



Intervention effect of food literacy on household food waste in the KwaDukuza municipality

Nosipho Miti

Thesis submitted in fulfilment of the requirements of the degree of:

Master of Applied Science in Food and Nutrition

Department of Food and Nutrition: Consumer Science

Faculty of Applied Sciences

Durban University of Technology

Supervisor: Prof Ashika Naicker

Date: 19 August 2024

Co-supervisor: Dr Heleen Grobbelaar

Date: 19 August 2024

DECLARATION

I, Nosipho Miti, hereby declare that the research work presented in this thesis is my original work and all the materials used are appropriately acknowledged and explicitly referenced. A reference list is attached to the thesis.

I also confirm that the thesis has not been submitted in any of its part or in its entirety for any degree in any other institution of higher learning locally or internationally.

I therefore give permission that my work be available for replication and/or for re-printing, for inter-library loan, and for the title and abstract of my thesis to be made available to other educational institutions and students that might need it.

Student:

Nosipho Miti

Date: 19 August 2024

Supervisor:

Prof Ashika Naicker

Date: 19 August 2024

Co-supervisor:

Dr Heleen Grobbelaar

Date: 19 August 2024

DEDICATION

I dedicate this thesis to:

My late great grandmother, Ndabazi Nxumalo

My late grandmother, Margret Mthembu and My amazing mother, Sizakele Miti

and finally

Myself, Nosipho Miti

“The strength of a woman is not measured by the impact that all her hardships in life have had on her; but the strength of a woman is measured by the extent of her refusal to allow those hardships to dictate her and who she becomes”.

JoyBell C.

ACKNOWLEDGEMENT

Without God and my ancestors, none of this would have been possible.

I also acknowledge those who supported me and steered me through this academic journey:

- My supervisor - Prof Ashika Naicker, thank you for believing in me, for all your hard work, patient guidance, encouragement, and constant motivation throughout my master`s journey. Thank you for sharing this journey with me. Your useful advice will always stay with me. You have been such an excellent mentor, and I cannot thank you enough. I appreciate everything you have taught me. Thank you for always inspiring me.
- My co-supervisor - Dr Heleen Grobbelaar, I appreciate your knowledge, assistance, and commitment to this study. Thank you for being part of my academic journey since 2015; words cannot express how thankful I am for your support and guidance throughout these years.
- My parents - Sizakele and Themba Miti, thank you both for the solid love and support you have given me throughout my life. You have both been my rock. Thank you for all the sacrifices you both have made towards my education. Because of you, I am the woman I am today and I owe it all to you.
- To my co-parents, Musa and Nelly Zulu, thank you for the support and continued love you have shown me throughout this journey.
- To my Godparents, Xolani and Nelisiwe Ngcobo, thank you for being the best mentors. I am grateful for everything you have taught me throughout my life.
- My siblings, Snezelo Mthembu, Sphiwe and Sanele Miti, thank you for being the best brothers a girl could ever wish for. I appreciate your forever support and love.
- My uncles, Thulani and Phakamani Mthembu, thank you for being my pillar of strength and being there for me when I needed you. Thank you for being part of this journey with me and being the best uncle any niece could ever dream of.
- My amazing huge family, Mthembu, Miti, Fumo, Mdlesthe, Zulu, Ngubane, Mbambo and Ndlovu, family is a gift worth more than anything I can think of. I wouldn't be here today without your help. Thank you for your love and continuous support in everything I do.
- My sisters, Nhlanhla Msibi, Nokuthula Mthembu, Mbali Mdletshe, Kg Gumede, Celiwe Miti, Nothando Mthembu, Tiny Ngobese, Samke Mthembu and Lusanda Zulu, thank you for always supporting and encouraging me in everything I do. I love and appreciate all of you.
- To my twin, Sihle Fumo, thank you for always being the best supporter and biggest cheerleader for the past two years. I am sure I made you proud.
- My best friends – Lethiwe Ngubane, Bongumusa Ngcobo, Zinzile Ndlovu, Olwethu Shangase, Neliswa Phungula, Noluthando Gumede Nkanyiso Ntuli, Nomzamo Gumede and Kamaziba Chichi, I want to thank you for always being there for me when I needed a shoulder to cry on,

your continuous encouragement and support in my journey. I couldn't have asked for better friends.

- To my field workers, Nomonde Ngobese, Zamandulo Mbatha, Mlungisi Dlodla, Sinethemba Thabethe, Sanele Miti and Sibusiso Ngcobo, thank you for all your diligence, assistance and support during this study.
- To my research assistants, Siphosethu Nase, Sandra Ndlovu, and Riashnee Thaver, thank you for all the hard work.
- To my statistician, Gill Hendry, and my language editor, Michael Vermeer, thank you both for your competent and precise work.
- Shivneta Singh and Dr Imana Pal, thank you for always being willing to assist me and words of support when I needed it. Shivneta, thank you for believing in me when I did not, and thank you most for holding my hand throughout this journey.
- Noxolo Blose, thank you for always being so helpful; you are appreciated.
- Dr L. P Dlamini, thank you for believing in me and supporting me through the difficult moments. Unfortunately, you are not around to witness this, but I am sure I have made you proud.
- KwaDukuza Municipality residents, Thank you for your willingness to be part of this study. It would not have been possible without you.
- CSIR and DUT Research and Postgraduate Support Directorate for funding this project.

ABSTRACT

Background: Approximately one-third of the food produced for human consumption is lost annually across the global food supply chain. In South Africa, it is estimated that around 10.3 million tonnes of food are wasted each year. Despite food waste occurring at various stages of food production, individual households have been identified as the primary producers of food waste at the consumption stage, driven by consumer behaviour and practice. While food waste is a global concern, South Africa's household food waste mimics that of developed countries. Although household food waste studies in South Africa have gained momentum, nearly all studies focus on household food waste consumer practices. No intervention study has been conducted to change consumer behaviour towards household food waste in South Africa. Likewise, the cost of household food waste, nutritional losses, and the environmental impact of household food waste have yet to be explored through an intervention. Interventions that target a change in human behaviour towards reducing household food waste can make a meaningful impact on food and nutrition security, and the environment.

Aim: This study aimed to determine the intervention effect of food literacy on household food waste in the KwaDukuza municipality.

Methods: In this randomised control trial (RCT), middle and high Living Standards Measure (LSM) households from five areas in the KwaDukuza municipality used in a formative study to determine household food waste behaviour and practices were eligible to participate in the study. All households at baseline received three colour-coded bins [used to separate food waste by food categories], bin-liners, food labels and freezer bags to contain cooked food waste. The first objective was to calculate household food waste through a weighed food waste audit at baseline and endline. A weighed food audit was conducted at each household (n=180). Objective two of this study included calculating the cost, associated nutrient losses and environmental impact of household food waste using the results of the food waste audit at baseline and endline. The cost of household food wasted was analysed using the mean price of foods from retail stores in the study area to determine the cost (Rand value) of household food waste at baseline and end line. The nutrient losses were calculated using the South African Medical Research Council Food Finder 3 web-based software at baseline and endline. The environmental impact was calculated using the My Emission Footprint calculator for food wasted at baseline and endline. The third objective of this study was to determine the intervention effect on household food waste. Households were randomly assigned into three intervention groups, intervention 1 (n=60), intervention 2 (n=60), and the control group (n=60). Households who were part of Intervention 1 received the food literacy toolkit and food literacy lessons on how to reduce household food waste; households in intervention 2 received the food literacy toolkits only and were reliant on self-efficacy to use the toolkit and households that were part of the control group did not receive any intervention.

Results: Findings from the food waste audit showed that at baseline, the total mean of household food waste produced by all households (n=180) in this study was 1.53 kg (1531.29 g) per week, decreasing to 0.31 kg (307.47 g) per household/ week at the endline. A significant reduction of household food waste was recorded post-intervention (average waste per household = 307.47 g) When household

food waste was separated into categories of the type of food wasted, the fresh produce pre-intervention (average waste per household = 917.73 g) was significantly more than the fresh produce post-intervention (average waste = 173.43g). Meat produce wasted pre- (average waste per household = 109.56g) also surpassed the meat produce wasted post- (average waste per household = 43.26g). The cooked food wasted pre- (average waste per household = 387.07 g) was significantly greater than the cooked food post- (average waste per household = 76.39 g)-.

The cost of food waste for the whole group pre- (average waste per household = R145.57) was significantly more than the cost of food waste for the whole group post- (average waste per household = R39.75). In terms of the environmental impact, the pre- (average waste per household = 7664.13 gCO₂e) exceeded the environmental impact post- (average waste per household = 6407.67 gCO₂e). A high nutrient loss from household food waste was recorded at baseline, and there was a significant reduction of macro-and micronutrient nutrient loss at the endline for the whole group (n=180). In intervention 1, intervention 2 and the control group, most nutrient losses such as energy, total protein, total lipids, total carbohydrates, and total dietary fibre were greater during the pre-intervention phase compared to the post-intervention phase.

In this RCT, a significant reduction of household food waste was observed for the whole group (n=180) and across intervention groups. Following the 6-week intervention duration, between intervention arms, there was no discernible difference in household food waste, economic loss, nutritional loss and environmental impact. However, for every intervention group, there was a substantial decrease in all measured outcomes from baseline to endline. The main reason for this result could be attributed to the fact that households probably perceived that they were being monitored through the food waste audit at baseline and endline, implying that sensitisation of communities to their actual household food waste can be an impactful intervention strategy to conscientise consumers to reduce their household food waste.

Conclusion: This study shows a clear linkage between household food waste, nutrition, economic and environmental impact. The disposal of food waste from households has a substantial and wide-ranging effect on the food chain, leading to various economic, environmental, and social challenges. The social ramifications of food waste are enormous, given the striking difference between the significant amounts wasted in affluent households and the prevalent hunger and food insecurity in many communities. In order to create a food system that is more environmentally friendly and able to withstand challenges, it is crucial to focus on and decrease the amount of food wasted in households. This requires a combined initiative of educating consumers, implementing effective waste management practices, and enacting legislation that encourages responsible consumption.

TABLE OF CONTENTS

<i>DECLARATION</i>	<i>II</i>
<i>DEDICATION</i>	<i>III</i>
<i>ACKNOWLEDGEMENT</i>	<i>IV</i>
<i>ABSTRACT</i>	<i>VI</i>
<i>LIST OF TABLES</i>	<i>XI</i>
<i>LIST OF FIGURES</i>	<i>XII</i>
<i>LIST OF APPENDICES</i>	<i>XIII</i>
<i>LIST OF ABBREVIATIONS</i>	<i>XIV</i>
<i>CHAPTER ONE: INTRODUCTION</i>	<i>1</i>
1.1 Introduction	1
1.2 Importance of the study	1
1.3 Problem statement	3
1.4 Aim of study	3
1.5 Objectives of the study	3
1.6 Assumptions	3
1.7 Study parameters	3
1.8 Definition of terms.....	4
1.9 Structure of the thesis.....	5
1.10 Outline of the research study.....	6
1.11 Conceptual framework.....	7
1.12 Conclusion.....	9
1.13 Referencing style.....	9
<i>CHAPTER TWO: LITERATURE REVIEW</i>	<i>10</i>
2.1 Introduction	10
2.2 What is food waste?	10
2.2.1 Types of food waste.....	10
2.2.2 Food waste vs. food loss	10
2.3 Food waste on a global scale	11
2.3 Food waste from farm to fork.....	13
2.3.1 Food loss during cultivation and harvest	13
2.3.2 Food loss during post-harvest	14
2.3.3 Food loss and waste during distribution, retail, and consumption	14
2.4 Food waste in developing vs. developed countries	15
2.5 Food waste in South Africa	18
2.6 Impact of COVID-19 on food waste globally and in SA.....	19

2.7 Impact of food waste on food security globally and in SA	20
2.8 Economic impact of food waste globally and in South Africa	21
2.9 Environmental impact of food waste.....	21
2.10 Waste management on a global scale.....	23
2.11 Waste management at the South African municipal level.....	24
2.12 Initiatives to reduce household food waste.....	25
2.13 Food waste at a generational level.....	25
2.14 Cultural factors influencing household food waste	26
2.15 Influence of retail and food packaging shelf-life labelling on food waste.....	27
2.16 Household income.....	28
2.17 Food literacy interventions to reduce household food waste.....	28
2.18 Conclusion.....	30
<i>CHAPTER 3: METHODOLOGY.....</i>	<i>31</i>
3.1 Introduction.....	31
3.2 Study location	31
3.3 Study design.....	32
3.4 Sample population.....	34
3.4.1 Eligibility criteria.....	34
3.4.2 Recruitment of households.....	34
3.5 Measurement Tools	34
3.5.1 Household food waste.....	34
3.5.2 Economic loss	36
3.5.3 Nutritional losses	36
3.5.4 Environmental impacts	36
3.5.5 Food literacy toolkit.....	37
3.5.6 Endline.....	37
3.6 Statistical analysis	37
3.7 Validity	38
3.8 Quality assurance and reduction of bias	38
3.9 Data quality management.....	39
3.10 Ethics.....	39
3.11 COVID-19 Protocol	40
3.12 Conclusion.....	40
<i>CHAPTER 4: RESULTS AND DISCUSSION.....</i>	<i>41</i>
4.1 Introduction.....	41
4.2 Demographic characteristics of participants.....	41
4.3 Pre-and post-food waste audit by food category, cost of food waste, and environmental.....	42
impact for the whole group	42

4.4 Pre-and post- nutrient loss from the food waste audit per household for the whole group	44
4.5 Pre-and post-intervention total food waste, food waste categorised by food type, cost of food waste and environmental impact by intervention groups.....	47
4.5.1 Intervention 1	48
4.5.2 Intervention 2.....	49
4.5.3 Control group.....	49
4.6 Pre-and post-intervention nutrient loss for each intervention group	49
4.6.1 Intervention 1	53
4.6.2 Intervention 2.....	54
4.6.3 Control group.....	55
4.7 Intervention effect between groups	56
4.8 DISCUSSION	61
4.8.1 Overview of household food waste.....	61
4.8.2 Intervention effect	62
4.8.2.1 Nutritional loss	62
4.8.2.2 Economic loss	63
4.8.2.3 Environmental impact.....	64
4.9 Conclusion.....	65
<i>CHAPTER 5: CONCLUSION AND RECOMMENDATIONS.....</i>	<i>66</i>
5.1 Introduction.....	66
5.2 Summary of the findings.....	66
5.3 Strengths of the study.....	67
5.4 Limitations of the study.....	67
5.5 Recommendations.....	68
5.6 Conclusion.....	68

LIST OF TABLES

TABLE 4.1: Demographic characteristics of household and household participants (n=180)	41
TABLE 4.2: Results of total food waste, pre- and post-intervention and by food category, cost of food waste and environmental impact for the whole group	43
TABLE 4.3: Result of total nutrient loss pre-and post-intervention for the whole group	44
TABLE 4.4: Pre-and post- intervention total food waste, food waste categorised by food type, cost of food waste and environmental impact by intervention groups.....	47
TABLE 4.5: Pre-post intervention nutrient loss from household food waste for each intervention group	50

LIST OF FIGURES

FIGURE 1.1 Outline of the study	6
FIGURE 1.2: Overview of the impact of food literacy on household food waste.....	8
FIGURE 2.1: Difference between food loss and food waste	11
FIGURE 2.2: Comparison of food waste and loss in different stages of the food supply chain between developed and developing countries	16
FIGURE 2.3: The relationship between gross national income per capita and food waste per capita in some countries	17
FIGURE 3.1: Map of Kwazulu-Natal showing the municipalities and districts, including the Kwadukuza municipality in Ilembe	31
FIGURE 3.2: Consort diagram detailing the research participation flow	33
FIGURE 3.3: Fieldworker collecting bin bags.....	35
FIGURE 3.4: Fieldworkers weighing bin bags using a hanging scale and recording the weight.....	35
FIGURE 3.5: Separation of food waste by food items and weighing using an electronic compact scale	36
FIGURE 3.6: Food literacy toolkit.....	37
FIGURE 3.7: Fieldworkers wearing their PPE.....	39
FIGURE 4.1: Total food waste, pre- and post-intervention by intervention groups	57
FIGURE 4.2: Fresh produce and dry goods food waste for each intervention group.....	57
FIGURE 4.3: Meat, fish and poultry waste, pre- and post-by intervention group	58
FIGURE 4.4: Cooked food waste, pre- and post-by intervention group	59
FIGURE 4.5: Cost of food waste, pre- and post-intervention by intervention group	59
FIGURE 4.6: Environmental impact, pre- and post-intervention by intervention group.....	60

LIST OF APPENDICES

Appendix A: Newspaper article to recruit participant

Appendix B: Food waste audit recording sheet

Appendix C: Food waste labels for cooked food

Appendix D: Fieldworker training manual

Appendix E: Ethical clearance letter

Appendix F: Letter of information and consent form

LIST OF ABBREVIATIONS

APO	Asian Productivity Organization
CGCSA	The Consumer Goods Council of South Africa
CO ₂	Carbon Dioxide
CONSORT	Consolidated Standards of Reporting Trials
CSIR	Council for Scientific and Industrial Research
DEA	Department of Environmental Affairs
DEFF	Department of Environment, Forestry and Fisheries
DST	Department of Science and Technology
DUT	Durban University of Technology
FAO	Food and Agricultural Organization
FSC	Food Supply Chain
FW	Food Waste
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GNI	Gross National Income
GWP	Global Warming Potential
IREC	Institutional Research Ethics Committee
KG	Kilogram
KJ	Kilojoules
LCA	Life Cycle Assessment
LSM	Living Standard Measure
MRC	Medical Research Council
NASA	National Aeronautics and Space Administration
PPE	Personal Protective Equipment
RCT	Randomised Control trial
SA	South Africa

SANHANES	South African National Health and Nutrition Examination Survey
SAWIC	The South African Waste Information Centre
SDG	Sustainable Development Goal
SPSS	Statistical Package for Social Science
UK	United Kingdom
UN	United Nations
UNEP	United Nations Environment Programme
UNICEF	United Nations International Children's Emergency Fund
US	United States
USD	United States Dollars
USEPA	United States Environment Protective Agency
WB	World Bank
WFP	World Food Programme
WHO	World Health Organization
WRAP	Waste and Resources Action Programme
WWF	World Wide Fund for Nature
ZAR	South African Rand

CHAPTER ONE: INTRODUCTION

1.1 Introduction

The introductory chapter will provide an overview and summary of the research study and explain the importance of the study, the problem statement, the aim, objectives, assumptions, and study parameters and lastly, provide an outline of the research study, the structure of the thesis and the conceptual framework.

1.2 Importance of the study

Food waste is a worldwide problem that is now gaining attention in the light of food security issues and associated environmental concerns (Amirudin and Gim 2019: 104335). According to Gustavsson (2011: 1), roughly a third of the food that is produced in the world from farm to fork goes to waste, with an estimated 1,3 billion tonnes of food produced for human consumption per annum wasted. In a world where 26% of the population is food insecure and 28.3% is on the brink of starvation, wasting food seems unwise (Mathee 2020: 8). According to Marx-Pienaar, Du Rand and Viljoen and Fisher (2019: 239), global food loss and waste are estimated to cost around USD940 billion per year which translates to nearly three trillion ZAR. In addition, most of the waste is disposed of in landfills, placing enormous stress on waste management, and posing global environmental challenges.

Studies to determine household food waste in South Africa have gained momentum, ranging from the sampling of municipality waste to self-reported food waste (Oelofse, Muswema and Ramukhwatho 2018: 5; Cronjé, Müller and Van der Merwe 2018: 4; Ramukhwatho 2016: 8; Chakona and Shackleton 2017: 19). According to Oelofse, Muswema and Ramukhwatho (2018: 5), an average of 0.48 kg (Ekurhuleni) and 0.69 kg (Johannesburg) of food waste (including inedible items) was disposed of into the municipal bins per household per week in these two municipalities. Oelofse, Muswema and Ramukhwatho (2018: 4) translated this to per capita food waste disposal of 8 kg and 12 kg per annum, respectively, compared to the estimated 6–11 kg per annum in sub-Saharan Africa and South and Southeast Asia. In the study by Cronjé, Müller and Van der Merwe (2018: 4) conducted in Kimberely using a self-reported food waste questionnaire, it was found that a significant proportion of consumers indicated that excess leftover food was discarded.

According to Mathee (2020: 12), 27 million tonnes of food is discarded in South Africa each year, resulting in a loss of approximately R505 million. Fruits, vegetables, and cereals account for 70% of this food waste and depletion of natural resources, which occurs mainly in the food supply chain. The amount of energy lost in South Africa each year in processing food that is not used is calculated to be enough to fuel the city of Johannesburg for approximately 16 weeks (Lephaila 2021: para. 6 line 5). Three global challenges are attributed to food waste, namely food insecurity, greenhouse gas pollution, and waste management (Oelofse, Muswema and Ramukhwatho 2018: 5; Cronjé, Müller and Van der Merwe 2018: 4). Food waste results in a waste of energy used in food processing and has an environmental effect on the food supply chain (Oelofse, Muswema and

Ramukhwatho 2018: 6). Food loss and waste can occur at any point in the food supply chain. It influences farmers' ability to make a living during the development cycle (Searchinger, Waite, Hanson, Ranganathan, Dumas and Matthews 2018: 8). It affects the price of food in the remaining stages (processing, distribution, and retail). Hermanussen, Loy and Egamberdiev (2022: 3) and Searchinger *et al.* (2018: 9) reported that food waste/loss affects household nutritional status and spending during the consumption period, which is the final stage. Food that is harvested for human consumption but is wasted use nearly one-quarter of all agricultural water per year and accounts for approximately 8-10% of greenhouse gas (GHG) emissions (United Nations Development Programme 2021: para. 1 line 2). Reducing household food waste can play a role in fostering a more sustainable food system (Joardder and Masud 2019: 4; Yu and Li 2020: 5; Karwowska, Łaba and Szczepański 2021:1; Bajželj, Quested, Rööös and Swannell 2020: 10).

Food waste was also found to be exacerbated by a lack of meal planning, bulk shopping, and purchasing the wrong goods (Cronjé, Müller and Van der Merwe 2018: 5). The findings of this study suggest that alternative techniques to educate consumers on what to do with surplus food should be developed, implemented, and assessed, and that culture-specific and localised interventions should be synthesised, implemented, and evaluated (Cronjé, Müller and Van der Merwe 2018: 7). The move towards a sustainable diet for [the sake of] planetary health is critical. A sustainable diet is characterised as a dietary pattern that promotes all dimensions of an individual's health and well-being, has low environmental pressure and impact, is accessible, safe and equitable, and is culturally acceptable (Food and Agricultural Organization (FAO) and World Health Organization (WHO) 2019: 8). One of the guiding principles for a sustainable diet is to reduce food waste. To make sustainable healthy diets available, accessible, affordable, safe and desirable, food system changes could be guided by promoting capacity development strategies for behaviour change, including consumer empowerment, and effective food and nutrition education (FAO and WHO 2019: 9).

While most studies have focused on baseline measurements of household food waste, intervention studies have been emerging to reduce household food waste. One such strategy to harness behavioural change towards household food waste is through food literacy interventions and developing responsible food citizens. However, Nahman and de Lange (2013: 2493) stated that there needs to be more evidence on the exact impact of food literacy on household food waste, and hence there is an opportunity for research. According to van der Werf, Seabrook and Gilliland (2019: 486), the lack of food literacy among consumers is a key factor in the generation of household food waste. Food literacy is regarded as a useful tool and skill in reducing food waste and non-communicable diseases. Begley, Paynter and Dhaliwal (2018: 2) reported that food literacy plays an integral role as it develops and broadens an individual's knowledge about food practices, which is a part of daily life and allows one to make informed choices regarding food purchasing, consumption and storage and in turn reduce food wastage and economic losses and promote better individual health. There has been no intervention study to change consumer behaviour towards household food waste in South Africa. Preventing household food waste will save money and has

physical, social, and environmental benefits (Marx-Pienaar *et al.* 2019: 240). Within this context, this study aims to determine the intervention effect of food literacy on household food waste in the KwaDukuza municipality.

1.3 Problem statement

While food waste is a global concern, South Africa's household food waste mimics that of developed countries. Although household food waste studies in South Africa have gained momentum, nearly all studies have focused on household food waste consumer practices. No intervention study has been conducted to change consumer behaviour towards household food waste in South Africa. Likewise, the cost of household food waste, nutrition losses, and the environmental impact of household food waste through an intervention have yet to be explored. Interventions that target a change in human behaviour towards reducing household food waste can make a meaningful impact on food and nutrition security, and the environment.

1.4 Aim of study

To determine the intervention effect of food literacy on household food waste in the KwaDukuza municipality.

1.5 Objectives of the study

The objectives of this study are:

- To calculate household food waste through a weighed food waste audit at baseline and endline.
- To calculate the cost, associated nutrient losses and environmental impact of household food waste using the results of the food waste audit at baseline and endline.
- To determine the intervention effect on household food waste.

1.6 Assumptions

- All participants were presumed to be above the age of 18.
- It was assumed that the responses collected from participants and the household food waste audit were of an unbiased and honest nature.
- It was assumed that all participants involved in this research could comprehend English, which was the language used to communicate.
- It was assumed that the sampled households were relatively homogenous.

1.7 Study parameters

- This study was limited to KwaDukuza municipality in the iLembe district, KwaZulu-Natal.
- Only 180 households were used for this study.

1.8 Definition of terms

Avoidable food waste: Discarded food and drink that was not consumed but discarded (Leverenz, Moussawel, Maurer, Hafner, Schneider, Schmidt and Kranert 2019: 2).

Completely unused foods: Food that has been discarded that has not been used, such as unopened packets (van Herpen, van Geffen, Nijenhuis-de Vries, Holthuysen, van der Lans and Qusted 2019: 2771).

Food insecurity: The condition of having inconsistent access to sufficient amounts of affordable, nutritious food (FAO 2023: para. 1 line 1).

Food loss: A reduction in the amount or quality of food caused by decisions and activities on the part of food producers in the supply chain, except for retailers, food service providers, and consumers (FAO 2017: 1).

Food waste: Refers to a reduction in the quantity or quality of food as a result of retailer, food service supplier, and customer decisions and behaviour (FAO 2017: 1).

Global warming potential (GWP): The Global Warming Potential (GWP) compares various gases and their global warming impacts. It is an average amount of energy per tonne of a gas consumed in a specific period compared to a tonne of carbon dioxide emissions (United States Environmental Protection Agency (USEPA) 2020: para. 2 line 1).

Greenhouse gases: These heat-trapping gas emissions in the atmosphere, such as carbon dioxide, are referred to as greenhouse gases (National Aeronautics and Space Administration (NASA) 2021: para. 4 line 2).

Leftovers after storing: Food leftovers that have been discarded after being stored in the fridge or freezer with the intention of being consumed later, e.g., a frozen pasta slice (van Herpen *et al.* 2019: 2771).

Meal leftovers: Leftovers that are discarded after they have been left on plates, or in bowls, pans and pots (van Herpen *et al.* 2019: 2771).

Partly used foods: Food discarded after being used at a meal or on special occasions (van Herpen *et al.* 2019: 2771).

Unavoidable food waste: Food or drink that will never be edible, e.g. bones, eggshells, fruit peels, and tea bags (Nicholes, Qusted, Reynolds, Gillick and Parry 2019: 180).

1.9 Structure of the thesis

This thesis is reported according to the following format.

Chapter 1: Introduction

- Provides the background to the study, research problem and justification of the research. The aim and objectives of the research are also presented.

Chapter 2: Literature Review

- Provides a thorough review of studies conducted by other researchers.

Chapter 3: Methodology

- Presents methods and measurement tools used in the study. The quality of the data, in terms of validity and reliability, is outlined and ethical issues relating to the research are discussed.

Chapter 4: Results and Discussion

- All data and results are depicted in the form of figures and tables and provided with a detailed description and discussion.

Chapter 5: Conclusion and Recommendations

- Provides a conclusion, and recommendations for further research and investigations on the study.

1.10 Outline of the research study

The study outline, as depicted in Figure 1.1, was developed in collaboration with the research supervisors.



Figure 1.1: Outline of the study

1.11 Conceptual framework

The three-phased study entitled, “The impact of food literacy on household food waste”, funded by the Council for Scientific and Industrial Research (CSIR), aimed to implement a food literacy intervention to determine the impact of food waste and the change in human behaviour towards the prevention of food waste at the household level (Figure 1.2). Phase 1 included the food behaviour and practices related to a household food waste survey. Phase 2 of the study comprised the design and testing of food literacy tools. This thesis represents phase 3 of the study, measuring the impact of food literacy on household food waste, and involving the intervention effect of food literacy on household food waste.

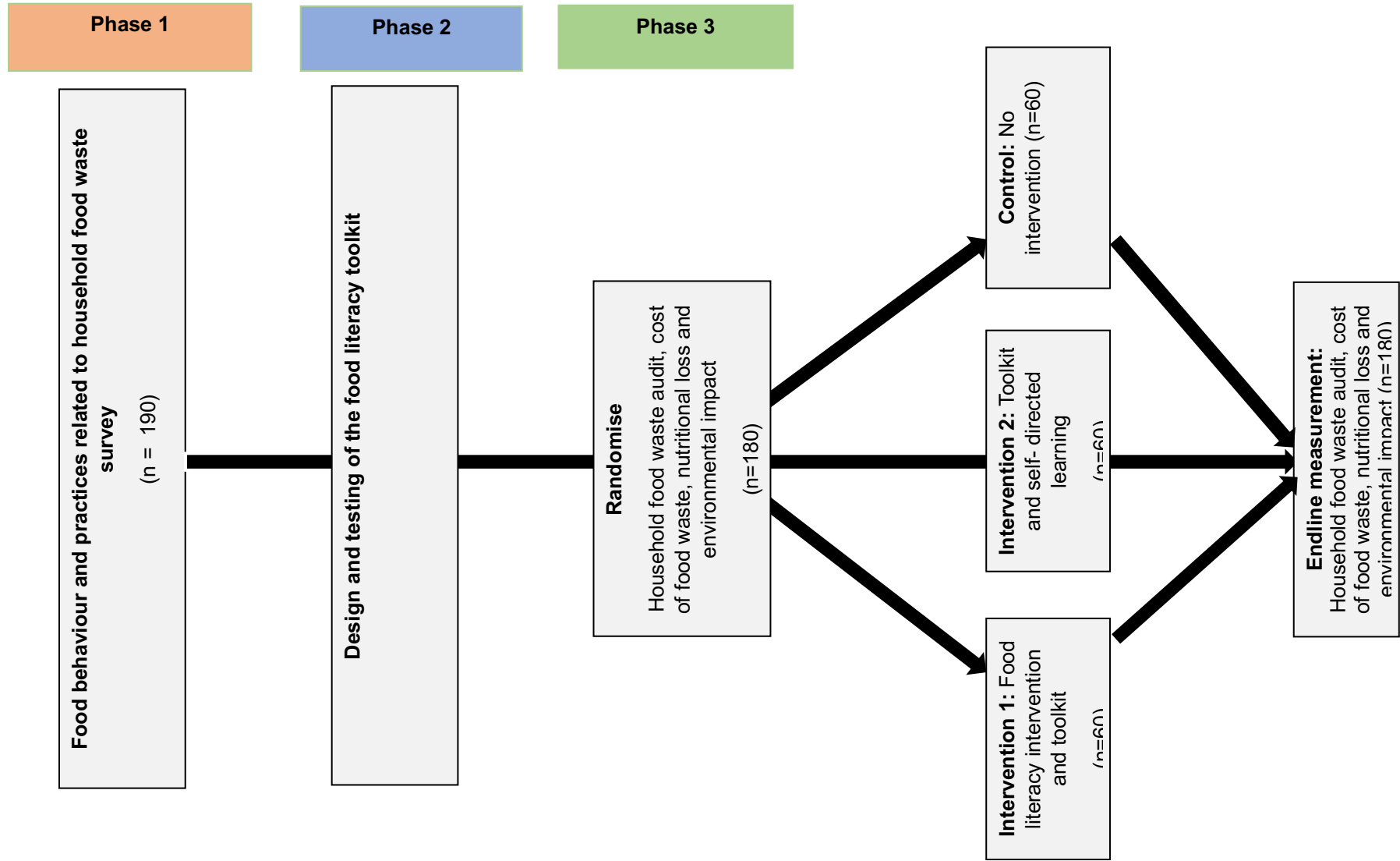


Figure 1.2: Overview of the impact of food literacy on household food waste

1.12 Conclusion

The importance of this study is outlined in this chapter. Household food waste has a significant impact on both the environment and the economy. Reducing household food waste offers several key benefits, such as the conservation of natural resources and the preservation of ecosystems and biodiversity. Various strategies can be implemented to reduce household food waste. The following chapter will discuss the literature related to the study in detail.

1.13 Referencing style

The referencing style used in this thesis is according to the Durban University of Technology (DUT) Harvard referencing guidelines (Mitha, Naidoo and Thomas 2017: 1).

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This chapter reviews the information gathered and reported by various researchers who have conducted studies around key topics related to household food waste and interventions to reduce household food waste.

2.2 What is food waste?

The Food and Agriculture Organization (2023: para 1 line 3) defines food waste as the disposal of edible food at the retail and consumer levels. Fabi, Cachia, Conforti, English and Moncayo (2021: 2) refer to food waste as the removal of food which is suitable for human consumption from the supply chain, or discarded food which has spoiled or expired due to economic behaviour, poor stock management or neglect. Furthermore, food waste on a plate includes served food that is not consumed, vegetable peels, and spoiled goods that are deemed inedible and are managed in a variety of ways, such as animal feed, compost, or landfills (United States Environmental Protection Agency (US EPA) 2022: para. 6 line 2). Common to these definitions is edible food that is wasted at the consumer level. Edible food waste can be avoided or minimised (Ramukhwatho 2016: 1). The Food and Agricultural Organization (FAO 2011: 2) explains that edible food waste is food that is discarded even though it is still fit for human consumption. However, food waste from inedible food is waste that cannot be avoided (Waste and Resources Action Programme (WRAP) 2009: 4).

2.2.1 Types of food waste

Food waste can be divided into three categories: (1) avoidable waste, (2) unavoidable waste, (3) potentially avoidable waste (Dhir, Talwar, Kaur and Malibari 2020: 1). Ramukhwatho (2016: 7) refers to avoidable food waste as products that could have been consumed, such as prepared but unfinished food (like cooked pasta), food that was allowed to spoil (like dry bread or rotting fruits and vegetables), and other food items that were thrown away while still being edible. Unavoidable food waste is defined as food that cannot be consumed by humans, such as peels, bones, shells, and other items that are typically not considered edible (WRAP 2009: 4). Dhir *et al.* (2020: 1) explain that bread crusts, potato skins, and carrot roots are a few examples of potentially avoidable food waste that happen as a result of personal preferences. Some people enjoy these foods, while others avoid them.

2.2.2 Food waste vs. food loss

According to the FAO (2019: 1), there are several definitions of food waste and food loss in literature, and there still needs to be a universally accepted definition of food loss and food waste. Food loss and food waste are terms used to define wasted food, claims Mathee (2020: 22). Food waste is a subset of food loss and involves any cooked or raw quality food along the value chain that is suitable for human

consumption but ultimately ends up unconsumed or discarded, typically at the retail or consumer end of the chain, and food waste is widely regarded as avoidable food loss (Kibler, Reinhart, Hawkins, Motlagh, and Wright 2018: 53). On the other hand, as shown in Figure 2.1, Parfitt, Barthel and Macnaughton (2010: 3066) describe food loss as a decrease in edible food quantity or quality that occurs during production, postharvest, and processing in the food supply chain. Food loss happens before the food reaches the consumer. Each point in the chain where a specific amount of food originally intended for consumption does not reach the intended customer is collectively referred to as "food supply chain losses" (Richter and Bokelmann 2016: 424; Bloemhof and Soysal, 2017: 396). According to Mathee (2020: 22), food loss is caused by inappropriate handling or disposal of food that is still edible. Food waste happens as a result of either mishandling in the food supply chain or a deliberate decision to throw away edible foods (Kibler *et al.* 2018: 53). Food waste happens later in the food chain after the food has been consumed (Parfitt, Barthel and Macnaughton 2010: 3065).



Figure 2.1: Difference between food loss and food waste (Onethird 2023: para. 9 line 1)

2.3 Food waste on a global scale

The FAO (2011: 4) reported that a third of the food produced for human consumption is lost along the world's food supply chain every year, which runs from cultivation and production to household consumption. Since the FAO revealed that one-third of the food produced worldwide is wasted, food waste has attracted public interest, resulting in several scientific publications (FAO 2011: 6) raising awareness of the issue and making it one of the sustainable development goals (SDG 12.3) of the 2030 Agenda (UN 2015: 22). Around 50% of food produced worldwide never reaches the point of being

consumed by people. Although food waste happens at every stage of the food supply chain, private households have been pinpointed as significant contributors to this issue (Schanes, Dobernig and Gözet 2018: 978). The United Nations (2022: para. 2 line 1) states that 13% of the world's food is lost after harvest, and 17% of the of total global food production is wasted in households, in the food service industry and in retail all together. Forty percent of food loss and waste occur at the retail and consumer (households and retail) levels in industrialised countries, with private households accounting for most of this loss and waste (Barrera and Hertel 2021: 1).

In 2019, the United Nations Environment Programme (UNEP) reported that 931 million tonnes of food waste were generated globally, 61% of which was household food waste (Giordano and Franco 2021: 1). The authors further explain that household food waste happens mostly in developed rather than developing countries due to the inability to recover food waste for other uses, resulting in refuse coupled with urbanisation and increased income. Europeans and Americans waste 95-115 kg of food per week (Gustavsson *et al.*, 2011: 5). Contrarily, consumers in South/ Southeast Asia and Sub-Saharan Africa discard 6–11 kg of food per person weekly (Gustavsson *et al.*, 2011: 5). Given the enduring nature of world hunger and food security, food loss and waste also pose a social conundrum; the researchers went on to state that it is estimated that 222 million tonnes of food are wasted at the consumer level in industrialised countries, which is approximately as much as the region's whole net food production (SSA) (230 million tonnes) (Barrera and Hertel 2021: 1).

The economic impact associated with global food waste totalled R37.57 trillion, of which R14.45 trillion is related to environmental factors such as pesticide exposure, water use, greenhouse gas emissions, biodiversity loss, and soil erosion (South Africa (SA), Department of Environment, Forestry and Fisheries (DEFF) and Council for Scientific and Industrial Research (CSIR) 2021: 9). Nearly one-fourth of the world's cropland and fertiliser are utilised in the production of food. These resources are lost and wasted, providing about 3.3 gigatonnes of methane emissions comparable to carbon dioxide (CO₂) (FAO 2013: 15) and (Kummu, de Moel, Porkka, Siebert, Varis and Ward 2012: 478). According to the Food and Agriculture Organization (FAO 2023: para 2 line 1), an estimated \$1 trillion worth of food is wasted annually. The environmental costs of this waste are \$700 billion due to the use of natural resources to produce food that is thrown away or left uneaten, while the social costs are roughly \$900 billion US dollars.

Due to its potential to improve global food security, reducing food waste has become a responsibility for the entire globe (Mathee 2020: 8). Additionally, reducing food waste can free up resources, reduce financial losses, and diminish adverse environmental effects (Jörissen, Priefer and Bräutigam 2015: 2696). The reduction of global food waste at the consumer level (including food waste at the retail level, along the production, storage, processing, and distribution stages in the food supply chain, as well as post-harvest) was designated by the United Nations as an essential Sustainable Development Goal (SDG 12.3) because it is an important first step toward achieving environmental sustainability (UN 2015: 22).

2.3 Food waste from farm to fork

All stages of the food supply chain (FSC) consist of numerous agricultural and industrial operations, within which various types of losses and waste occur (Luo, Olsen and Liu 2021: 7). More than 1.3 billion tonnes of food are lost or wasted annually (FAO 2011: 1). A series of related activities used to produce, distribute, prepare and consume food is referred to as the food supply chain (FSC) (FAO 2019: 1). According to Sheahan and Barrett (2017: 5), some technologies, methods, techniques, and practices used and employed by the different actors in the food supply chain include mechanisation, agronomic practices, and farm management practices. Brand, Bricas, Conaré, Daviron, Debru, Michel and Soulard (2019: 17) state that another factor contributing to the production of a lot of food waste is urbanisation, which has forced the FSC to grow to satisfy the growing population's needs. As emerging countries experience economic growth, their infrastructure and farming methods improve, and food losses take on new forms. Most food loss happens during the harvest and post-harvest phases in countries with less developed post-harvest infrastructure, whereas food waste occurs during the retail and consumption stages in the same countries (FAO 2011: 10). Additional factors include both natural ones, such as the presence of insects, pests, mould, adverse temperatures, and humidity, as well as socioeconomic ones, including the accessibility of market information. These factors can considerably impact food loss and waste (Nicastro and Carillo 2021: 1). The production stage is seen to be the most critical point for food loss, particularly during product processing such as interrupted production. Still, the majority of waste happens at the household level (Dora, Wesana, Gellynck, Seth, Dey and De Steur 2020: 52).

2.3.1 Food loss during cultivation and harvest

During the cultivation and harvesting stages, several factors, including biotic, for example, insects and pests, and abiotic ones, like climatic conditions and disease pressures, contribute to food losses (Mesterhazy, Olah and Popp 2020: 3). The amount of food wasted depends on the type of crop and the region in which it is grown (Song, Semakula and Zhang 2015: 192). Mesterházy, Oláh and Popp (2020: 3) added that developed countries use more advanced cultivation and harvesting methods than non-industrialised countries, where a lack of information about the best practices to use at these phases, and the necessary equipment is the primary source of losses. According to Hammond, Brown, Burger, Flanagan, Fristoe, Mercado-Silva, Nekola and Okie (2015: 759), pathogens can act even more quickly if damage is incurred during the various stages of harvest, cultivation, and transportation. In underdeveloped countries, which frequently have poor infrastructure, such as barely functional roads and subpar storage facilities, Nicastro and Carillo (2021: 3) elaborated that a lack of proper knowledge also causes the losses suffered, as well as ineffective management practices in the warehouse, and the absence of sufficient technological, financial, and managerial resources.

The improper handling of items during harvest, including the use of heavy machinery, can result in damage and injuries that make it easier for infections to take hold and cause crops, roots and tubers to deteriorate more quickly (Liliane and Charles 2020: 2). Harvesting techniques and timing affect food

losses as well. Premature harvesting can result in food loss, especially in developing countries. When farmers are forced to harvest crops early owing to food shortages or a need for money, they might lose out on both the market value and the nutritional worth of their harvests, wasting unfit-for-consumption food (Johnson, Bloom, Dunning, Gunter, Boyette and Creamer 2019: 1). A delayed harvest can also result in food losses since crops left in the field after maturity are vulnerable to pests, rodents, and fungal attacks. This causes a rise in decay, a drop in quality, and an increase in susceptibility to damage during transport (Mesterházy, Oláh and Popp 2020: 1).

2.3.2 Food loss during post-harvest

Most post-harvest losses occur during storage, which is easier to predict and prevent (Cardoen, Joshi, Diels, Sarma and Pant 2015: 145). The FAO (FAO 2011: 1) indicated that the reasons behind food losses differ amongst similar commodities worldwide. For instance, low-income countries experience a more significant loss of fresh fruit and vegetable production than industrialised countries due to insufficient infrastructure or a lack of cold storage and due to their shorter shelf life and, higher perishability these products are therefore headed for disposal.

Many produce items, especially fruit and vegetables, must adhere to specific size, shape, and quality criteria to meet customer demands. However, this is sometimes not achieved due to production faults or damaged packaging (Dora *et al.* 2020: 49). Dora *et al.* (2020: 49) went on to say that even though these mistakes don't always indicate a change in flavour, nutritional value, or food safety, food that is still edible is thrown out. According to Eggersdorfer, Kraemer, Cordaro, Fanzo, Kennedy, Labrique and Steffen (2016: 1), food is mainly consumed during specific seasons in many developing countries, and investing in storage or processing facilities is frequently not financially advantageous. Food losses therefore rise due to insufficient infrastructure for properly storing fresh food to fulfil demand. Products with broken or improperly sealed packaging must be discarded to maintain the necessary standards because these mistakes could lower the quality of the goods, harming the processors because they would be rejected by the purchasers (Dora *et al.* 2020: 49).

2.3.3 Food loss and waste during distribution, retail, and consumption

Food losses can occur during transportation related to packaging breakage, which leaves products more exposed to spoiling, as well as the long distances between the point of production and the point of sale. This results in greater transportation expenses as well as the likelihood of more considerable food losses due, for example, to damaged roads or inefficient modes of transportation (Liliane and Charles 2020: 2). Good physical infrastructure and effective trade logistics are essential during transit to reduce food losses (Food and Agriculture Organization (FAO) and Asian Productivity Organization 2006: 24). This is supported by the finding made by Cattaneo, Sánchez, Torero and Vos (2021: 4) that well-integrated rural-urban value chains experience fewer losses than are commonly reported in the literature.

According to Cattaneo *et al.* (2021: 4), direct reasons for food waste at the retail level are typically linked to food products' short shelf life, the requirement that they adhere to aesthetic standards in terms of colour, shape, and size, and demand fluctuation. It's critical to ascertain demand at the retail level to avoid products going unsold before their designated use-by date. This is difficult, however, because demand is affected by product seasonality, supermarket promotions, and the time of year (Nicastro and Carillo 2021: 3). Mena, Adenso-Diaz and Yurt (2011: 650) state that to satisfy consumer demand, supermarkets in industrialised countries stock a wide variety of products from various brands and product categories, but this raises the possibility that goods won't be sold before their use-by date, which will result in more waste. Liliane and Charles (2020: 6) report that proper procedures for storage and display at the retail level are equally crucial, which is why training for shop workers is necessary. Both industrialised and developing countries primarily experience this. The lack of sufficient cooling infrastructure and unsanitary market conditions are the leading causes of food waste, resulting in improper food preservation.

Consumer waste is frequently brought on by careless planning during food shopping and meal preparation, excessive shopping, label confusion, and inadequate food storage at home (Cattaneo *et al.* 2021: 2). In countries where there is extreme poverty, there is relatively little wastage, and it rarely affects households (Liliane and Charles 2020: 6). In contrast, consumers in wealthy countries can "afford" to waste food because of their higher standard of living as well as the abundance of food available from restaurants and grocery stores (Bräutigam, Jörissen and Priefer 2014: 685). Retail stores promote "special offers" encouraging over-purchasing; restaurants offer buffets where you may take as much food as you want for a set price, encouraging customers to take more food than they can eat or need (Papargyropoulou, Steinberger, Wright, Lozano, Padfield and Ujang 2019: 2). According to Toma, Font and Thompson (2020: 545), sometimes, consumers are unaware of how much food is prepared in their homes and what the outcome will be (Kibler *et al.* 2018: 56). According to Aschemann-Witzel, de Hooge, Amani, Bech-Larsen and Oostindjer (2015: 6462), consumer attitudes towards food waste vary. While some are aware of food waste and its effects, many are not aware, which leads to more household food waste generation (Richter 2017: 642). The root of all this is an incomplete understanding of waste levels and their effects on the economy and the environment (Liliane and Charles 2020: 1).

2.4 Food waste in developing vs. developed countries

Food waste happens at every stage of the food supply chain. However, the several causes of food waste can be distinguished based on the level of development of the country (FAO 2011: 1). Mathee (2020: 24) explains that food waste varies between developing and developed countries. Chalak, Abou-Daher, Chaaban and Abiad (2016: 419) agreed with the above statement and added that it depends on the country's economic growth, industrialisation, and development.

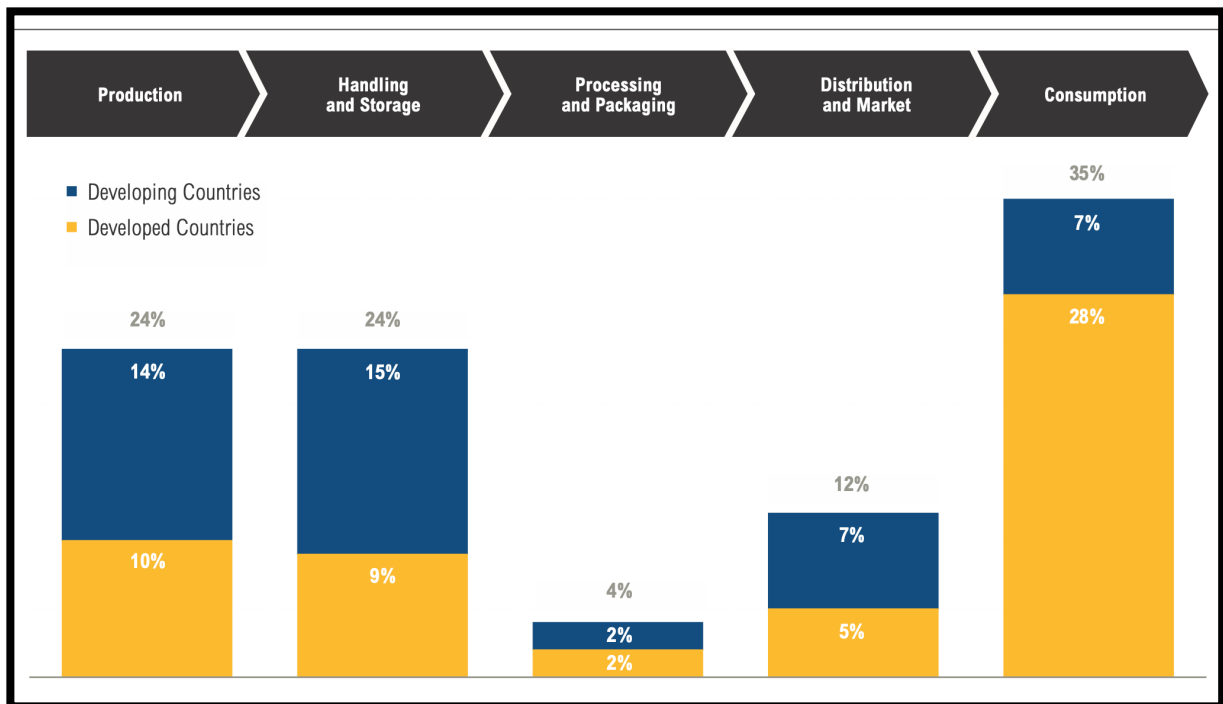


Figure 2.2: Comparison of food waste and loss in different stages of the food supply chain between developed and developing countries (Lipinski, Hanson, Kitinoja, Waite and Searchinger 2013: 8)

In developing countries, food waste occurs mainly at the start of the food supply chain, as shown in Figure 2.2. This is because of restrictions on planting and harvesting, lack of infrastructure for the food supply chain, transportation, and field of technological investment (Godfray, Beddington, Crute, Haddad, Lawrence, Muir, Pretty, Robinson, Thomas and Toulmin 2010: 813), whereas in developed countries, the primary factors of food waste are caused by the production of surplus food and consumer behaviour (Buzby and Hyman 2012: 562; FAO 2011:1). Developed countries account for more food waste than developing countries (Mathee 2020: 24). Fifty-six percent of food is wasted and lost in developed countries. In comparison, 44% of food is wasted and lost in developing countries (Lipinski *et al.* 2013: 1). Additionally, developed and developing countries waste significantly different amounts of food per person (Mathee 2020: 24). Developed countries lose or waste 257kg per capita of food annually, while underdeveloped countries waste 157 kg per capita of food annually (Wansink 2018: 501). In agreement with Wansink (2018: 502), Gustavsson *et al.*, (2011: 5) emphasised that, on average, sub-Saharan Africa and South/Southeast Asia waste 120–170 kg of food per capita per year, whereas Europe and North America waste 280–300kg /person/annum. This data shows that developed countries experience greater food loss and waste than developing countries. Thi, Kumar and Lin (2015: 308) reported that 107 kg and 56 kg of food waste per person was experienced annually in developed and developing countries. These numbers demonstrate the differences in food waste generation between developed and developing countries, with higher living conditions leading to more food waste creation (Lipinski, Hanson, Lomax, Kitinoja, Waite and Searchinger 2013: 9). According to Mathee

(2020: 25), each person in Finland wastes roughly 550 kg of food annually, and 20% of the food is lost during preparation and handling.

Oelofse and Nahman (2013: 83) elaborated on why consumers do not plan while shopping or cooking. Meanwhile, Mathee (2020: 28) stated that there is one factor that contributes to food waste in developed countries, and it is the lack of knowledge and interest in the issue of food waste on the part of the customer. The author further stated that consumers in the UK discard 30% of edible food which can be avoided. For example, 53% of the food Europeans purchase is wasted (Wansink 2018: 503). Consumers in Switzerland throw away about 18% of the food they purchase, some of it leftovers, during storage and preparation (Kibler *et al.* 2018: 58).

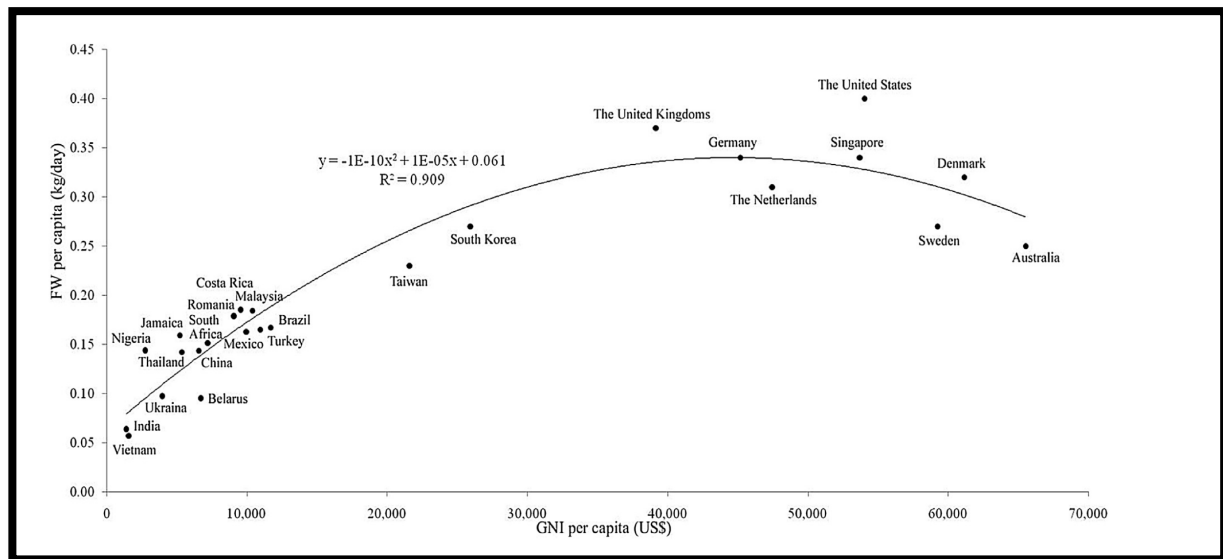


Figure 2. 3: The relationship between gross national income per capita and food waste per capita in some countries (Thi, Kumar and Lin 2015: 309)

Figure 2.3 explains the relationship between food waste per capita and Gross National Income (GNI) per capita in some countries. The trend in food waste generation has revealed an association between income levels (GNI per capita) and the rate of food waste creation. Food waste generation-based GNI tends to split into two groups in developed countries. In the first group, the food waste generation gradually declines with income level (GNI more than US\$42,000), but the food waste generation tends to rise in the second group (GNI less than US\$42,000) (Thi, Kumar and Lin 2015: 307). According to Song, Li and Zeng (2015: 199), "zero waste" affects the factors separating food waste generation per capita into two groups. The first group comprises more developed countries with higher GNIs currently managing their food waste by implementing a "zero waste" strategy, such as Sweden, Australia, and the United States. On the other hand, other developed countries have not embraced the "zero waste" option. As a result, their food waste creation per capita is significant due to a low food waste diversion rate and a high rate of virgin waste development during the production operations field (Adhikari, Barrington and Martinez 2006: 422).

In developing countries, the food waste generation trend appears governed by the rule that the wealthier the country (greater GNI per capita), the higher the waste generation (food waste per capita). The relative influences on the food waste generation rate in developed countries are the rate of urbanisation and population growth, both of which are correlated with income levels (Adhikari, Barrington and Martinez 2006: 421). The writers elaborated that the creation rate is 0.19 kg/day in Costa Rica (small-scale population), whereas the food waste generation rate is 0.06 kg/day in India (large-scale population). High levels of food waste will be produced by population increase and economic expansion in developing countries.

2.5 Food waste in South Africa

As millions of South Africans go to bed hungry each night, it is estimated that around 10.3 million tonnes of food are wasted in South Africa each year, equalling 34% of the locally produced food (Council for Scientific and Industrial Research (CSIR) 2021: para 2 line 1). Nahman and de Lange (2013: 2495) reports that over 10.2 million tonnes of locally produced food are lost each year in South Africa, including imports. Consumers only throw away 0.5 million tonnes of food, while most food loss and waste happen during cultivation, processing, and distribution (Pal, Naicker and Grobbelaar 2023: para. 8 line 2). Out of the 10 million tonnes of food waste generated annually in South Africa, 70% of the waste and loss of food consists of fruits, vegetables, and cereals. This loss and waste mostly takes place in the early stages of the food supply chain (Notten, Bole-Rentel and Rambaran 2014: 11).

Domestic waste in South Africa costs an average of R21.7 billion annually, making it the country that produces the most food waste on the continent. Its prevention would save households money and improve economic, environmental, and social dynamics (Oelofse, Muswema and Ramukhwatho 2018: 1). The authors also observe that a weekly average of 6 kg of household garbage in Tshwane, Gauteng classifies post-consumer waste in South Africa as high, raising concerns about the negative implications of food waste. Consumers in Johannesburg deposit 12 kilograms of food waste per person annually into municipal trash, compared to 8 kilograms in Ekurhuleni (SA, DEFF and CSIR 2021: 9). A food waste study in the Enkanini informal settlement in Stellenbosch, Western Cape, revealed that informal settlement households produce between 5.2 and 9.6 kg of food waste each week. Despite the likelihood that people with lower income consume less overall, they produce more food waste overall than people with higher income (Mollatt 2014: 1). According to research conducted by Notten *et al.*, (2014: 12) in the city of Rustenburg in the North West province, the amount of food waste as a proportion of the overall amount of domestic garbage gathered from various households was determined as follows: homes in low-income areas generated 27% of the weight of food waste, those in middle-income areas generated 13%, and those in high-income areas generated 17% of the weight of domestic waste.

De Lange and Nahman (2015: 168) estimated that post-consumer food waste cost South Africa over R21.7 billion annually. According to Marx-Pienaar *et al.* (2019: 238), consumer food waste in South Africa is predicted to cost the economy R21.7 billion annually. Findings of a study on household food waste in Mamelodi by Ramukhwatho, duPlessis and Oelofse (2017: 255) showed that 82% of the

families that participated in the survey wasted food and disposed of an average of one bag per week (24kg).

Ramukhwatho, duPlessis and Oelofse (2017: 255) stated that leftover food, special deals, food that has been prepared in excess, and food that has passed its best-before date were the leading causes of food waste generation among Mamelodi families in South Africa. Chakona and Shackleton (2017: 1) also found that 27% of prepared food, 15% of unprepared food, and 8% of beverages was wasted by South African families. According to a different study by Oelofse and Nahman (2013: 83), South African families wasted various items, but fruits and vegetables were the most wasted. They also wasted milk, fish, oil, seeds, and other commodities.

The amount of food wasted varies and is influenced by household income, according to the results of waste characterisation research done in Johannesburg (Mathee 2020: 25). Low-income urban families waste more food on average by 12-26.2% more than high-income urban families, who waste food on average by no more than 7-7.6% (Oelofse and Nahman 2013: 84). Additionally, compared to high-income households, low-income families tend to spend a more significant percentage of their income on food because it is a basic need for them (Oelofse and Nahman 2013: 84).

With 10.3 million tonnes of edible food waste, South Africa has pledged to support the 2030 SDG agenda of reducing food waste by 50%. It hopes to encourage other African countries to do the same, opening the door for creative solutions and waste management tools that governments can use to achieve the objective (Bessa, Aganga and Monthe 2021: para. 11 line 1).

2.6 Impact of COVID-19 on food waste globally and in SA

Many factors that have been identified as significant contributors to household food waste have been significantly reversed by the COVID-19 epidemic, including the shopping and preparation of food in the home (Rodgers, Lombardo, Cerolini, Franko, Omori, Linardon, Guillaume, Fischer and Fuller-Tyszkiewicz 2021: 1). Closed borders caused more complex effects which were felt in the food chain. Distribution system delays resulted from permit and licence checks; while Europe and the US rely heavily on seasonal and migrant workers (Oelofse, Nahman, Baig, Salemdeeb, Nizami and Reynolds 2020: 209). Globally, millions of tonnes of crops in the US, Israel, and Europe perished in the field due to delayed or non-existent harvesting. In China, a lack of grain caused animals and poultry to starve to death (Pan, Yang, Zhou and Kong 2020: 2). It was reported by Meyer, Reardon, Davids, Van der Merwe, Jordaan, Delport and Van Den Burgh (2022: 2) that in South Africa, food losses in the distribution chains were projected to rise as a result of inefficient product transportation, and container problems at ports have a detrimental effect on citrus exports to Asia. According to Oelofse *et al.* (2020: 209), in the course of COVID-19, transportation was limited which had an impact on global food waste since foods did not arrive at retail establishments as usual; however, South Africa did not experience significant wastage.

In a study by Jribi, Ismail, Doggui and Debbabi (2020: 3940), households were more aware of their wastage during the lockdown in which there was a higher demand for leftovers in the household during

the lockdown, however inadequate food storage may have led to increased waste in the longer term. Failed cooking and baking experiments may also have resulted in increased wastage. In Spain, during COVID-19, household food waste increased by 12 percent while 93 percent of respondents in Tunisia said that the lockdown had an effect on their levels of household waste Oelofse *et al.* (2020: 9).

2.7 Impact of food waste on food security globally and in SA

The World Bank (WB) (2023: para. 1 line 1) and FAO (2006: para. 1 line 1) defines food security as "a state that exists when all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that satisfies their dietary needs and food preferences for an active and healthy life". Food insecurity still affects one in nine people worldwide, making it a global issue (FAO 2015: 62). The prevalence of food insecurity is rising despite efforts to reduce it (FAO 2022: para. 2 line 1). According to the State of Food and Nutrition Security in the World (2023), it was estimated that between 690 and 793 million people worldwide faced hunger in 2022 (FAO, UNICEF, WFP and WHO 2023). Moreover, six hundred and ninety million people, or 9.8% of the world's population, are malnourished, according to the latest statistics (FAO 2022: para. 4 line 2). Almost two billion people suffer from the detrimental health effects of micronutrient deficiencies. There are 828 million undernourished people, making food and nutrition security a problem for the entire world according to the FAO (2022: para. 1 line 1). The social impact of food waste has an important bearing on food security as well as the ethical concerns of wasting food in view of the global challenge of food security.

In South Africa, 42.6% of people are unemployed, and very few South Africans grow all of their food (Department of Statistics South Africa (StatsSA) 2022: para. 1 line 2). Families with low income spend 50% of their earnings on food, 23% of households cannot afford to buy food, and 21% skip meals to stretch their food budget even further (StatsSA 2016: para. 2 line 2). In addition, the cost of maize, a staple food for those with low incomes, has increased twofold since 2010 (Mathee 2020: 22). Food prices would rise if food waste persisted, making it impossible for low-income people to buy enough food to satisfy their nutritional needs (FAO 2013: 15). Due to South Africa's high rates of under- and overnutrition, integrated measures are necessary to solve this issue that is harming the country's societies. One such measure is to encourage good food management to reduce food waste (Shisana, Labadarios, Rehle, Simbayi, Zuma, Dhansay, Reddy, Parker, Hoosain, Naidoo, Hongoro, Mchiza, Steyn, Dwane, Makoe, Maluleke, Ramlagan, Zungu, Evans, Jacobs, Faber and the SANHANES-1 Team 2014: 49). According to May (2021: 824), 27% of South African children under the age of five are malnourished, and nearly a quarter of the population of the nation is estimated to be living below the poverty line. In addition, 43.6% of children do not get enough vitamin A, which weakens their immune systems and raises their chances of developing cancer, disease, and blindness (WWF 2017: 13).

Food waste is responsible for the loss of nutrients that could have been used to meet the nutritional needs of a person who doesn't have access to food (WWF 2017: 13). According to the WWF (2017: 13), in South Africa, 50% of fruits, vegetables, fish, poultry, eggs, and essential fatty acids are wasted,

resulting in a loss of vitamins, minerals, and fatty acids. Food waste reduction is necessary to combat poverty and achieve food security in South Africa (WWF 2017: 13).

2.8 Economic impact of food waste globally and in South Africa

The economic impact of household food waste is just one of several adverse effects. Food waste increases food prices and restricts access to food, reducing food affordability and availability for the poorest people and enhancing malnutrition in developed and developing countries (Abiad and Meho 2018: 311). In developed countries compared to developing countries, overall food losses along the supply chain are far higher per capita since one-third of the edible portions of food produced for human consumption worldwide are lost or wasted (FAO 2019: para. 2 line 1). The estimated cost of these losses is \$940 billion USD annually. In a country where one in nine people still lack adequate nutrition, 40% of food in the US is lost or wasted every year, costing the economy an estimated \$218 billion, or 1.3% of GDP (US EPA 2023: para.1 line 3).

At least 12 million South Africans endure hunger daily, and the country is said to have the highest rate of food waste in all of Africa. According to (Oelofse, Muswema and Ramukhwatho 2018: 1), the average cost of household food waste in South Africa is ZAR 21.7 billion annually. By integrating pre-and post-consumer food waste, the overall cost of food waste across the food value chain in South Africa was calculated to be R61.5 billion annually (Nahman and de Lange 2013: 2494). However, the cost of food loss and waste in South Africa has been estimated by the CSIR to be R61.5 billion, or 2.1% of the country's GDP (WWF 2017: 9). Nahman, de Lange, Oelofse and Godfrey (2012: 2147) found that households waste food at a rate of about 0.8% of the national GDP, or R21.2 billion, per year. In South Africa, the cost of inedible food waste is estimated to be R6.9 billion annually or R2863 per tonne. The overall cost, including edible food waste expenditure, is R71.9 billion annually (de Lange and Nahman 2015: 168).

2.9 Environmental impact of food waste

Food production and supply have several harmful environmental effects since they deplete natural resources and release pathogenic emissions that worsen climate change (Abiad and Meho 2018: 311). Boulet, Hoek and Raven (2021: 5) explain that household food waste has detrimental effects on the environment that are substantial and impact both human and planetary health in many ways. The researchers elaborated that it has an impact on sustainability, raises threats about global warming, and accelerates the degradation of the environment. Food waste puts pressure on the planet's already-dwindling forests and worsening climate by increasing the need for agricultural land.

Food waste is believed to be the sort of waste that municipal landfills collect the most, and it emits greenhouse gases that harm the environment and cause climate change (Rust 2022: para. 3 line 1). World Wide Fund (2017: 11) uses greenhouse gases to estimate the cost of food waste's detrimental effects on the environment. According to WWF (2017: 11), there are two ways to assess greenhouse

gas emissions: first, [by assessing] the impact of food waste dumped at landfills on the ecosystem, and second, [assessing] the carbon emissions generated throughout the life cycle of the wasted food. About 2.8 to 4.14 tonnes of carbon dioxide equivalent are released into the atmosphere during the food supply chain for every tonne of food (WWF 2017: 5). Graham-Rowe, Jessop and Sparks (2014: 15) reported that biodegradable waste that is disposed of in landfills releases greenhouse gases, mainly methane, which is more potent than carbon dioxide and is most likely to contribute to global warming. By 2050, estimates indicate that carbon dioxide emissions from food loss and waste might grow 3.5 times to between 5.7 and 7.9 billion tonnes yearly (WWF 2017: 12).

According to Cronjé, Müller and Van der Merwe (2018: 2) and Mathee (2020: 7), food waste disposed of in landfills creates environmental issues. The main problem with disposing of organic waste in landfills is that when the garbage decomposes, it produces leachate and methane, a greenhouse gas. In South Africa, landfills are used to dispose of 90% of food waste, from where methane and carbon dioxide are allowed to escape (Oelofse *et al.* 2018: 4). Methane significantly raises the atmospheric temperature and has an environmental impact that is 28–26 times higher than that of carbon dioxide (WWF 2017: 12). In 2002, the WWF (2017: 12) predicted that by 2030, the surface temperature would rise by 1-2°C as a result of climate change. Moreover, the FAO (2023: para. 2 line 1) estimates that food waste has contributed to 3.3 billion tonnes of carbon dioxide.

The most accurate method for measuring the environmental impact of food, according to WWF (2017: 12), is a life cycle assessment (LCA). One approach for assessing a product's inputs, outputs, and potential environmental impact is a life cycle assessment (LCA) (Cucurachi, Scherer, Guinée and Tukker 2019: 292). Information on the quantity of energy, water, and other resources utilised during the life cycle of the food item or product is provided by the LCA (WWF 2017: 12). The environmental impact of food can be evaluated using the information on food waste and the amount of energy utilised during the life cycle in the form of CO₂ emissions (WWF 2017: 12).

Producing food demands resources and energy, and wasting it harms the environment. Manufacturing food requires resources such as energy and wasting food harms the environment (Williams, Wikström, Otterbring, Löfgren and Gustafsson 2012: 144). For instance, R1 billion worth of energy is used to prevent food waste each year (WWF 2017: 5). The energy needed to produce wasted food is enough to light up Johannesburg for 16 weeks, claims WWF (2017: 5). Remarkably, South Africa—the 30th driest country on the planet—uses a fifth of its water resources to produce food that is wasted (WWF 2017: 9). Furthermore, the trash contains enough water to fill almost 600,000 Olympic swimming pools (WWF 2017: 9). In the UK, 17% of the carbon dioxide emissions are caused by the production, distribution, storage, consumption, and disposal of edible food waste. Food waste has a negative impact on other issues as well, such as water waste, because it causes all water utilised for agricultural and food production to be wasted (Graham-Rowe, Jessop, and Sparks 2014: 15). The environmental effects of food waste are a global problem because the industrialised world's water and carbon footprint emissions come from countries where the food is produced and processed as well as from places where it is wasted (Oelofse, Muswema and Ramukhwatho 2018: 1).

The need for food has grown, so food production has expanded (Mathee 2020: 25). Increased food production, according to Mathee (2020: 25), has a severe adverse effect on the ecosystem. Environmental degradation is caused mainly by the unsustainable farming practices used to produce food (Shafiee-Jood and Cai 2016: 8432).

2.10 Waste management on a global scale

Globally, about 2 billion tonnes of municipal solid waste is produced each year, and out of this, almost 33% is still not collected by municipalities (Aleluia and Ferrão 2016: 416). According to Nanda and Berruti (2021: 1434), the top three producers of municipal solid waste globally are the United States, China, and India. The reporters explain that the composition of solid materials varies according to income: low- to middle-income countries produce mainly organic waste, whereas high-income countries produce more waste paper, metal, and glass. Around 3.5 billion individuals worldwide lack access to even the most basic waste management services (The World Bank 2023: para. 1 line 1). The average daily volume of waste generated per capita per day is around 0.74 kg (Aleluia and Ferrão 2016: 416).

About 70% of municipal solid waste collected by municipalities ends up in landfills, or dumping sites, 19% is recycled, and 11% is used for energy recovery (Elsheekh, Kamel, Elsherif and Shalaby 2021: 2). The World Bank (2023: para. 1 line 1) projects that by 2050, 3.4 billion tonnes of municipal solid garbage would have been produced. Also, it is probable that by 2050, 5.6 billion people will need more access to basic waste management services. Nanda and Berruti (2021: 1434) explain that municipal solid waste comprises the waste materials a municipality collects from businesses, residences, and other small-scale institutions. Municipal solid waste is managed differently in various municipalities, cities, states, and countries, much like its miscellaneous composition. However, the basic steps in the management of municipal solid waste are: (1) waste generation, (2) waste collection, handling, and transport, and (3) waste disposal, processing, and treatment (Moya, Aldás, Jaramillo, Játiva and Kaparaju 2017: 330). According to Nanda and Abraham (2013: 3099), developed countries have well-established waste-to-energy methods for converting municipal solid waste to fuels, heat, and power. On the other hand, emerging countries that have a lack of landfilling capacity due to population density nevertheless work to handle the collection, transportation, and disposal of municipal solid waste hygienically and adequately (Rasche 2020: 228). Lack of good planning, economic obstacles, inadequate recycling facilities, and public passivity regarding trash management are a few issues preventing integrated waste management in developing countries (Gupta and Misra 2014: 31).

On a global basis, just 25% of the municipal solid trash collected is redirected to waste management methods like composting, anaerobic digestion, and recycling. Since different countries have different waste recycling patterns and practices, it is crucial to identify the most efficient method for the disposal or treatment of municipal solid waste worldwide, according to Nanda and Berruti (2021: 1434). Non-recyclable waste is traditionally buried in landfills around the world. At the same time, in some poor countries, the rubbish is disposed of in mounds or dumped into pits instead of being covered with soil (Aleluia and Ferrão 2016: 416). Although landfills are the most popular way of disposing of municipal

solid waste, the lack of land for new landfills in highly populated cities and developing countries is forcing the deployment of waste-to-energy options for recycling municipal solid waste (Hoornweg and Bhada-Tata 2012: 1).

2.11 Waste management at the South African municipal level

The Department of Environmental Affairs (DEA) (2023: 279) explains that waste management is a city-specific concern in South Africa, as it is in most developing countries, due to population growth and continuous urbanisation. In 2030 and 2050, it is anticipated that the number of people living in urban areas in South Africa will have risen by 71.3% and 80%, respectively. A waste report included in the third National Waste Baseline Report released by the South African Department of Environmental Affairs (DEA) states that around 108 million tonnes of waste, including both general and hazardous waste, were produced in 2012. Less than 10% of the waste produced was recycled. A significant amount (approximately 9 million tonnes) was dumped in landfills (SA, Department of Environmental Affairs (DEA) 2012: 14). By 2017, hazardous waste generation climbed to 66.9 million tonnes, while general waste generation increased to 54.2 million tonnes (DEA 2023: 230).

In South Africa, the disposal of waste in landfills is still standard practice. However, a landfill charge discourages this practice, which encourages alternate waste management methods (Simelane 2016: 19). Different landfill locations have varying capacities and estimates of how long they will continue to operate. According to data from the South African Waste Information Centre (SAWIC) (2015: 1), there are 370 waste storage facilities, 224 recycling facilities, 109 waste transport stations, 20 incinerator facilities, and 19 composting facilities in South Africa. The most licensed facilities are in the province of Gauteng. In addition to Brazil, China, India, and Russia, South Africa has been identified as one of the five emerging new markets with waste management opportunities (SA, Department of Science and Technology (DST) 2014: 1). A financial value of around R15.3 billion, or 0.51% of the GDP, was attained by the private and public formal waste sector in South Africa as of 2012 (SA, DST 2013: 1). According to Dowling, Kibaara, Chowdhury and Chowdhury (2012: 2), the largest metropolis for garbage creation is the City of Johannesburg, which has a population of about 4.3 million and a total area of over 1646 km². It serves as South Africa's commercial and economic centre and adds over 47% to the province's economy and 17% to the country's overall economic growth (SA Waste Information Centre 2015: 1). Municipal solid waste is typically dumped, burned, and landfilled in public areas, like in most developing cities. The primary methods of waste management include waste collection, recycling, and landfilling (Dada and Mbohwa 2016: 1; Mohee and Simelane 2015: 1).

In comparison to other regions of the continent, just 10% of the total garbage produced in South Africa gets recycled (DEA 2012: 1). According to a DEA report, in 2017, over 38.6% of all general garbage was recycled, an increase from 2012 (DEA 2023: 279). About 80–90% of post-consumer recyclable paper and packaging in South Africa is collected by the informal sector for recycling, keeping it out of landfills (Godfrey, Muswema, Strydom Mamafa and Mapako 2017: 800). One of South Africa's waste recycling markets with the quickest rate of growth is plastic recycling. In South Africa, plastic is recycled

at a rate of 43.7%, with 334,727 tonnes of plastic recycled as raw materials in 2017 (Plastics SA 2018: para. 1 line 1).

2.12 Initiatives to reduce household food waste

Food donation is encouraged to alleviate hunger and ensure food security for a growing population since food waste has become an increasingly widespread issue where a greater share is from human consumption (Attiq, Habib, Kaur, Hasni and Dhir 2021: 2). Consumers are believed to have short-term perspectives when it comes to reducing food waste; it is thus crucial to teach them proper dining habits such as sharing meals and exercising restraint at mealtimes to maximise meal consumption and reduce domestic food waste (Sirola, Sutinen, Närvänen, Mesiranta and Mattila 2019: 2).

The idea that household participation in waste reduction could enhance sustainability by lowering the overall amount of waste, referred to as the by-product of household consumption, is true. Through meal planning and using leftovers to make a new meal, consumers can be encouraged to employ various tactics for reducing food waste (Attiq et al. 2021: 1).

Food contributions can be seen as a solution to alleviate the burden of food poverty and food waste, with donations for human consumption being the next best course of action if food waste cannot be stopped, according to Sundin, Osowski, Strid and Eriksson (2022: 1). Consequently, developed countries have embraced the idea of consumers reducing food waste through donations and have passed laws like the Food Recovery Act and Food Donation Act, both of which were passed in 2017. These laws promise to support reducing waste and food losses by using a variety of strategies (Fan, Ellison and Wilson 2022: 1). Sundin *et al.* (2022: 1) state that while praising the efforts of food donation, they note that it only addresses the short-term problem of home waste reduction due to certain constraints, such as the short shelf-life of perishable foods.

2.13 Food waste at a generational level

Food waste is higher in households where women are in charge of food purchasing and among single women (Koivupuro, Hartikainen, Silvennoinen, Katajajuuri, Heikintalo, Reinikainen and Jalkanen 2012: 185). However, according to Hamilton, Denniss and Baker (2005: 1), younger people squander more food than older people, and the “post-war generation” is responsible for the least food waste (Richter 2017: 642; Parfitt, Barthel and Macnaughton (2010: 3066). In contrast, a study conducted by Zepeda and Balaine (2017: 630) has offered evidence that suggests younger generations are less prone to waste food because they are more aware of the concept and concerned about the environment and cost (Comber and Thieme 2013: 1198). No research has compared the food waste habits of the Baby Boomers, Generation X, Generation Y, and Generation Z generations. According to earlier studies, younger age groups tend to waste food more frequently than older groups (Bravi, Francioni, Murmura and Savelli 2020: 1; Mallinson, Russell and Barker 2016: 18; Quested, Marsh, Stunell and Parry 2013: 44; WRAP 2009: 1). Arguments that the older generation’s experiences with food shortages and

rationing during World War II, or the experience of their parents, has sensitised them support the claim that older generations waste less food (Visschers, Wickli and Siegrist 2016: 69).

2.14 Cultural factors influencing household food waste

Food waste is often driven by customer behaviour at a retail store, which may be influenced by their reaction to price reductions or special offers that prompt impulse purchases (van Geffen, van Herpen, Sijtsema and van Trijp 2020: 3). Households produce the majority of food waste due to their shopping habits, which include buying in excess, over-preparation, over-stocking, reacting to packaging, and purchasing undesirable goods. Consumers who do not use a shopping list frequently purchase food that is not necessary, according to prior study (Di Talia, Simeone and Scarpato 2019: 167). In addition, people often fail to check what they already have in their refrigerator and pantry before making a shopping list or purchasing food, which results in them purchasing unnecessary items (Kibler *et al.* 2018: 56). Those who purchase more food than necessary waste it, according to Kibler *et al.* (2018: 56).

According to Krisjanti and Quita (2020: 93), consumers are vulnerable to marketing tactics that affect their purchasing power, particularly when it comes to commercially processed foods and bulk purchases, which are linked to higher rates of food waste in households where women are in charge of shopping. On the other hand, Janssens-Maenhout, Crippa, Guizzardi, Muntean, Schaaf, Dentener, Bergamaschi, Pagliari, Olivier, Peters, van Aardenne, Monni, Doering, Petrescu, Solazzo and Oreggioni (2019: 959) argue that consumer behaviour—specifically, over-purchasing—is the primary cause of household food waste in industrialised countries and urge both consumers and their equivalents, the retailers, to accept responsibility. Household food waste cannot be characterised as a single behaviour, but rather as a collection of behaviours involving a variety of drivers of the food's entry into the home, which means that by the time the food is thrown away, the chance to segregate it and keep it from going to waste would have already passed (Schmidt and Matthies 2018: 2). Schmidt and Matthies (2018: 2) discourages overspending as a result of impulsive purchases made on discounted goods because doing so increases the risk of products reaching their sell-by dates before consumption, which puts consumers in the position of having to throw away food. Instead, it suggests food-specific research approaches that measure the performance level and various categories of household food waste (Schmidt and Matthies 2018: 2).

Richter (2017: 642) reports that some customers are knowledgeable about food waste and its implications, but others are not, which increases the amount of home food waste generated. Consumer attitudes around food waste differ, claim Aschemann-Witzel, Giménez and Ares (2018: 30). Customers occasionally need to be made aware of how much food waste is generated in their homes and its repercussions (Kibler *et al.* 2018: 56).

Overcooking, as part of food preparation, is one of the leading causes of household food loss, even if it may not be intentional. This emphasises the value of learning fundamental cooking techniques like

measuring ingredients and recycling leftovers to cut down on waste (van Geffen, van Herpen and van Trijp 2020: 30). In most households, the amount of food prepared, cooked, and served at a single meal is greater than what can be consumed entirely at once, which is why it is classified as a contributor to food waste. Reducing food waste is crucial for producing and consuming sustainable food (Ramukhwatho, du Plessis and Oelofse 2018: 255). Improved cooking ability will enable customers to be more inventive in using commonly purchased food timeously, including leftovers, reducing household food waste. Hopefully, this will reduce cooking accidents and wastage (van Geffen, van Herpen and van Trijp 2020: 30).

2.15 Influence of retail and food packaging shelf-life labelling on food waste

Retail promotions have a direct impact on consumer food waste. During a shopping occasion, the following reasons were frequently cited: "purchasing too much", "offers to take three items and only pay for two", and "multi-packs" as reasons for buying more than needed which leads to food waste. Food that has passed its sell-by date was mentioned as the primary factor contributing to food waste in households (Cox and Downing 2007: 1). Many consumers around the world misunderstand labels according to Mesiranta, Närvänen and Mattila (2022: 147). Consumers display confused behaviour in response to the food product date labelling system, which includes a sell-by date, a best-before-date, and an expiration date, according to Hebrok and Heidenstrøm (2019: 1441). Customers who use their eyes and nose to judge whether food is still safe to eat waste less food, according to Hebrok and Heidenstrøm (2019: 1442). According to Aschemann-Witzel *et al.* (2015: 6458) some consumers throw away food that has expired even though it is still safe to consume.

On packaging, the "Sell-By" label provides information about when the product should be sold to consumers by merchants. However, the product is still safe to use after the sell-by state (Kavanaugh and Quinlan 2020: 1). The "Best Before Date" is a warning [to consumers] and the point at which the food item's quality declines and it becomes unusable (Zielińska, Bilka, Marciniak-Łukasiak, Łepecka, Trzaskowska, Neffe-Skocińska, Tomaszewska, Szydłowska and Kołożyn-Krajewska 2020: 1). In Germany, a research study revealed that individuals' perception of food safety and their willingness to dispose of food were highly influenced by "Best Before" dates as a result of their limited understanding of date labelling (Buttlar, Löwenstein, Geske, Ahlmer and Walther 2021: 1). Generally, a food product is still usable by consumers for one-third of the time after its sell-by date. Meanwhile, the best-by date is a recommendation to the user about when to use the product to ensure ideal quality (Kavanaugh and Quinlan 2020: 1). The "use by" label is intended to inform consumers when a product should be consumed, primarily for quality reasons rather than because doing so will inevitably result in illness. Beyond the "use-by" date, however, product quality will likely decline significantly more quickly, and safety may be compromised (Turvey, Moran, Scheck, Arashiro, Huang, Heley, Johnston and Neff 2021: 390).

It's a frequent assumption that these dates are established by general law, manufacturer/producer rules, or federal regulation. However, the "expiry date" marking has become less common in favour of the

more precise and subdued "best by" and "sell by" labels. These labels are used for products whose usage after the stated date is strongly discouraged. Stores can be held to account if products with expired "sell by" dates are still on their shelves or in their freezers. With regard to "Use by" dates, consumers should use their discretion.

2.16 Household income

Di Talia, Simeone and Scarpato (2019: 168) state that high-income families waste more food than low-income families. On the other hand, Wansink (2018: 501) found that middle-class families waste less food than low-income households. A correlation between household food waste output, household income, and the number of occupants was found by Oelofse, Muswema and Ramukhwatho (2018: 2). In this study it was found that larger households tended to waste less food and that rising household income levels increased food waste. As a result, households in developed countries tended to waste more food. The study conducted by Romani, Grappi, Bagozzi, and Barone (2018: 215) reports that consumers who experience an increase in income and a lifestyle change are likely to contribute to a higher amount of food waste, underscoring the importance of the role that the government, policymakers, and stakeholders involved in the food supply chain should play in reducing the factors that lead to domestic food waste. When completing a purchase, consumers rely on their food shopping habits, which makes it easier for them to buy more food than they need or things they won't use, increasing waste (Romani *et al.* 2018 216).

2.17 Food literacy interventions to reduce household food waste

According to Grant, Gallardo and McCluskey (2019: 1), having a basic understanding of how one's food choices affect one's health, the environment, and the economy is instrumental. The importance of improving literacy to reduce household food waste is highlighted by the further explanation that food literacy includes consumers' past consumption experience combined with food knowledge, thereby encouraging waste reduction practices. Informed consumers are able to demonstrate better ability to plan meals and control portions and can spontaneously make a meal with available ingredients, attesting to less wastefulness (Grant, Gallardo and McCluskey 2019: 1).

Encouraging customers to develop the habit of consuming wholesome, affordable, and sustainable foods, and increasing the emphasis on food literacy aims to improve practical food-management skills while lowering waste (Rowat, Soh, Malan, Jensen, Schmidt and Slusser 2019: 461). Food literacy has been characterised in the literature as the acquisition of knowledge and skills that enable consumers to make wise food decisions that promote sustainable food practices and good health (Fernandez, Schofield, Perry and Slater 2020: 44). Brazil and Canada modified their food-based dietary recommendations to include advice on how to choose, handle, and eat food mindfully, as well as warnings about eating habits. These actions support the goal of food literacy by increasing consumer awareness of food practices that aim to reduce domestic waste (Fernandez *et al.* 2020: 45).

Countries have used a number of strategies to reduce household food waste (Filimonau and Coteau 2019: 235). For instance, in the US emphasis is placed on encouraging individuals to avoid waste through mindful food purchasing (Okumus 2020: 292). Sri Lanka created two policies in 2019 in an attempt to reduce food loss and waste: the National Waste Management Policy and the National Policy on Sustainable Consumption and Production (Reitemeier, Aheeyar, and Drechsel 2021: 1).

Additionally, as indicated in shops in France, many European Union countries have started to enact legislation to promote the reduction of food waste within specific industries or even to penalise food wasters (Vittuari, Azzurro, Gaiani, Gheoldus, Burgos, Aramyan, Valeeva, Rogers, Östergren, Timmermans and Bos-Brouwers 2016: 5). A campaign named "Reduce Food Waste, Save Money" in London used food literacy messages to encourage reducing the amount of money lost on food waste and boosting perceived behavioural control (van der Werf, Seabrook and Gilliard 2021: 160). A comparison of garbage samples from before and after the intervention in this study revealed a 31% decrease in total food waste in treated households, which was larger ($p = .02$) than the decrease in control households. Similar to this, avoidable food waste in treatment families decreased by 30% and increased significantly ($p < 0.05$) compared to control households (van der Werf, Seabrook and Gilliland 2021: 16). The food literacy messaging in the intervention focused on giving recommendations on how to plan meals better, shop, cook, and store food appropriately, as well as how to manage leftovers to reduce the amount of food that goes to waste (van der Werf, Seabrook and Gilliland 2021: 160).

Sweden has created particular objectives and strategies to reduce food loss and waste that involve a variety of government organisations (WWF 2017: 17). A platform that makes data accessible at the national, corporate, and household levels has also been created in Sweden (WWF 2017: 17). A study conducted by Farr-Wharton, Choi and Foth (2014: 352) found that one of the most important tools for assisting the process of reducing food waste is the use of mobile technology to support behaviour change. Three mobile programmes were created to reduce household food waste in Sweden namely Leftover Swap, Fridge Buddy, and EatChaFood.

The Western Cape government introduced the "Nourish to Flourish" strategic framework to guarantee household food and nutrition security in 2016. The management and reduction of food waste was one of the methods introduced to meet one of the objectives of the "Nourish to Flourish" initiative (WWF 2017: 17). In addition, the South African Food Loss and Waste Voluntary Agreement was jointly launched in 2021 by the national departments of Forestry, Fisheries, and Environment and the South African Consumer Goods Council (CGCSA) (CGCSA 2021, line 2, para. 2).

Several businesses, including Food Forward SA, the Shoprite group, Pick 'n Pay, SA Harvest, Woolworths, and Tiger brands, aligned with this voluntary agreement (CGCSA 2021: para 11, line 1). According to the SA, DEFF and CSIR (2021: 34), Food Forward SA distributed 4,350 tonnes of leftover food to 600 registered recipient organisations in South Africa in 2017. This leftover food was used to make an average of 14.5 million meals. Farmers, retailers, and food manufacturers all contribute this excess food (SA, DEFF and CSIR 2021: 34). Woolworths, one of the retail outlets, usually donates

extra food to 1000 charities every year (SA, DEFF and CSIR 2021: 34). Foods that have passed their "Sell By" date but not their "Best Before" date fall under this category (SA, DEFF and CSIR 2021: 34). The CSIR has conducted a study on the issue in several cities and municipalities to increase the amount of knowledge about food waste in South Africa (WWF 2017: 26).

The government can take action by raising public awareness on food loss and waste. They can employ educational interventions, notably awareness campaigns, to try and persuade consumers to waste less food, as well as introduce information campaigns to reduce food waste (FAO 2019: 1). The emphasis of the awareness campaigns is on educating people about the drawbacks of food waste, such as harm to the environment, and the benefits of waste prevention. With the ultimate goal of reducing the waste produced, several educational programs are being carried out to increase problem awareness (van Geffen, van Herpen and van Trijp 2020: 27).

2.18 Conclusion

Food loss and waste are a global concern and ongoing problem. Whilst there is ample evidence on food waste behaviours and practices at a household level, including the impact of food waste on the environment, economy and natural resources, research on food waste interventions is very limited, especially in South Africa. In conclusion, more initiatives to reduce household food waste are required because of the rising concerns about nutrition and food security and the consequences of not doing so.

3.3 Study design

This study followed the Consolidated Standards of Reporting Trials (CONSORT) guidelines (Figure 3.2) and used mixed-method research. The randomised controlled trial was composed of three parts. In the first part of the study, a food waste audit was conducted among 190 households. The information obtained from the first part of the study was used to calculate the actual food waste, cost of food waste, nutritional loss, and environmental impact. In the second part of the study, the households were randomised into three intervention groups, Intervention 1, Intervention 2 and the Control group, using a random number method. All households were grouped together in a list according to their area, and using the sequence of 1,2,3, all households were labelled, and the number 1s were grouped together to form intervention group one and all the number 2s made up intervention group two, and all the number 3s made up the control group. The third part of the study comprised the endline measurements where a food waste audit was repeated.

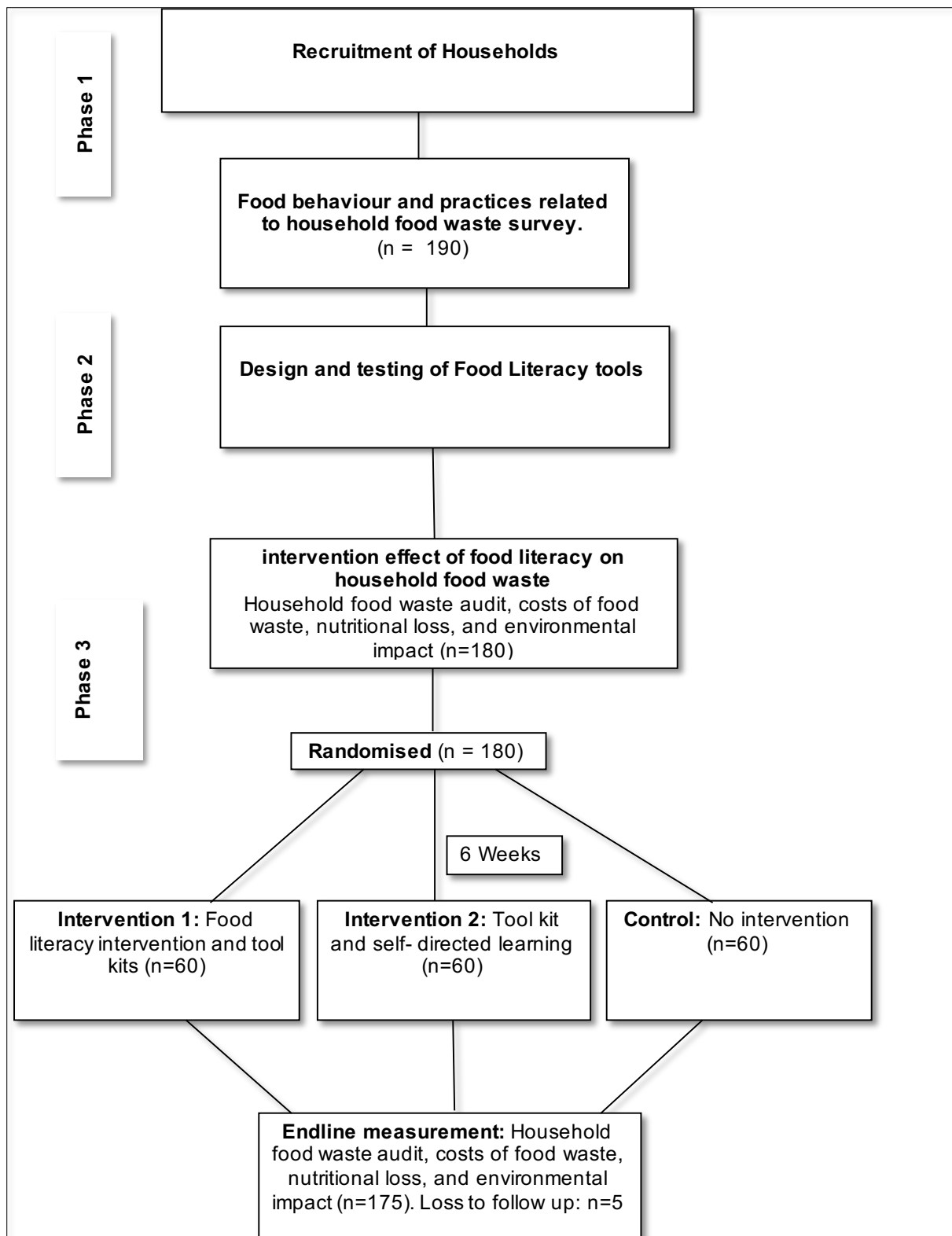


Figure 3.2: CONSORT diagram detailing the research participation flow (Schulz, Altman and Moher 2010: 101)

3.4 Sample population

The study by Oelofse, Muswema and Ramukhwato (2018: 5) was used to guide the sample size calculation. In this study, food waste was 0.69 kg per week in Johannesburg, which is a similar setting to Durban. A post-intervention 20% reduction in the treatment of household food waste disposal in the garbage stream, was considered practically meaningful. To detect a meaningful difference of 0.138 kg (i.e., 20%) of food waste between groups assuming an alpha of .05, it was estimated that n= 35 households were required for each group (i.e., intervention 1 and intervention 2 and control households). Thus, a minimum of 106 households were required to meet the sample size calculation requirements. To account for this estimated attrition, a 20% buffer of additional households was added to both the pre- and post-intervention sampling rounds, resulting in a starting minimum of n= 179 households (i.e., 106 households* 1.3= 137 households*1.3= 179 households), which was further rounded up to 180 households. Since this study is the baseline phase of a randomised control trial, the sample size would be 180. For this study, 180 households were recruited through convenience snowball sampling.

3.4.1 Eligibility criteria

To participate in the study, the following eligibility criteria were used:

- Participants must be 18 years and older and responsible for food purchase and/or food preparation in households.
- Households in the KwaDukuza municipality.
- Participants who are not on holiday.

3.4.2 Recruitment of households

The researcher published an advert in the local community newspaper named Stanger Weekly (Appendix A). Households were recruited through convenience snowball sampling, via household visits. The researcher and research assistants approached possible participants and asked them to participate in the study. If they were interested, they were asked for their contact information (phone number and email address). The participants were then contacted to obtain their consent to take part in the study.

3.5 Measurement Tools

3.5.1 Household food waste

To determine household food waste, a weighed food audit was conducted at each household after completing the household food waste survey (Appendix B). Households were requested to collect their food waste over two weeks from 27 October 2022 to 6 December 2022. Each household was provided with three colour-coded labelled bins and disposable bags; one green bin and bag for fresh produce waste and dry goods, one red bin and bag for fish, meat and poultry waste, and one clear/black bin and bag for cooked food/ leftovers. Participants were required to collect and refrigerate/ freeze all leftover cooked food in provided freezer bags and label the main ingredients from cooked food samples (Appendix C). Refuse was weighed on refuse removal days. Bags were collected from participants,

once a week, weighed using a calibrated hanging scale (in kgs) and analysed (into avoidable and unavoidable mass) by trained fieldworkers (Appendix D). The process was repeated in week two.



Figure 3.3: Fieldworker collecting bin bags



Figure 3.4: Fieldworkers weighing bin bags using a hanging scale and recording the weight



Figure 3. 5: Separation of food waste by food items and weighing using an electronic compact scale

3.5.2 Economic loss

Food waste (in kgs) from the weighed food waste audit was analysed for economic loss using the mean price of foods from Checkers Hyper and Woolworth Foods in the area to determine the Rand value of the food waste at baseline and endline. Checkers Hyper and Woolworth Foods were chosen because the study location is located in a middle to high LSM area.

3.5.3 Nutritional losses

Nutritional losses were calculated by using the South African Medical Research Council Food Finder 3 Software web-based version to determine nutrient losses. In the cases where cooked food waste was presented, participants were provided with labels to document the ingredients they used and the number of servings discarded in the bag (Appendix C).

3.5.4 Environmental impacts

The environmental impacts were calculated using the My Emission Footprint calculator, which estimates the amount of carbon dioxide (CO₂) produced per kg of specific food types, including composite meals (My Emission 2022: para. 1 line 1). My Emission is the top supplier of carbon labelling, partnering with some of the biggest food companies in the world. My Emissions has a free food carbon footprint calculator, which provides straightforward carbon evaluations for specific foods and drinks; all calculations follow the GHG protocol and consider the entire life cycle of a product which includes scope 3 packaging and transportation emissions (My Emission 2022: para. 2 line 5).

3.5.5 Food literacy toolkit

In phase two of the study, the food literacy toolkit was designed based on the findings from the household food waste behaviour and practice survey from phase one. Households which were part of the intervention (intervention 1 & intervention 2) received a toolkit that comprised of a black shopping bag with the Sustainable Development Goal (SDG) wheel forefronting the SDG 12 goal, “Responsible Consumption and Production”, a magnetic household food waste infographic, bio-degradable plantable coasters with food waste reduction messages, an “eat me first” fridge prompt acrylic stand, food storage bag clips and a recipe book titled “Completing Zero Waste Cookbook and Guide”, which is a zero waste cookbook and food literacy guide, available at <https://doi.org/10.51415/dut.49>. In addition, intervention 1 had cook-along and food waste literacy lessons based on recipes from the recipe book. These lessons were posted on YouTube, available at <http://www.youtube.com/@COMPLEATINGZEROFOODWASTE>. The researcher explained each toolkit item to households who were part of the intervention.



Figure 3.6: Food literacy toolkit

3.5.6 Endline

After the six-week intervention period, the food waste audit was repeated at all households.

3.6 Statistical analysis

Statistical analysis was conducted using the Statistical Package for Social Sciences (SPSS®) version 28 IBM Corp, Armonk, NY, US). Descriptive statistics, including means and standard deviations, were used to define the proportion of responses for each question. The Wilcoxon Signed Ranks test, a non-parametric alternative to the paired t-test, was employed to assess differences between the pre- and post-interventions.

3.7 Validity

According to Heale and Twycross (2015: 66), validity in research refers to the degree of accuracy achieved through a study, meaning that instruments are able to measure what they are supposed to assess. Researchers Heale and Twycross (2015: 67) elaborated that a key component of good research communication is measure consistency, which is sometimes referred to as reliability in research. To guarantee the accuracy and dependability of the data, every stage of this investigation was verified using a variety of methods.

Construct validity refers to ensuring the method of measurement corresponds to the construct you want to measure (Heale and Twycross 2015: 66).

Content validity assesses whether a test or scale measuring is representative of all aspects of a construct; to produce valid outcomes, the content of a test, survey or measurement method must cover all related parts of the subject its aims to calculate, Almanasreh, Moles and Chen (2019: 215).

Face validity considers how appropriate the content of a test seems to be on a surface or whether a scale “appears” to measure what it is supposed to measure. Face validity is like content validity, but face validity is a more informal and subjective assessment (Hunter 2013: 3).

Predictive validity refers to when tests can predict a future outcome, using statistics to measure the relationship between the researcher's future performance as well as between the researcher's performance and their status as a master or a non-master. To establish this type of validity, the test must correlate with a variable that can only be assessed at some point in the future (Hunter 2013: 3).

In this study, both construct validity and content validity were used, and examples include an adapted food behaviour and practices related to household food waste survey that was compiled using validated surveys from other food waste studies (Ramukhwatho 2016: 119; Mathee 2020: 109 and van Herpen *et al.* 2019: 2767), The researcher conducted training with the field workers and explained the research tools used in the study. A calibrated hanging scale was used to ensure the accuracy of food waste mass, a validated carbon footprint was used to calculate the environmental impact of food waste, and MRC Food Finder software was used to determine nutritional losses.

3.8 Quality assurance and reduction of bias

Fieldworkers were trained to conduct data collection in an unbiased and respectful manner when interacting with participants; they were also trained to follow all COVID-19 safety protocols, i.e., maintain a 1.5m social distancing from participants and other fieldworkers, wear a cloth mask covering the nose and mouth at all times and sanitise regularly. Clear examples were provided to participants for labelling their cooked food waste and the food waste audit. Fieldworkers were briefed on how to collect and measure food waste from the audit. All equipment, such as scales used in the food waste audit, were verified at the start of each food waste audit and calibrated at the start of the study.

3.9 Data quality management

The researcher oversaw data collection to ensure the accuracy of data collected from the food waste audit. The researcher recorded data from food waste audit sheets on a Microsoft Excel spreadsheet. The supervisor and statistician double-checked the data entry for precision and reliability. Data accuracy was ensured during the data capture, coding, and cleaning processes by ensuring that all data was collected in a standardised way, coded correctly, and cleaned so that no errors were present. Only the researcher, supervisor, and statistician had access to the electronic data, which was secured by a password.

3.10 Ethics

The research study obtained full ethical approval from the Durban University of Technology (DUT) Institutional Research Ethics Committee (IREC) (ethical clearance number IREC 226/22) (Appendix E). This study applied non-invasive methods. Each household was given a letter of information (Appendix F). Signed informed consent was obtained from household participants that agreed to take part in the (Appendix F). Participants from the households were informed that participating in this study would be voluntary, with the right to withdraw at any time. Households were deidentified, and households were referred to by a code. During the collection of household food waste, fieldworkers wore personal protective equipment (PPE) for hygiene purposes. With regard to the management of data, hard copy would be stored at the Durban University of Technology (DUT), Department of Food and Nutrition for five years and then disposed of thereafter and access to data would only be granted to the research team and would be password protected.



Figure 3.7: Fieldworkers wearing their PPE

3.11 COVID-19 Protocol

The safety of both fieldworkers and participants was of the greatest priority; thus, the following steps were followed to ensure safety and reduce the danger of contracting COVID-19. Both the fieldworkers and the household participants were required to sanitise their hands at the start of any interaction, and no physical contact, such as handshaking, was permitted. Participants and fieldworkers were encouraged to wear a cloth mask that covered both the nose and mouth and a social distance of 1.5m was to be maintained when conducting the household food waste behaviour and practice survey. When household food waste was collected from participants' houses, there was no physical contact between the fieldworkers and participants—participants were instructed to deposit their garbage outside their houses to prevent unnecessary interaction.

3.12 Conclusion

Chapter 3 has outlined and described in detail the methods used in this research study. Chapter 4 will report on and discuss the results of the study.

CHAPTER 4: RESULTS AND DISCUSSION

4.1 Introduction

In this chapter, the results of the study, according to the objectives outlined in chapter one, are presented, followed by a detailed in-depth analysis of the findings.

4.2 Demographic characteristics of participants

Table 4.1 represents the demographic characteristics of the household participants who took part in the randomised control trial.

Table 4.1: Demographic characteristics of household and household participants (n=180)

Variables	Category	(%)	(n)
Gender	Male	36.3	65
	Female	63.7	115
Age (years)	Unspecified	0.5	12
	Over 65	15.3	28
	56-65	24.2	44
	46-55	24.7	44
	36-45	20.0	36
	26-35	8.9	16
	18-25	6.3	11
Ethnicity	Indian	42.6	77
	White	40.0	72
	Black	15.8	28
	Other	1.6	3
Income	Unspecified	60.5	109
	>R30 000	12.6	23
	R26 000-R35 000	7.9	14
	R21 000-R25 000	4.2	8
	R16 000-R20 000	2.6	5
	R11 000-R15 000	3.7	7
	R5 000-R10 000	8.4	15
Household composition	One adult	6.8	12
	Two adults	45.3	82
	Three adults	28.0	50
	Four adults	27.0	47

Variables	Category	(%)	(n)
	Five adults	5.3	10
	Six or more adults	1.1	2
Families with children	Unspecified	85.26	154
	One child	3.7	7
	Two children	8.4	15
	Three children	2.1	4
	Four children	0.5	1

A total of 180 households participated in the randomised control trial. Of the 180 households, 63.7% of participants (n= 115) were females, and 36.3% (n= 65) were males. Most household participants fell within the 45 to 55 age group (24.7% n= 44), closely followed by 56 to 65 years (24.2% n= 44). In addition, 20.0% (n= 36) belonged to the 36 to 45 years age group, 15.3% (n=28) were over 65 years, 8.9% (n= 16) were between 26 to 35 years, 6.3% (n=11) were between 18 to 25 years and 0.5 % (n= 12) did not provide an age range. Regarding ethnicity, a large percentage of households were Indian (42.6% n= 77), while 40.0% (n= 72) were White, 15.8% (n= 28) were Black, and 1.6% (n= 3) reported belonging to “other” ethnic groups. The majority of households, 60.5% (n= 109), opted not to disclose their monthly income range. Of those who did, 12.6% (n= 23) reported a monthly income greater than R30 000, 8.4% (n= 15) reported a monthly income between R5 000 and R10 000, 7.9% (n= 14) of the households had a monthly income between R26 000 and R35 000, 4.2% (n= 8) had a monthly income between R21 000 and R25 000; 3.7% (n= 7) reported an income between R16 000 to R20 000; and 2.6% (n= 5) reported a monthly income between R11 000 to R15 000. In terms of adult family composition, 45.3% of the households consisted of just two adults (n =82), followed by 28.0% (n= 50) of the households with three adults, 27.0% (n= 47) having four adults, 6.8% (n= 12) had one adult, 5.3% of the households (n= 10) had five adults, and 1.1% (n= 2) had six or more adults living in a household. Most households (85.26% n= 154) did not disclose if they were families with children. Among those who did, 8.4% (n= 15) households had two children, 3.7% (n= 7) households had one child, 2.1% (n= 4) households had three children and 0.5% (n= 1) household had four children.

4.3 Pre-and post-food waste audit by food category, cost of food waste, and environmental impact for the whole group

Table 4.2 presents the results of the Wilcoxon Signed-Ranks test that compared the pre- and post-food waste for the whole group for the food waste audit per household. The table includes total food waste, food waste categorised by types of foods, the cost of food waste, and the environmental impact.

Table 4.2: Results of total food waste, pre- and post- intervention and by food category, cost of food waste and environmental impact for the whole group

Item	Mean (SD)		n	Z	p-value
	PRE	POST			
Total waste (g)	1531.29 (1793.15)	307.47 (308.99)	175	-9.295	<.001*
Fresh produce (g)	917.73 (1019.60)	173.43 (152.01)	175	-9.016	<.001*
Meat produce (g)	109.56 (392.59)	43.26 (78.00)	175	-2.735	.006*
Cooked food (g)	387.07 (778.60)	76.39 (142.29)	175	-5.288	<.001*
Cost (R)	145.57 (209.86)	39.75 (51.17)	175	-7.981	<.001*
Environmental impact (gCO₂e)	7664.13 (12274.81)	6407.67 (11590.04)	175	-2.405	.016*

*p<0.001

In Table 4.2, all *p* values are <0.05 therefore, the pre- and post-values all differ significantly. This indicates that the values for pre- are significantly higher than post- for all variables. Analysis from the Wilcoxon Signed-Ranks test showed that the total waste pre- (average waste per household = 1531.29g) was more than the total waste post- (average waste per household = 307.47 g, Z = -9.295, p<0.001) for the whole group. Similarly, the fresh produce pre- (average waste per household = 917.73 g) was more than the fresh produce post- (average waste = 173.43g), Z = -9.016, p<0.001. Meat produce pre- (average waste per household = 109.56g) also surpassed the meat produce post- (average waste per household = 43.26g), Z = -2.735, p=0.006. In comparison, the cooked food pre- (average waste per household = 387.07 g) was greater than the cooked food post- (average waste per household = 76.39 g), Z = -5.288, p<0.001. The cost of food waste for the whole group pre- (average waste per household = R145.57) was more than the cost of food waste for the whole group post- (average waste per household = R39.75), Z = -7.981, p<0.001. In terms of the environmental impact, the pre- (average waste per household = 7664.13 gCO₂e) exceeded the environmental impact post- (average waste per household = 6407.67 gCO₂e), Z = -2.405, p=0.016.

4.4 Pre-and post- nutrient loss from the food waste audit per household for the whole group

Table 4.3 presents the results of the Wilcoxon Signed-Ranks test that compared the pre- and post-nutrient loss from the food waste audit per household for the whole group.

Table 4.3: Result of total nutrient loss pre-and post-intervention for the whole group

Item	Mean (SD)		Z	p-value
	N			
	PRE	POST		
Energy(kJ)	6135.90 (6877.82) n= 171	1235.29 (2111.80) n= 167	-8.664	.000
Total protein (g)	55.60 (56.17) n= 158	12.07 (20.19) n= 167	-8.976	.000
Total lipids (g)	42.39 (64.15) n= 157	14.01 (18.69) n= 167	-4.797	.000
Carbohydrate total (g)	245.17 (278.86) n= 157	47.90 (81.74) n= 167	-9.021	.000
Total dietary fibre (g)	29.51 (27.89) n=157	4.01 (8.36) n=167	-9.597	.000
Ca (mg)	359.55 (445.72) n= 157	58.30 (104.58) n= 168	-8.793	.000
Fe (mg)	17.04 (21.03) n= 157	30.86 (69.94) n= 168	-1.407	.159
Mg (mg)	310.74 (341.12) n= 157	43.19 (88.12) n=168	-9.470	.000
P (mg)	811.27 (771.65) n= 168	174.23 (279.24) n= 168	-9.198	.000
K (mg)	3121.25 (3425.99) n=157	509.88 (668.10) n=168	-9.693	.000

Item	Mean (SD) N		Z	p-value
	PRE	POST		
Na (mg)	1485.58 (2361.25) n=157	437.73 (559.20) n=168	-6.196	.000
Zn (mg)	98.86 (258.52) n=157	63.61 (142.45) n=168	-2.703	.000
Vitamin A (RAE)(mcg)	65.05 (233.89) n= 157	53.99 (110.01) n=168	-1.009	.313
Thiamine (mg)	1.52 (1.71) n=157	13.75 (9113.41) n=168	-2.809	.005
Riboflavin (mg)	0.8061 (0.79) n=157	0.2567 (0.28) n=168	-8.105	.000
Vitamin B6 (mg)	0.00 (0.00) n=157	0.08 (0.16) n=168	-2.838	.005
Folic acid (mcg)	346.60 (488.66) n=157	35.77 (68.17) n=168	-9.398	.000
Vitamin B12 (mcg)	1.95 (3.80) n=157	20.96 (59.36) n=168	-7.451	.000
Vitamin C (mg)	225.71 (264.52) n=157	33.50 (72.77) n= 168	-9.367	.000
Vitamin D (mcg)	1.78 (4.36) n= 157	10.86 (23.17) n= 168	-6.602	.000
Vitamin E(mg)	7.27 (17.09) n= 157	1.39 (2.53) n= 168	-7.935	.000

*p<0.001

In Table 4.3, all *p* values are <0.05, therefore the pre- and post-values all differ significantly except Vitamin A and iron. Analysis from the Wilcoxon Signed-Ranks test showed that the energy loss pre-

intervention (average waste per household = 6135.90 kJ) was more than the energy loss post-intervention (average waste per household = 1235.29 kJ), $Z = -8.664$, $p < 0.000$ for the whole group. The total protein loss pre-intervention (average waste per household = 55.60 g) was greater than the total protein loss post-intervention (average waste per household = 12.07), $Z = -8.976$, $p < 0.000$ for the whole group. Total lipids loss pre-intervention (average waste per household = 42.39 g) was higher than the total lipids loss post-intervention (average waste per household = 14.01 g), $Z = -4.797$, $p < 0.000$ for the whole group. Carbohydrate total loss pre-intervention (average waste per household = 245.17 g) was more than the carbohydrate total loss post-intervention (average waste per household = 47.90 g), $Z = -9.021$, $p < 0.001$ for the whole group. Total dietary fibre loss pre-intervention (average waste per household = 29.51 g) was greater than the total dietary fibre loss post-intervention (average waste per household = 4.01 g), $Z = -9.591$, $p < 0.001$ for the whole group.

Calcium (Ca) loss pre-intervention (average waste per household = 359.55 mg) was more than the calcium loss post-intervention (average waste per household = 58.30 mg), $Z = -8.793$, $p < 0.000$ for the whole group. Iron (Fe) loss pre-intervention (average waste per household = 17.04 mg) was more than the iron loss post-intervention (average waste per household = 30.86), $Z = -1.407$, $p < 0.159$ for the whole group. Meanwhile, magnesium (Mg) loss pre-intervention (average waste per household = 310.74 mg) was more than the magnesium loss post-intervention (average waste per household = 43.19 mg), $Z = -8.793$, $p < 0.000$ for the whole group. Phosphorus (P) loss pre-intervention (average waste per household = 811.27 mg) was more than the phosphorus loss post-intervention (average waste per household = 174.23 mg), $Z = -9.198$, $p < 0.000$ for the whole group. At the same time, potassium (K) loss pre-intervention (average waste per household = 3121.25 mg) was more than the potassium loss post-intervention (average waste per household = 509.88 mg), $Z = -9.693$, $p < 0.000$ for the whole group. Sodium (Na) loss pre-intervention (average waste per household = 1485.58 mg) was more than the sodium loss post-intervention (average waste per household = 437.73 mg), $Z = -6.196$, $p < 0.000$ for the whole group. Zinc (Zn) loss pre-intervention (average waste per household = 98.86 mg) was more than the zinc loss post-intervention (average waste per household = 63.61 mg), $Z = -2.703$, $p < 0.000$ for the whole group. In terms of Vitamin A (RAE)(mcg) loss, pre-intervention (average waste per household = 65.05 mcg) was more than the vitamin A loss post-intervention (average waste per household = 53.99 mcg), $Z = -1.009$, $p < 0.313$ for the whole group. Thiamine loss pre-intervention (average waste per household = 1.52 mg) was higher than the thiamine loss post-intervention (average waste per household = 13.75 mg), $Z = -2.809$, $p < 0.005$ for the whole group also surpassed. Riboflavin loss pre-intervention (average waste per household = 811.27 mg) was more than the riboflavin loss post-intervention (average waste per household = 174.23 mg), $Z = -9.198$, $p < 0.000$ for the whole group. Vitamin B6 loss pre-intervention (average waste per household = 0.00 mg) was greater than the Vitamin B6 loss post-intervention (average waste per household = 0.08 mg), $Z = -2.838$, $p < 0.005$ for the whole group. Folic acid loss pre-intervention (average waste per household = 346.60 mg) was greater than the folic acid loss post-intervention (average waste per household = 35.77 mg), $Z = -9.398$, $p < 0.000$ for the whole group. Likewise, vitamin B12 loss pre-intervention (average waste per household = 1.95 mg) was greater than the vitamin B12 loss post-intervention (average waste per household = 20.96 mg), $Z = -9.398$, $p < 0.000$ for the whole group.

= -7.451, $p < 0.000$ for the whole group. Vitamin C loss pre-intervention (average waste per household = 225.71 mg) was greater than the vitamin C loss post-intervention (average waste per household = 33.50 mg), $Z = -9.367$, $p < 0.000$ for the whole group. Vitamin D loss pre-intervention (average waste per household = 1.78 mg) was greater than the vitamin D loss post (average waste per household = 10.86 mg), $Z = -6.602$, $p < 0.000$ for the whole group. Vitamin E loss pre-intervention (average waste per household = 7.27 mg) was greater than the vitamin E loss post-intervention (average waste per household = 1.39 mg), $Z = -7.935$, $p < 0.000$ for the whole group.

4.5 Pre-and post-intervention total food waste, food waste categorised by food type, cost of food waste and environmental impact by intervention groups

Table 4.4 presents the results of the Wilcoxon Signed-Ranks test for pre- and post-food waste for each intervention group. The table includes total food waste, food waste categorised by type of foods, the cost of food waste, and environmental impact for each intervention group.

Table 4.4: Pre-and post- intervention total food waste, food waste categorised by food type, cost of food waste and environmental impact by intervention groups

	Item	Mean (SD)		n	Z	p-value
		PRE	POST			
Intervention 1	Total waste (g)	1495.03 (1478.77)	315.09 (375.22)	60	-5.873	<.001*
	Fresh produce (g)	946.29 (984.36)	157.24 (117.56)	60	-5.714	<.001*
	Meat produce (g)	82.90 (116.42)	63.90 (108.68)	60	-1.165	.244*
	Cooked food (g)	403.51 (972.54)	55.69 (87.05)	60	-3.466	.001*
	Cost (R)	182.03 (285.45)	45.30 (62.171)	60	-4.468	<.001*
	Environmental impact (gCO ₂ e)	9179.37 (16923.82)	5727.76 (10223.72)	60	-1.906	.057*
Intervention 2	Total waste (g)	1661.28 (1420.80)	316.00 (293.89)	60	-6.055	<.001*

	Fresh produce (g)	1110.16 (1135.60)	180.00 (151.27)	60	-5.827	<.001*
	Meat produce (g)	162.93 (647.26)	37.08 (59.54)	60	-1.391	.164*
	Cooked food (g)	422.05 (642.50)	103.82 (210.69)	60	-3.427	.001*
	Cost (R)	134.26 (151.24)	35.46 (33.71)	60	-5.664	<.001*
	Environmental impact (gCO ₂ e)	6521.23 (7237.77)	7486.85 (12819.33)	60	-1.059	.289*
Control group	Total waste (g)	1434.78 (2350.38)	290.27 (245.98)	60	-4.006	<.001*
	Fresh produce (g)	694.02 (894.41)	182.98 (182.22)	60	-3.745	<.001*
	Meat produce (g)	81.52 (154.21)	28.77 (49.527)	60	-2.339	.019*
	Cooked food (g)	335.33 (696.65)	68.60 (84.32)	60	-2.139	.032*
	Cost (R)	121.20 (167.90)	38.65 (54.21)	60	-3.573	<.001*
	Environmental impact (gCO ₂ e)	7336.10 (10887.12)	5979.07 (11653.93)	60	-3.573	.253*

*p<0.001

4.5.1 Intervention 1

Results from the Wilcoxon Signed-Ranks test indicated that the total waste pre-intervention (average waste = 1495.03 g per household) was greater than the total waste post-intervention (average waste per household = 314.09 g), $Z = -5.873$, $p < 0.001$ for the intervention 1. The fresh produce pre-intervention (average waste per household = 946.29 g) was greater than the fresh produce post-intervention (average waste per household = 157.24 g), $Z = -5.714$, $p < 0.001$ for intervention 1. The meat produce wasted pre-intervention (average waste per household = 82.90 g) was more than the meat produce wasted post-intervention (average waste per household = 63.90 g), $Z = -1.165$, $p = 0.244$ for intervention 1, and cooked food wasted pre-intervention (average waste per household = 403.51 g) was more than the cooked food wasted post-intervention (average waste per household = 55.69 g), $Z = -3.466$, $p = 0.001$. The cost of the food waste pre-intervention (average waste per household = R182.03) was greater than the cost of food waste post-intervention (average waste per household = R45.30), Z

= -4.468, $p < 0.001$. The environmental impact from the food wasted pre-intervention (average waste per household = 9179.37 gCO_{2e}) was greater than the environmental impact post-intervention for intervention 1 (average waste per household = 5727.76 gCO_{2e}), $Z = -1.906$, $p = 0.057$.

4.5.2 Intervention 2

The Wilcoxon Signed-Ranks test indicated that the total waste pre-intervention (average waste per household = 1661.28 g) was significantly more than the total waste post-intervention (average waste per household = 316.00 g), $Z = -6.055$, $p < 0.001$ for intervention 2. The fresh produce pre-intervention (average waste per household = 1110.16 g) was more than the fresh produce post-intervention (average waste per household = 180.00 g), $Z = -5.827$, $p < 0.001$ for intervention 2. The meat produce wasted pre-intervention (average waste per household = 162.93 g) was more than the meat produce wasted post-intervention (average waste per household = 37.08 g), $Z = -1.391$, $p = 0.164$, and the cooked food pre-intervention (average waste per household = 422.05 g) was more than the cooked food post-intervention (average waste per household = 103.82 g), $Z = -3.427$, $p < 0.001$ for intervention 2. The cost pre-intervention (average waste per household = R134.26) was more than the cost post-intervention (average waste per household = R35.46), $Z = -5.664$, $p < 0.001$. The environmental impact pre-intervention (average waste per household = 6521.23 gCO_{2e}) was less than the environmental impact post-intervention for intervention 2 (average waste per household = 7486.85 gCO_{2e}), $Z = -1.059$, $p = 0.289$.

4.5.3 Control group

Analysis from the Wilcoxon Signed-Ranks test indicated that the total waste pre-intervention (average waste per household = 1434.78 g) was greater than the total waste post-intervention (average waste per household = 290.27 g), $Z = -4.006$, $p < 0.001$ for the control group. The fresh produce pre-intervention (average waste per household = 694.02g) was more than the fresh produce post-intervention (average waste per household = 182.98 g), $Z = -3.745$, $p < 0.001$ for the control group. The meat produce wasted pre-intervention (average waste per household = 81.52 g) was more than the meat produce wasted post-intervention (average waste per household = 28.77 g), $Z = -2.339$, $p = 0.019$. The cooked food pre-intervention (average waste per household = 335.33 g) was more than the cooked food post-intervention (average waste per household = 68.60 g), $Z = -2.139$, $p = 0.032$ for the control group. The cost pre-intervention (average waste per household = R121.20) was more than the cost post-intervention (average waste per household = R38.65), $Z = -3.573$, $p < 0.001$. The environmental impact pre-intervention (average waste per household = 7336.10 gCO_{2e}) was more than the environmental impact post-intervention (average waste per household = 5979.07 gCO_{2e}), $Z = -3.573$, $p = 0.253$.

4.6 Pre-and post-intervention nutrient loss for each intervention group

Table 4.5 presents the results of the Wilcoxon Signed-Ranks test for pre- and post-intervention nutrient loss from household food waste for each intervention group.

Table 4.5: Pre-post intervention nutrient loss from household food waste for each intervention group

Intervention arm	Item	Mean (SD)		n	Z	p-value
		PRE	POST			
Intervention 1	Energy (kJ)	6736.34 (7950.41)	1236.16 (2219.23)	60	-5.457	.000
	Total protein (g)	56.13 (59.04)	12.17 (18.03)	60	-5.427	.000
	Total lipids (g)	50.35 (88.49)	15.94 (24.12)	60	-3.563	.000
	Carbohydrate total (g)	251.99 (273.90)	43.84 (90.29)	60	-5.564	.000
	Total dietary fibre (g)	31.53 (30.51)	3.16 (4.51)	60	-5.810	.000
	Ca (mg)	445.66 (619.85)	52.25 (71.76)	60	-5.564	.000
	Fe (mg)	21.93 (29.58)	22.62 (29.63)	60	-0.292	.770
	Mg (mg)	332.00 (378.51)	39.96 (62.67)	60	-5.599	.000
	P (mg)	844.45 (882.54)	166.45 (203.99)	60	-5.502	.000
	K (mg)	3432.68 (4429.72)	457.38 (448.01)	60	-5.993	.000
	Na (mg)	1330.88 (1673.08)	458.52 (1673.08)	60	-3.289	.001
	Zn (mg)	126.50 (331.25)	59.29 (131.83)	60	-1.125	.261
	Vitamin A (RAE)(mcg)	83.38 (304.85)	51.02 (82.17)	60	-0.444	.657
	Thiamine (mg)	1.59 (1.70)	31.65 (192.64)	60	-0.405	.685
	Riboflavin (mg)	.91 (0.95)	.251 (0.22)	60	-5.091	.000
	Vitamin B6 (mg)	3.93 (5.14)	2.74 (3.63)	60	-1.217	.224
Folic acid (mcg)	338.06	30.71	60	-5.537	.000	

		(444.81)	(47.25)			
	Vitamin B12 (mcg)	1.91 (3.67)	20.06 (926.22)	60	-4.590	.000
	Vitamin C (mg)	226.64 (241.97)	27.27 (36.12)	60	-5.670	.000
	Vitamin D (mcg)	2.47 (6.53)	14.10 (33.16)	60	-3.602	.000
	Vitamin E (mg)	9.87 (27.15)	1.47 (3.08)	60	-4.590	.000
Intervention 2	Energy (kJ)	6256.51 (6448.48)	1313.06 (2139.95)	60	-5.710	.000
	Total protein (g)	57.09 (52.60)	13.40 (24.11)	60	-5.463	.000
	Total lipids (g)	34.15 (35.95)	13.82 (15.84)	60	-3.578	.000
	Carbohydrate total (g)	255.92 (307.04)	49.25 (73.41)	60	-5.488	.000
	Total dietary fibre (g)	30.02 (27.07)	4.18 (7.24)	60	-5.840	.000
	Ca (mg)	298.28 (265.22)	66.01 (116.16)	60	-4.994	.000
	Fe (mg)	15.33 (14.49)	29.01 (53.95)	60	-1.194	.232
	Mg (mg)	316.66 (346.64)	43.96 (67.84)	60	-5.748	.000
	P (mg)	843.50 (730.03)	171.76 (248.14)	60	-5.882	.000
	K (mg)	3065.91 (2864.57)	505.38 (587.23)	60	-5.907	.000
	Na (mg)	1414.40 (1508.40)	422.21 (537.26)	60	-4.012	.000
	Zn (mg)	72.03 (134.45)	56.49 (120.72)	60	-1.923	.054
	Vitamin A (RAE)(mcg)	71.24 (235.40)	47.99 (108.94)	60	-.270	.787
	Thiamine (mg)	1.65 (2.01)	2.53 (6.82)	60	-3.092	.002
	Riboflavin (mg)	.81 (.76)	.26 (.30)	60	-5.216	.000

	Vitamin B6 (mg)	3.92 (4.19)	2.33 (3.69)	60	-2.706	.007
	Folic acid (mcg)	385.11 (605.26)	37.84 (57.76)	60	-5.731	.000
	Vitamin B12 (mcg)	2.21 (4.60)	15.87 (38.11)	60	-4.512	.000
	Vitamin C (mg)	243.33 (302.50)	22.77 (29.53)	60	-5.806	.000
	Vitamin D (mcg)	1.15 (2.33)	8.82 (12.85)	60	-4.485	.000
	Vitamin E (mg)	5.15 (5.97)	1.36 (1.97)	60	-4.516	.000
Control group	Energy (kJ)	5297.04 (6037.56)	1149.28 (1998.42)	60	-3.911	.000
	Total protein (g)	52.85 (58.17)	10.52 (17.78)	60	-4.549	.000
	Total lipids (g)	43.13 (55.64)	12.19 (14.76)	60	-3.607	.000
	Carbohydrate total (g)	221.79 (248.74)	50.71 (82.29)	60	-4.340	.000
	Total dietary fibre (g)	26.20 (25.65)	4.73 (11.95)	60	-4.954	.000
	Ca (mg)	330.05 (351.17)	56.28 (120.41)	60	-4.605	.000
	Fe (mg)	12.99 (12.62)	41.40 (105.75)	60	-1.054	.232
	Mg (mg)	275.07 (282.09)	45.72 (124.19)	60	-5.080	.000
	P (mg)	724.58 (676.61)	184.95 (368.93)	60	-4.535	.000
	K (mg)	2790.30 (2553.06)	569.17 (905.97)	60	-4.814	.000
	Na (mg)	1783.07 (3718.32)	432.85 (568.13)	60	-3.552	.000
	Zn (mg)	99.04 (279.28)	75.73 (173.22)	60	-1.521	.128
	Vitamin A (RAE)(mcg)	32.84 (68.64)	63.50 (134.98)	60	-1.302	.193

Thiamine (mg)	1.24 (1.19)	7.23 (38.01)	60	-1.403	.161
Riboflavin (mg)	.66 (.55)	.26 (.30)	60	-3.566	.000
Vitamin B6 (mg)	2.8 (3.43)	3.11 (4.61)	60	-.942	.346
Folic acid (mcg)	305.77 (356.08)	38.79 (93.24)	60	-4.954	.000
Vitamin B12 (mcg)	1.68 (2.67)	27.35 (93.56)	60	-3.724	.000
Vitamin C (mg)	200.74 (240.75)	51.49 (117.87)	60	-4.654	.000
Vitamin D (mcg)	1.72 (2.48)	9.69 (18.87)	60	-3.176	.001
Vitamin E (mg)	6.74 (7.43)	1.34 (2.47)	60	-4.706	.000

p<0.001

4.6.1 Intervention 1

Analysis from the Wilcoxon Signed-Ranks test indicated that the energy loss pre- (average waste per household = 6736.34 kJ) was more than the energy loss post- (average waste per household = 1236.16 kJ), $Z = -5.421$, $p < 0.000$ for intervention 1. Similarly, total protein loss pre- (average waste per household = 56.13 g) was more than the total protein loss post- (average waste per household = 12.17 g), $Z = -5.427$, $p < 0.000$ for intervention 1. Total lipids loss pre- (average waste per household = 50.35 g) was more than the total lipids loss post- (average waste per household = 15.941 g), $Z = -3.563$, $p < 0.000$ for intervention 1. Carbohydrate total loss pre- (average waste per household = 251.99 g) was more than the carbohydrate total loss post- (average waste per household = 43.84 g), $Z = -5.564$, $p < 0.000$ for intervention 1. Total dietary fibre loss pre- (average waste per household = 31.53 g) was more than the total dietary fibre loss post- (average waste per household = 3.16 g), $Z = -5.810$, $p < 0.000$ for intervention 1. Calcium (Ca) loss pre- (average waste per household = 445.66 mg) was more than the calcium loss post- (average waste per household = 52.25 mg), $Z = -5.564$, $p < 0.000$ for intervention 1. Iron (Fe) loss pre- (average waste per household = 21.93 mg) was higher than the iron loss post- (average waste per household = 22.62 mg), $Z = -0.292$, $p < 0.770$ for intervention 1. Meanwhile, magnesium (Mg) loss pre- (average waste per household = 332.00 mg) was more than the magnesium loss post- (average waste per household = 39.69 mg), $Z = -5.599$, $p < 0.000$ for intervention 1. Phosphorus (P) loss pre- (average waste per household = 844.45 mg) was more than the phosphorus loss post- (average waste per household = 166.45 mg), $Z = -5.502$, $p < 0.000$ for intervention 1 while potassium (K) loss pre- (average waste per household = 3432.68 mg) was more than the potassium loss post- (average waste per household = 457.38 mg), $Z = -5.993$, $p < 0.000$ for intervention 1. Sodium (Na) loss pre- (average waste per household = 1330.88 mg) was more than the loss sodium post-

(average waste per household = 458.52 mg), $Z = -3.289$, $p < 0.001$ for intervention 1. Zinc (Zn) loss pre- (average waste per household = 126.50 mg) was more than the zinc loss post- (average waste per household = 59.29 mg), $Z = -1.125$, $p < 0.261$ for intervention 1. In terms of Vitamin A (RAE)(mcg) loss pre- (average waste per household = 83.38 mcg) was more than the vitamin A loss post- (average waste per household = 51.02 mcg), $Z = -0.444$, $p < 0.657$ for intervention 1. Thiamine loss pre- (average waste per household = 1.59 mg) was more than the thiamine loss post- (average waste per household = 31.65 mg), $Z = -0.405$, $p < 0.685$ for intervention 1. Riboflavin loss pre- (average waste per household = .91 mg) was more than the riboflavin loss post- (average waste per household = .251 mg), $Z = -5.091$, $p < 0.000$ for intervention 1. Vitamin B6 loss pre- (average waste per household = 3.93 mg) was greater than the Vitamin B6 loss post- (average waste per household = 2.74 mg), $Z = -1.217$, $p < 0.224$ for intervention 1. Folic acid loss pre- (average waste per household = 338.06 mg) was greater than the folic acid loss post- (average waste per household = 30.71 mg), $Z = -5.537$, $p < 0.000$ for intervention 1. Likewise, vitamin B12 loss pre- (average waste per household = 1.91 mg) was greater than the vitamin B12 loss post- (average waste per household = 20.06mg), $Z = -4.590$, $p < 0.000$ for intervention 1. Vitamin C loss pre- (average waste per household = 226.64 mg) was greater than the vitamin C loss post- (average waste per household = 27.27 mg), $Z = -5.670$, $p < 0.000$ for intervention 1. Vitamin D loss pre- (average waste per household = 2.47 mg) was greater than the vitamin D loss post- (average waste per household = 14.10 mg), $Z = -3.602$, $p < 0.000$ for intervention 1. In terms of Vitamin E loss, pre- (average waste per household = 9.87 mg) was greater than the vitamin E loss post- (average waste per household = 1.47 mg), $Z = -4590$, $p < 0.000$ for intervention 1.

4.6.2 Intervention 2

Results from the Wilcoxon Signed-Ranks test indicated that the energy loss pre- (average waste per household = 6256.51 kJ) was more than the energy loss post- (average waste per household = 1313.06 kJ), $Z = -5.710$ $p < 0.000$ for intervention 2. Correspondingly, total protein loss pre- (average waste per household = 57.09 g) was more than the total protein loss post- (average waste per household = 13.40 g), $Z = -5.463$, $p < 0.000$ for intervention 2. Total lipids loss pre- (average waste per household = 34.15 g) was more than the total lipids loss post- (average waste per household = 13.82 g), $Z = -3.578$, $p < 0.000$ for intervention 2. Carbohydrate total loss pre- (average waste per household = 255.92g) was more than the carbohydrate total loss post- (average waste per household = 49.25 g), $Z = -5.488$, $p < 0.000$ for intervention 2. Total dietary fibre loss pre- (average waste per household = 30.02 g) was more than the total dietary fibre loss post- (average waste per household = 4.18 g), $Z = -5.840$, $p < 0.000$ for intervention 2. Calcium (Ca) loss pre- (average waste per household = 298.28mg) was more than the calcium loss post- (average waste per household = 66.01 mg), $Z = -4.994$, $p < 0.000$ for intervention 2. Iron (Fe) loss pre- (average waste per household = 15.33 mg) was more than the iron loss post- (average waste per household = 29.01), $Z = -1.194$, $p < 0.232$ for intervention 2. Meanwhile, magnesium (Mg) pre-loss (average waste per household = 316.66 mg) was more than the magnesium loss post- (average waste per household = 43.96 mg), $Z = -5.748$, $p < 0.000$ for intervention 2. Phosphorus (P) loss pre- (average waste per household = 843.50 mg) was more than the phosphorus loss post- (average waste per household = 171.76 mg), $Z = -5.882$, $p < 0.000$ for intervention 2, while potassium (K) loss

pre- (average waste per household = 3065.91 mg) was more than the potassium loss post- (average waste per household = 505.38 mg), $Z = -5.907$, $p < 0.000$ for intervention 2. Sodium (Na) loss pre- (average waste per household = 1414.40mg) was more than the sodium loss post- (average waste per household = 422.21 mg), $Z = -6.196$, $p < 0.000$ for intervention 2. Zinc (Zn) loss pre- (average waste per household = 72.03 mg) was more than the zinc loss post- (average waste per household = 56.49 mg), $Z = -1.923$, $p < 0.054$ for intervention 2. In terms of Vitamin A (RAE)(mcg), loss pre- (average waste per household = 71.24 mcg) was more than the vitamin A loss post- (average waste per household = 47.99 mcg), $Z = -.270$, $p < 0.787$ for intervention 2. Thiamine loss pre- (average waste per household = 1.65 mg) was more than the thiamine loss post- (average waste per household = 2.53 mg), $Z = -3.092$, $p < 0.002$ for intervention 2. Riboflavin loss pre- (average waste per household = .81 mg) was more than the riboflavin loss post- (average waste per household = .26mg), $Z = -5.126$, $p < 0.000$ for intervention two. Vitamin B6 loss pre- (average waste per household = 3.92 mg) was greater than the Vitamin B6 loss post- (average waste per household = 2.33mg), $Z = -2.706$, $p < 0.007$ for intervention 2. Folic acid loss pre- (average waste per household = 385.11 mg) was greater than the folic acid loss post- (average waste per household = 37.84mg), $Z = -5.731$, $p < 0.000$ for intervention 2. Likewise, vitamin B12 loss pre- (average waste per household = 2.21 mg) was greater than the vitamin B12 loss post- (average waste per household = 15.87 mg), $Z = -4.512$, $p < 0.000$ for intervention 2. Vitamin C loss pre- (average waste per household = 243.33 mg) was greater than the vitamin C loss post- (average waste per household = 22.77mg), $Z = -5.806$, $p < 0.000$ for intervention 2. Vitamin D loss pre- (average waste per household = 1.15 mg) was greater than the vitamin D loss post- (average waste per household = 8.82mg), $Z = -4.485$, $p < 0.000$ for intervention 2. In terms of Vitamin E, loss pre- (average waste per household = 5.15 mg) was greater than the vitamin E loss post- (average waste per household = 1.36 mg), $Z = -4.516$ $p < 0.000$ for the intervention group.

4.6.3 Control group

Results from the Wilcoxon Signed-Ranks test indicated the energy loss pre- (average waste per household = 5297.04 kJ) was more than the energy loss post- (average waste per household = 1149.28 kJ), $Z = -3.911$, $p < 0.000$ for the control group. Correspondingly, total protein loss pre- (average waste per household = 52.85 g) was more than the total protein loss post- (average waste per household = 10.52), $Z = -4.549$, $p < 0.000$ for the control group. Total lipids loss pre- (average waste per household = 43.13 g) was more than the total lipids loss post- (average waste per household = 12.191g), $Z = -3.607$, $p < 0.000$ for the control group. Carbohydrate total loss pre- (average waste per household = 221.79g) was more than the carbohydrate total loss post- (average waste per household = 50.71g), $Z = -4.340$, $p < 0.000$ for the control group. Total dietary fibre loss pre- (average waste per household = 26.20 g) was more than the total dietary fibre loss post- (average waste per household = 4.73g), $Z = -4.9541$, $p < 0.000$ for the control group. Calcium (Ca) loss pre- (average waste per household = 330.05 mg) was more than the calcium loss post- (average waste per household = 56.28 mg), $Z = -4.605$, $p < 0.000$ for the control group. Iron (Fe) loss pre- (average waste per household = 12.99mg) was more than the iron loss post- (average waste per household = 41.40), $Z = -1.054$, $p < 0.232$ for the control group. Meanwhile, magnesium (Mg) loss pre- (average waste per household = 275.07 mg) was more

than the magnesium loss post- (average waste per household = 45.72 mg), $Z = -5.080$, $p < 0.000$ for the control group. Phosphorus (P) loss pre- (average waste per household = 724.58 mg) was more than the phosphorus loss post- (average waste per household = 184.95 mg), $Z = -4.535$, $p < 0.000$ for the control group, while the potassium (K) loss pre- (average waste per household = 2790.30 mg) was more than the potassium loss post- (average waste per household = 569.178 mg), $Z = -4.814$, $p < 0.000$ for the control group. Sodium (Na) loss pre- (average waste per household = 1783.07 mg) was more than the sodium loss post- (average waste per household = 432.85 mg), $Z = -3.552$, $p < 0.000$ for the control group. Zinc (Zn) loss pre- (average waste per household = 99.04 mg) was more than the zinc loss post- (average waste per household = 75.73 mg), $Z = -1.521$, $p < 0.128$ for the control group. In terms of Vitamin A (RAE)(mcg) loss, pre- (average waste per household = 32.84 mcg) was more than the vitamin A loss post- (average waste per household = 63.50 mcg), $Z = -1.302$, $p < 0.193$ for the control group. Thiamine loss pre- (average waste per household = 1.24 mg) was more than the thiamine loss post- (average waste per household = 7.23 mg), $Z = -1.403$, $p < 0.161$ for the control group. Riboflavin loss pre- (average waste per household = .66 mg) was less than the riboflavin loss post- (average waste per household = .26 mg), $Z = -3.566$, $p < 0.000$ for the control group. Vitamin B6 loss pre- (average waste per household = 2.8 mg) was greater than the Vitamin B6 loss post- (average waste per household = 3.11 mg), $Z = -.942$, $p < 0.346$ for the control group. Folic acid loss pre- (average waste per household = 305.77 mg) was greater than the folic acid loss post- (average waste per household = 38.79 mg), $Z = -4.954$, $p < 0.000$ for the control group. Likewise, vitamin B12 loss pre- (average waste per household = 1.68 mg) was greater than the vitamin B12 loss post- (average waste per household = 27.35 mg), $Z = -3.724$, $p < 0.000$ for the control group. Vitamin C loss pre- (average waste per household = 200.74 mg) was greater than the vitamin C loss post- (average waste per household = 51.490 mg), $Z = -4.654$, $p < 0.000$ for the control group. Vitamin D loss pre- (average waste per household = 1.72 mg) was greater than the vitamin D loss post- (average waste per household = 9.69 mg), $Z = -3.176$, $p < 0.001$ for the control group. In terms of Vitamin E loss, pre- (average waste per household = 6.74 mg) was greater than the vitamin E loss post- (average waste per household = 1.34 mg), $Z = -4.706$, $p < 0.000$ for the control group.

4.7 Intervention effect between groups

Figure 4.1 graphically represents household food waste for pre- and post-intervention by intervention groups.

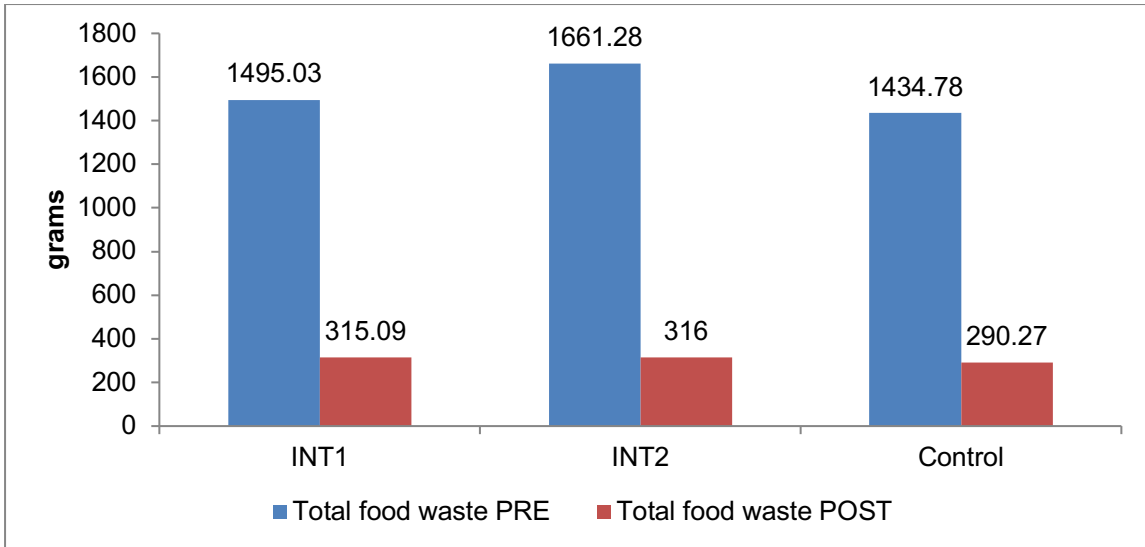


Figure 4.1: Total food waste, pre- and post-intervention by intervention groups

During the baseline (pre-) for intervention 1, the weight of total food wasted was 1495.03g per household. Following the implementation of the intervention, the total weight of food wasted decreased to 315.09g, therefore indicating a reduction of 1179.94g at the endline (post-). In intervention group 2, at baseline (pre-) the total food wasted was 1661.28g. Subsequent to the intervention implementation, the total food wasted was 316g; therefore, there was a decrease of 1345.28 g at the endline (post-). At the baseline (pre-) for the control group, the total food wasted was 1434.78g. After the intervention implementation, the total food wasted was 290.27g, a decrease of 1144.51g at the endline (post-).

Figure 4.2 graphically represents the total fresh produce and dry goods food waste pre- and post-intervention for households by intervention group.

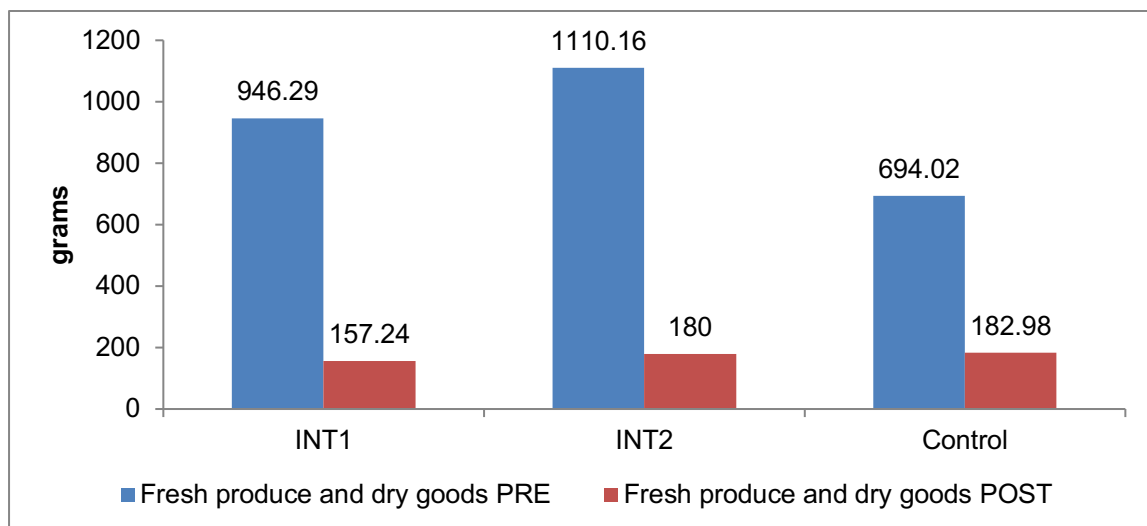


Figure 4.2: Fresh produce and dry goods food waste for each intervention group

In intervention 1, at the baseline (pre-), a total of 946.29 g of fresh produce and dry goods was wasted. Following the intervention, 157.24 g of fresh produce and dry goods were wasted, indicating a decrease of 789.05g at the endline (post-). At the baseline (pre-) for intervention 2, a total of 1110.16 g of fresh produce and dry goods was wasted. Following the intervention implementation, 180 g of fresh produce was wasted. Therefore, there was a decrease of 930.16 g at the endline (post-). In the control group at baseline (pre-), a total of 694.0 g of fresh produce and dry goods was wasted. After the intervention period, 182.98 g of fresh produce and dry goods were wasted, indicating a decrease of 511.04 g at the endline (post-).

Figure 4.3 graphically represents the total meat, fish and poultry food waste from households for pre- and post by intervention groups.

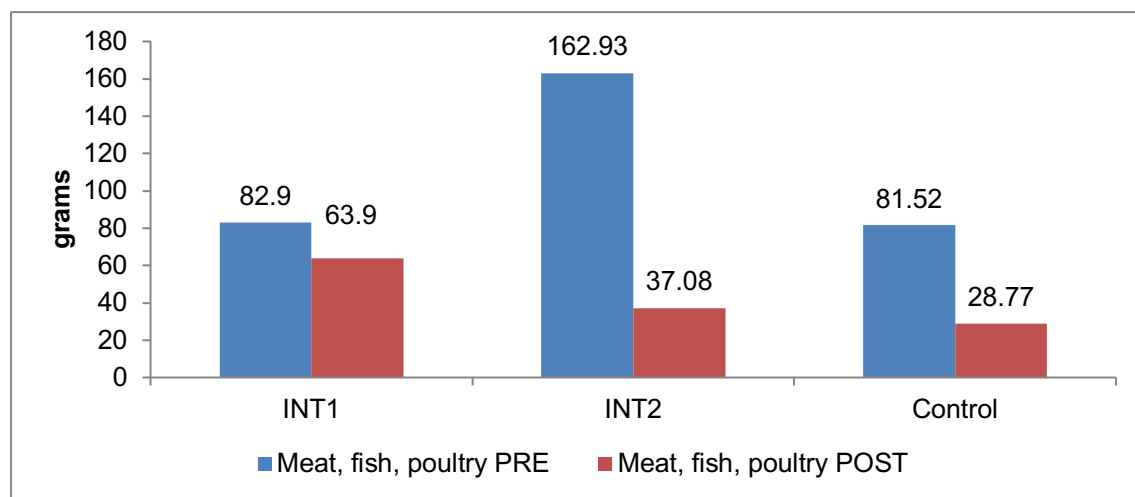


Figure 4.3: Meat, fish and poultry waste, pre-and post-by intervention group

At the baseline (pre-) for intervention 1, the total weight of meat, fish, and poultry wasted was 82.90 g. Following the intervention implementation, the meat, fish, and poultry waste decreased to 63.90 g; therefore, there was a decrease of 19 g at the endline (post-). In intervention group 2, at baseline (pre-), 162.93 g of meat, fish, and poultry was wasted. After the intervention was implemented, 37.00 g of meat, fish, and poultry was wasted, indicating a decrease of 125.93 g at the endline (post-). At the baseline (pre-) for the control, 81.52 g of meat, fish, and poultry was wasted. After the intervention duration, 28.77 g of meat, fish, and poultry was wasted, indicating a decrease of 52.75 g at the endline (post-).

Figure 4.4 graphically represents the total cooked food waste for households for pre- and post-intervention by intervention groups.

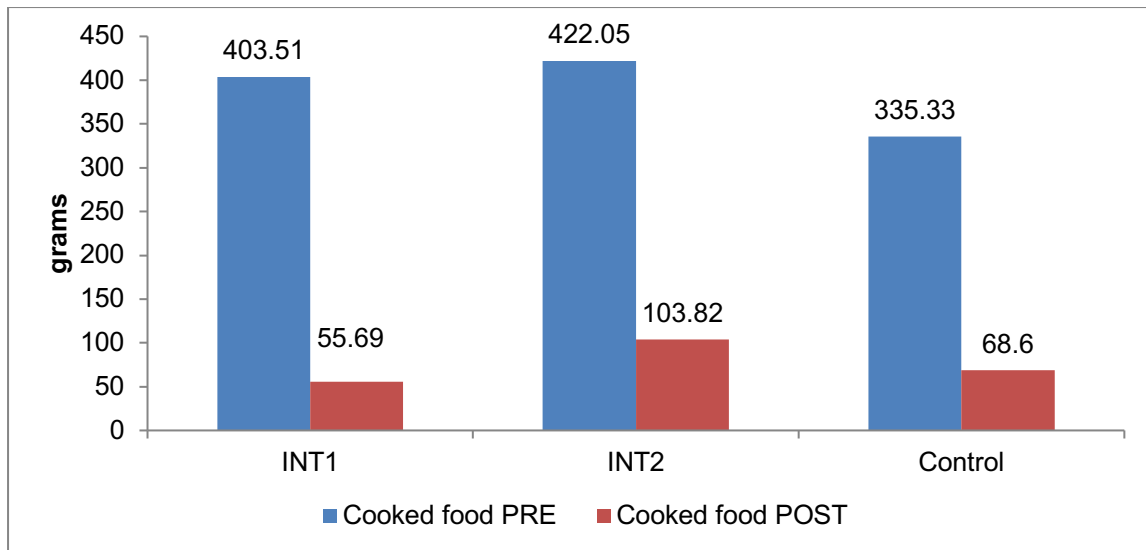


Figure 4.4: Cooked food waste, pre- and post- by intervention group

In intervention 1, at the baseline (pre-), 403.51 g of cooked food was wasted. After the intervention, 55.69g of cooked food was wasted, indicating a decrease of 347.82 g at the endline (post). During intervention 2's baseline (pre-), 422.05 g of cooked food was wasted. After the intervention was implemented, 103.82 g of cooked food waste was wasted, indicating a decrease of 318.23 g at the endline (post). In the control group at the baseline (pre-), 335.33g of cooked food was wasted. After the intervention duration, 68.60 g of cooked food was wasted, indicating a decrease of 266.73 g at the endline (post-).

Figure 4.5 graphically represents the cost effect of food waste for pre-and-post-intervention by intervention groups.

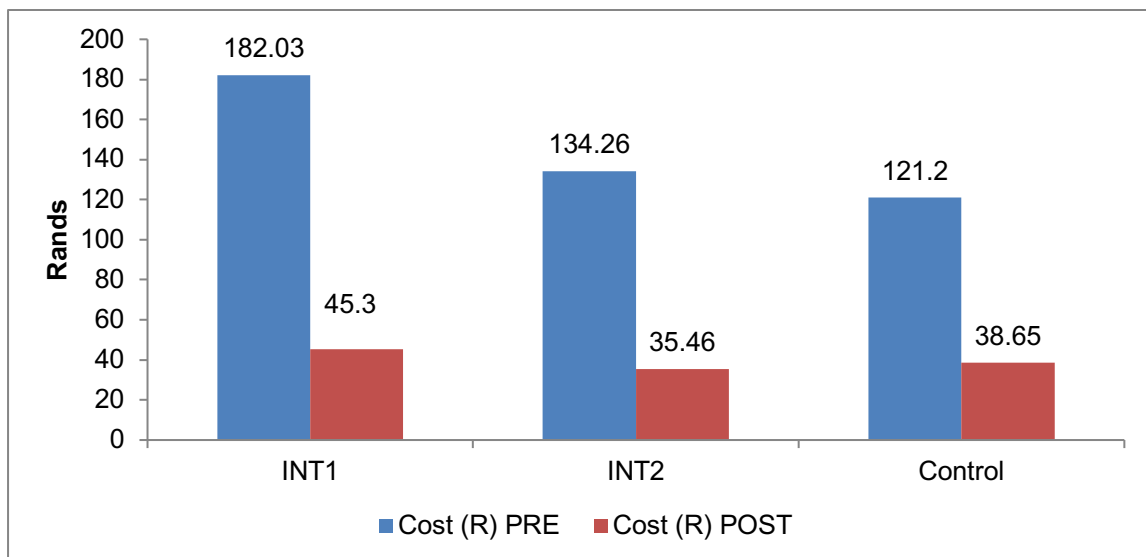


Figure 4.5: Cost of food waste, pre-and post-intervention by intervention group

At the baseline (pre-) for intervention 1, the cost of food waste was R182.03. After the intervention was implemented, the cost of food wasted was R45.30; therefore, there was a decrease of R136.73 at the endline (post-). In intervention group 2, at the baseline (pre-), the cost of food wasted was R134.26. After the intervention was implemented, the cost of food wasted was R35.46, therefore indicating a decrease of R98.00 at the endline (post-). During the baseline (pre-) for the control group, the cost of food wasted was R121.20. After the intervention duration, the cost of food wasted was R38.65, a decrease of R82.55 at the endline (post-).

Figure 4.5 graphically represents the environmental impact of food waste for pre- and post-intervention by intervention groups.

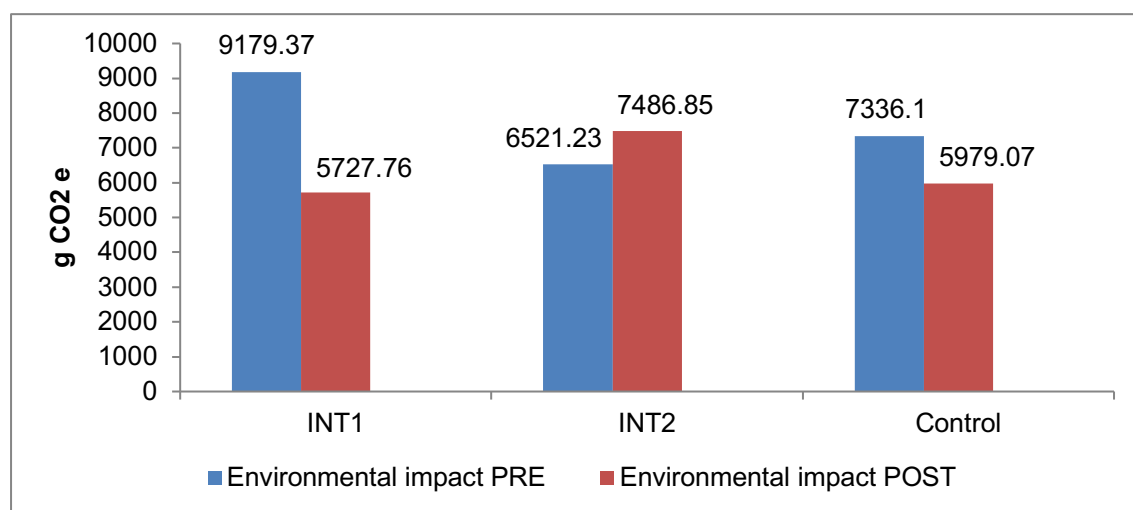


Figure 4.6: Environmental impact, pre-and post-intervention by intervention group

In intervention 1, at the baseline (pre-), the environmental impact from the food waste was 9179.37 gCO₂e. After the intervention was implemented, the environmental impact from the food waste was 5727.76 gCO₂e, indicating a decrease of 3451.61 gCO₂e at the endline (post-). At the baseline (pre-) for intervention 2, the environmental impact from the food waste was 6521.23 gCO₂e. After the intervention was implemented, the environmental impact from the food waste was 7486.85gCO₂e, indicating an increase of 965.62 gCO₂e at the endline (post-). In the control group at the baseline (pre-), the environmental impact from the food waste was 7336.1 gCO₂e. After the intervention, the environmental impact from the food waste was 5979.07 gCO₂e, indicating a decrease of 1357.03 gCO₂e at the endline (post-).

4.8 DISCUSSION

4.8.1 Overview of household food waste

The findings from this study indicated that before the intervention, households generated an average of 1.53 kg of total food waste per week. In contrast, this amount decreased to 0.31 kg per week after the intervention for the whole group. For Intervention 1, the weekly household food waste averaged 1.50 kg at baseline and 0.315 kg at the endline. For intervention 2, the weekly household food waste averaged 1.66 kg at baseline and 0.316 kg at the endline. For the control group, the weekly household food waste averaged 1.43 kg at baseline and 0.29 kg at endline. In a cross-sectional study conducted by Oelofse, Muswema, and Ramukhwatho (2018: 3) regarding the disposal of household food waste in South Africa, the average weekly per-household food waste amounted to 0.69 kg in Johannesburg and 0.48 kg in Ekurhuleni. The overall average of food waste in this study at baseline was greater than that reported by Oelofse, Muswema, and Ramukhwatho (2018: 3), which is potentially attributable to methodological differences. In our study, a food waste audit was conducted on a household-by-household basis, allowing for the traceability of food waste to individual households. Furthermore, each household was given three bins each with a bin bag to collect and separate food waste. In contrast, the study conducted in Johannesburg and Ekurhuleni utilised bulk sampling of garbage collected by the municipal waste collection service, thus restricting the generalisability of results pertaining to food waste disposed in the municipal bins. This study's annual pre-intervention household food waste equates to 79.56 kg and a post-intervention annual amount of 16.12 kg. According to a study conducted by Chakona and Shackleton (2017: 1) investigating the impact of local settings on household food waste in mid-sized South African towns, the average annual food waste per person was 12.35 kg. The overall annual average of food waste was greater than in the current study. However, in the study by Chakona and Shackleton (2017: 1), a self-reporting approach was implemented, with households receiving food waste diaries to document the food they discarded. Quested, Parry, Eastal and Swannell (2011: 464) found that the amount of waste recorded in diaries was nearly 40% lower than the amount obtained through the analysis of waste streams. Similarly, Hanson, Lipinski, Robertson, Dias, Gavilan, Gréverath, Ritter, Fonseca, VanOtterdijk, Timmermans and Lomax (2016: 1) reported that the household food waste diary method consistently underrated levels of food loss and waste. In the literature review, it was established that the proportion of food wasted by consumers on a per capita basis is much higher in developed countries (95-115 kg/annum in Europe and North America) compared to developing countries (6-11 kg/annum in Sub-Saharan Africa and South/Southeast Asia) (Gustavsson *et al.* 2011). One plausible explanation for the average food waste per household, amounting to 79.56 kg per annum, could be attributed to the fact that only middle and high LSM households were included in this study, excluding low LSM households. Furthermore, the period from 2011 to 2023 has witnessed an increase in South African income, lifestyle and accessibility of a wide range of foods through the food system.

4.8.2 Intervention effect

4.8.2.1 Nutritional loss

The results of this study indicate that pre-intervention for intervention 1, the average energy loss per household per week was 6135.90 kJ, whereas post-intervention, the average energy loss per household was 1235.29 kJ for the whole group. This post-intervention amount is higher than the findings from a study conducted by Khalid *et al.* (2019: 1017) in Pakistan, where the average energy loss from food waste was 54.42 kcal (227.69 kJ) per capita per day, amounting to an estimated 1593.83 kJ per week. This study was reliant on secondary data, and food waste was calculated across the entire supply chain using a recall method. In comparison, households in Canada wasted an average of 3366 kcal per week (14083.34 kJ per week), according to Von Massow *et al.* (2019: 11). In the United States, Buzby, Farah-Wells, and Hyman (2014: 17) reported a daily per capita food waste of 789 kcal (3301.18 kJ) at retail and consumer levels. In contrast, our study observed energy losses of 6135.90 kJ pre-intervention and 1235.29 kJ post-intervention per week due to food waste. Drawing from the findings of this study and global perspectives, the disparities underscore the variability in food waste energy losses between different countries, highlighting the need for region-specific interventions and awareness campaigns to address and mitigate these issues effectively. In this study, using contextualised interventions based on the formative research on the behaviour and practices of household food waste disposal conducted in the same community (Pal, Naicker and Grobbelaar 2023:1), the energy loss was reduced to 1235.29 kJ post-intervention.

Regarding micronutrients, the study revealed that the average total protein loss per household per week was 55.60 g pre-intervention and 12.07 g post-intervention. The average total lipids loss pre-intervention amounted to 42.39 g, whereas there was an average loss of 14.01 g post-intervention. Regarding carbohydrates, pre-intervention losses were 245.17 g, and post-intervention losses were 47.90 g. Additionally, total dietary fibre pre-intervention was 29.51 g, whereas post-intervention recorded a loss of 4.01 g per household per week. Comparatively, Khalid *et al.* (2019: 1017) in Pakistan identified nutritional losses from various food waste types, including protein (2.61 g), lipids (2.21 g), carbohydrates (10.58 g) and fibre (0.75 g) per capita per day, equivalent to 18.27 g protein, 15.47 g lipids, 74.06 g carbohydrates and 5.26 g fibre per capita per week. This study found Calcium (Ca) loss pre-intervention (359.55 mg) and calcium loss post-intervention (58.30 mg), Iron (Fe) loss pre-intervention (17.04 mg) and iron loss post-intervention (30.86 mg), magnesium (Mg) loss pre-intervention (310.74 mg) and magnesium loss post-intervention (43.19 mg), phosphorus (P) pre-intervention (811.27 mg) and phosphorus loss post-intervention (174.23 mg), potassium (K) loss pre-intervention (3121.25 mg) and potassium loss post-intervention (509.88 mg), vitamin A (RAE)(mcg) pre- (65.05 mg) and vitamin A loss post- (53.99 mg), vitamin D loss pre- (1.78 mg) and vitamin D loss post- (10.86 mg). A study conducted by Spiker, Hiza, Siddiqi, and Neff (2017: 1035) highlighted that the food wasted in the United States food supply chain in 2012 at the retail and consumer level included losses in energy (1217 kcal), protein (33 g), dietary fibre (5.9 g), vitamin D (1.7 µg), calcium (286 mg), and potassium (880 mg) per capita per day. In Khalid's study, vitamin A (96.83RE), calcium (22.49 mg), and phosphorus (P) (37.11 mg) per capita per day were reported. The nutrients identified in our study

surpass those reported in other countries (Khalid *et al.* 2019: 1017). This difference may be attributed to variations in the types and quantities of food wasted and differences in the method of food estimation. Additionally, our study involved primary data directly obtained from household waste bins. In contrast, the aforementioned studies relied on secondary data, calculated food waste across the entire supply chain (from farm to fork) using recall methods, or considered the difference between food supplied and food consumed as food waste.

Total lipids loss pre-intervention had an average of (42.39 g), and the total lipids loss post-intervention had an average of (14.01g), carbohydrate loss pre-intervention was (245.17g) with carbohydrate loss post-intervention (47.90g) and total dietary fibre pre-intervention (29.51 g) and post-intervention it was (4.01g) per household/per week. Khalid *et al.* (2019: 1017) in Pakistan found nutritional losses from all types of food waste, including protein (2.61 g), lipids (2.21 g), carbohydrates (10.58 g) and fibre (0.75 g) per capita per day, which is equivalent to (18.27 g), lipids (15.47 g), carbohydrates (74.06 g) and fibre (5.26 g) per capita per week.

This study found Calcium (Ca) loss pre-intervention (359.55 mg) and calcium loss post-intervention (58.30 mg), Iron (Fe) loss pre-intervention (17.04 mg) and iron loss post (30.86 mg), magnesium (Mg) loss pre-intervention (310.74 mg) and magnesium loss post-intervention (43.19 mg), Phosphorus (P) pre-intervention (811.27 mg) and phosphorus loss post-intervention (174.23 mg), potassium (K) loss pre- (3121.25 mg) and potassium loss post (509.88 mg), Vitamin A (RAE)(mcg) pre- (65.05 mg) and vitamin A loss post- (53.99 mg), Vitamin D loss pre- (1.78 mg) and vitamin D loss post- (10.86 mg). Spiker, Hiza, Siddiqi and Neff (2017: 1035) reported that in the US, in 2012, food wasted at the retail and consumer levels amounted to the following nutritional loss: energy (1217 kcal), protein (33 g), dietary fibre (5.9 g), vitamin D (1.7 µg), calcium (286 mg), and potassium (880 mg) per capita per day, in Khalid's study vitamin A was (96.83RE), calcium (Ca) (22.49 mg) and phosphorous (P) (37.11 mg) per capita per day.

The nutrient loss found in this study is greater than those found in other countries. This could be due to differences in the types and amount of wasted food and the method of food estimation. The nutrient loss from wasted food can have several negative effects on both individuals and the broader community. When food is wasted, it means that the nutrients contained in that food are not being utilised for their intended purpose, which is to nourish, sustain and support human health.

4.8.2.2 Economic loss

The cost of food waste for the whole group pre-intervention (average waste per household/week = R145.57) was more than the cost of food waste for the whole group post- (average waste per household/week = R39.75), resulting in an estimated annual cost of R7969.64 (pre-) and R2067.00 (post-). Households for intervention 1 incurred an average weekly cost of R182.03 at baseline, totalling an estimated R9456.56 per annum. The average weekly cost per household decreased to R45.30 post-intervention, resulting in an estimated annual cost of R2355.60 per annum. Households for intervention

2 incurred an average weekly cost of R134.26 at baseline, totalling an estimated R6981.52 per annum. The average weekly cost per household decreased to R35.46 post-intervention, resulting in an estimated annual cost of R1843.92. Households for the control group incurred an average weekly cost of R121.20 at baseline, totalling an estimated R6302.40 per annum. The average weekly cost per household decreased to R38.65 post-intervention, resulting in an estimated annual cost of R2009.80.

Nahman and De Lange (2013: 4) determined the annual cost of food waste throughout the food value chain in South Africa to be R61.5 billion, with around R6 billion originating from households. Nahman and De Lange (2013: 4) used a three-stage process method to determine the overall cost of food waste in South Africa. In the initial stage, they calculated the food waste at each point in the value chain in physical units for various food commodity groups. In the second stage, weighted average representative prices (per tonne) were estimated for each commodity group at every value chain stage. Finally, in the third stage, these prices were multiplied by quantities, and the resultant values were aggregated across the value chain for all commodity groups.

In this study, the economic loss was computed based on the actual weight of food waste, enhancing its reliability. The economic loss was then assessed using the mean prices of food items at Checkers Hyper and Woolworth Foods in the region, determining the Rand value of food waste at both the baseline and endline. Quantifying the exact economic cost of household food waste can be complex due to the multifaceted nature of the issue. However, it is clear that reducing food waste can have positive economic implications, both at the household level and on a broader societal scale. In this study, through this RCT, a significant reduction in food waste was evident, highlighting the economic burden of household food waste and the potential gains from reducing household food waste. The study provides valuable insights into the economic costs of food waste at the household level, showcasing the potential positive impact of interventions.

4.8.2.3 Environmental impact

This study indicated that the average carbon footprint pre-intervention for the whole group was 7664.13g (7.66 kg) CO₂e per week per household, equating to 398.53 kg CO₂e per annum. The average carbon footprint decreased to 6407.67g (6.41 kg) CO₂e per week/ household, totalling 333.20 kg CO₂e post-intervention per annum. For intervention 1, at baseline, the average carbon footprint pre-intervention was 9179.37 g (9.18 kg) CO₂e and 5727.76 g (5.73 kg) CO₂e at endline per week/ household, equating to 447.36 kg CO₂e at baseline and 297.96 kgCO₂e at endline per annum. For intervention 2, at baseline, the average carbon footprint pre-intervention was 6521.23 g (6.52 kg) CO₂e and 7486.85 g (7.49 kg) CO₂e at endline per week/ household, equating to 339.04 kgCO₂e at baseline and 389.43 kgCO₂e at endline per annum. For the control group at baseline, the average carbon footprint pre-intervention was 7336.1 g (7.34 kg) CO₂e and 5979.07 g (5.98 kg) CO₂e at endline per week/ household, equating to 381.68 kgCO₂e at baseline and 310.96 kgCO₂e at endline per annum.

This amount is notably lower than a study conducted in the US , where annual emissions linked to household food waste averaged 3934 kgCO₂e (Weber and Matthews, 2009: 2). In addition, a study conducted in Canada by Gooch, Matsubuchi-Shaw, Bucknell, LaPlain and Kohler (2022: 779) reported an environmental footprint of 742 kgCO₂e from 282 kg of food waste. Furthermore, Song, Li, Semakula, and Zhang (2015: 195) documented an annual average of 148 kg CO₂e per household in China. It is evident that in this study, regardless of the intervention treatment, households reduced their food waste, which had a direct impact on the environmental emissions.

4.9 Conclusion

Chapter 4 presented the results of the study, which were analysed and discussed according to the objectives of this study. In this RCT study, households were assigned to one of three intervention groups. All households at baseline received three colour-coded bins [used to separate food waste by food categories enlisted in Chapter 3], bin-liners, food labels and freezer bags to contain cooked food waste. In Intervention 1, households received a food literacy toolkit and food literacy lessons; households in Intervention 2 received the toolkit without any support and were dependent on self-efficacy to use the toolkit. The control group received no intervention.

Following the 6-week intervention duration, between intervention arms there was no discernible difference in household food waste, economic loss, nutritional loss and environmental impact. However, for every intervention group, there was a substantial decrease in all measured outcomes from baseline to endline. The main reason for this result could be attributed to the fact that households probably perceived that they were monitored through the food waste audit at baseline and endline. The next chapter (chapter 5) will comprise the conclusion and recommendations of this study.

CHAPTER 5: CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter draws conclusions from the main findings of the study that were discussed in the previous chapter and makes recommendations. The strengths, limitations and recommendations are also discussed to assist and provide guidance for future studies within this field. The purpose of the study was to determine the intervention effect of food literacy on household food waste in the KwaDukuza municipality in KZN.

5.2 Summary of the findings

This study aimed to research three objectives:

Objective 1: *To calculate household food waste through a weighed food waste audit at baseline and endline.*

In this study, the average food waste was determined for the whole study group, and individual intervention groups through weighed food waste audits at baseline and endline to determine the intervention effect on the reduction of household food waste. Results indicate that households in all intervention arms experienced a decrease in household food waste from baseline to endline. Monitoring of food waste through food waste audits conscientised households about their household food waste, which resulted in the reduction of their household food waste. At baseline, the total average household food waste stood at 1.53 kg (1531.29 g) per week, decreasing to 0.31 kg (307.47 g) per household per week at the endline. This translates to 0.016 g (per capita/week) and 79.56 kg (per capita/annum) at baseline, compared to 0.003 g (per capita/week) and 0.83 kg (per capita/annum) at endline.

Objective 2: *To calculate the cost, associated nutrient losses and environmental impact of household food waste using the results of the food waste audit at baseline and endline.*

Cost

In this study, using the weighed food waste audit data, the cost of household food waste was calculated for the whole study group and by intervention groups to determine the intervention effect on monetary savings. The average household food waste/per week cost was R145.57 at baseline and significantly reduced to R39.75 per week/ household at the endline for the whole group. The results indicated that households in all intervention arms experienced a decrease in costs of household food waste from baseline to endline, alluding to the fact that, regardless of the type of intervention arm participants belonged to, their awareness of household food waste was increased, which positively impacted on their savings from reduced food waste.

Nutrient loss

In this study, nutritional loss from household food waste was calculated using the weighed food waste audit data and the South African food composition database for the whole study group and by intervention groups to determine the intervention effect of on nutritional loss through household food waste. The findings of the study demonstrated a high nutrient loss from the household food waste audit at baseline and a significant reduction of macro- and micronutrient nutrient loss at the endline for the whole study group and across intervention groups.

Environmental impact

In this study, the environmental impact of household food waste was calculated using weighed food waste audit data at baseline and endline for the whole study group and by intervention group to determine the intervention effect on the environmental impact of household food waste. The findings of the study demonstrated a high reduction in environmental CO₂e emissions from the household food waste audit from baseline to endline for the whole group and across intervention groups.

Objective 3: To determine the intervention effect on household food waste.

In this study, through a three-arm RCT, a significant reduction of household food waste was observed, for the whole group and across intervention groups. It can be extrapolated from the findings of the RCT that regardless of the intervention and treatment group, household food waste reduction and the associated benefits were noted across intervention groups, implying that monitoring of household food waste through the food waste audit was more impactful than the intervention treatment.

5.3 Strengths of the study

This study had several strengths:

- Weighed food waste audits of household food waste were conducted on a household-by-household basis over a two-week period at baseline and at endline, allowing for accuracy of household food waste, identification of specific food items that were wasted, and the traceability of food waste to individual households.
- The weighed food waste audit data enabled the calculation of the environmental impact and economic and nutrient loss of household food waste.
- The design and content of the food literacy toolkit were based on the findings of the formative results of the project, which determined investigating the behaviour and practices of household food waste disposal of consumers in the KwaDukuza municipality, South Africa (Pal *et al.* 2023:1)
- Trained fieldworkers conducted the food waste audit.

5.4 Limitations of the study

Despite the strengths of this study, it is important to acknowledge the following potential limitations of the study:

- The study's findings are representative of middle and high LSM households in the KDM and may not be representative of the broader South African population.

- Food prepared, purchased, and eaten at hotels and restaurants, and fed to animals was not included in the study.
- The recruiting process for households was challenging since the majority of households were not interested and there is a likelihood that participants who participated in the study showed greater awareness of food waste and environmental concerns than the wider population.
- The voluntary nature of participation in this study may have led to some self-selection bias. It may be possible that some families with a pre-existing interest in and understanding of food waste chose to participate.
- Participants were aware that their waste was being audited. Participants in intervention groups and, in particular, in the control group, may have altered their behaviour during the study, consciously or subconsciously, knowing that their food waste was being monitored. Despite indicating that households should exhibit normal behaviour and practices of household food waste during the intervention period, there could have been underreporting of the actual amount of food wasted, affecting the accuracy of the data.
- Household food waste collection was sometimes impacted by homeless people, dogs, vervet monkeys and municipal waste collectors who got to the bins before the research team.
- Since this study was conducted over one season, types of food waste recorded during the study had the potential to influence the dataset.

5.5 Recommendations

- The responsibility for addressing household food waste extends to various stakeholders, including retailers, consumers, and policymakers.
- Future research should include a similar study on households from the lower LSM.
- Cost-effective, multi-language household waste food literacy tools are needed.
- Retailers must adopt responsible practices in promoting bulk buying of perishable foods such as fruit and vegetables. Promotions on perishable items inadvertently contribute to household food waste. Consumers are enticed by the lower per-unit cost but cannot consume the bulk purchase in time, which may result in food waste. Instead, retailers should offer the unit cost at the same lower price as bulk prices, supporting the correct supply and demand of foods within the food system.
- The impact of the home environment, nutrition loss, and economic impact on food waste types, volumes, and disposal practices also warrant further research.
- Communities should consider starting community fridges [a space that allows excess food to be shared with the local community] to redirect household food waste to those who are in need.

5.6 Conclusion

This study shows a clear linkage between household food waste, nutrition, economic and environmental impact. This study will serve as a foundation for future research in reducing household food waste at a

community level. The disposal of food waste from households has a substantial and wide-ranging effect on the food chain, leading to various economic, environmental, and social challenges. At the environmental level, the process of organic waste decomposition in landfills generates methane, which is a highly potent greenhouse gas that contributes to the phenomenon of climate change. Moreover, the use of resources towards the cultivation, production, and transportation of the lost food signifies a waste of energy, water, and land. From an economic standpoint, food waste results in losses for producers and consumers alike because the production and distribution of food that is not consumed adds expenses to the whole supply chain. Furthermore, the social ramifications of food waste are enormous, given the striking difference between the significant amounts wasted in affluent households and the prevalent hunger and food insecurity in many communities. In order to create a food system that is more environmentally friendly and able to withstand challenges, it is crucial to focus on and decrease the amount of food wasted in households. This requires a combined initiative of educating consumers, implementing effective waste management practices, and enacting legislation that encourages responsible consumption.

REFERENCES

- Abiad, M. G. and Meho, L. I. 2018. Food loss and food waste research in the Arab world: a systematic review. *Food Security*, 10: 311-322. Available: <https://doi.org/10.1007/s12571-018-0782-7> (Accessed 15 January 2023).
- Adhikari, B. K., Barrington, S. and Martinez, J. 2006. Predicted growth of world urban food waste and methane production. *Waste Management & Research: The Journal for a Sustainable Circular Economy*, 24(5): 421-433. Available: <https://doi.org/10.1177/0734242X06067767> (Accessed 12 April 2023).
- Aleluia, J. and Ferrão, P. 2016. Characterization of urban waste management practices in developing Asian countries: a new analytical framework based on waste characteristics and urban dimension. *Waste Management*, 58: 415-429. Available: <https://doi.org/10.1016/j.wasman.2016.05.008> (Accessed 07 March 2023).
- Almanasreh, E., Moles, R. and Chen, T. F. 2019. Evaluation of methods used for estimating content validity. *Research in Social and Administrative Pharmacy*, 15(2): 214-221. Available: <https://doi.org/10.1016/j.sapharm.2018.03.066> (Accessed 28 March 2023).
- Amirudin, N. and Gim, T. T. 2019. Impact of perceived food accessibility on household food waste behaviors: a case of the Klang Valley, Malaysia. *Resources, Conservation and Recycling*, 151: 104335. Available: <https://doi.org/10.1016/j.resconrec.2019.05.011> (Accessed 10 January 2022).
- Aschemann-Witzel, J., de Hooge, I., Amani, P., Bech-Larsen, T. and Oostindjer, M. 2015. Consumer-related food waste: causes and potential for action. *Sustainability*, 7(6): 6457-6477. Available: <https://doi.org/10.3390/su7066457> (Accessed 05 March 2023).
- 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: 29-39. Available: <https://doi.org/10.1016/j.foodqual.2018.01.020> (Accessed 25 March 2023).
- Attiq, S., Habib, M. D., Kaur, P., Hasni, M. J. S. and Dhir, A. 2021. Drivers of food waste reduction behaviour in the household context. *Food Quality and Preference*, 94: 1-11. Available: <https://doi.org/10.1016/j.foodqual.2021.104300> (Accessed 25 March 2023).
- Barrera, E. L. and Hertel, T. 2021. Global food waste across the income spectrum: Implications for food prices, production and resource use. *Food Policy*, 98: 1-16. Available: <https://doi.org/10.1016/j.foodpol.2020.101874> (Accessed 14 February 2023).

Begley, A., Paynter, E. and Dhaliwal, S. S. 2018. Evaluation Tool Development for Food Literacy Programs. *Nutrients*, 10(11): 1-15. Available: <https://doi.org/10.3390/nu10111617> (Accessed 16 January 2022).

Bessa, L., Aganga, O. and Monthe, B. 2021. *Turning Africa's food waste problem into a regenerative opportunity*. Available: <https://climatechampions.unfccc.int/turning-africas-food-waste-problem-into-a-regenerative-opportunity/> (Accessed 10 March 2023).

Bloemhof, J. M., Soysal, M. 2017. Sustainable food supply chain design. In: Bouchery, Y., Corbett, C., Fransoo, J. and Tan, T. eds. *Sustainable supply chains: a research-based textbook on operations and strategy*. Springer: Cham, 395-412. Available: https://doi.org/10.1007/978-3-319-29791-0_18 (Accessed 11 January 2023).

Boulet, M., Hoek, A. C. and Raven, R. 2021. Towards a multi-level framework of household food waste and consumer behaviour: untangling spaghetti soup. *Appetite*, 156: 1-12. Available: <https://doi.org/10.1016/j.appet.2020.104856> (Accessed 01 March 2023).

Brand, C., Bricas, N., Conaré, D., Daviron, B., Debru, J., Michel, L. and Soulard, C. eds. 2017. *Designing urban food policies: concepts and approaches*. Switzerland: Springer Nature Switzerland AG. Available: <https://doi.org/10.1007/978-3-030-13958-2> (Accessed 22 January 2023).

Bräutigam, K., Jörissen, J. and Priefer, C. 2014. The extent of food waste generation across EU-27: different calculation methods and the reliability of their results. *Waste Management & Research: The Journal for a Sustainable Circular Economy*, 32(8): 683-694. Available: <https://doi.org/10.1177/0734242X14545374> (Accessed 11 February 2023).

Bravi, L., Francioni, B., Murmura, F. and Savelli, E. 2020. Factors affecting household food waste among young consumers and actions to prevent it. a comparison among UK, Spain and Italy. *Resources, Conservation and Recycling*, 153:1-13. Available: <https://doi.org/10.1016/j.resconrec.2019.104586> (Accessed 05 March 2023).

Buttlar, B., Löwenstein, L., Geske, M., Ahlmer, H. and Walther, E. 2021. Love food, hate waste? ambivalence towards food fosters people's willingness to waste food. *Sustainability*, 13(7): 1-24. Available: <https://doi.org/10.3390/su13073971> (Accessed 22 February 2023).

Buzby, J. C. and Hyman, J. 2012. Total and per capita value of food loss in the United States. *Food Policy*, 37(5): 561-570. Available: <https://doi.org/10.1016/j.foodpol.2012.06.002> (Accessed 07 March 2023).

Cardoen, D., Joshi, P., Diels, L., Sarma, P. M. and Pant, D. 2015. Agriculture biomass in India: part 2. post-harvest losses, cost and environmental impacts. *Resources, Conservation and Recycling*, 101: 143-153. Available: <https://doi.org/10.1016/j.resconrec.2015.06.002> (Accessed 18 January 2023).

Cattaneo, A., Sánchez, M. V., Torero, M. and Vos, R. 2021. Reducing food loss and waste: five challenges for policy and research. *Food Policy*, 98: 1-9. Available: <https://doi.org/10.1016/j.foodpol.2020.101974> (Accessed 25 January 2023).

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): 1-20. Available: <https://doi.org/10.1371/journal.pone.0189407> (Accessed 05 February 2022).

Comber, R. and Thieme, A. 2013. Designing beyond habit: opening space for improved recycling and food waste behaviors through processes of persuasion, social influence and aversive affect. *Personal and Ubiquitous Computing*, 17: 1197-1210. Available: <https://doi.org/10.1007/s00779-012-0587-1> (Accessed 18 March 2023).

Council for Scientific and Industrial Research (CSIR). 2021. *45% of available food supply in South Africa wasted, shows new CSIR study*. Available: <https://www.csir.co.za/food-supply-south-africa-wasted-shows-new-csir-study> (Accessed 29 March 2023).

Cox, J. and Downing, P. 2007. *Food behaviour consumer research: quantitative phase*. Available: <https://wrap.org.uk/sites/default/files/2020-12/Food-behaviour-consumer-research-quantitative-phase.pdf> (Accessed 02 March 2023).

Cronjé, N., Müller, I. and Van der Merwe, I. 2018. Household food waste : a case study in Kimberley, South Africa. *Journal of Consumer Sciences*, 46(1): 1-9. Available: <https://journals.co.za/doi/epdf/10.10520/EJC-105276040d> (Accessed 07 March 2022).

Cucurachi, S., Scherer, L., Guinée, J. and Tukker, A. 2019. Life cycle assessment of food systems. *One Earth*, 1(3): 292-297. Available: <https://doi.org/10.1016/j.oneear.2019.10.014> (Accessed 19 March 2023).

Dada, O. R. and Mbohwa, C. 2016. *Municipal solid waste from landfills a solution to energy crisis in South Africa*. Available: <https://ujcontent.uj.ac.za/esploro/outputs/conferencePaper/Municipal-solid-waste-from-landfills-a/9910559007691/filesAndLinks?index=0> (Accessed 21 February 2023).

de Lange, W. and Nahman, A. 2015. Costs of food waste in South Africa: incorporating inedible food waste. *Waste Management*, 40: 167-172. Available: <https://doi.org/10.1016/j.wasman.2015.03.001> (Accessed 28 January 2023).

Department of Statistics South Africa. 2022. *South Africa's youth continues to bear the burden of unemployment*. Available: <https://www.statssa.gov.za/?p=15407> (Accessed 11 February 2023).

Department of Environmental Affairs (DEA). 2023. *Chapter 13 Waste management*. Available: https://www.dffe.gov.za/sites/default/files/reports/environmentoutlook_chapter13.pdf (Accessed 11 February 2023).

Dhir, A., Talwar, S., Kaur, P. and Malibari, A. 2020. Food waste in hospitality and food services: a systematic literature review and framework development approach. *Journal of Cleaner Production*, 270: 1-16. Available: <https://doi.org/10.1016/j.jclepro.2020.122861> (Accessed 10 January 2023).

Di Talia, E., Simeone, M. and Scarpato, D. 2019. Consumer behaviour types in household food waste. *Journal of Cleaner Production*, 214: 166-172. Available: <https://doi.org/10.1016/j.jclepro.2018.12.216> (Accessed 08 March 2023).

Dora, M., Wesana, J., Gellynck, X., Seth, N., Dey, B. and De Steur, H. 2020. Importance of sustainable operations in food loss: evidence from the Belgian food processing industry. *Annals of Operations Research*, 290: 47-72. Available: <https://doi.org/10.1007/s10479-019-03134-0> (Accessed 19 February 2023).

Dowling, M., Kibaara, S., Chowdhury, S. and Chowdhury, S. P. 2012. *Economic feasibility analysis of electricity generation from landfill gas in South Africa*. Available: https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=6401430&casa_token=NSjIVSbBPY8AAAAA:1rdL3H3ZhJLQv0FN4XiUklGiIDAq_A-cNBseO_EOjLm7mynRIGPnymcdi3SnfNaoEXYKYUWiPFU (Accessed 21 February 2023).

Eggersdorfer, M., Kraemer, K., Cordaro, J. B., Fanzo, J., Kennedy, E., Labrique, A. A. and Steffen, J. 2016. eds. *Good nutrition: perspectives for the 21st century*. 1st ed. Switzerland: S Karger Ag.

Elsheekh, K. M., Kamel, R. R., Elsherif, D. M. and Shalaby, A. M. 2021. Achieving sustainable development goals from the perspective of solid waste management plans. *Journal of Engineering and Applied Science*, 68(9): 1-15. Available: <https://doi.org/10.1186/s44147-021-00009-9> (Accessed 01 March 2023).

Fabi, C., Cachia, F., Conforti, P., English, A. and Moncayo, J. R. 2021. Improving data on food losses and waste: from theory to practice. *Food Policy*, 98: 1-11. Available: <https://doi.org/10.1016/j.foodpol.2020.101934> (Accessed 15 January 2023).

Fan, L., Ellison, B. and Wilson, N. L. W. 2022. What food waste solutions do people support?. *Journal of Cleaner Production*, 330: 1-13. Available: <https://doi.org/10.1016/j.jclepro.2021.129907> (Accessed 05 March 2023).

Farr-Wharton, G., Choi, J. H. and Foth, M. 2014. *Food talks back: exploring the role of mobile applications in reducing domestic food wastage*. New York: Association for Computing Machinery. Available: <https://doi.org/10.1145/2686612.2686665> (Accessed 10 February 2023).

Filimonau, V. and Coteau, D. A. 2019. Food waste management in hospitality operations: a critical review. *Tourism Management*, 71: 234-245. Available: <https://doi.org/10.1016/j.tourman.2018.10.009> (Accessed 19 March 2023).

Food and Agriculture Organization (FAO) and Asian Productivity Organization. 2006. *Improving postharvest management and marketing in the Asia-Pacific region: issues and challenges: postharvest management of fruit and vegetables in the Asia-Pacific region*. Rome: Food and Agriculture Organization (FAO) and Asian Productivity Organization. Available: [https://www.apo-tokyo.org/wp-content/uploads/2015/11/e-edition Postharvest-MGT-of-Fruit-and-Vegetables.pdf#page=27](https://www.apo-tokyo.org/wp-content/uploads/2015/11/e-edition_Postharvest-MGT-of-Fruit-and-Vegetables.pdf#page=27) (Accessed 23 February 2023).

Food and Agriculture Organization. 2006. *Food security*. Available: https://www.fao.org/fileadmin/templates/faoitaly/documents/pdf/pdf_Food_Security_Cocept_Note.pdf (Accessed 05 April 2023).

Food and Agriculture Organization of the United Nations. 2011. *Global food losses and food waste: extent, causes and prevention*. Rome: Food and Agriculture Organization. Available: <https://www.fao.org/3/mb060e/mb060e.pdf> (Accessed 16 January 2023).

Food and Agriculture of the United Nations. 2013. *Toolkit: reducing the food wastage footprint*. Available: <https://www.fao.org/3/i3342e/i3342e.pdf> (Accessed 15 March 2023).

Food and Agriculture of the United Nations. 2017. *Food loss and waste in the food supply chain*. Available: <https://www.fao.org/3/bt300e/bt300e.pdf> (Accessed 17 March 2023).

Food and Agriculture Organization of the United Nations. 2019. *The state of food and agriculture: moving forward on food loss and waste reduction*. Rome: Food and Agriculture Organization of the United Nations. Available: https://www.agri-peri.ac.ir/dorsapax/Data/Sub_0/File/FAO-The%20State%20of%20Food%20and%20Agriculture%202019.pdf (Accessed 17 January 2023).

Food and Agricultural Organisation (FAO) and World Health Organization (WHO). 2019. *sustainable healthy diets guiding principles*. Rome: Food and Agriculture Organization of the United Nations. Available: <https://www.fao.org/3/ca6640en/ca6640en.pdf> (Accessed 18 January 2023).

Food and Agriculture of the United Nations. 2022. *UN Report: Global hunger numbers rose to as many as 828 million in 2021*. Available: <https://www.fao.org/newsroom/detail/un-report-global-hunger-SOFI-2022-FAO/en> (Accessed 15 March 2023).

Food and Agriculture of the United Nations. 2023. *Food wastage: Key facts and figures*. Available: <https://www.fao.org/news/story/en/item/196402/icode/> (Accessed 14 March 2023).

Food and Agriculture of the United Nations. 2023b. *Hunger and food insecurity*. Available: <https://www.fao.org/hunger/en/> (Accessed 15 March 2023).

Food and Agriculture Organization of the United Nations. 2023c. *Food Wastage Footprint*. Available: <https://www.fao.org/nr/sustainability/food-loss-and-waste/en/#:~:text=Food%20waste%20refers%20to%20the.at%20a%20steep%20environmental%20price>. (Accessed 14 March 2023).

Giordano, C. and Franco, S. 2021. Household food waste from an international perspective. *Sustainability*, 13(9): 1-9. Available: <https://doi.org/10.3390/su13095122> (Accessed 22 February 2023).

Godfray, H. C. J., Beddington, J. R., Crute, I. R., Haddad, L., Lawrence, D., Muir, J. F., Pretty, J., Robinson, S., Thomas, S. M. and Toulmin, C. 2010. Food security: the challenge of feeding 9 billion people. *Science*, 327(5967): 812-818. Available: <https://doi.org/10.1126/science.1185383> (Accessed 01 March 2023).

Godfrey, L., Muswema, A., Strydom, W., Mamafa, T. and Mapako, M., 2017. Co-operatives as a development mechanism to support job creation and sustainable waste management in South Africa. *Sustainability Science*, 12: 799-812. Available: <https://link.springer.com/article/10.1007/s11625-017-0442-4> (Accessed 03 March 2023).

Gooch, M., Matsubuchi-Shaw, M., Bucknell, D., LaPlain, D. and Kohler, L., 2022. Quantifying the carbon footprint of household food waste and associated GHGs in Oakville, Ontario, and a municipality's role in reducing both food waste and GHGs. *The Canadian Geographer/Le Géographe canadien*, 66(4):769-782. Available: <https://doi.org/10.1111/cag.12794> (Accessed 30 November 2023).

Graham-Rowe, E., Jessop, D. C. and Sparks, P. 2014. Identifying motivations and barriers to minimising household food waste. *Resources, Conservation and Recycling*, 84: 15-23. Available: <https://doi.org/10.1016/j.resconrec.2013.12.005> (Accessed 19 March 2023).

Grant, K., Gallardo, R. K. and McCluskey, J. J. 2019. *Are consumers willing to pay to reduce food waste?*. *Choices*, 34(1): 1-7. Available: <https://www.jstor.org/stable/26758663> (Accessed 02 March 2023).

Gupta, R. and Misra, A. K. 2014. Cross functional team for Integrated Solid Waste Management (ISWM) practices: an approach suitable for India and other developing countries. *Advances in Energy Engineering*, 2: 30-36. Available: [https://d1wqtxts1xzle7.cloudfront.net/48230605/AEE046_2_0_30_36-libre.pdf?1471899869=&response-content-disposition=inline%3B+filename%3DCross Functional Team for Integrated Sol.pdf&Expires=1701002222&Signature=ZtET0HRaXLzUrfHplz3N0efGBIWLTyn6AFIqxqBYwsYbKHyU9XAV8y0H8Lg6xnhXdJEMJHZGd33hgSURDcyRadkFPO0HSf9pnLEJdTg3DpLtzO0Lh4y18SjrZDWP5hth72KnJ95I058x](https://d1wqtxts1xzle7.cloudfront.net/48230605/AEE046_2_0_30_36-libre.pdf?1471899869=&response-content-disposition=inline%3B+filename%3DCross+Functional+Team+for+Integrated+Sol.pdf&Expires=1701002222&Signature=ZtET0HRaXLzUrfHplz3N0efGBIWLTyn6AFIqxqBYwsYbKHyU9XAV8y0H8Lg6xnhXdJEMJHZGd33hgSURDcyRadkFPO0HSf9pnLEJdTg3DpLtzO0Lh4y18SjrZDWP5hth72KnJ95I058x)

[M8m38xo5jklcih3Zz4p8uGMG7YuV1Chouaggvc-X-BJDfpUul5ezyHIAg-We7doG3glK8cdA707PArl7r-r4yM9U8PqyNpv5ZqXbOobMQxQpt~ZmQJ3jRjzpu5p6UQ8EwFjlm88D5wtDygCZ4VbceMIFwhRCt9Tz0NJZ9oo7qPetln9L2kbg3mqQiU6wDK7N2qvmVFIA &Key-Pair-Id=APKAJLOHF5GGSLRBV4ZA](https://www.fao.org/docrep/014/mb060e/mb060e00.pdf)
(Accessed 29 March 2023).

Gustavsson, J., Cederberg, C., Sonesson, U., Van Otterdijk, R. and Meybeck, A., 2011. Global food losses and food waste. *Food and Agriculture Organization of the United Nations*: 1-12. Available: <http://www.fao.org/docrep/014/mb060e/mb060e00.pdf> (Accessed 12 June 2023).

Hamilton, C., Denniss, R. and Baker, D. 2005. *Wasteful consumption in Australia*. Available: https://australiainstitute.org.au/wp-content/uploads/2020/12/DP77_8.pdf (Accessed 05 March 2023).

Hammond, S. T., Brown, J. H., Burger, J. R., Flanagan, T. P., Fristoe, T. S., Mercado-Silva, N., Nekola, J. C. and Okie, J. G. 2015. Food spoilage, storage, and transport: implications for a sustainable future. *BioScience*, 65(8): 758-768. Available: <https://doi.org/10.1093/biosci/biv081> (Accessed 02 February 2023).

Hanson, C., Lipinski, B., Robertson, K., Dias, D., Gavilan, I., Gréverath, P., Ritter, S., Fonseca, J., VanOtterdijk, R., Timmermans, T. and Lomax, J., 2016. *Food loss and waste accounting and reporting standard*. Available: <https://policycommons.net/artifacts/1360255/food-loss-and-waste-accounting-and-reporting-standard/1973602> (Accessed 30 November 2023).

Heale, R. and Twycross, A. 2015. Validity and reliability in quantitative studies. *Evidence-Based Nursing*, 18(3): 66-67. Available: <http://dx.doi.org/10.1136/eb-2015-102129> (Accessed 10 February 2023).

Hebrok, M. and Heidenstrøm, N. 2019. Contextualising food waste prevention - decisive moments within everyday practices. *Journal of Cleaner Production*, 210: 1435-1448. Available: <https://doi.org/10.1016/j.jclepro.2018.11.141> (Accessed 03 March 2023).

Hoorweg, D. and Bhada-Tata, P. 2012. *What a waste: a global review of solid waste management*. Washington, DC: World Bank. Available: <https://openknowledge.worldbank.org/bitstreams/d0f9aa7d-df54-514a-996c-af0992ba01b5/download> (Accessed 03 March 2023).

Jribi, S., Ismail, H. B., Doggui, D. and Debbabi, H. 2020. COVID-19 virus outbreak lockdown: what impacts on household food wastage?. *Environment, Development and Sustainability*, 22: 3939-3955. Available: <https://doi.org/10.1007/s10668-020-00740-y> (Accessed 20 February 2023).

Joardder, M. U. H. and Masud, M. H. 2019. Correction to: food preservation in developing countries: challenges and solutions. In: *Food preservation in developing countries: challenges and solutions*.

Springer, Cham. Available: https://doi.org/10.1007/978-3-030-11530-2_11 (Accessed 17 November 2023).

Johnson, L. K., Bloom, J. D., Dunning, R. D., Gunter, C. C., Boyette, M. D. and Creamer, N. G. 2019. Farmer harvest decisions and vegetable loss in primary production. *Agricultural Systems*, 176: 1-11. Available: <https://doi.org/10.1016/j.agsy.2019.102672> (Accessed 16 January 2023).

Jörissen, J., Priefer, C. and Bräutigam, K. 2015. Food waste generation at household level: results of a survey among employees of two European research centers in Italy and Germany. *Sustainability*, 7(3): 2695-2715. Available: <https://doi.org/10.3390/su7032695> (Accessed 16 February 2023).

Karwowska, M., Łaba, S. and Szczepański, K. 2021. Food loss and waste in meat sector—why the consumption stage generates the most losses?. *Sustainability*, 13(11): 1-13. Available: <https://doi.org/10.3390/su13116227> (Accessed 18 November 2023).

Kavanaugh, M. and Quinlan, J. J. 2020. Consumer knowledge and behaviors regarding food date labels and food waste. *Food Control*, 115: 1-5. Available: <https://doi.org/10.1016/j.foodcont.2020.107285> (Accessed 22 February 2023).

Khalid, S., Naseer, A., Shahid, M., Shah, G.M., Ullah, M.I., Waqar, A., Abbas, T., Imran, M. and Rehman, F., 2019. Assessment of nutritional loss with food waste and factors governing this waste at household level in Pakistan. *Journal of cleaner production*, 206: 1015-1024. Available: <https://www.sciencedirect.com/science/article/pii/S0959652618328610#sec4> (Accessed 30 November 2023).

Kibler, K. M., Reinhart, D., Hawkins, C., Motlagh, A. M. and Wright, J. 2018. Food waste and the food-energy-water nexus: a review of food waste management alternatives. *Waste Management*, 74: 52-62. Available: <https://doi.org/10.1016/j.wasman.2018.01.014> (Accessed 18 January 2023).

Koivupuro, H., Hartikainen, H., Silvennoinen, K., Katajajuuri, J., 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: 183-191. Available: <https://doi.org/10.1111/j.1470-6431.2011.01080.x> (Accessed 05 March 2023).

Krisjanti, M. N. and Quita, A. G. 2020. Food shopping behavior: a long way to prevent food waste. *Media Ekonomi dan Manajemen*, 35(1): 92-99. Available: <http://dx.doi.org/10.24856/mem.v35i1.1251> (Accessed 28 February 2023).

Kummu, M., de Moel, H., Porkka, M., Siebert, S., Varis, O. and Ward, P. J. 2012. Lost food, wasted resources: global food supply chain losses and their impacts on freshwater, cropland, and fertiliser use. *Science of The Total Environment*, 438: 477-489. Available: <https://doi.org/10.1016/j.scitotenv.2012.08.092> (Accessed 03 February 2023).

Lephaila, D. 2021. Five food waste facts that are hard to swallow. *World Wide Fund for Nature* (blog). Available:

https://www.wwf.org.za/our_news/our_blog/five_food_waste_facts_that_are_hard_to_swallow/

(Accessed 05 February 2022).

Leverenz, D., Moussawel, S., Maurer, C., Hafner, G., Schneider, F., Schmidt, T. and Kranert, M. 2019. Quantifying the prevention potential of avoidable food waste in households using a self-reporting approach. *Resources, Conservation and Recycling*, 150: 1-10. Available:

<https://doi.org/10.1016/j.resconrec.2019.104417> (Accessed 27 February 2021).

Liliane, T. N. and Charles, M. S. 2020. Factors Affecting Yield of Crops. In: Khan, A. ed. *Agronomy: climate change & food security*. United Kingdom: IntechOpen, 1-16. Available:

<https://www.intechopen.com/chapters/70658> (Accessed 10 March 2023).

Lipinski, B., Hanson, C., Lomax, J., Kitinoja, L., Waite, R. and Searchinger, T. 2013. *Reducing food loss and waste: creating a sustainable food future, installment two*. Washington, DC: World Resources Institute. Available: https://files.wri.org/d8/s3fs-public/reducing_food_loss_and_waste.pdf (Accessed 10 March 2022).

Luo, N., Olsen, T. L. and Liu, Y. 2021. A conceptual framework to analyze food loss and waste within food supply chains: an operations management perspective. *Sustainability*, 13(2): 1-21. Available:

<https://doi.org/10.3390/su13020927> (Accessed 16 February 2023).

Mallinson, L. J., Russell, J. M. and Barker, M. E. 2016. Attitudes and behaviour towards convenience food and food waste in the United Kingdom. *Appetite*, 103: 17-28. Available:

<https://doi.org/10.1016/j.appet.2016.03.017> (Accessed 02 March 2023).

Marx-Pienaar, N., Du Rand, G., Viljoen, A. and Fisher, H. 2019. Food wastage: a concern across the South African quick service restaurant supply chain. *Waste Management and the Environment IX*, 237: 237-243. Available:

https://www.academia.edu/63692872/Food_Wastage_A_Concern_Across_the_South_African_Quick_Service_Restaurant_Supply_Chain (Accessed 18 March 2022).

Map Of.net.(image) available: <https://municipalities.co.za/provinces/view/4/kwazulu-natal> (Accessed 18 March 2022).

Mathee, L. M. 2020. Exploring household behaviour contributing to food waste in Mangaung, Free State. Master of Science in Consumer Science, University of the Free State. Available: <https://scholar.ufs.ac.za/items/a2125b4e-0786-452a-920c-66e8cea1c874> (Accessed 18 March 2022).

May, J. 2021. Food security, hunger, and stunting in South Africa. In: Oqubay, A., Tregenna, F. and Valodia, I. eds. *The Oxford Handbook of the South African Economy*. United Kingdom: Oxford University

Press, 823-843. Available: <https://doi.org/10.1093/oxfordhb/9780192894199.013.37> (Accessed 26 March 2023).

My Emissions Food Carbon Footprint Calculator (online). 2022. Available: <https://myemissions.green/food-carbon-footprint-calculator/> (Accessed 28 March 2023).

Mesiranta, N., Närvänen, E. and Mattila, M. 2022. Framings of food waste: how food system stakeholders are responsabilized in public policy debate. *Journal of Public Policy & Marketing*, 41(2): 144-161. Available: <https://doi.org/10.1177/07439156211005722> (Accessed 28 March 2023).

Mesterházy, Á., Oláh, J. and Popp, J. 2020. Losses in the grain supply chain: causes and solutions. *Sustainability*, 12(6): 1-18. Available: <https://doi.org/10.3390/su12062342> (Accessed 11 January 2023).

Mitha, S., Naidoo, S. and Thomas, D. 2017. *Referencing guide: DUT Harvard referencing style*. Available: <https://library.dut.ac.za/wp-content/uploads/2017/08/Referencing-Guide.pdf> (Accessed 17 March 2021).

Meyer, F., Reardon, T., Davids, T., Van der Merwe, M., Jordaan, D., Delpont, M. and Van Den Burgh, G., 2022. Hotspots of vulnerability and disruption in food value chains during COVID-19 in South Africa: industry-and firm-level “pivoting” in response. *Agrekon*, 61(1): 1-21. Available: <https://journals.co.za/doi/full/10.1080/03031853.2021.2007779#> (Accessed 12 March 2023).

Mohee, R. and Simelane, T. eds., 2015. *Future directions of municipal solid waste management in Africa*. Africa Institute of South Africa.

Mollat, M. C. 2014. ecological food sense: connections between food waste flows and food production in Enkanini informal settlement, Stellenbosch. Master of Philosophy in Sustainable Development, Stellenbosch University. Available: <https://scholar.sun.ac.za/server/api/core/bitstreams/51c3bb8d-8981-46c3-b55a-7e26777bef22/content> (Accessed 12 April 2023).

Moya, D., Aldás, C., Jaramillo, D., Játiva, E. and Kaparaju, P. 2017. Waste-to-energy technologies: an opportunity of energy recovery from municipal solid waste, using Quito - Ecuador as case study. *Energy Procedia*, 134: 327-336. Available: <https://doi.org/10.1016/j.egypro.2017.09.537> (Accessed 15 January 2023).

Muijs, D., West, M. and Ainscow, M., 2010. Why network? Theoretical perspectives on networking. *School effectiveness and school improvement*, 21(1): 5-26.

Nahman, A. and de Lange, W. 2013. Costs of food waste along the value chain: evidence from South Africa. *Waste Management*, 33(11): 2493-2500. Available: <https://doi.org/10.1016/j.wasman.2013.07.012> (Accessed 10 January 2022).

Nahman, A., de Lange, W., Oelofse, S. and Godfrey, L. 2012. The costs of household food waste in South Africa. *Waste Management*, 32(11): 2147-2153. Available: <https://doi.org/10.1016/j.wasman.2012.04.012> (Accessed 28 March 2023).

Nanda, S. and Abraham, J. 2013. Remediation of heavy metal contaminated soil. *African Journal of Biotechnology*, 12(21): 3099-3109. Available: <https://www.ajol.info/index.php/ajb/article/view/131630/121227> (Accessed 29 March 2023).

Nanda, S. and Berruti, F. 2021. Municipal solid waste management and landfilling technologies: a review. *Environmental Chemistry Letters*, 19: 1433-1456. Available: <https://doi.org/10.1007/s10311-020-01100-y> (Accessed 29 March 2023).

National Aeronautics and Space Administration (NASA). 2021. *What is the greenhouse effect?*. Available: <https://climatekids.nasa.gov/greenhouse-effect/> (Accessed 17 March 2021).

Nicastro, R. and Carillo, P. 2021. Food loss and waste prevention strategies from farm to fork. *Sustainability*, 13(10): 1-23. Available: <https://doi.org/10.3390/su13105443> (Accessed 22 January 2023).

Notten, P., Bole-Rentel, T. and Rambaran, N., 2014. Developing an understanding of the energy implications of wasted food and waste disposal. *Understanding the Food Energy Water Nexus. WWF-SA, South Africa*.

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(5/6): 1-6. Available: <https://doi.org/10.17159/sajs.2018/20170284> (Accessed 15 February 2021).

Oelofse, S., Nahman, A., Baig, M. B., Salemdeeb, R., Nizami, A. and Reynolds, C. 2020. Food waste within South Africa and Saudi Arabia. In: Reynolds, C., Soma, T., Spring, C. and Lazell, J. eds. *Routledge handbook of food waste*. 1st ed. London: Routledge, 207-224.

Oelofse, S. H. H. and Nahman, A. 2013. Estimating the magnitude of food waste generated in South Africa. *Waste Management & Research: The Journal for a Sustainable Circular Economy*, 31(1): 80-86. Available: <https://doi.org/10.1177/0734242X12457117> (Accessed 24 March 2023).

Okumus, B. 2020. How do hotels manage food waste? evidence from hotels in Orlando, Florida. *Journal of Hospitality Marketing & Management*, 29(3): 291-309. Available: <https://doi.org/10.1080/19368623.2019.1618775> (Accessed 03 March 2023).

Onethird. 2023. Food loss and food waste: what's the difference?. *Onethird* (blog). Available: <https://onethird.io/one-third-blogs/food-loss-and-food-waste-whats-the-difference> (Accessed 18 July 2023).

Pal, I., Naicker, A. and Grobbelaar, H. 2023. Investigating the behaviour and practices of household food waste disposal of consumers in the KwaDukuza municipality, South Africa. *Current Research in Nutrition and Food Science*, 11(3). Available: <https://bit.ly/3QX3ggv> (Accessed 15 November 2023).

Pan, D., Yang, J., Zhou, G. and Kong, F., 2020. The influence of COVID-19 on agricultural economy and emergency mitigation measures in China: A text mining analysis. *PloS one*, 15(10), p.e0241167. Available: <https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0241167> (Accessed 11 March 2023).

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 B: Biological Sciences*, 365(1554): 3065-3081. Available: <https://doi.org/10.1098/rstb.2010.0126> (Accessed 14 January 2023).

Papargyropoulou, E., Steinberger, J. K., Wright, N., Lozano, R., Padfield, R. and Ujang, Z. 2019. Patterns and causes of food waste in the hospitality and food service sector: food waste prevention insights from Malaysia. *Sustainability*, 11(21): 1-21. Available: <https://doi.org/10.3390/su11216016> (Accessed 11 February 2023).

Plastic SA .2017. *2017 plastics recycling figures released*. Available:https://www.plasticsinfo.co.za/wp-content/uploads/2019/09/2017-PLASTICS-RECYCLING-FIGURES-RELEASED_FINAL.pdf (Accessed 15 February 2023).

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: 43-51. Available: <https://doi.org/10.1016/j.resconrec.2013.04.011> (Accessed 02 March 2023).

Quested, T.E., Parry, A.D., Easteal, S. and Swannell, R., 2011. Food and drink waste from households in the UK. *Nutrition Bulletin*, 36(4): 460-467 Available: <https://doi.org/10.1111/j.1467-3010.2011.01924.x> (Accessed 15 March 2023).

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. Master of Science in Environmental Management, University of South Africa. Available: https://uir.unisa.ac.za/bitstream/handle/10500/21162/dissertation_ramukhwatho_fr.pdf?sequence=4&isAllowed=y (Accessed 15 February 2020).

Ramukhwatho, F., duPlessis, R. and Oelofse, S. 2017. Preliminary drivers associated with household food waste generation in South Africa. *Applied Environmental Education & Communication*, 17(3): 254-265. Available: <https://doi.org/10.1080/1533015X.2017.1398690> (Accessed 12 April 2023).

Rasche, A. 2020. The United Nations global compact and the sustainable development goals. In: Laasch, O., Suddaby, R., Freeman, R. E. and Jamali, D. eds. *Research Handbook of Responsible Management*. United Kingdom: Edward Elgar Publishing Limited, 228-241. Available: https://books.google.co.za/books?hl=en&lr=&id=6ifnDwAAQBAJ&oi=fnd&pg=PA228&dq=The+United+Nations+Global+Compact+and+the+Sustainable+Development+Goals&ots=kgreXvuXpj&sig=8vIN3L LqoYTLM8pKIQ-sAI75JJs&redir_esc=y#v=onepage&q=The%20United%20Nations%20Global%20Compact%20and%20the%20Sustainable%20Development%20Goals&f=false (Accessed 15 March 2023).

Reitemeier, M., Aheeyar, M. and Drechsel, P. 2021. Perceptions of food waste reduction in Sri Lanka's commercial capital, Colombo. *Sustainability*, 13(2): 1-16. Available: <https://doi.org/10.3390/su13020838> (Accessed 21 March 2023).

Richter, B. and Bokelmann, W. 2016. Approaches of the German food industry for addressing the issue of food losses. *Waste Management*, 48: 423-429. Available: <https://doi.org/10.1016/j.wasman.2015.11.039> (Accessed 08 February 2023).

Richter, B. 2017. Knowledge and perception of food waste among German consumers. *Journal of Cleaner Production*, 166: 641-648. Available: <https://doi.org/10.1016/j.jclepro.2017.08.009> (Accessed 08 February 2023).

Rodgers, R. F., Lombardo, C., Cerolini, S., Franko, D. L., Omori, M., Linardon, J., Guillaume, S., Fischer, L. and Fuller-Tyszkiewicz, M. 2021. "Waste not and stay at home" evidence of decreased food waste during the COVID-19 pandemic from the U.S. and Italy. *Appetite*, 160: 1-7. Available: <https://doi.org/10.1016/j.appet.2021.105110> (Accessed 15 March 2023).

Rowat, A. C., Soh, M., Malan, H., Jensen, L., Schmidt, L. and Slusser, W. 2021. Promoting an interdisciplinary food literacy framework to cultivate critical citizenship. *Journal of American College Health*, 69(4): 459-462. Available: <https://doi.org/10.1080/07448481.2019.1679149> (Accessed 28 March 2023).

Rust, R. 2022. Reducing food waste: the dietitian's role in helping the cause and strategies for counseling clients. *Today's Dietitian*, March 2022. Available: <https://www.todaysdietitian.com/newarchives/0322p36.shtml> (Accessed 29 March 2023).

Schanes, K., Dobernig, K. and Gözet, B. 2018. Food waste matters - a systematic review of household food waste practices and their policy implications. *Journal of Cleaner Production*, 182: 978-991. Available: <https://doi.org/10.1016/j.jclepro.2018.02.030> (Accessed 14 February 2023).

Schmidt, F. and Hunter, J., 2013. History, development, evolution, and impact of validity generalization and meta-analysis methods, 1975–2001. In *Validity Generalization*, Available: <https://books.google.co.za/books?hl=en&lr=&id=AvXOR2BaRTMC&oi=fnd&pg=PA31&dq=validity+by>

[+hunter+2013&ots=4HGbjt2fEt&sig=tyfFrerXyRRwcwXR65vIMcOnMGc&redir_esc=y#v=onepage&q=validity%20by%20hunter%202013&f=false](#) (Accessed 21 March 2023).

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: 1-14. Available: <https://doi.org/10.1016/j.resconrec.2018.07.023> (Accessed 08 March 2023).

Searchinger, T., Waite, R., Hanson, C., Ranganathan, J., Dumas, P. and Matthews, E. 2018. *Creating a sustainable food future: a menu of solutions to feed nearly 10 billion people by 2050 - synthesis report*. Washington, DC: World Resources Institute. Available: <https://apo.org.au/sites/default/files/resource-files/2018-12/apo-nid230536.pdf> (Accessed 26 March 2022).

Shafiee-Jood, M. and Cai, X. 2016. Reducing food loss and waste to enhance food security and environmental sustainability. *Environmental Science & Technology*, 50(16): 8432-8443. Available: <https://doi.org/10.1021/acs.est.6b01993> (Accessed 07 March 2023).

Sheahan, M. and Barret, C. B. 2017. Review: food loss and waste in Sub-Saharan Africa. *Food Policy*, 70: 1-12. Available: <https://doi.org/10.1016/j.foodpol.2017.03.012> (Accessed 22 January 2023).

Shisana, O., Labadarios, D., Rehle, T., Simbayi, L., Zuma, K., Dhansay, A., Reddy, P., Parker, W., Hoosain, E., Naidoo, P., Hongoro, C., Mchiza, Z., Steyn, N. P., Dwane, N., Makoae, M., Maluleke, T., Ramlagan, S., Zungu, N., Evans, M. G., Jacobs, L., Faber, M. and the SANHANES-1 Team. 2014. *The South African national health examination survey SANHANES-1*. Cape Town: HSRC Press. Available: <https://repository.hsra.ac.za/bitstream/handle/20.500.11910/2864/7844.pdf?sequence=1&isAllowed=y> (Accessed 11 March 2023).

Sirola, N., Sutinen, U., Närvänen, E., Mesiranta, N. and Mattila, M. 2019. Mottainai!—a practice theoretical analysis of Japanese consumers' food waste reduction. *Sustainability*, 11(23): 1-14. Available: <https://doi.org/10.3390/su11236645> (Accessed 15 February 2023).

Simelane, O.T. and SA, A., 2016, October. Implementing alternative waste treatment technologies: a comparative study of South Africa and the European Union. In *Proceedings of the 23rd WasteCon Conference*: 17-21.

Song, G., Li, M., Semakula, H.M. and Zhang, S., 2015. Food consumption and waste and the embedded carbon, water and ecological footprints of households in China. *Science of the Total Environment*, 529: 191-197. Available: <https://www.sciencedirect.com/science/article/pii/S0048969715301273> (Accessed 03 March 2023).

Song, Q., Li, J. and Zeng, X. 2015. Minimizing the increasing solid waste through zero waste strategy. *Journal of Cleaner Production*, 104: 199-210. Available: <https://doi.org/10.1016/j.jclepro.2014.08.027> (Accessed 08 February 2023).

South Africa, Department of Environment, Forestry and Fisheries and Council for Scientific and Industrial Research. 2021. *Food waste prevention & management: a guideline for South Africa*. Pretoria: Department of Environment, Forestry and Fisheries (DEFF) and Council for Scientific and Industrial Research (CSIR). Available: [https://www.csir.co.za/sites/default/files/Documents/Food%20waste%20prevention LANDSCAPE\(EDMS\)%20-%2005-02-2021.pdf](https://www.csir.co.za/sites/default/files/Documents/Food%20waste%20prevention%20LANDSCAPE(EDMS)%20-%2005-02-2021.pdf) (Accessed 29 April 2023).

South Africa, Department of Environmental Affairs. 2012. *National waste information baseline report*. Pretoria: Department of Environmental Affairs. Available: <http://sawic.environment.gov.za/documents/1567.docx> (Accessed 03 March 2023).

South Africa, Department of Science and Technology. 2013. *Waste research, development and innovation roadmap*. Pretoria: Department of Science and Technology. Available: https://www.dffe.gov.za/sites/default/files/docs/dst_waste_rdi_roadmap.pdf (Accessed 27 February 2023).

South Africa, Department of Science and Technology. 2014. *A national waste research, development (r&d) and innovation roadmap for South Africa: phase 2 waste RDI roadmap*. Pretoria: Department of Science and Technology. Available: https://wasteroadmap.co.za/wp-content/uploads/2020/03/trends_in_waste_management.pdf (Accessed 27 March 2023).

South Africa Waste Information Centre. 2015. *Alternative waste treatment technology project ingwenyama resort Mpumalanga province 9-11 March 2015*. Available: <https://sawic.environment.gov.za/documents/3959.pdf> (Accessed 21 February 2023).

Sundin, N., Osowski, C. P., Strid, I. and Eriksson, M. 2022. Surplus food donation: effectiveness, carbon footprint, and rebound effect. *Resources, Conservation and Recycling*, 181: 1-14. Available: <https://doi.org/10.1016/j.resconrec.2022.106271> (Accessed 11 March 2023).

Thi, N. B. D., Kumar, G. and Lin, C. 2015. An overview of food waste management in developing countries: current status and future perspective. *Journal of Environmental Management*, 157: 220-329. Available: <https://doi.org/10.1016/j.jenvman.2015.04.022> (Accessed 24 March 2023).

Toma, L., Font, M. C. and Thompson, B. 2020. Impact of consumers' understanding of date labelling on food waste behaviour. *Operational Research – An International Journal*, 20: 543-560. Available: <https://doi.org/10.1007/s12351-017-0352-3> (Accessed 10 February 2023).

Turvey, C., Moran, M., Sacheck, J., Arashiro, A., Huang, Q., Heley, K., Johnston, E. and Neff, R. 2021. Impact of messaging strategy on consumer understanding of food date labels. *Journal of Nutrition Education and Behavior*, 53(5): 389-400. Available: <https://doi.org/10.1016/j.jneb.2021.03.007> (Accessed 03 March 2023).

United Nations (UN). 2015. *Transforming our world: the 2030 agenda for sustainable development*. New York: United Nations. Available: <https://documents-dds-ny.un.org/doc/UNDOC/GEN/N15/291/89/PDF/N1529189.pdf?OpenElement> (Accessed 18 March 2023).

United Nations (UN). 2022. *Reducing food loss and waste: Taking Action to Transform Food Systems*. Available: <https://www.un.org/en/observances/end-food-waste-day> (Accessed 13 February 2023).

United Nations Environment Programme (UNEP). 2021. *UNEP food waste index report 2021*. Available: <https://www.unep.org/resources/report/unep-food-waste-index-report-2021> (Accessed 11 March 2023).

United States Environmental Protection Agency (USEPA). 2022. *Sustainable management of food basics*. Available: <https://www.epa.gov/sustainable-management-food/sustainable-management-food-basics> (Accessed 31 December 2022).

United States Environmental Protection Agency (USEPA). 2023. *International efforts on wasted food recovery*. Available: <https://www.epa.gov/international-cooperation/international-efforts-wasted-food-recovery> (Accessed 15 November 2023).

van der Werf, P., Seabrook, J. A. and Gilliland, J. A. 2019. Food for naught: using the theory of planned behaviour to better understand household food wasting behaviour. *The Canadian Geographer / Géographies canadiennes*, 63(3): 478-493. Available: <https://doi.org/10.1111/cag.12519> (Accessed 16 January 2022).

van der Werf, P., Seabrook, J. A. and Gilliard, J. A. 2021. "Reduce food waste, save money": testing a novel intervention to reduce household food waste. *Environment and Behavior*, 53(2): 151-183. Available: <https://doi.org/10.1177/0013916519875180> (Accessed 10 February 2023).

van Geffen, L., van Herpen, E., Sijtsema, S. and van Trijp, H. 2020. Food waste as the consequence of competing motivations, lack of opportunities, and insufficient abilities. *Resources, Conservation & Recycling: X*, 5: 1-10. Available: <https://doi.org/10.1016/j.rcrx.2019.100026> (Accessed 01 March 2023).

Van Geffen, L., van Herpen, E. and van Trijp, H., 2020. Household Food waste—How to avoid it? An integrative review. *Food waste management: Solving the wicked problem*: 1-28. Available: https://link.springer.com/chapter/10.1007/978-3-030-20561-4_2 (Accessed 01 March 2023).

van Herpen, E., van Geffen, L., Nijenhuis-de Vries, M., Holthuysen, N., van der Lans, I. and Quested, T. 2019. A validated survey to measure household food waste. *MethodsX*, 6: 2767-2775. Available: <https://doi.org/10.1016/j.mex.2019.10.029> (Accessed 09 March 2022).

Visschers, V. H. M., Wickli, N. and Siegrist, M. 2016. Sorting out food waste behaviour: a survey on the motivators and barriers of self-reported amounts of food waste in households. *Journal of Environmental Psychology*, 45: 66-78. Available: <https://doi.org/10.1016/j.jenvp.2015.11.007> (Accessed 01 March 2023).

Vittuari, M., Azzurro, P., Gaiani, S., Gheoldus, M., Burgos, S., Aramyan, L., Valeeva, N., Rogers, D., Östergren, K., Timmermans, T. and Bos-Brouwers, H. 2016. *Recommendations and guidelines for a common European food waste policy framework*. Bologna: FUSIONS. Available: <http://dx.doi.org/10.18174/392296> (Accessed 10 February 2023).

Von Massow, M., Parizeau, K., Gallant, M., Wickson, M., Haines, J., Ma, D.W., Wallace, A., Carroll, N. and Duncan, A.M., 2019. Valuing the multiple impacts of household food waste. *Frontiers in nutrition*, 6: 1-17. Available: <https://www.frontiersin.org/articles/10.3389/fnut.2019.00143/full> (Accessed 30 November 2023).

Wansink, B. 2018. Household food waste solutions for behavioral economists and marketers. *Journal of Food Products Marketing*, 24(5): 500-521. Available: <https://doi.org/10.1080/10454446.2018.1472694> (Accessed 24 March 2023).

Waste and Resources Action Programme (WRAP). 2009. *Household food and drink waste in the UK*. Banbury: Waste and Resources Action Programme. Available: <https://wrap.org.uk/sites/default/files/2020-12/Household-Food-and-Drink-Waste-in-the-UK-2009.pdf> (Accessed 09 March 2023).

Weber, C.L. and Matthews, H.S., 2009. Food-miles and the relative climate impacts of food choices in the United States. *Environmental Science & Technology* 42(10): 3481-3906. Available: <https://pubs.acs.org/doi/epdf/10.1021/es702969f> (Accessed 30 November 2023).

Williams, H., Wikström, F., Otterbring, T., Löfgren, M. and Gustafsson, A. 2012. Reasons for household food waste with special attention to packaging. *Journal of Cleaner Production*, 24: 141-148. Available: <https://doi.org/10.1016/j.jclepro.2011.11.044> (Accessed 19 March 2023).

World Bank (WB). 2023. *What is Food Security?*. Available: <https://www.worldbank.org/en/topic/agriculture/brief/food-security-update/what-is-food-security> (Accessed 11 September 2023).

World Wide Fund for Nature (WWF). 2017. *Food loss and waste: facts and futures: taking steps towards a more sustainable food future*. Switzerland: World Wide Fund for Nature (WWF). Available:

[http://awsassets.wwf.org.za/downloads/WWF Food Loss and Waste WEB.pdf](http://awsassets.wwf.org.za/downloads/WWF_Food_Loss_and_Waste_WEB.pdf) (Accessed 12 April 2023).

Yu, Q. and Li, H. 2020. Moderate separation of household kitchen waste towards global optimization of municipal solid waste management. *Journal of Cleaner Production*, 277: 1-11. Available: <https://doi.org/10.1016/j.jclepro.2020.123330> (Accessed 18 November 2023).

Zepeda, L. and Balaine, L. 2017. Consumers' perceptions of food waste: a pilot study of U.S. students. *International Journal of Consumer Studies*, 41(6): 627-637. Available: <https://doi.org/10.1111/ijcs.12376> (Accessed 14 January 2023).

Zielińska, D., Bilska, B., Marciniak-Łukasiak, K., Łepecka, A., Trząskowska, M., Neffe-Skocińska, K., Tomaszewska, M., Szydłowska, A. and Kołożyn-Krajewska, D. 2020. *International Journal of Environmental Research and Public Health*, 17(5): 1-19. Available: <https://doi.org/10.3390/ijerph17051632> (Accessed 12 January 2023).

Appendix A- Newspaper advertisement to recruit participants

NEWSPAPER ADVERTISEMENT

A research study titled “Intervention effect of food literacy on household food waste in the Kwa Dukuza Municipality” will be conducted in the KwaDukuza municipality. The aim of this study is to determine the intervention effect of food literacy on household food waste in the KwaDukuza municipality.

One hundred and eighty households in the KwaDukuza municipality will be randomly selected through informed consent to participate in the study, which will take place from September 2022 to December 2022. To determine household food waste, a weighed food audit will be conducted at each household at the start and end of the study. Thereafter, through random selection, 60 households will receive Intervention 1 with online food waste education lessons for one month (4 lessons), followed by two weeks of maintenance classes with text message support. Sixty households will receive Intervention 2. These households will receive the food waste tool kit and will have

to engage in self-directed learning. The remaining 60 households will be the control and will receive no intervention. After 6 weeks, a food waste audit will be conducted again.

Your participation will make a valuable contribution to our research findings, which is likely to lead to a great public understanding of household food waste.

If you are interested in learning more about the study or are willing to participate, please contact:

Principal researcher: Nosipho Miti, Masters candidate: Food and Nutrition Consumer

Sciences: cell number 0605274032 or nosiphomiti@gmail.com/ 21348606@dut4life.ac.za

Supervisor: Dr A. Naicker, PhD: Nutrition, email ashikan@dut.ac.za

Appendix B - Food weighed recording audit



Weighed Food Audit Sheet

Instructions for fieldworkers:

- Time limit- 15 minutes maximum per household.
- Please verify that the type of food waste is stored in the correct colour-coded bags.
- Please tare/ zero all scales before packets can be weighed.
- All cooked food waste (freezer bags) is to be placed into one large bin bag and weighed.
- Please record weight in kgs and to the nearest 2 decimal places.

Week no: 1

House no.		Individual items
Weight:	Type of food waste	
	Fresh produce waste/ dry goods (green bag)	
	Meat, fish and poultry waste (red waste)	
	Cooked food waste (clear/ black bag)	

	Total weight of waste in kgs (nearest 2 decimal place)	
--	--	--

Week no: 2

House no.		Individual items
Weight:	Type of food waste	
	Fresh produce waste/ dry goods (green bag)	
	Meat, fish and poultry waste (red waste)	
	Cooked food waste (clear/ black bag)	
	Total weight of waste in kgs (nearest 2 decimal place)	

Appendix C - Food waste labels for cooked food



**Freezer Bag Label –
Cooked Food Waste**

Instructions:

You have been issued freezer bags to collect your cooked food waste, please use the peel-and-stick labels below on these freezer bags.

- Please see an example of a completed label and complete the information below as best you can.
- Kindly put your cooked food into this freezer bag and freeze until the collection date.

Example of a cooked food label:

Name of dish:	Chicken Curry
Date dish was prepared:	09 February 2022
Number of servings put into freezer bag:	1
Main ingredients used to prepare dish:	150g mixed chicken portions ½ medium onion ½ medium tomato 20 g spices 20g green frozen peas

Name of dish:	
Date dish was prepared:	
Number of servings put into freezer bag:	
Main ingredients used to prepare dish:	



Title of study:

A randomised control trial to reduce household food waste in the KwaDukuza municipality

IREC number:

226/22

**FIELDWORKERS TRAINING MANUAL:
FOOD WASTE AUDIT**

INTRODUCTION TO THE STUDY

Purpose of The Study

This study aims to determine the intervention effect of food literacy on household food waste in the KwaDukuza municipality. In this randomised controlled trial, 180 households in the KwaDukuza municipality area will be systematically randomly selected to participate in the study through informed consent. This study is composed of two phases. The first phase, baseline assessments will include a food waste audit and calculation of the associated cost, nutrient losses and environmental impact of household food waste using the food waste audit results. In the second phase, households will be randomly allocated to intervention 1 (online food literacy lessons and a food waste tool kit), intervention 2 (food waste tool kit) or control. The intervention duration will be six weeks. The intervention effect, cost of food waste, nutritional loss and environmental impact will be calculated at endline. Implementation outcomes of the intervention will be assessed for reach, effectiveness, cost and sustainability for the purposes of scaling up intervention components to other communities in South Africa.

Aim

To determine the intervention effect of food literacy on household food waste in the KwaDukuza municipality

Specific Objectives

- To calculate household food waste through a weighed food waste audit at baseline and endline.
- To calculate the cost, associated nutrient losses and environmental impact of household food waste using the results of the food waste audit at baseline and endline.
- To determine the intervention effect on household food waste.
- To evaluate the implementation outcomes of intervention effectiveness for reach and cost.

Background and Context of the study

Food waste is a worldwide problem that is now gaining attention in light of food security problems and associated environmental concerns (Amirudin and Gim 2019: 104335). According to Ramukhwatho (2016: 42), roughly a third of the food that is produced around the world from farm to fork goes to waste, with an estimate of approximately 1,3 billion tonnes of food produced for human consumption per annum that is wasted. In a world where 26% of the population is food insecure and 28.3% is on the brink of starvation, wasting food seems unwise (Mathee 2020: 8). According to Marx-Pienaar (2019: 239), global food loss and waste are estimated to be around USD940 billion per year which translates to nearly three Trillion South African Rands. In addition, 90% of waste is disposed of in landfills, placing enormous stress on waste management, posing global environmental challenges.

In South Africa, 27 million tonnes of food is wasted, resulting in a loss of approximately R505 million (Mathee 2020: 5). Research to investigate household food waste in South Africa has gained momentum ranging from the sampling of municipal waste to self-reported food waste (Oelofse 2018: 5; Cronje 2018: 4; Ramukhwatho 2016 :8; Chakona and Shackleton 2017: 22). The study by Oelsefe (2018: 6) reported that an average of 0.48 kg (Ekurhuleni) and 0.69 kg (Johannesburg) of food waste (including indigestible parts) was thrown into the municipal bin per household per week in each municipality, respectively. This translates to per capita food waste disposal of 8 kg and 12 kg per annum, respectively in South Africa as compared to the 6–11 kg per annum in sub-Saharan Africa.

Whilst most studies have focused on baseline measurements of household food waste, intervention studies to reduce household food waste have been emerging. One such strategy to harness behavioural change towards household food waste is through food literacy interventions developing responsible food citizens. However, Nahman and De Lange (2013: 2493) state that, there is limited evidence on the exact impact of food literacy on household food waste, and hence there is an opportunity to research. Van Der Werf, Seabrook, and Gilliard (2019: 9) state that consumers lack food literacy which directly contributes to household food wastage. No intervention study to change consumer behaviour towards household food waste have been conducted in South Africa. Preventing household food waste will save money and has physical, social, and environmental benefits (Marx-Pienaar 2019: 240). It is within this context that this study is aimed at determining the intervention effect of food literacy on household food waste in the KwaDukuza municipality.

Research design:

This study is a randomised control intervention trial.

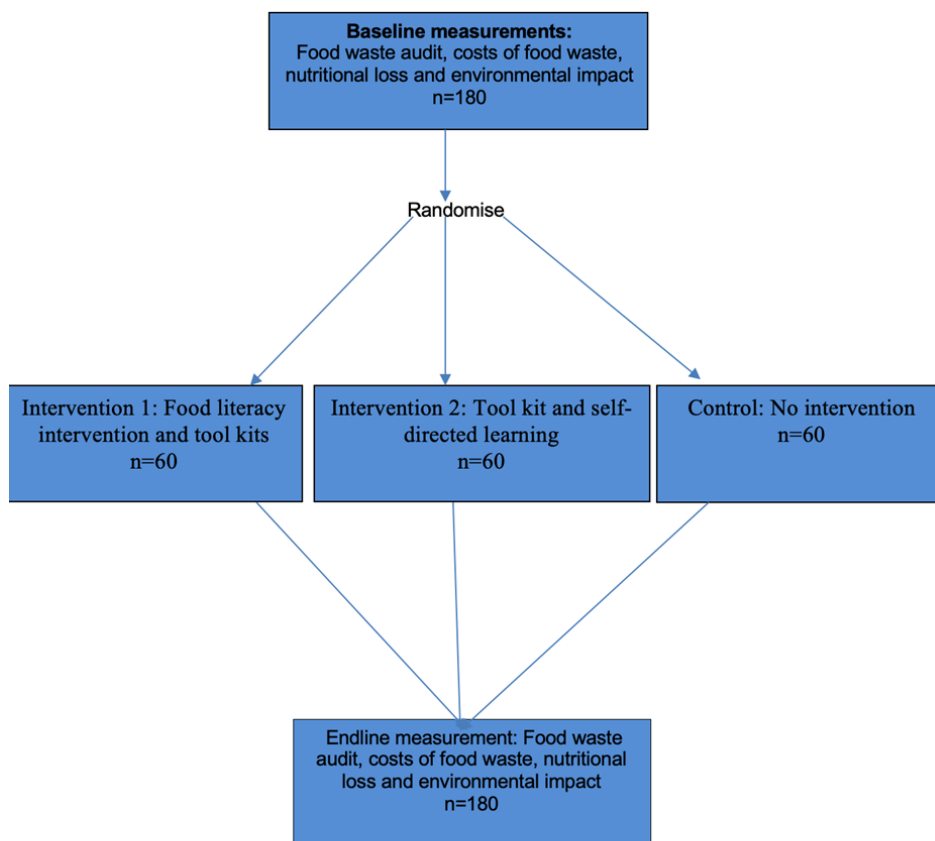


Figure 1: Planned flow of study

Eligibility criteria:

- Households in the KwaDukuza municipality.
- Participants must be 18 years and older and responsible for food purchase and/or food preparation in households.

Recruitment of households:

The study notice will be published in the local community newspaper. For the purpose of this study, five areas in the KwaDukuza municipality have been purposely selected; Ballito, Salt Rock, Tinley Manor, Blythedale Beach and Stanger Manor. These areas are serviced by the municipality with household waste removal between once or twice a week. Thereafter, every third house per street in the selected area will be systematically randomly selected until the sample size is reached. Households will be recruited through household visits or telephonically. Household food waste audits will be conducted with consenting households thereafter, households will be randomised into intervention group 1, intervention group 2 and control per area to minimise contamination of the intervention.

Data collection measurement tools:

a). Household food waste audit (n=180):

To determine household food waste, a weighed food audit will be conducted at each household at baseline and endline. Households will be requested to collect their food waste over a two-week period, each household will be provided with three x colour coded labelled bins and disposable bags; one x green bin and bag for fresh produce waste and dry goods, 1 x red bin and bag for fish, meat and poultry waste and one x clear/black bin and bag for cooked food/ leftover (participants will be required to collect and refrigerate/ freeze all cooked food in provided freezer bags and label the main ingredients from cooked food samples in order to deposit their food waste during this period. Refuse will be weighed in on days of refuse removal collectively and per item. Bags will be obtained from households, once a week, weighed and analysed (into avoidable and unavoidable food waste) by trained fieldworkers. The process will be repeated in week two.

b). Economic loss (n=180):

Food waste in (kgs) from the weighed food waste audit and will be analysed for economic loss using the mean price of foods from the largest retail store in the area to determine the Rand value of food waste at baseline and endline.

c). Nutritional losses (n=180):

Nutritional losses of food waste will be calculated using the South African Medical Research Council Food Finder 3 Software web-based version. In the cases where cooked food waste is presented, participants will be provided with labels to document the ingredients they used and the number of servings discarded in the bag.

d). Environmental impacts (n=180):

The environmental impacts will be calculated using the My emission and Plate up for the Planet carbon footprint calculators which estimates the amount of carbon dioxide (CO₂) produced per kg of specific food types including composite meals (My Emission 2022; Plate up for the Planet 2022).

e). Intervention (n=180):

One third of the households (n=60) will receive Intervention 1 which includes, online food waste education lessons for one month (4 lessons), followed by two weeks of maintenance classes with text messages support, dose tapered, totalling an intervention duration of six weeks. Food waste intervention studies reported a positive intervention effect for an intervention duration of four to six weeks (Pelt, Saint-Bauzel, Barbier, and Fointiat 2020: 3, Boulet et al., 2022). For Intervention 2, one third of the households (n= 60) will receive the food waste tool kit and will have to engage in self-directed learning. The remaining third of the of the households (n= 60) will be the control and will receive no intervention (Figure 1).

- Intervention 1 households will receive online food waste education lessons, including cook along lessons and a food waste tool kit: recipe book (2-1 recipes, zero waste recipes, refrigerator recipes), food waste fridge magnet, tips on reducing food waste, purchasing guide and labels.
- Intervention 2 households will receive a food waste toolkit: recipe book (2-1 recipes, zero waste recipes, refrigerator recipes), food waste fridge magnet, tips on reducing food waste, purchasing guide and labels.
- Control households will receive no intervention.

End line: After the six weeks of the intervention period. The food waste audit would be repeated. The following implementation outcomes will be assessed.

1. Reach (% of households attended the food waste education lessons)
2. Effectiveness (change in food waste)
3. Implementation cost (cost per food waste class/ cost per person, cost per tool kit)

FOOD WASTE AUDIT



Freezer Bag Label – Cooked Food Waste

Instructions:

You have been issued freezer bags to collect your cooked food waste, please use the peel and stick labels below on these freezer bags.

- Please see an example of a completed label and complete the information below as best you can.
- Kindly put your cooked food into this freezer bag and freeze until collection date.

Example of cooked food label:

Name of dish:	Chicken Curry
Date dish was prepared:	09 February 2022
Number of servings put into freezer bag:	1
Main ingredients used to prepare dish:	150g mixed chicken portions ½ medium onion ½ medium tomato 20 g spices 20g green frozen peas

Name of dish:	
Date dish was prepared:	
Number of servings put into freezer bag:	
Main ingredients used to prepare dish:	



Weighed Food Audit Sheet

Instructions for fieldworker:

- Time limit- 15 minutes maximum per household.
- Please verify that type of food waste stored in correct colour coded bags.
- Place your scale on a flat surface.
- Please tare/ zero all scales before packets can be weighed.
- All cooked food waste (freezer bags) is to be placed into one large bin bag and weighed.
- Please record weigh in kgs and to the nearest 2 decimal place.
- Please ensure that PPE is worn

Guidelines for using hanging scale- total weight of plastic bags:

1. Ensure that the plastic bag you are weighing has a secure handle or attachment for lifting.
2. Place the bag on a level surface.
3. Using the suspension hook on the scale, hook this around the object's handle.
4. Lift the object with the hand grip at the top of the hanging scale.
5. Check the LED screen on the scale for the object's weight- record results in kgs (2 decimal places) in the correct space provided.

Each food items needs to be weighed further as individual food items, and recorded in the spaces provided below-use flat/counter scale- method below:

- Place your scale on a flat surface.
- Turn the scale on- press the TARE or zero button. Place individual food sample on scale- record weight in kg rounding off to 2 decimal places.
- Please take a picture or record contents on cooked food label prior to disposal.
- Please record weigh in kgs and to the nearest 2 decimal place.
- Waste can be discarded in communal refuse bins or as instructed by Body Corporate/ Maintenance personnel- DO NOT CREATE A MESS.
- Please sanitise your hands after each households as well as wipe down your equipment as needed.
- Food waste collected from the households will be discarded via normal DSW refusal route.

- Bins will remain with the household till the endline phase of the study. After 6 weeks, final collection, with regards to week 1 collection of waste the households will hand over the liners and the field workers will discard of them.
- After endline week two of the audit, you will be instructed on how to issue vouchers to participants

Week no: 1

House no.		Individual items
Weight:	Type of food waste	
	Fresh produce waste/ dry goods (green bag)	
	Meat, fish and poultry waste (red waste)	
	Cooked food waste (clear/ black bag)	
	Total weight of waste in kgs (nearest 2 decimal place)	

Week no: 2

House no.		Individual items
Weight:	Type of food waste	
	Fresh produce waste/ dry goods (green bag)	

	Meat, fish and poultry waste (red waste)	
	Cooked food waste (clear/ black bag)	
	Total weight of waste in kgs (nearest 2 decimal place)	

REFERENCES

Amirudin, N. and Gim, T.H.T. 2019. Impact of perceived food accessibility on household food waste behaviors: A case of the Klang Valley, Malaysia. *Resources, Conservation and Recycling*, 151: 104335. Available: <https://www.sciencedirect.com/science/article/abs/pii/S0921344919302174> (Accessed 10 January 2022).

Boulet, M., Grant, W., Hoek, A. and Raven, R., 2022. Influencing across multiple levels: The positive effect of a school-based intervention on food waste and household behaviours. *Journal of Environmental Management*, 308, p.114681. Available: <https://doi.org/10.1016/j.jenvman.2022.114681> (Accessed 10 June 2022).

Chakona, G. and Shackleton, C.M. 2017. Local setting influences the quantity of household food waste in mid-sized South African towns. *Journal of Plos One*, 12(12): 22-26. Available: <https://doi.org/10.1371/journal.pone.0189407> (Accessed 25 January 2022).

Cronjé, N. 2018. Household food waste: A case study in Kimberley, South Africa. *Journal of Family Ecology and Consumer Sciences*, 46(1): 4-8. Available: <https://journals.co.za/doi/10.10520/EJC105276040>d (Accessed 20 January 2022).

Marx-Pienaar, N. 2019. Food Wastage: A concern across the South African quick service restaurant supply chain. *Journal of Waste Management and the Environment*, 231(1):237- 243. Available: <http://doi:10.2495/WM180221> (Accessed 22 February 2022).

Mathee, L.M. 2020. *Exploring household behaviour contributing to Food waste in Mangaung, Free State*. Bloemfontein: University of the Free State Bloemfontein. Available: <https://scholar.ufs.ac.za/xmlui/handle/11660/10665> (Accessed 27 January 2022).

My Emissions Food Carbon Footprint Calculator (online). 2022. Available: <https://myemissions.green/food-carbon-footprint-calculator/> (Accessed 25 February 2022).

Nahman, A. and de Lange, W. 2013. Costs of food waste along the value chain: Evidence from South Africa, *Waste Management*, 33 (11): 2493-2500 <https://doi.org/10.1016/j.wasman.2013.07.012> (Accessed 10 January 2022).

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 (5-6): 5-6. Available: <http://dx.doi.org/10.17159/sajs.2018/20170284> (Accessed 18 February 2022).

Pelt, A., Saint-Bauzel, R., Barbier, L. and Fointiat, V., 2020. Food waste: Disapproving, but still doing. An evidence-based intervention to reduce waste at household. *Resources, Conservation and Recycling*, 162, p.105059. Available: <https://reader.elsevier.com/reader/sd/pii/S0921344920303761?token=4D1D10A22BC71D1F4473D54BAFAC5FD7F3AC8C318BCC7AD3368AC2B198770E29999E9FBCA6DD40A04045D640C4D4C5A5C&originRegion=eu-west-1&originCreation=20220620195240> (Accessed 20 June 2022).

Plate Up for the Planet Carbon Calculator (online). 2022. Available: <https://assets.plateupfortheplanet.org/carbon-calculator/> (Accessed 25 February 2022).

Ramukhwatho, M. 2016. *An Assessment Of The Household Food Waste In A Developing Country: A Case Study Of Five Areas In The City Of Tshwane Metropolitan Municipality, Gauteng Province, South Africa*. Durban: University of South Africa. Available: http://uir.unisa.ac.za/bitstream/handle/10500/21162/dissertation_ramukhwatho_fr.pdf?sequence=4&isAllo_wed=y (Accessed 10 January 2022).

Van der Werf, P., Seabrook, J. A. and Gilliland, J. A. 2019. Food for naught: Using the theory of planned behaviour to better understand household food wasting behaviour. *The Canadian Geographer*. 63(3): 478-493. Available: <https://onlinelibrary.wiley.com/doi/epdf/10.1111/cag.12519> (Accessed 16 January 2022).

Appendix E- IREC approval letter



5 October 2022

Ms N N Miti

P.O. Box 2366 KwaDukuza 4450

Dear Ms Miti

Intervention effect of food literacy on household food waste in the KwaDukuza municipality

I am pleased to inform you that Full Approval has been granted to your proposal.

The Proposal has been allocated the following Ethical Clearance number IREC 226/22. Please use this number in all communication with this office.

Approval has been granted for a period of ONE YEAR, before the expiry of which you are required to apply for safety monitoring and annual recertification. Please use the Safety Monitoring and Annual Recertification Report form which can be found in the Standard Operating Procedures [SOP's] of the DUT-IREC. This form must be submitted to the DUT-IREC at least 3 months before the ethics approval for the study expires.

Any adverse events [serious or minor] which occur in connection with this study and/or which may alter its ethical consideration must be reported to the DUT-IREC according to the DUT-IREC SOP's.

Please note that any deviations from the approved proposal require the approval of the DUT-IREC as outlined in the DUT-IREC SOP's.

Yours Sincerely



Prof J K Adam

Chairperson: DUT-IREC

APPENDIX F- Letter of information and Informed consent



LETTER OF INFORMATION

Title of the Research Study:

A randomised control trial to reduce household food waste in the KwaDukuza municipality

Principal Investigator/s/researcher:

Nosipho Miti, BTech in Consumer Science: Food and Nutrition

Co-Investigator/s/supervisor/s:

Dr Ashika Naicker, PhD Nutrition, Dr H Grobbelaar, PhD Food and Nutrition

Brief Introduction and Purpose of the Study:

Good day Mam/ Sir

I am a Master's candidate in Consumer Science: Food and Nutrition at the Durban University of Technology. I would like to invite you to participate in the study titled, "A randomised control trial to reduce household food waste in the KwaDukuza Municipality". This study aims to determine the intervention effect of food literacy on household food waste in the KwaDukuza municipality. One hundred and eighty households in the KwaDukuza municipality will be selected through informed consent to participate in the study. To determine household food waste, a weighed food audit will be conducted at each household at the start and end of the study. Thereafter, through random selection, 60 households will receive Intervention 1 with online food waste education lessons for one month (4 lessons), followed by two weeks of maintenance classes with text message support. Sixty households will receive Intervention 2. These households will receive the food waste tool kit and will have to engage in self-directed learning. The remaining 60 households will be the control and will receive no intervention. After 6 weeks, a food waste audit will be conducted again.

Outline of the Procedures:

- You will be given an information letter on the details regarding the study to be conducted.
- After being informed, I will request permission from you via a consent letter.
- You will be given colour-coded bins and bags to separate your household food waste: fresh produce and dry goods (green), meat, fish, and poultry products (red) and cooked food waste (black/ clear). You will be instructed to collect and refrigerate/ freeze all cooked food waste in the provided freezer bags and labels; the main ingredients from cooked food samples will have to be recorded, as well as the number of portions discarded.
- We will come through on the morning of the waste removal to weigh the collected waste. All waste will be properly repackaged for collection by the municipal waste removal service.
- You will randomised into one of three intervention groups.

Risks or Discomforts to the Participant:

- There are no potential risks to you should you participate in this study.

Benefits:

- The results and recommendations will assist in making residents in KwaDukuza municipality aware of food wastage and assist in improving food security in the community.

Reason/s why the participant may be withdrawn from the study:

- You have the right to withdraw from the study at any time.

Remuneration:

- You will receive a R50 gift card for your participation at baseline and at the endline.

Costs of the Study:

- You will not incur any costs for being part of the study.

Confidentiality:

- You will remain anonymous during data collection, a participant number will be allocated to you.
- Access to data will only be granted to the researcher and supervisor only to protect the participant. All information collected from this study will be kept strictly confidential.

Results:

- Results and findings will be made available to you through the local newspapers.

Research-related Injury:

- This study poses no threats to your health, nor does it inflict any in type of mental or physical injury should you choose to participate.

Storage of all electronic and hard copies, including tape recordings:

- Data will be stored in the Durban University of Technology server.
- This information will only be available to the research team for a retention period of 5 years.

Persons to contact in the event of any problems or queries:

Principal researcher: Nosipho Miti, B-tech: Food and Nutrition, cell number 0605274032 or nosiphomiti@gmail.com./ 21348606@dut4life.ac.za Supervisor: Dr A. Naicker, PhD: Nutrition, cell number: 0313732333 or email ashikan@dut.ac.za or the Institutional Research Ethics Administrator on 031 373 2375. Complaints can be reported to the Director: Research and Postgraduate Support Dr L Linganiso at 031 373 2577 or researchdirector@dut.ac.za.



CONSENT LETTER

Full Title of the Study: A randomised control trial to reduce household food waste in the KwaDukuza municipality

Names of Researcher/s: Nosipho Miti

Statement of Agreement to Participate in the Research Study:

- I hereby confirm that I have been informed by the researcher, Nosipho Miti, about the nature, conduct, benefits, and risks of this study - Research Ethics Clearance Number: 226/22
- I have also received, read, and understood the above-written information (Participant Letter of Information) regarding the study.
- I am aware that the results of the study, including personal details regarding my sex, age, date of birth, initials, and diagnosis, will be anonymously processed into a study report.
- In view of the requirements of research, I agree that the data collected during this study can be processed in a computerized system by the researcher.
- I may, at any stage, without prejudice, withdraw my consent and participation in the study.
- I have had sufficient opportunity to ask questions and (of my own free will) declare myself prepared to participate in the study.
- I understand that significant new findings developed during the course of this research which may relate to my participation will be made available to me.

Full Name of Participant Date Time Signature/Right Thumbprint

I, Nosipho Miti (name of researcher) herewith confirm that the above participant has been fully informed about the nature, conduct and risks of the above study.

Full Name of Researcher

Date

Signature

Full Name of Witness (If applicable)

Date

Signature

Full Name of Legal Guardian (If applicable)

Date

Signature

