and affordability may be the reason they discarded larger amounts of food compared to larger households, which were mostly from the low and middle-income suburbs. Interesting to note is that in Middelburg a positive association was observed, where food waste generation increased with household size. This could be that larger households were noted amongst low-income suburbs, where most respondents indicated that they lacked proper storage to preserve food from spoiling.

There was also a significant negative association between employment status and food waste generation. Households with a larger proportion for unemployed members wasted relatively lower amounts of food compared to those with a higher proportion for employed household members. People who do not work may spend most of their time at home, and therefore are most likely to generate food waste (Neubig *et al.,* 2020), this explanation may not be necessarily true for a country like South Africa, because food is a high expenditure in developing countries (Pearson *et al.,* 2013). A more plausible explanation could be that unemployed respondents may be placing a high value in food because it takes up a huge portion of their money- which is mainly social grants. These results are not consistent with a study from the United Kingdom, which indicated that people who are not working generate more

food waste compared to those who are either working full-time, or part-time (Neubig *et al.,* 2020)

A significant positive association in the amount of food wasted and wealth status was also observed in Cradock and Middelburg, this means that wealthier households discarded more food. This is consistent with previously reported studies, which have indicated that affordability, which is influenced by higher income; affects how much food people throw away. This is because wealthy people do not consider food as a high expenditure item. Further, abundance when purchasing food is identified with wealth (Nunkoo *et al.,* 2021), meaning that the wealthier households may be purchasing, preparing, or even serving more food than they need- consequently increasing the amounts of food thrown away.

Gender was a significant factor in food waste generation in both towns, this could be that majority of respondents were females and hence the results revealed that households with female respondents wasted more food compared to those with males. The results of this study corroborate with many studies which have revealed that women waste more food than men (Secondi *et al,* 2015; Preka *et al.,* 2020; van der Werf *et al.,* 2021). This is of great interest because females are identified as more likely to feel guilty when throwing away food because they feel that they have failed managing their households (Neubig *et al.,* 2020).

### *3.4.4. Food waste minimisation strategies*

Remarkable is the observed link between the quantities of food waste generated and food waste minimisation strategies. For example, Cradock had a marginally higher proportion (79%) of households that had implemented food waste minimisation strategies than Middelburg (75%).Yet, recorded the highest quantities of food waste (5.05±2.68 kg) in the previous 48 hours, while Middelburg recorded the least (3.84±2.59 kg). Similarly, households in the affluent suburbs in both towns had higher proportions for not practicing household food waste minimisation strategies and quantities of food waste disposed compared to those in the low and middle-income suburbs. This finding is not consistent with Quested *et al.* (2013), Abeliotis *et al.* (2016) and Nunkoo *et al.* (2021) who claimed that the lack of food waste management impacts negatively on the global efforts to combat food waste generation. A plausible explanation for the finding in this study could be that households in Cradock were not implementing the existing anti-food waste strategies effectively.

It is worth noting that there is no available data on the proportion of households that have implemented food waste minimisation strategies, particularly in South Africa. Preka *et al.* (2020) reveals that a weak attitude towards food budgeting and planning usually impacts negatively on food waste management. In this context, the lack of food waste minimisation strategies could be attributed to a weak attitude towards minimising the quantities of food disposed, awareness campaigns and programmes.

The most adopted household food waste minimisation strategy (23%) in Cradock is cooking less frequently, while in Middelburg (26%) it is chopping and freezing vegetables to preserve them from spoiling. Between the suburbs, cooking less frequently, buying food weekly, chopping and freezing vegetables and cooking small portions were the most reported strategies amongst households in the affluent and middle-income suburbs. Whereas, households in the low-income suburbs minimised food waste through food budget planning using shopping lists and checking for expiry dates for the food they purchase. Strikingly, the reported strategies in Cradock and Middelburg do not differ from those reported by Quested *et al.* (2013) and Schmidt and Matthies (2018) who reported that the leverage points for preventing, or reducing household food waste include food planning and preparation (cooking small portions), storage (i.e. freezing food); shopping (buying small portions of food); and consumption practices (i.e. eating leftovers).

Worth highlighting is that households in the three income suburbs reported different food waste minimisation strategies, and according to Preka *et al.* (2020) proximity to shopping centres influences food purchases. Indeed, the households in the affluent and the middle-income suburbs were closer to shops than low-income areas. Therefore, purchasing food weekly and cooking less frequently are practical interventions for minimising food waste.

To address household food waste, it is worth investigating the challenges associated with effective implementation of household food waste minimisation strategies amongst households that have pre-existing strategies. For example, most of the respondents (72% in Cradock and 85% in Middelburg) reported that unwillingness to implement pre-existing strategies by some household members remains a barrier to effectively preventing, or minimising food waste. A plausible explanation for this finding could be attributed to lack of guilt and shame towards wasting food. For example, several studies reveal that emotions such as guilt and shame influence people's willingness to minimise food waste (Goh and Jie, 2019; Roe and Bender, 2020; Nunkoo *et al.,* 2021). The study also found that more than 80% of households in the

affluent suburbs indicated that some of the household members wasted more food than others. While this finding could also be attributed to guilt and shame, Nunkoo *et al.* (2021) argued that wealthy people have reduced empathy towards food waste issues.

Interestingly, more than 50% of the respondents in both towns reported that children and particularly girls (females) contributed more to food waste compared to adults. This finding coincides with Parizeau *et al.* (2015), Canali *et al.* (2017) and Sorokowska *et al.* (2020) who found that children are most likely to generate more food waste because they are picky when it comes to food and more often refuse to finish their meals. Canali *et al.* (2017) claimed that females tend to generate more food compared to males because they are mostly responsible for preparing food than males. The same sequence is observed for most homes in South Africa, especially in low-income households as female children are responsible for house chores, including preparing meals.

## 3.5. CONCLUSIONS

This chapter aimed to assessing the types, quantifying the amounts of food waste, and assessing household food waste minimising strategies in urban households in the Eastern Cape province. To fulfil this aim, the study addressed three objectives and hypothesis.

Objective one focused on identifying the common wasted types of food amongst two towns.

- Overall, vegetables were the most wasted food types, followed by meat. As such, the first hypothesis was proven to be correct (except that meat was mostly wasted amongst households in the affluent and middle-income suburbs).

Objective two focused on quantifying food wasted between the two towns.

- The second hypothesis was also correct as the results show that food waste decreased as one moves from the affluent to the low-income suburbs, with households in the affluent suburbs discarding significantly higher quantities of food compared to its counterparts. However, the quantities of food wasted decreased from breakfast to supper, with larger amounts discarded at breakfast and the least at supper.

- When comparing self-reported and weighed amounts of food wasted, it was found that households wasted seven to nine times the amounts they reported to be discarding. As such, the third hypothesis was proven to be correct. The findings also show that food waste generation increased with larger households, higher number of people employed, and the wealthier the households.

Objective three focused on investigating the implementation of food waste minimisation strategies and whether there are any significant differences between and within the study towns.

- It was found that more than 70% of the households in both towns had no strategies in place, and that those that had were faced with challenges such as some members, i.e. children, often not implementing the strategies.
- It was also found that households are likely to generate even higher quantities of food in summer, Easter weekends, and on Christmas as there would be more food with limited storage.

# CHAPTER 4

# SYNTHESIS AND RECOMMENDATIONS


Image 4: Taken from Fusion (2016).

# CONCLUSION AND WAY FORWARD

## 4.1. INTRODUCTION

Understanding the drivers of food waste and the quantities of food waste generated among households from varying income groups is an important step towards developing effective strategies for minimising food waste. Food waste is a significant global environmental issue (Parfitt *et al.,* 2010; Ananno *et al.,* 2020), including in South Africa (Chakona and Shackleton, 2017; Cronjé *et al.,* 2018; Ramukhwatho *et al.,* 2018; Li *et al.,* 2020; Nunkoo *et al.,* 2021). Therefore, minimising the quantities of food waste going into landfills is becoming a significant contributor to reducing greenhouse gas emissions (i.e., methane gas) (El-Fadel *et al.,* 1997; DEA, 2011; White *et al.,* 2018). While many studies have focused on assessing the drivers of food waste and quantifying the amounts generated by households, food waste generation, disposal and minimisation remains poorly understood in developing countries, including in South Africa. This research used household questionnaires to assess the drivers, quantities, patterns and behaviour associated with food waste generation, disposal and minimisation in households. Further, scales were used to directly weigh the food waste generated. Lack of food waste minimisation strategies globally, together with the underestimation of food waste quantities using questionnaires, are expected to lead to elevated greenhouse gas emissions, particularly methane (El-Fadel *et al.,* 1997; DEA, 2011; White *et al.,* 2018).

The study sought to better understand food waste generation, disposal and minimisation at household level. To achieve this aim, the study assessed the types, quantities and the perceived drivers of food waste. The study further looked at anti-food waste strategies implemented by households. Finally, the study highlighted the significant differences in the types and quantities of food waste generated at household scale across three income suburbs at different mealtimes and between the estimated and weighed food waste. This section presents a summary of the two results chapters (Chapters 2 and 3), as well as the findings of the study in relation to findings deduced from other studies as presented in Chapter 1.

## 4.2. SUMMARY OF KEY FINDINGS

### *4.2.1. What are the drivers of household food waste?*

An assessment of the drivers of food waste generation and disposal across households from varying income suburbs provides the basis for developing practical and context-based anti-food waste strategies. Many studies have assessed the drivers of food waste from a general context in South Africa (Ramukhwatho *et al.,* 2014; Chakona and Shackleton, 2017; Oelofse *et al.,* 2020). The main driver of food waste generation and disposal particularly for households in the affluent suburbs was due to the behaviour of people thinking that food waste is not an issue. Meanwhile people in the middle and low-income suburbs were generating and disposing food waste mainly due to cooking too much and food expiring before being consumed. All in all, there are no major differences in the drivers of food waste between Cradock and Middelburg, but differences were evident between the three income suburbs. This result strongly suggests that food waste is influenced by income and research should focus on this narrative for the development and implementation of effective anti-food waste strategies (White *et al.,* 2018).

Considering the drivers noted on this study, and that most of the respondents indicated that they would generate less food waste if they knew about the impact of food waste generation to climate systems. I suggest that food waste minimisation initiatives should focus on distributing food waste and climate change related information (Painter *et al.,* 2016; White *et al.,* 2018) through food waste campaigns. This will highlight the benefits of food waste minimisation to global climate systems.

As far as the food waste research in South Africa is concerned, there are no studies on the drivers of food waste amongst households from different income groups. This is likely to be because of the lack of understanding that households from varying income groups may behave differently and therefore require greater examination. I suggest that municipalities should include food waste programmes in their annual planning to engage communities on the behaviours driving food waste generation and disposal.

As reported by Lyndhurst *et al.* (2007), Graham-Rowe *et al.* (2014) and Jörissen *et al.* (2015), Chapter 2 revealed that shopping behaviours contributed more to food waste generation and disposal. For example, the greatest behavioural challenge amongst households in the effluent

suburbs was more frequent shopping while households in the middle and low-income suburbs attracted to food specials. Therefore, a focus on what drives food waste at household level lays a foundation unto which food waste minimisation strategies can be based.

This suggests that for food waste to be minimised, future research should outline household food waste behaviours such as the use of shopping lists, how to respond to food specials, growing fresh food, checking for expiry dates, and eating leftover food from different income suburbs. Such information provides an understanding of the behaviours driving food waste across different income suburbs. To tackle food waste, households should be educated on the negative impacts of food waste and be encouraged to cook smaller portions (enough for the meal) and check for expiry dates on food products before buying them. This could catalyse a change in behaviour, thereby, minimising the quantities of food wasted and disposed in waste bins (El-Fadel *et al.,* 1997; DEA, 2011).

### *4.2.2. What are the commonly wasted food types and quantities of food wasted?*

An assessment and quantification of food waste generated by households is a step towards the development of anti-food waste strategies and monitoring performance against food waste minimisation targets (Painter *et al.,* 2016). The significant differences in the types and quantities of food waste generated and disposed by households from different income groups indicate a lack of sound awareness and practical interventions for food minimisation. Chapter 3 used questionnaires and direct measurements to assess the types and quantities of food wasted. The food waste results indicate that households in the affluent and middle-income suburbs wasted more vegetables and meat, while those in the low-income suburbs wasted more vegetables and carbohydrates. The significant differences in the proportions of households wasting the different food types indicate the need for context-based interventions (i.e., anti-waste strategies focused on the types of food wasted by households from different income groups).

Regarding the quantities of food waste generated and disposed, the findings revealed that the average self-reported food waste quantities of 23.40±47.20 kg/capita/year and the average weighed quantities of 202.60±128.30 kg/capita/year were generated and disposed at Cradock and Middelburg. The average self-reported quantity generated per person per year is far below the global average of 145 kg/capita/annum (Preka *et al.,* 2020), 95-115 kg/capita/year in Czech Republic (Sosna *et al.,* 2019) and 28 kg/capita/year reported in South Africa (Nahman et al., 2012), while average weighed quantities are far above. The difference between estimated and

weighed food waste quantities could be that people are likely to underestimate the amount of food waste they generate and dispose in waste bins. Echoing a study by Elimelech *et al.* (2018). Considering this, future results should focus on using direct methods for food waste quantification for more accurate food waste quantities and to close the gap between the use of questionnaires and direct measurement to quantify food wasted.

### *4.2.3. At what mealtime are households most likely to generate and dispose food waste?*

Despite a study by Ramukhwatho *et al.* (2018) indicating that in South Africa, disproportion of income distribution result in several households having limited food for daily consumption. The study shows that households in Cradock mostly generated and disposed food waste at breakfast (156.70±75.0 kg/capita/year) and the least at lunch (71.40±40.60 kg/capita/year), while in Middelburg a greater quantity of food waste is generated and disposed at supper (70.80±48.70 kg/capita/year) and the least at lunch (39.10±27.0 kg/capita/year). Echoing Aschemann-Witzel et al. (2015), Hebrok and Boks (2017) and Schmidt and Matthies (2018) food waste can be attributed to food availability. Therefore, I recommend that awareness campaigns must be planned such that they also focus on households with unlimited access to food and how best they can prepare food such that it does not end up in waste bins at the highlighted mealtimes.

### *4.2.4. What are the household food waste minimisation strategies implemented?*

Anti-waste strategies have been found to reduce food waste in households globally (White *et al.,* 2018). In this study, the most adopted household food waste minimisation strategy in Cradock is cooking less frequently, while in Middelburg it is chopping and freezing vegetables to preserve them from spoiling. Between the suburbs, these antifood waste strategies overlapped, with cooking less frequently being the most reported strategy amongst households in the affluent and middle-income suburbs, and food budget planning using shopping lists the common strategy among those in the low-income suburbs. Despite this being the case, many households, particularly those in the affluent suburbs in both towns, were not practicing food waste minimisation strategies. This demands implementation of information on food waste impacts on climate change as well as the economic and environmental benefits of implementing minimisation strategies. The urgent need to implement anti-waste strategies to reduce greenhouse gas emissions was also reported by Quested *et al.* (2013), Abeliotis *et al.* (2016)

and Nunkoo *et al.* (2021) who claimed that the lack of food waste management impacts negatively on the global efforts to combat food waste generation.

To mitigate the impacts of food waste, food waste minimisation is key (White *et al.,* 2018; Nunkoo *et al.,* 2021). The importance of raising awareness in respect to the implementation of anti-waste strategies at household scale should be of primary focus because even the households that were practicing food waste minimisation strategies reported that some of their household members were not knowledge some in respect to effective implementation.

Reflecting on the study, it is evident that the more people know about food waste and its impact, the better (Chapter 2), and the more likely they are to reduce the amounts generated (Chapter 3). As discussed in Chapter 1 and shown in Chapter 3, socio-economic factors and lack of education about food waste influences food waste behaviour. As such, from a development perspective, raising awareness on food waste is likely to influence behavioural change (Painter *et al.,* 2016; White *et al.,* 2018). For instance, there is strong evidence that household food waste minimisation strategies have successfully minimised food wasted among households in the United Kingdom. With the quantities of food waste collected by local municipalities in the United Kingdom declined by at least 380 000 tonnes between 2006 and 2009 despite population growth (IDP *et al.,* 2013).

## 4.3. CONCLUSION AND RECOMMENDATIONS

This study revealed the links between the behaviour and food waste generation, disposal and minimisation. The study further highlighted that design of food waste minimisation strategies requires a better understanding of the drivers of food waste across households from different income groups. While the findings presented in this study may not be sufficient to draw conclusions for households in other towns and provinces within South Africa due to different socio-economic contexts, I believe they set a point of departure to developing and implementing context-based household food waste minimisation strategies. Further, it is safe to say household income plays a huge role in the generation and disposal of food waste at household level. Going forward, there is still a need for further research on household food waste in South Africa and expanding into Southern Africa. More research will provide more empirical evidence to conclusively develop context-based food waste minimisation strategies.

Information on food waste and its impacts to climate systems would allow all household members to begin to take food waste seriously and implement food waste strategies effectively.

Future studies should focus on people's attitudes towards anti-food waste strategies to ensure effective implementation. Such an assessment might point towards issues that need attention, thus avoiding developing and implementing food waste strategies that fail to meet food waste minimisation targets. Finally, I conclude with the point that the drivers, types and quantities of food waste generated and disposed reported in this study should be of great concern to municipalities and policy makers. This evidence should be used to engage households on the development and effective implementation of anti-food waste strategies. This task would aid in minimising landfilled food, and thereby reducing methane gas emissions from decomposing food in landfills.

I recommend that future research should seek to sample households from other municipalities to obtain a representative sample of the household food waste situation in the Eastern Cape province and South Africa as a whole. It is highly necessary that awareness created with respect to food waste drivers and food waste minimisation strategies is done at provincial and national level.

I recommend that future research should consider developing a context sensitive household food waste minimisation framework. Once the household food waste minimisation framework is developed, measures should be taken to implement it and then monitor and evaluate whether the quantities of food waste generated decrease with effective implementation. The findings on pre-existing food waste minimisation strategies identified in this study can be used as a basis to develop the framework.

The links between food waste generation and methane gas emissions from decomposing household food waste in landfills were briefly uncovered in Chapter 1. However, some of the respondents did not think that food waste is an issue and were not knowledgeable about the effects of food waste on climate systems, which could have added to their ignorance. Therefore, I recommended that policy makers, municipalities, waste management non-governmental organisations to consider raising awareness in this respect. Further, I recommend that future future research should seek to quantify methane gas emitted from decomposing food to establish primary data for South African households and use this to bring perspective when

raising awareness about household food waste. This may influence household food waste behaviours, which could be a benefit to climate systems globally.

# 5. REFERENCE LIST


Abeliotis, K., Lasaridi, K., Costarelli, V., and Chroni, C., 2015. The implications of food waste generation on climate change: the case of Greece. *Sustainable Production and Consumption, 3,* pp.8-14.

Abeliotis, K., Lasaridi, K., and Chroni, C., 2016. Food waste prevention in Athens, Greece: the effect of family characteristics. *Waste Management and Research*, *34* (12), pp.1210-1216.

Adhikari, B.K., Barrington, S., and Martinez, J., 2006. Predicted growth of world urban food waste and methane production. *Waste Management and Research*, *24* (5), pp.421-433.

Alooh, A.O., 2015. *Quantifying food plate waste: case study of a university dining.* PhD. thesis, Stellenbosch University, Stellenbosch, pp.50-80.

Ananno, A.A., Masud, M.H., Chowdhury, S.A., Dabnichki, P., Ahmed, N., and Arefin, A.M.E., 2021. Sustainable food waste management model for Bangladesh. *Sustainable Production and Consumption*, *27*, pp.35-51.

Annunziata, A., Agovino, M., Ferraro, A., and Mariani, A., 2020. Household food waste: a case study in Southern Italy. *Sustainability*, *12* (4), pp.14-95.

Aschemann-Witzel, J., Giménez, A., and Ares, G., 2018. Consumer in-store choice of suboptimal food to avoid food waste: the role of food category, communication, and perception of quality dimensions. *Food Quality and Preference*, *68*, pp.29-39.

Beretta, C., Stoessel, F., Baier, U., and Hellweg, S., 2013. Quantifying food losses and the potential for reduction in Switzerland. *Waste Management, 33* (3), pp.764-773.

Blair, D., and Sobal, J., 2006. Luxus consumption: wasting food resources through overeating. *Agriculture and Human Values, 23* (1), pp.63-74.

Bloom, J., 2010. American wasteland: how America throws away nearly half of its food (and what we can do about it). *Journal of Progressive Human Services, 24*, pp.165-171.

Byker, C.J., Farris, A.R., Marcenelle, M., Davis, G.C., and Serrano, E.L., 2014. Food waste in a school nutrition program after implementation of new lunch program guidelines. *Journal for Nutrition Education Behaviour, 46,* pp.406- 411.

Canali, M., Amani, P., Aramyan, L., Gheoldus, M., Moates, G., Östergren, K., Silvennoinen, K., Waldron, K., and Vittuari, M., 2017. Food waste drivers in Europe, from identification to possible interventions. *Sustainability, 9* (1), pp.37-37.

Chakona, G., and Shackleton, C.M., 2017. Local setting influences the quantity of household food waste in mid-sized South African towns. *PLoS One*, *12* (12).

Chalak, A., Abou-Daher, C., Chaaban, J., and Abiad, M.G., 2016. The global economic and regulatory determinants of household food waste generation: a cross-country analysis. *Waste Management, 48,* pp.418-422.

Chris Hani District Municipality (CHDM), 2018. Environmental status quo final report. Http://www.kamva.co.za/downloads/Chris_Hani_Final_Environmental_Status_Quo Report_v1_0_25July2018.pdf (26 January 2021).

Cronjé, N., Van der Merwe, I., and Müller, I.M., 2018. Household food waste: a case study in Kimberley, South Africa. *Journal of Consumer Sciences, 46,* pp.1-7.

Comstock, E.M., Symington, L.E., Chmielinski, H.E., and McGuire, J.S., 1979. Plate waste in school feeding programs: individual and aggregate measures. Https://apps.dtic.mil/sti/citations/ADA097819 (05 May 2021).

Cox, J., and Downing, P., 2007. Food behaviour consumer research: quantitative phase. Http://www.wrap.org.uk/sites/files/wrap/Food%20behaviour%20 (10 September 2020).

Department of Environmental Affairs (DEA), 2011. National waste management strategy. Http://www.environment.gov.za/sites/default/files/docs/nationalwaste_management_strategy (20 October 2020).

Diaz-Ruiz, R., Costa-Font, M., and Gil, J.M., 2018. Moving ahead from food-related behaviours: an alternative approach to understand household food waste generation. *Journal of Cleaner Production*, *172*, pp.1140-1151.

Drewnowski, A., and Eichelsdoerfer, P., 2010. Can low-income Americans afford a healthy diet?. *Nutrition Today*, *44* (6), pp.246.

do Carmo Stangherlin, I., and de Barcellos, M.D., 2018. Drivers and barriers to food waste reduction. *British Food Journal*, *120* (10), pp.2364-2387.

Eastern Cape Socio Economic Consultative Council (ECSECC) 2020. Poverty rate in Eastern Cape using Statistics South Africa's definitions. Https://ecsecc.org/page/poverty-rate-in-ec-using-ssa-definition (15 April 2021).

El-Fadel, M., Findikakis, A.N., and Leckie, J.O., 1997. Environmental impacts of solid waste landfilling. *Journal of Environmental Management, 50* (1), pp.1-25.

Elimelech, E., Ayalon, O., and Ert, E., 2018. What gets measured gets managed: a new method of measuring household food waste. *Waste Management*, *76*, pp.68-81.

Evans, D., 2012. Beyond the throwaway society: ordinary domestic practice and a sociological approach to household food waste. *Sociology*, *46(1),* pp.41-56.

Falasconi, L., Vittuari, M., Politano, A., and Segrè, A., 2015. Food waste in school catering: an Italian case study. *Sustainability, 7* (11), pp.14745-14760.

Food and Agriculture Organization (FAO), 1981. *Food loss prevention in perishable crops*. Unpublished report, Agricultural Service Bulletin, Rome, Italy.

Food and Agriculture Organization (FAO), 2009. *Feeding the world, eradicating hunger*. Unpublished report, World Summit on Food Security, Rome, Italy.

Food and Agriculture Organization (FAO), 2013. *Global food losses and food waste- extent, causes and prevention.* Food and Agricultural Organization of the United Nations, Rome, Italy.

Friedrich, E., 2013. *An investigation into the emissions of greenhouse gases associated with the disposal of solid waste in the eThekwini Municipality*. PhD. thesis, University of KwaZulu Natal, Durban, pp.60-90.

FUSIONS, 2016. Estimates of European food waste levels reducing food waste through social. Https://www.eufusions.org/phocadownload/Publications/Estimates%20of%20European%20 (27 November 2020).

Ganglbauer, E., Fitzpatrick, G., and Comber, R., 2013. Negotiating food waste: using a practice lens to inform design. *Association for Computing Machinery Transaction on Computer–Human Interaction, 20* (2), pp.11-25.

Garske, B., Heyl, K., Ekardt, F., Weber, L.M., and Gradzka, W., 2020. Challenges of food waste governance: An assessment of European legislation on food waste and recommendations for improvement by economic instruments. *Land, 9(7)*, pp.231-236.

Gatley A., Caraher M., and Lang T., 2014. A qualitative, cross cultural examination of attitudes and behaviour in relation to cooking habits in France and Britain. *Appetite, 75* (1), pp.71-81.

Golan, E., Stewart, H., Kuchler, F., Dong, D., and Kirlin, J.A., 2008. Can low-income Americans afford a healthy diet?. *Amber Waves*, *6* (5), pp.26-32.

Graham-Rowe, E., Jessop, D.C., and Sparks, P., 2014. Identifying motivations and barriers to minimising household food waste. *Resources, Conservation and Recycling*, *84*, pp.15-23.

Grainger, M.J., Aramyan, L., Piras, S., Quested, T.E., Righi, S., Setti, M., Vittuari, M., and Stewart, G.B., 2018. Model selection and averaging in the assessment of the drivers of household food waste to reduce the probability of false positives. *PLoS One, 13* (2).

Grasso, A.C., Olthof, M.R., Boevé, A.J., van Dooren, C., Lähteenmäki, L., and Brouwer, I.A., 2019. Socio-demographic predictors of food waste behaviour in Denmark and Spain. *Sustainability*, *11* (12), pp.32-44.

Grover, P., and Singh, P., 2014. An analytical study on effect of family income and size on per capita household solid waste generation in developing countries. *American Research Institute for Policy Development*, *3* (1), pp.127-143.

Gunders, D., 2012. Wasted: how America is losing up to 40 percent of its food from farm to fork to landfill. Https://www.nrdc.org/sites/default/files/wasted-food-IP (20 December 2020).

Gustavsson, J., Cedeberg, C., Sonesson, U., Otterdijk, R., and van Meybeck, A., 2011. Global food losses and food waste- extent, causes and prevention. Https://www.researchgate.net/publication/285683189_Global_Food_Losses_and_Food_Waste-_Extent_Causes_and_Prevention (30 January 2021).

Gustavsson, J., Cederberg, C., Sonesson, U., and Emanuelsson, A., 2013. The methodology of the Food and Agriculture study: global food losses and food waste- extent, causes and prevention. Http://www.fao.org/3/i2697e/i2697e.pdf (30 January 2021).

Hamilton, C., Denniss, R., and Baker, D., 2005. Wasteful consumption in Australia. Http://www.tai.org.au/documents/dp_fulltext/DP77 (20 May 2021).

Hansen, T.L., Schmidt, J.E., Angelidaki, I., Marca, E., la Cour Jansen, J., Mosbaek, H., and Christensen, T.H., 2004. Method for determination of methane potentials of solid organic waste. *Waste Management*, *24* (4), pp.393-400.

Hebrok, M., and Boks, C., 2017. Household food waste: Drivers and potential intervention points for design- an extensive review. *Journal of Cleaner Production*, *151*, pp.380-392.

Hendrickson, D., Smith, C., and Eikenberry, N., 2006. Fruit and vegetable access in four low-income food deserts communities in Minnesota. *Agriculture and Human Values*, *23* (3), pp.371-383.

Herszenhorn, E., Quested, T., Easteal, S., Prowse, G., Lomax, J., and Bucatariu, C., 2014. Prevention and reduction of food and drink waste in businesses *and households*. Http://www.oneplanetnetwork.org/sites/default/files/prevention_and_reduction_of_food_and_drink_waste_in_businesses_and_households_executive_summary (27 May 2020).

High Level Panel Expects (HLPE), 2014. Food losses and waste in the context of sustainable food systems. Http://www.fao.org/policy-support/tools-and-publications/resources-details/en/c/854257/ (28 February 2021).

Integrated Development Plan (IDP), 2020. Chris Hani District Municipality 2017-2022 Integrated Development Plan. Https://www.ecsecc.org/documentrepository/informationcentre/chdm-2017-2022-idp_55897 (27 November 2020).

Ilakovac, B., Voca, N., Pezo, L., and Cerjak, M., 2020. Quantification and determination of household food waste and its relation to sociodemographic characteristics in Croatia. *Waste Management*, *102*, pp.231-240.

Jalonick, M.C., 2014. GOP supports break from healthy school meal standards. Http://www.huffingtonpost.com/2014/12/08/gop-healthy-schoollunch-waiver (20 October 2020).

Jebe, T., 2018. *Potential socio-economic implications of ethanol production as a green economic initiative in Cradock, Eastern Cape.* PhD. thesis, Cape Peninsula University of Technology, Cape Town, pp.30-50.

Jeswani, H.K., Figueroa-Torres, G., and Azapagic, A., 2021. The extent of food waste generation in the United Kingdom and its environmental impacts. *Sustainable Production and Consumption*, *26*, pp.532-547.

Jörissen, J., Priefer, C., and Bräutigam, K.R., 2015. Food waste generation at household level: results of a survey among employees of two European research centres in Italy and Germany. *Sustainability, 7* (3), pp.2695-2715.

Kambo, A.R.B.E.N., and Osmani, M.Y.S.L.Y.M., 2018. *An evaluation of apple production waste in the municipalities of Korca and Devoll and some related issues.* Https://www.researchgate.net/profile/MyslymOsmani/publication/336284750_ (20 May 2021).

Koivupuro, H.K., Hartikainen, H., Silvennoinen, K., Katajajuuri, J.M., Heikintalo, N., Reinikainen, A., and Jalkanen, L., 2012. Influence of socio-demographical, behavioural and

attitudinal factors on the amount of avoidable food waste generated in Finnish households. *International Journal of Consumer Studies*, *36 (2),* pp.183-191.

Langley J., Yoxall A., Heppell G., Rodriguez E.M., Bradbury S., Lewis R., Luxmoore J., Hodzic A., and Rowson J., 2010. Food for thought? - a United Kingdom pilot study testing a methodology for compositional domestic food waste analysis. *Waste Management and Research, 28* (3), pp.220- 227.

Li, B., Maclaren, V., and Soma, T., 2020. Urban household food waste: drivers and practices in Toronto, Canada. *British Food Journal*, *123* (5), pp. 1793-1809.

Lipinski, B., Hanson, C., Waite, R., Searchinger, T., Lomax, J., and Kitinoja, L., 2013. Reducing food loss and waste. Https://pdf.wri.org/reducing_food_loss_and_waste (14 August 2020).

Lyndhurst, B.; Cox, J.; and Downing, P., 2007. Food behaviour consumer research: Https://wrap.org.uk/resources/report/food-behaviour-consumer-research-quantitative-phase (21 May 2020).

Mallinson, L.J., Russell, J.M., and Barker, M.E., 2016. Attitudes and behaviour towards convenience food and food waste in the United Kingdom. Https://doi.org/10.1016/j.appet.2016.03.017 (10 May 2021).

Martindale, W., and Schiebel, W., 2017. The impact of food preservation on food waste. *British Food Journal*, *112* (12), pp. 2510-2518.

Masud, M.H., Ananno, A.A., Arefin, A.M., Ahamed, R., Das, P., and Joardder, M.U., 2019a. Perspective of biomass energy conversion in Bangladesh. *Clean Technologies and Environmental Policy*, *21* (4), pp.719-731.

Masud, M.H., Islam, M.T., Ananno, A.A., and Ahmed, M.A., 2019b. Towards a zero-energy based food drying system by utilizing the waste heat. *Diesel Engine*, *300*, pp.1-5.

McConnachie, M.M., and Shackleton, C.M., 2010. Public green space inequality in small towns in South Africa. *Habitat International, 34* (2), pp.244-248.

Monier, M.V., Mudgal, M.S., Escalon, M.V., O'Connor, M.C., Anderson, M.G., Montoux, M.H., Reisinger, M.H., Dolley, M.P., Ogilvie, M.S., and Morton, M.G., 2010. Sustainable value chains for sustainable food systems. Http://www.fao.org/3/i6511e/i6511e (02 June 2021).

Monsivais, P., Aggarwal, A., and Drewnowski, A., 2012. Are socio-economic disparities in diet quality explained by diet cost?. *Journal of Epidemiol Community Health*,*66* (6), pp.530-535.

Mucina, L., and Rutherford, M.C., 2006. The vegetation of South Africa, Lesotho and Swaziland. Https://www.researchgate.net/publication/287992846_The_vegetation_of_South_Africa_Lesotho_and_Swaziland (26 March 2021).

Nahman, A., and de Lange, W., 2013. Costs of food waste along the value chain: evidence from South Africa. *Waste Management, 33* (11), pp.2493-2500.

Nunkoo, R., Bhadain, M., and Baboo, S., 2021. Household food waste: attitudes, barriers and motivations. *British Food Journal*, *123* (6), pp.2016-2035.

Oelofse, S.H., and Nahman, A., 2013. Estimating the magnitude of food waste generated in South Africa. *Waste Management and Research*, *31* (1), pp.80-86.

Oelofse, S., Muswema, A., and Ramukhwatho, F., 2018. Household food waste disposal in South Africa: a case study of Johannesburg and Ekurhuleni. *South African Journal of Science*, *114* (5), pp.1-6.

Oelofse, S., Nahman, A., Barjees Baig, M., Salemdeeb, R., Nizami, A.S., and Reynolds, C., 2020. Food waste within South Africa and Saudi Arabia. Https://www.taylorfrancis.com/chapters/edit/10.4324/9780429462795-17/food-waste-within-south-africa-saudi-arabia-suzan-oelofse-anton-nahman-mirza-barjees-baig-ramy-salemdeeb-abdul-sattar-nizami-christian-reynolds (25 May 2021).

Okop, K.J., Ndayi, K., Tsolekile, L., Sanders, D., and Puoane, T., 2019. Low intake of commonly available fruits and vegetables in socio-economically disadvantaged communities of South Africa: influence of affordability and sugary drinks intake. *Public Health*, *19* (1), pp.1-14.

Painter, K., Thondhlana, G., and Kua, H.W., 2016. Food waste generation and potential interventions at Rhodes University, South Africa. *Waste Management, 56,* pp.491-497.

Parfitt, J., Barthel, M., and Macnaughton, S., 2010. Food waste within food supply chains: quantification and potential for change to 2050. *Philosophical Transactions of the Royal Society: Biological Science*, *365* (1554), pp.3065-3081.

Pearson, D., Minehan, M., and Wakefield-Rann, R., 2013. Food waste in Australian households: why does it occur. *Australasian Pacific Journal of Regional Food Studies, 3,* pp.118-132.

Pekcan, G., Koksal, E., Küçükerd € onmez, O., and Ozel, H., 2006. Household food wastage in Turkey. http://www.fao.org/3/am063e/am063e.pdf (25 July 2021).

Phasha, L., Molelekwa, G.F., Mokgobu, M.I., Morodi, T.J., Mokoena, M.M., and Mudau, L.S., 2020. Influence of cultural practices on food waste in South Africa-a review. *Journal of Ethnic Foods*, *7* (1), pp.1-13.

Ponis, S.T., Papanikolaou, P.A., Katimertzoglou, P., Ntalla, A.C., and Xenos, K.I., 2017. Household food waste in Greece: A questionnaire survey. *Journal of Cleaner Production*, *149*, pp.1268-1277.

Preka, R., Berjan, S., Capone, R., El Bilali, H., Allahyari, M.S., Debs, P., Bottalico, F., and Mrdalj, V., 2020. Household food wastage in Albania: causes, extent and implications. Https://www.thefutureoffoodjournal.com/index.php/FOFJ/article/view/262 (15 May 2021).

Quested, T., and Johnson, H., 2009. Household food and drink waste in the United Kingdom. Https://wrap.org.uk/resources/report/household-food-and-drink-waste-uk (15 November 2020).

Quested, T.E., Marsh, E., Stunell, D., and Parry, A.D., 2013. Spaghetti soup: the complex world of food waste behaviours. *Resources, Conservation and Recycling, 79,* pp.43-51.

Ramukhwatho, F.R., Du Plessis, R., and Oelofse, S.H., 2014. Household food wastage in a developing country: a case study of Mamelodi township in South Africa. Https://researchspace.csir.co.za/dspace/handle/10204/7757 (18 July 2020).

Ramukhwatho, F.R., 2016. *An assessment of the household food wastage in a developing country: a case study of five areas in the City of Tshwane Metropolitan Municipality, Gauteng Province, South Africa.* PhD. thesis, University of South Africa, City of Tshwane, pp.35-70.

Ramukhwatho, F., duPlessis, R., and Oelofse, S., 2018. Preliminary drivers associated with household food waste generation in South Africa. *Applied Environmental Education and Communication*, *17* (3), pp.254-265

Redlingshöfer, B., Barles, S., and Weisz, H., 2020. Are waste hierarchies effective in reducing environmental impacts from food waste? A systematic review for organisation for economic co-operation and development countries. *Resources, Conservation and Recycling*, *156*, pp.104-723.

Ritchie, H., and Roser, M., 2020. Environmental impacts of food production: our world in data. Https://ourworldindata.org/environmental-impacts-of-food (20 July 2020).

Roe, B.E., Qi, D., and Bender, K.E., 2020. Some issues in the ethics of food waste. *Physiology and Behaviour*, *219*, pp.112-860.

Romani, S., Grappi, S., Bagozzi, R.P., and Barone, A.M., 2018. Domestic food practices: a study of food management behaviours and the role of food preparation planning in reducing waste. *Appetite*, *121*, pp.215-227.

Rozin, P., 2014. Psychological basis of food wasting behaviour. Https://repository.upenn.edu/thelastfoodmile/sessions/session/7/ (30 June 2020).

Salhofer, S., Obersteiner, G., Schneider, F., and Lebersorger, S., 2008. Potentials for the prevention of municipal solid waste. *Waste Management*, *28* (2), pp.245-259.

Schmidt, K., 2016. Explaining and promoting household food waste-prevention by an environmental psychological based intervention study. *Resources, Conservation and Recycling*, *111*, pp.53-66.

Schmidt, K., and Matthies, E., 2018. Where to start fighting the food waste problem? Identifying most promising entry points for intervention programs to reduce household food waste and overconsumption of food. *Resources, Conservation and Recycling*, *139*, pp.1-14.

Schneider, F., 2011. Review of food waste prevention on an international level. *In Proceedings of the Institution of Civil Engineers- Waste and Resource Management*, *166* (4), pp.187-203.

Secondi, L., Principato, L., and Laureti, T., 2015. Household food waste behaviour in EU-27 countries: a multilevel analysis. *Food Policy*, *56*, pp.25-40.

Steinfeld, H., Gerber, P., Wassenaar, T.D., Castel, V., Rosales, M., Rosales, M., and de Haan, C., 2006. Livestock's long shadow: environmental issues and options. Http://www.fao.org/3/a0701e/a0701e00.pdf (04 June 2020).

Shams, S., Sahu, J.N., Rahman, S.S., and Ahsan, A., 2017. Sustainable waste management policy in Bangladesh for reduction of greenhouse gases. *Sustainable Cities and Society*, *33*, pp.18-26.

Sorokowska, A., Marczak, M., Misiak, M., Stefańczyk, M.M., and Sorokowski, P., 2020. Children older than five years do not approve of wasting food: An experimental study on attitudes towards food wasting behaviour in children and adults. *Journal of Environmental Psychology*, *71*, pp.101-467.

Sosna, D., Brunclikova, L., and Galeta, P., 2019. Rescuing things: Food waste in the rural environment in the Czech Republic. *Journal of Cleaner Production*, *214*, pp.319-330.

Statistics South Africa, 2020. Census 2020 Statistics South Africa. Http://www.statssa.gov.za/publications/P03014/P030142011.pdf (02 May 2021).

Stancu, V., Haugaard, P., and Lähteenmäki, L., 2016. Determinants of consumer food waste behaviour: two routes to food waste. *Appetite*, *96*, pp.7-17.

Stefan, V., van Herpen, E., Tudoran, A.A., Lahteenm € aki, L., hteenm, L., and ki, L., 2013. Avoiding food wjoriaste by Romanian consumers: the importance of planning and shopping routines. *Food Quality and. Preference, 28,* pp.375-381.

Strasser, Susan (1999). Toward a history of trash making. waste and want. Https://www.ghi-dc.org/fileadmin/publications/annual_lecture_series/waste_and_want (27 November 2020).

Stuart, T., 2009. Waste: uncovering the global food scandal. Https://www.amazon.com/waste-uncovering-global-food-scandal/dp/0393068366 (06 December 2020).

Thyberg, K.L., Tonjes, D.J., and Gurevitch, J., 2015. Quantification of food waste disposal in the United States: a meta-analysis. *Environmental Science and Technology*, *49* (24), pp.13946-13953.

Thyberg, K.L., and Tonjes, D.J., 2016. Drivers of food waste and their implications for sustainable policy development. *Resources, Conservation and Recycling*, *106*, pp.110-123.

United Nations, 2013. World population prospects. Https://www.un.org/en/development/desa/publications/world-population-prospects-the-2012-revision.html (05 May 2020).

United Nations, 2015. Transforming our world: the 2030 agenda for sustainable development. Https://doi.org/10.1007/s13398- 014-0173-7.2 (26 March 2021).

van der Werf, P., Seabrook, J.A., and Gilliland, J.A., 2021. Reduce food waste, save money: testing a novel intervention to reduce household food waste. *Environment and Behaviour, 53* (2), pp.151-183.

Van Garde, S.J., and Woodburn, M.J., 1987. Food discard practices of householders. *Journal of the American Dietetic Association*, *87* (3), pp.322-329.

Venter, N.R., 2017. *Consumers' knowledge of date labelling and the influence thereof on household fresh produce waste practices in Gauteng.* PhD. thesis, University of Pretoria, Pretoria, pp.40-80.

Ventour, L., 2008. *The food we waste.* Https://www.researchgate.net/publication/273137546 (15 June 2020).

Vicki Mavrakis, B.A., 2014. *The generative mechanisms of food waste in South Australian household settings.* PhD. thesis, Flinders University, Adelaide, pp.30-50.

Wertheim-Heck, S., Raneri, J.E., and Oosterveer, P., 2019. Food safety and nutrition for low-income urbanites: exploring a social justice dilemma in consumption policy. *Environment and Urbanisation*, *31* (2), pp.397-420.

White, J.W., Allen, D., Amar, P.K., Bogner, J.E., Bruhwiler, L.E., Cooley, D.S., Frankenberg, C., George, F., Hanle, L., Hristov, A.N., and Kebreab, E., 2018. Improving characterization of anthropogenic methane emissions in the United States. Https://ui.adsabs.harvard.edu/abs/2018AGUFMGC41A.01W/ (13 November 2020).

Waste and Resources Action (WRAP), 2007. Food behaviour consumer research: quantitative phase. Https://wrap.org.uk/resources/report/food-behaviour-consumer-research-quantitative-phase (13 November 2020).

Waste and Resources Action (WRAP), 2009. Household food and drink waste in the United Kingdom. Http://www.wrap.org.uk/node/13529 (13 November 2020).

Waste and Resources Action (WRAP), 2010. Helping consumers reduce food waste- a retail survey. Http://www.wrap.org.uk/content/helping-consumers-reduce-food-waste-retail-survey2011 (15 October 2020).

Waste and Resources Action (WRAP), 2011. New estimates for household food and drink waste in the United Kingdom. Http://www.wrap.org.uk/content/new-estimates-household-food-and-drinkwaste (20 January 2021).

Waste and Resources Action (WRAP), 2013. The milk model: simulating food waste in the home. http://www.wrap.org.uk/content/milk-model-simulating-food-waste-home (15 March 2021).

Youngs, A.J., Nobis, G., and Town, P., 1983. Food waste from hotels and restaurants in the United Kingdom. *Waste Management and Research*, *1* (4), pp.295-308.

# APPENDIX A: HOUSEHOLD FOOD WASTE QUESTIONNAIRES

**Town: _____ Township: _____Household number: _____**

## Section one: Household shopping

1. **How often do you do food shopping? (Select one option):**

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Everyday | | Once a week | | Twice a week | | Every two weeks | | Once a month | |

2. **When buying food, do you usually make use of a shopping list?**

| | | | | | |
|---|---|---|---|---|---|
| Yes | | No | | Sometimes | |

3. **What sort of outlet do you usually buy?**

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Vegetables | | Fruit | | Dairy | | Tinned | | Meat | | Rice | | Other | |

4. **Do you grow any of your own food? If yes, what type of food do you grow?**

_____

_____

5. **Do you ever buy food because of advertised special offers? (E.g. food products sold at discount):**

| | | | | | |
|---|---|---|---|---|---|
| Yes | | No | | Sometimes | |

6. **Do you know the difference between "Use by" and "Best before" date? If yes, please describe each of the two terms.**

_____

_____

_____

7. **Do you look at the use by or best before dates when buying? If yes, what type of food products do you do this for?**

_____

_____

_____

## Section two: Food waste

8. **Which of the following descriptions best describe you? (Select one option):**

| | |
|---|---|
| I concern myself with food waste and avoid wasting food however possible. | |
| I am aware of the issues related to food waste but I am not planning to change my behaviour. | |
| I used to concern myself with the issue of food waste, but no longer. | |
| I do not think food waste is as important as portrayed. | |

9. **What do you usually do with different types of uneaten food?**

| | **Vegetables** | **Fruits** | **Dairy** | **Tinned** | **Meat** | **Carbs e.g. rice or pap** | **Other** |
|---|---|---|---|---|---|---|---|
| I throw it away in the waste bin | | | | | | | |
| I donate it to the needy | | | | | | | |
| I throw it away in the composting | | | | | | | |
| I feed it to animals | | | | | | | |
| Other (please specify in space provided below) | | | | | | | |

10. **How much edible food was thrown away in your household in the last 48 hours?**

| | | **Vegetables** | **Fruits** | **Dairy** | **Tinned** | **Meat** | **Carbs e.g. rice or pap** | **Other** |
|---|---|---|---|---|---|---|---|---|
| Yesterday | Breakfast | | | | | | | |
| | Lunch | | | | | | | |
| | Supper | | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Day before | Breakfast | | | | | | | |
| | Lunch | | | | | | | |
| | Supper | | | | | | | |

**11. When last did you throw away food? (Select one option):**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Never | | Once a week | | Twice a week | | More than twice a week | |
| Once a month | | Twice a month | | More than twice a month | | Once after a month | |

**12. What type of food did you throw away?**

_____

_____

**13. When last did you eat leftover food?**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Never | | Once a week | | Twice a week | | More than twice a week | |

**14. What type of leftover food did you eat?**

_____

**15. How often does your household eat out or order takeaway as the main meal:**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Never | | Once a week | | Twice a week | | More than twice a week | |
| Once a month | | Twice a month | | More than twice a month | | Once after a month | |

**16. Which of the listed reasons for food waste do you think are more applicable to your household? (May select more than one option): by food types**

| | **Vegetables** | **Fruits** | **Dairy** | **Tinned** | **Meat** | **Carbs e.g.** | **Other** |
|---|---|---|---|---|---|---|---|

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | **rice or pap** | |
| Expired food | | | | | | | |
| Poor food labelling causing confusion during food shopping | | | | | | | |
| Lack of cooling facilities to preserve food | | | | | | | |
| Cooked too much | | | | | | | |
| No desire to eat leftovers | | | | | | | |
| Household members not liking the food cooked | | | | | | | |
| Can afford to buy more food | | | | | | | |
| Buy more food than needed | | | | | | | |
| Do not think food waste is an issue | | | | | | | |

**17. Please indicate what percentage of the following food types your household throws away in a typical week (Select one option for each food type):**

| | **Vegetables** | **Fruits** | **Dairy** | **Tinned** | **Meat** | **Carbs e.g. rice or pap** | **Other** |
|---|---|---|---|---|---|---|---|
| Less than 5% | | | | | | | |
| 6 to 10% | | | | | | | |
| 11 to 20% | | | | | | | |
| 21 to 30% | | | | | | | |
| More than 30% | | | | | | | |

**18. Are there times of the week, or month or year when the household wastes more than usual?**

**Yes/ No**

**If yes, when and why?**

_____

_____

_____

## Section three: Food waste minimisation

**19. Are there any food waste minimisation strategies practiced at your household?**
**Yes/ No**
**If yes, please list them**

_____
_____
_____

**20. Do all members of the household adhere to the above-mentioned strategies?**
**Yes/No**
**If no, why is that so?**

_____
_____

**21. Do some members of the household generally waste more food than others?**
**Yes/No**
**If yes, who? What is their age and gender? And why do you think they waste more food?**

_____
_____
_____
_____

**22. What do you think can be done to minimise household food waste?**

_____
_____
_____
_____

**23. You would likely waste less food if… (May select more than one option):**

| | |
|---|---|
| More informed about the negative impacts of food on climate systems | |
| Food labelling was clearer | |
| Pay higher tax for wasting and throwing more food to the waste bin for refuse removal by local authority | |
| Had proper food storage | |
| Had proper institutions collecting excessive consumable food for animal feeding | |

## Section four: Socio-demographic data

**24. Gender:**

**25. Age:**

**26. Highest level of education:**

**27. Occupation:**

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Full-time | | Part-time | | Retired | | Unemployed | | Scholar/student | |

**28. How many people live in this household and partake in regular meal consumption?**

_____

**29. How many children less or are 16 years old live in this household?**

_____

**30. How many people living in this household are employed or self-employed?**

_____

**31. How many of the following does your household have?**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TV | | Fridge | | Cell phones | | Vehicle | | Water tank | | Hifi system | |

**32. How many people living in this household receive social grants?**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Pension | | Child | | Disability | | Foster care | |

# APPENDIX B: HOUSEHOLD FOOD WASTE LOG

**Date: _____ Town: _____Township: _____Household no**: ____

| **Day** | **Meal Category** | **Food waste item** | | **Amount disposed (g) or (kg)** |
|---|---|---|---|---|
| Monday | Breakfast | Vegetables | | |
| | | Fruits | | |
| | | Dairy | | |
| | | Tinned | | |
| | | Meat | | |
| | | Carbs e.g. rice or pap | | |

| | | | | |
|---|---|---|---|---|
| | | Other | | |
| | Lunch | Vegetables | | |
| | | Fruits | | |
| | | Dairy | | |
| | | Tinned | | |
| | | Meat | | |
| | | Carbs e.g. rice or pap | | |
| | | Other | | |
| | Supper | Vegetables | | |
| | | Fruits | | |
| | | Dairy | | |

| | | | | |
|---|---|---|---|---|
| | | Tinned | | |
| | | Meat | | |
| | | Carbs e.g. rice or pap | | |
| | | Other | | |