Utilisation of traditional and indigenous foods and potential contribution to consumers' nutrition and vendors' income in Botswana

SN KASIMBA

Thesis submitted for the degree *Doctor philosophiae* in Nutrition at the North-West University

Promoter: Dr N Covic
Co-promoter: Dr BS Motswagole
Co-promoter: Dr N Claasen

Graduation: May 2018
Student number: 25646826

DEDICATION

This thesis is dedicated to my family who sacrificed a lot to make my studies possible and have been an amazing support system. To my husband, Elijah, I am grateful for your love, perseverance, support, patience and understanding during the entire study period.

To my children, Joshua and Vanessa - being away from you was the most challenging thing that I had to cope with during my studies, but glory goes to the Almighty God for His great care upon your lives. Words fail to express my appreciation and love to all of you.

ACKNOWLEDGEMENTS

I am greatly indebted to the following people who contributed towards successful completion of this study:

To Dr Covic, my promoter, I am thankful for your immense support, technical and valuable guidance throughout my research. Thank you.

To Dr Motswagole, my co-promoter, thank you for your endurance, endless patience during data collection and constant guidance throughout the study period. You are highly appreciated.

To Dr Nicole, my other co-promoter, I appreciate you for your dedication, expertise and profound guidance; your constant motivation and hard work during the course of my studies. I will forever be grateful for your determination and the role you played.

Professor Johann and Professor Marius, your expertise in leadership ensured a very conducive learning environment and for that, I thank you.

To Henriëtte Claasen and Ronel Benson, your sincere concern for me, friendliness and professionalism in providing logistic support made a world of difference. Without your assistance, the process would have been difficult and for that, I appreciate you.

A special thank you goes to the research participants who made this research possible. Your participation was priceless. To the enumerators who assisted in data collection, you made the process easier. I will forever be grateful.

To all my office colleagues, your support and encouragement was just what I needed to plod me on. Thank you.

Above all, a special appreciation goes to the Almighty God for His immense grace. He made everything possible. Holy Bible (KJV), Proverbs 16:3 says; "Commit thy works unto the lord, and thy thoughts shall be established".

ABSTRACT

Utilisation of traditional and indigenous foods and potential contribution to consumers' nutrition and vendors' income in Botswana

Background

Food systems are changing due to drivers such as urbanisation, nutrition transition and globalisation. As a result, there is reduced utilisation of traditional and indigenous foods (TIF) towards westernised diets. Food insecurity and all forms of malnutrition co-exist in different regions of the world, including Botswana. Traditional or indigenous foods are believed to provide better quality diets. There is, however, limited information on extent of access to and consumption of (TIF) in Botswana.

Aim

The aim of the study was to explore access to and consumption of TIF among rural and urban households in Botswana. In addition, the study sought to investigate the importance of TIF among street vendors of TIF in Gaborone.

Methods

The first component of this study determined household access to TIF and their association to household food security (access), household dietary diversity (HDD) and women BMI through a sequential explanatory mixed methods design; including a random household cross-sectional survey on household food insecurity (access), household dietary diversity (HDD) and women's BMI; followed by eight focus group discussions (FGDs) among purposefully selected participants on their perceptions of TIF. The study involved 400 households and 253 women in these households.

The second component determined consumption of TIF and their contribution to dietary nutrients intake of energy, protein, iron, zinc and vitamin A among children 2-5 and women 18-49 years old in Botswana. This was part of a cross-sectional study mentioned in the first component of this study. A 30-day quantitative food frequency questionnaire was administered to the sample which comprised of 173 children and 253 women.

The last component explored the relationship between vending TIF and vendors' overall household income, vendors' household food security (access) and vendors' household dietary diversity. The study made use of sequential explanatory mixed methods design. Face to face interviews were conducted with purposively selected street vendors of TIF (n=27) in Gaborone, followed by three focus group discussions (FGDs), each with 6 participants (18

participants in total) to get an in-depth insight on the contribution of TIF to household income and perceived challenges in sourcing and vending TIF.

Results

Study 1: Almost two thirds of households experienced moderate or severe food insecurity (28.8 and 37.3%, respectively) while more than half of women were overweight or obese (26.9 and 26.9%, respectively). Median HDD score was 6 (5, 7) out of a total of 12 while the majority of households (81.0%) fell into the medium HDD category (5-8 food groups). A positive correlation was found between the number of TIF accessed and HDD scores ($r = 0.457$; $P < 0.001$) while a negative correlation between the number of TIF accessed and HFIA scores ($r = - 0.272$; $P < 0.001$) was found. TIF were perceived as healthy, yet their consumption was reported to be declining due to convenience, easy accessibility to and a growing preference for modern foods.

Study 2: TIF accounted for relatively high percentages of energy intake in children and women (41 % and 36%, respectively). The intake of vitamin A in children was higher from TIF mean 234 (184 - 299) compared to non-TIF mean 176 (138-224) $P = 0.0851$. In women, the intake of vitamin A and zinc were significantly higher from TIF compared to non-TIF (zinc from TIF mean 4.9 (4.6 - 5.3), non-TIF mean 4.2 (3.9 - 4.5) $P = 0.0033$, vitamin A from TIF mean 409 (332 - 503), non-TIF mean 295 (240 - 362) $P = 0.0286$. Across quartiles of increasing TIF energy intake, children in the third quartile consumed a significantly higher intake of energy compared to children in the first quartile $P < 0.05$. Further, children in the second quartile consumed a significantly higher intake of zinc compared to children in the first quartile $P < 0.05$.

Study 3: It was observed that 74.0% of the vendors' households were food insecure, with 18.5%, 33.3% and 22.2% being mildly, moderately and severely food insecure, respectively. Vendors' median HDD score was 4 (3, 6) out of a total of 12 while slightly more than half of the households (51.9%) fell into the lowest group of HDD score (0-4 food groups). A positive correlation was found between monthly income from sale of TIF and vendors' overall household income ($r = 0.594$ $P = 0.004$) and between the number of TIF varieties for sale and vendors' HDD ($r = 558$, $P = 0.002$). No correlation was found between the number of TIF varieties for sale and HFIA scores ($r = 0.136$, $P = 0.498$). FGDs confirmed that vending of TIF contributed substantially to vendors' household income. A supply chain of TIF crossing boarders also emerged.

Conclusion

Food insecurity in terms of access and low diversified diets was found to be highly prevalent in the two urban and two rural areas of Botswana that were under study and among the vendors' households. Large proportions of the study population in the two rural and two urban areas were found to have access to TIF. This study highlights that TIF may present a useful potential to contribute to household food security (access), household dietary diversity and nutrients intake, especially of energy, vitamin A and zinc. In addition, it also highlights that vending of TIF may contribute significantly to vendors' households' income. However, there is a need to explore the potential benefits of optimal use of TIF in contributing to household food security (access), household dietary diversity, improved nutrients intake and vendors' household income. This should also include attention to related energy consumption and physical activity as these factors may influence overall nutrition status outcomes.

Key words: Traditional foods, indigenous foods, food security, dietary diversity, income, vendors, Botswana.

TABLE OF CONTENTS

DEDICATION i

ACKNOWLEDGEMENTS ii

ABSTRACT iii

LIST OF DEFINITIONS xii

CHAPTER 1: INTRODUCTION 1

1.1 Background and motivation 1

1.2 Aim and objectives 4

1.3 Research setting and design 5

1.4 Structure of this thesis 6

1.5 Ethical considerations 8

1.6 Authors contributions 8

1.7 References 10

CHAPTER 2: LITERATURE REVIEW 16

2.1. Introduction 16

2.2 Food security and malnutrition 16

2.2.1 Definition and concepts of food security and malnutrition 17

2.2.2 The global state food security and malnutrition 19

2.2.3 Food insecurity and malnutrition in Africa and Botswana 20

2.3 Traditional and indigenous foods 22

2.3.1 Concept and definition of traditional and indigenous foods 22

2.3.2 Utilisation of traditional and indigenous foods in Africa and Botswana 24

2.4 Nutritional value and health aspects of traditional and indigenous foods 27

2.5 Contribution of traditional and indigenous foods to dietary diversity and food security 29

2.6 Contribution of traditional and indigenous foods to local food biodiversity 30

2.7 Nutrient composition of traditional and indigenous foods and encountered challenges 31

2.8 Traditional and indigenous foods contribution to nutrients intake 33

2. 9 Vitamin A, iron and zinc importance 34

2.9.1 Vitamin A.... 34

2.9.2 Iron.... 34

2.9.3 Zinc 36

2.10 Potential contribution of traditional and indigenous foods to household income 36

2.11 Marketing and supply chain of traditional and indigenous foods 37

2.12 Reasons attributed to decline in the use of traditional and indigenous foods 38

CHAPTER 3.... 56

Household access to traditional and indigenous foods positively associated with food security and dietary diversity in Botswana 56

CHAPTER 4.... 78

Consumption of traditional and indigenous foods and their contribution to nutrients intake among children and women in Botswana 78

CHAPTER 5.... 106

Street vending of traditional and indigenous food and the potential contribution to household income, food security and dietary diversity: The case of Gaborone, Botswana 106

CHAPTER 6: CONCLUSION AND RECOMMENDATIONS 129

6.1 Introduction 129

6.2.1 Household access to traditional and indigenous foods positively associated with food security and dietary diversity in urban and rural areas in Botswana. 129

6.2.2 Consumption of traditional and indigenous foods and their contribution to nutrient intake among children 2-5 years and women 18-49 years old in Botswana.... 130

6.2.3 Street vending of traditional and indigenous food and the potential contribution to household income, food security and dietary diversity: The case of Gaborone, Botswana 131

6.3 Study limitations.... 131

6.4 Conclusion 133

6.5 Recommendations 133

Addendum 1: Instructions for authors Journal of Public Health nutrition.... 136

Addendum 3: Content and style guidelines for the Journal of Hunger and Environmental Nutrition 148

Addendum 4: Ethics PhD study 156

Addendum 5: Editors certificate 159

Addendum 6: TIF foods substituted with other foods from the MRC FoodFinder 160

Addendum 7: list of traditional and indigenous foods (TIF) and non-TIF 161

Addendum 8: Study questionnaires 165

Addendum 9: Consent forms 194

LIST OF ABBREVIATIONS

AFSUN	African Food Security Urban Network
BBS	Botswana Building Society
BMI	Body Mass Index
BWP	Botswana Pula
CEN	Centre of Excellence for Nutrition
CVDs	Cardiovascular Diseases
FAO	Food and Agricultural Organization
FGDs	Focus Group Discussions
GDP	Gross Domestic Product
HDD	Household Dietary Diversity
HFIA	Household Food Insecurity Access
HFIAS	Household Food Insecurity Access Scale
IFPRI	International Food Policy Research Institute
IMF	International Monetary Fund
IPIGRI	International Plant Generic Resource
IQR	Interquartile range
NCDs	Non Communicable Diseases
NFTRC	National Food Technology Research Centre
r	Correlation coefficient
SSA	Sub Saharan Africa
SSPS	Statistical Package for Social Sciences
TIF	Traditional and Indigenous Foods
UNICEF	United Nations International Children's Emergency Fund
WHO	World Health Organization

LIST OF TABLES

Chapter 1 **Page**

Table 1: Study objectives and manuscripts developed……………………………………5

Table 2: Research team and their contributions…………………………………….......9

Chapter 2

Table 1: Some edible wild fruit plants in *Shorobe* village, Northern Botswana …………26

Table 2: Composition of some selected indigenous fruits of Botswana 32

Table 3: Mineral contents of some indigenous fruits of Botswana…………………………33

Chapter 3

Table 1: Demographic and socioeconomic characteristics of households, food security, dietary diversity number of TIF accessed and women BMI……………………………......62

Table 2: TIF items per food group as derived from quantitative and qualitative data……………………………………………………………………………………………..64

Chapter 4

Table 1: Intake of selected nutrients from TIF and non- TIF………................................... 86

Table 2: Differences in the intake of selected nutrients from TIF and non-TIF adjusted for age sex and area in women and children…………………………………… 87

Table 3: Selected nutrient intake of the study participants (children and women) by quartile of TIF energy intake mean ± SD…………………………….......................... 89

Table 4: Top five TIF consumed that contributed to the selected nutrients in children…. 90

Table 5: Top five TIF consumed that contributed to the selected nutrients in women…...92

Chapter 5

Table 1: Characteristics of street vendors of TIF in Gaborone ……………………………120

Table 2: Types of TIF displayed for sale by TIF vendors in Gaborone …………….......122

Table 3: Spearman correlations of income from sale of TIF, household income, HFIA scores, TIF items displayed for sale, household income HFIA and HDD scores…........ 123

LIST OF FIGURES

Chapter 2 page

Figure 1: UNICEF; conceptual framework on causes of malnutrition……..................19

LIST OF DEFINITIONS AND CONCEPTS

Consumers	within food systems, "consumers eat the food produced by the system" (Global Panel on Agriculture and Food Systems for Nutrition, 2016: 82). This study focuses on consumers of TIF referring to **households, women and children.**
Consumers' nutrition	in this study, this concept summarises the study variables measured which included household food security (access), household's dietary diversity, women BMI, dietary nutrients intake of energy, protein, iron, zinc and vitamin A among consumers of TIF.
Food security	" a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe, nutritious food to meet their dietary needs and food preferences for an active and healthy life" (FAO, 2009:1). **In this thesis only one dimension of food security was measured and will be referred to- the access component.**
Food systems	comprise all the processes involved in keeping us fed: growing, harvesting, packing, processing, transforming, transporting, marketing, consuming and disposing of food (Global Panel on Agriculture and Food Systems for Nutrition, 2016: 82).
Market foods	are "foods that enter communities often through global industrially sponsored retail outlets and which must be purchased.
Indigenous foods	are "foods that originate and grow in a particular area. They are known locally in an area with respect to the country or region" (Maunder & Meaker 2007: 403).

Street vendors marketing is one among the processes within the food system, which comprises of the actors who move products through the market into the hands of the consumers. This is done in markets, in informal retail, by street vendors, in supermarkets and in small stores (Global Panel on Agriculture and Food Systems for Nutrition, 2016). In this study we focussed on the street vendors of TIF as distributors of TIF in Gaborone and also we explored them as consumers of TIF.

Traditional foods are "foods that indigenous people have access to locally without having to purchase them, and within traditional knowledge and the natural environment from farming or wild harvesting" (Kuhnlein et al., 2009: 3).

Traditional and Indigenous Foods (TIF) in this study **TIF** were defined as**; foods that are native or introduced into Botswana a long time ago, including plant and animal sources whether locally produced (either domesticated, cultivated) or accessed from the wild. Considering globalisation of food systems, these foods may also be purchased from retail outlets, irrespective of their origin but recognised as part of country's traditional food culture.**

TIF access to determine household access to TIF, a 1-point value was given to each individual traditional or indigenous food item reported by all household members in the previous 24 hours (HDD component). The sum of points indicated the household's access to TIF.

References

FAO (Food and Agricultural Organization). 2009. World Summit on Food Security. *Draft declaration of the world summit on food security;* 16-18 November. Rome, Italy: FAO.

Global Panel on Agriculture and Food Systems for Nutrition. 2016. Food systems and diets: Facing the challenges of the 21st century. London, UK. https://glopan.org/sites/default/files/ForesightReport.pdf. Date accessed 20 July 2017.

Kuhnlein, H.V., Erasmus, B. & Spigelski, D. 2009. Indigenous peoples' food systems: the many dimensions of culture, diversity and environment for nutrition and health: Food and Agriculture Organization of the United Nations Rome.

Maunder, E.M.W. and Meaker, J.L., 2007. The current and potential contribution of home-grown vegetables to diets in South Africa. *Water SA*, *33*(3).

CHAPTER 1: INTRODUCTION

1.1 Background and motivation

Over the past few decades, there has been a decrease in the consumption of traditional foods enabled by a shift towards the increased consumption of westernised diets - referred to as nutrition transition. This transition is described as a shift away from consumption of traditional foods which are believed to provide better quality diets compared to westernised diets which are highly refined, with lots of added sugar, fat and decreased fibre (Popkin *et al.*, 2001; Satia-Abouta, 2003; Popkin, 2006; Monda *et al.*, 2007; Anand *et al.*, 2015; Hawkes & Popkin, 2015). This has happened in both developed and developing countries (Anand *et al.*, 2015), spurred by globalisation, industrialisation, socio-economic changes and rapid increases in immigration (Satia-Abouta, 2003; Monda *et al.*, 2007; Damman *et al.*, 2008; Ruel *et al.*, 2010; Hawkes & Popkin, 2015). The effect of nutrition transition has been cited among the major factors contributing to increased non-communicable diseases (NCDs) such as hypertension, diabetes, obesity and other cardiovascular diseases (CVDS) (Frison *et al.*, 2005; Damman *et al.*, 2008; Hu, 2011; Anand *et al.*, 2015; Hawkes & Popkin, 2015). Additionally, the World Health Organization (WHO) observed that traditional diets play a significant role in preventing and controlling morbidity and premature mortality resulting from NCDs (WHO, 2003).

Food systems have transformed globally as food and food products have become commodities, produced and traded in a market that has expanded from an essentially local base to an increasingly global one (Anand *et al.*, 2015), a change described as unhealthy and equally unsustainable pattern of food production and consumption (Hawkes & Popkin, 2015). Consequently, the changes in the global food system are linked to nutrition transition, reflecting a shift away from consumption of traditional and indigenous foods to the increased consumption of energy-dense diets foods that are mostly packaged and processed with a limited variety of nutrient-dense foods that provide dietary fibre such as fruits, vegetables, legumes, diverse healthy coarse cereals, roots and tuber crops (Hawkes & Popkin, 2015). In addition, there is a global trend towards dietary simplification (Charrondière *et al.*, 2013). This encourages the loss of local food biodiversity of both plant and animal sources due to the over-reliance on a limited number of staple crops, mainly wheat, maize and rice from the modern and high input agricultural industry (Charrondière *et al.*, 2013; Stadlmayr *et al.*, 2013; Ebert, 2014), which delivers more than half of human calorie intake (Stamp *et al.*, 2012). Nutrition transition and transforming food systems are believed to lead to the reduced utilisation of traditional and indigenous foods that have, over time, served to sustain

populations in Africa and elsewhere; as well as to a loss of livelihood for many families that are engaged in related economic activities such as farmers and vendors. If no specific efforts are targeted at conserving the existing food biodiversity (crop or animal) and related knowledge, the capacity of achieving more healthy and sustainable diets will be compromised (FAO, 2010).

Recently, there has been a growing awareness on the need to recognise the potential value of traditional and indigenous foods in the face of transition and the transforming food systems as a way of addressing food insecurity and poor diets. Food security is defined as a situation that exists "when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life" (FAO, 2009:1). Besides increasing rates of overweight, obesity and other non-communicable diseases, food insecurity remains a major global challenge (Godfray *et al.*, 2010; Grote, 2014); with 795 million people being undernourished in 2015 (FAO, 2015); while an estimated more than 2 billion people in the world are considered to be deficient in key vitamins and minerals, particularly vitamin A, iodine, iron and zinc (Geleta *et al.*, 2012).

In Sub-Saharan Africa (SSA), a current review on obesity and nutrition transition indicated that the same phenomenon of nutrition transition is emerging as people shift from their traditional diets to westernised diets (Steyn & Mchiza, 2014). For example, the South African population is consuming diets containing more animal origin foods that are high in total fat and saturated fat, as well as foods with a high content of added sugar, causing negative health outcomes (Vorster *et al.*, 2011). Botswana is among the countries that are rapidly urbanising, with about 60% of the population residing in urban centres (Nnyepi *et al.*, 2015). It is also a country undergoing nutrition transition, characterised by the shift from the use of traditional foods to refined and processed foods such as rice, savoury snacks, fried meat, cheese, pies, potato chips, hot dogs, candy, biscuits, fizzy drinks and sweetened beverages (Maruapula *et al.*, 2011).

Food security in Botswana has been a major concern at both national and household level due to the country's low performing agricultural sector and recurring droughts (Lado, 2001; Raboloko, 2016). The climate is semi-arid with an erratic, unreliable rainfall pattern while the drought is endemic, contributing to low agricultural food production (Lado, 2001; Mojeremane & Tshwenyane, 2004; Brinkhurst, 2010). The contribution of the agriculture sector to Gross Domestic Product (GDP) in 2015 was 2.2 % (Statistics Botswana, 2015). Given that, the country follows a national food security strategy that focuses on food imports

rather than domestic food production (Crush *et al.*, 2011; Raboloko, 2016) to ensure the physical availability of food supplies to its population, with more than 80% of the food being imported from South Africa (Crush *et al.*, 2011).

Nutrient deficiencies, under-nutrition and micronutrient deficiencies are prevalent in Botswana as overweight and obesity are also becoming recognised health problems. FAO indicated that the prevalence of undernourished people in Botswana in 2010-2012 was 27.9 % (FAO, 2012) while according to WHO global nutrition report, in 2014, 31.4% of children under 5 years of age were stunted, 11.2% were underweight, 7.2% were wasted and 11.2% were overweight. On the other hand, the prevalence of obesity among adults 18 years and older for men and women was 12.7% and 32.3% respectively while the prevalence of anaemia among women 15-49 years of age was 29.0% (WHO, 2015).

The potential contribution of traditional and indigenous foods to food security due to their believed nutritional benefits has been gaining recognition in the recent years (Ebert, 2014: FAO, 2013: FAO, 2014). Traditional or indigenous foods are described as foods that can be accessed locally within the local environments without purchase (Kuhnlein *et al.*, 2009; Maunder & Meaker 2007). However, due to increased globalisation and widespread supermarkets as pointed out by Reardon and Gulati (2008), some of the traditional foods such as maize meal are being purchased locally, although they may be imported from the surrounding regions and countries. In this study, traditional and indigenous foods (TIF) were defined as foods that are native or were introduced into Botswana a long time ago, including plant and animal sources, whether locally produced (either domesticated, cultivated) or accessed from the wild. Considering globalisation of food systems, these foods may also be purchased from retail outlets, irrespective of their origin but recognised as part of country's traditional food culture. The definition of TIF was arrived at by a panel consisting of local nutrition experts, field assistants and the research team, in a consultative process prior to the study. Traditional or indigenous foods have been integral part of diets for many communities, for instance, East Africa, according to Muhanji *et al.* (2011), offers a diverse range of traditional and indigenous leafy vegetables and fruits which can play a significant role in providing food security in both urban and rural settings. In Ethiopia, traditional and indigenous food sources have played a major role in rescuing the lives of people during times of famine and war (Fentahun & Hager, 2009). Further studies elsewhere have reported that traditional green leafy vegetables and fruits are rich sources of micronutrients such as vitamin A, C, folic acid, thiamine, vitamin B2, niacin, calcium, potassium, sodium, phosphorus, iron and zinc (Orech *et al.*, 2007; Kwenin *et al.*, 2011; Penafiel *et al.*, 2011). According to Ebert (2014), there is a wider range of traditional and indigenous foods that

have been neglected and underutilised, but they could potentially improve agricultural systems and be a valuable component in contributing to food security due to their resilience and owing to their potential as sources of essential macro and micronutrients.

Against this background, previous studies in Botswana show that it is a country which is diverse in traditional or indigenous foods (Ohiokpehai, 2003; Mojeremane & Tshwenyane, 2004; Flyman & Afolayan, 2006a; Flyman & Afolayan, 2006b; Legwaila *et al.*, 2011). In addition, there are some street pockets where indigenous plant foods and animal foods are sold. However, currently, there is a lack of documented data to show extent of access to these traditional or indigenous foods and their potential contribution to household food security (access), household dietary diversity, specific dietary nutrient intake and household income. Hence, this study explored access to and consumption of traditional and indigenous foods in two rural and two urban areas in Botswana and the vending of TIF among street vendors of TIF in Gaborone.

1.2 Aim and objectives

The aim of the study was to explore access to and consumption of TIF in rural and urban households in Botswana (part A). In addition, the study focussed on street vendors of TIF in Gaborone in terms of household income, household food security (access), household dietary diversity and their in-depth views on vending of TIF (part B).

Specific objectives are:

PART A: Household survey

1. To determine TIF access among low socio-economic households in two rural and two urban study sites.
2. To determine the association between household access to TIF and household food security (access), household dietary diversity and women BMI in these households.
3. To investigate participants' perceptions on TIF regarding their health importance, availability and access trends.
4. To determine the consumption of TIF and the contribution of reported TIF consumed to dietary nutrient intake of energy, protein, vitamin A, iron and zinc based on a 30 day quantitative food frequency questionnaire among children 2-5 and women 18-49 years.

PART B: Vendors

5. To determine the monthly income from vending TIF among street vendors of TIF in Gaborone.
6. To determine the relationship between monthly income from vending TIF and vendors' overall household income, household food security (access) and household dietary diversity.
7. To explore in-depth vendors' perceptions on challenges and opportunities when sourcing and vending TIF.

The various study objectives and the manuscripts developed from the study objectives are presented in table 1.

Table1: study objectives and manuscripts developed

Article	Manuscript Title	Objectives
Article 1:	Household access to traditional and indigenous foods positively associated with food security and dietary diversity in Botswana.	Objectives 1, 2, 3
Article 2:	Consumption of traditional and indigenous foods and their contribution to nutrients intake among children 2-5 years and women 18-49 years old in Botswana.	Objective 4
Article 3:	Street vending of traditional and indigenous foods and the potential contribution to household income, food security and dietary diversity: The case of Gaborone, Botswana.	Objectives 5, 6, 7

1.3 Research setting and design

The study in this thesis was conducted in two parts;

Part A; Household survey

This was a cross-sectional study conducted in two urban areas (Old Naledi and Area W) and two rural areas (Maun and Tsabong) in Botswana. These areas were purposively selected to include predominantly low socio-economic areas and to accommodate the possible variations in availability of TIF in the country. Old Naledi and Area W are situated in Gaborone and Francistown, respectively. Gaborone is the country's largest city and its capital. Francistown is the second largest city. Tsabong is in the Kgalagadi District, a region which covers a vast area of the Kalahari Desert. Maun is located in the North-West District. A

mixed methods research approach was followed, applying a sequential explanatory design which involved quantitative data collection in the form of a household survey, followed by a qualitative phenomenological approach, collecting data with FGDs (Creswell, 2008). In this study, data on TIF access at household level, household food security (access), household dietary diversity and women BMI were collected. In addition, data on consumption of TIF based on a 30 day quantitative food frequency questionnaire among children 2-5 and women 18-49 years were collected. Furthermore, participants' perceptions were also investigated to get in-depth insights on various aspects of TIF as described in the study objectives (part A).

Part B vendors

In this component of the study, the research applied the food systems approach that considers various processes in the food system until the food reaches to the consumer. These processes include food production, processing, storage, transportation, trade, transformation and retailing (Global Panel on Agriculture and Food Systems for Nutrition, 2016). In this context, street vendors of TIF were purposively selected as the study participants in part B of this study as they were perceived as consumers and distributors of TIF in Gaborone. The study was conducted in Gaborone City along the streets of three malls, the Botswana Building Society Mall, the Main Mall and the Rail Park Mall at the bus rank. Gaborone was purposively selected because it is Botswana's largest city and the nation's capital that accommodates the largest number of rural- urban migrants. It is highly urbanising and facing the challenge of urban food insecurity. It is also common to observe TIF being sold along the streets and alleys around some shopping malls. A mixed methods research approach was followed, applying a sequential explanatory study design which involved quantitative data collection in the form of structured interviews with TIF street vendors, followed by qualitative data collection in the form of focus group discussions (FGDs). Data on monthly household income, types of TIF the vendors sold, monthly income earned from selling TIF, household food security (access) and household dietary diversity were collected. Additionally, vendors' perspectives on TIF as described in the objective section of part B was investigated through FGDs.

1.4 Structure of this thesis

The structure of this thesis is presented in an article format and it comprises of six chapters. References used in chapters 1, 2 and 6 are provided at the end of each chapter according to the North-West University required style. Articles presented in chapters 3, 4 and 5 are formatted and referenced according to the required style of the respective journals.

Chapter 1: The introductory chapter provides background information, the aim and objectives of the study, structure of the thesis and the research team.

Chapter 2: Presents the relevant literature on TIF in relation to consumers' nutrition (household food security, household dietary diversity, women BMI, and nutrients intake) and vendors' household income). This chapter presents an overview of literature required for the interpretation of the data from the article manuscripts in this thesis.

Chapter 3: An article entitled, 'Household access to traditional and indigenous foods positively associated with food security and dietary diversity in Botswana'. This manuscript determines household access to traditional and indigenous foods (TIF) and the association to household food security, household dietary diversity and women BMI in low socio-economic households in two urban and two rural areas in Botswana. It also covers study participants' perspectives on various aspects of TIF as described in the study objectives (part A). The article has been published in the *Journal of Public Health Nutrition*. http://dx.doi.org/10.1017/S136898001700369X. The content and style guidelines for Journal of *Public Health Nutrition* are presented in Addendum 1.

Chapter 4: An article entitled, 'Consumption of traditional and indigenous foods and their contribution to nutrients intake among children 2-5 years and women 18-49 years old in Botswana'. It determines the consumption of traditional and indigenous foods and their contribution to energy, protein, vitamin A, iron and zinc intake among children 2-5 years and women 18-49 years old in two urban and two rural areas in Botswana. This manuscript will be submitted for publication to the *Journal of Ecology of Food and Nutrition*. The content and style guidelines for *Journal of Ecology of Food and Nutrition* are presented in Addendum 2.

Chapter 5: An article entitled, 'Street vending of traditional and indigenous foods and the potential contribution to household income, food security and dietary diversity: The case of Gaborone, Botswana'. This manuscript explores the potential contribution of vending TIF to vendors' overall household income, vendors' household food security (access) and household dietary diversity. It also determines vendors' perspectives on TIF as described in the study objectives (part B). This manuscript has been submitted for publication to the *Journal of Hunger and environmental Nutrition*. The content and style guidelines for Journal of *Hunger and environmental Nutrition* are presented in Addendum 3.

Chapter 6: The last chapter comprises of summary of the findings, conclusions and recommendations.

1.5 Ethical considerations

Ethical clearance for this study was obtained from the Faculty of Health Sciences, Health Research Ethics Committee, Potchefstroom Campus, North–West University, South Africa; (NWU -00206-14-S1) and the Botswana Health Research and Development Division of the Ministry of Health. Signed informed consent was obtained from the participants after being given adequate explanation in their local language. Participants had the choice to withdraw from the study at any point.

1.6 Authors contributions

This study involved several research team members. Their names and roles are as listed in Table 2. Co- authors' statement is included, confirming the roles they played in this study as well as their written consent to include the articles in this thesis. The statement is as follows:

"I declare that as co-author, I have approved the above-mentioned articles, that my role in the study, as indicated below is representative of my actual contribution and that I hereby give my consent that the articles may be published as part of the PhD thesis of Mrs SN Kasimba."

Table 2: Research team and their contributions

Name	Affiliation	Role
Salome Kasimba PhD student	Centre of Excellence for Nutrition, North-West University	Responsible for conception and designing of the protocol, formulating the research questions, study design and literature review. Also involved in data collection, data entry and statistical analysis as well as drafting the three manuscripts in this thesis (Chapters 3, 4 and 5) and writing up of the thesis.
Dr Namukolo Covic	Poverty, Health and Nutrition Division, International Food and Policy Research Institute, Addis Ababa, Ethiopia	Supervised this thesis. Involved in conception designing of the protocol, formulating the research questions, study design, interpretation of results and co-authored the three manuscripts in this thesis (Chapters 3, 4 and 5).
Dr Boitumelo, S. Motswagole	National Food Technology Research Centre, Botswana	Co-supervised this thesis. Involved in conception and designing of the protocol, formulating the research questions, study design, involved in data collection, interpretation of results and co-authored the three manuscripts in this thesis (Chapters 3, 4 and 5).
Dr Nicole Claasen	Africa Unit for Transdisciplinary Health Research (AUTHeR), North-West University, South Africa	Co-supervised this thesis. Involved in interpretation of results and co-authored the three manuscripts in this thesis (Chapters 3, 4 and 5).
Maricke Cockran	Medicine Usage in South Africa, Faculty of Health Sciences North-West University	Statistician who guided analysis for the first and third manuscripts.
Ria Laubscher	Biostatics Unit, South African Medical Research Council	Statistician who guided analysis for the second manuscript.

1.7 References

Anand, S.S., Hawkes, C., De Souza, R.J., Mente, A., Dehghan, M., Nugent, R., Zulyniak, M.A., Weis, T., Bernstein, A.M. & Krauss, R.M. 2015. Food consumption and its impact on cardiovascular disease: importance of solutions focused on the globalized food system: a report from the Workshop Convened by the World Heart Federation. *Journal of the American College of Cardiology*, 66(14):1590-1614.

Brinkhurst, M. 2010. Fruit of sand: complexities of Botswana's veld plant resources. *Studies by Undergraduate Researchers at Guelph*, 3(2).

Charrondière, U.R., Stadlmayr, B., Rittenschober, D., Mouille, B., Nilsson, E., Medhammar, E., Olango, T., Eisenwagen, S., Persijn, D. & Ebanks, K. 2013. FAO/INFOODS food composition database for biodiversity. *Food Chemistry*, 140(3):408-412.

Creswell JW. Qualitative, Quantitative, and mixed methods approaches. 2008. SAGE publications, inc. Asia pacific.

Crush, J., Hovorka, A. & Tevera, D. 2011. Food security in Southern African cities. The place of urban agriculture. *Progress in Development Studies*, 11(4):285-305.

Damman, S., Eide, W.B. & Kuhnlein, H.V. 2008. Indigenous peoples' nutrition transition in a right to food perspective. *Food Policy*, 33(2):135-155.

Ebert, A.W. 2014. Potential of underutilized traditional vegetables and legume crops to contribute to food and nutritional security, income and more sustainable production systems. *Sustainability*, 6(1):319-335.

FAO (Food and Agricultural Organization). 2009. World Summit on Food Security. *Draft declaration of the world summit on food security;* 16-18 November. Rome, Italy: FAO.

FAO (Food and Agricultural Organization). 2010. Expert Consultation on Nutrition Indicators for Biodiversity. Rome, Italy. http://www.fao.org/docrep/010/a1582e/a1582e00.htm. Date accessed 18 July 2017.

FAO (Food and Agricultural Organization). 2012. The State of Food Insecurity in the World: Economic Growth is necessary but not sufficient to Accelerate Reduction of Hunger and Malnutrition. Rome, Italy. http://www.fao.org/docrep/016/i3027e/i3027e.pdf. Date accessed 17 July 2017.

FAO (Food and Agricultural Organization). 2013. Linkages between Biodiversity, Foods and Nutrition. Rome, Italy. http://www.bioversityinternational.org/uploads/tx_news/Chpt7_Linking_biodiversity_and_nutrition.pdf. Date accessed 13 July, 2017.

FAO (Food and Agricultural Organization). 2014. Promotion of underutilized indigenous food resources for food security and nutrition in Asia and the Pacific. Bangkok, Thailand. http://www.fao.org/3/a-i3685e.pdf. Date accessed 15 September, 2016.

FAO (Food and Agricultural Organization). 2015. The State of Food Insecurity in the World 2015. Meeting the 2015 international hunger targets: taking stock of uneven progress. Rome, Italy. http://www.fao.org/3/a-i4671e.pdf. Date accessed 18 July 2017.

Fentahun, M.T. & Hager, H. 2009. Exploiting locally available resources for food and nutritional security enhancement: wild fruits diversity, potential and state of exploitation in the Amhara region of Ethiopia. *Food Security*, 1(2):207-219.

Flyman, M. & Afolayan, A. 2006a. The suitability of wild vegetables for alleviating human dietary deficiencies. *South African Journal of Botany*, 72(4):492-497.

Flyman, M.V. & Afolayan, A.J. 2006b. A survey of plants used as wild vegetables in four districts of Botswana. *Ecology of Food and Nutrition*, 45(6):405-415.

Frison, E., Smith, I.F., Cherfas, J., Eyzaguirre, P. & Johns, T. 2005. Using biodiversity for food, dietary diversity, better nutrition and health. *South African Journal of Clinical Nutrition*, 18(2):112-114.

Geleta, B., Ameri, G., Amdemariam, K., Fan, S., Stein, A.J. & Olofinbiyi, T. 2012. Reducing the risk of food and nutrition insecurity among vulnerable populations: International Food Policy Research Institute. http://www.ifpri.org/publication/reducing-risk-food-and-nutrition-insecurity-among-vulnerable-populations. Date accessed 17 July 2017.

Global Panel on Agriculture and Food Systems for Nutrition. 2016. Food systems and diets: Facing the challenges of the 21st century. London, UK. https://glopan.org/sites/default/files/ForesightReport.pdf. Date accessed 20 July 2017.

Godfray, H.C., Beddington, J.R., Crute, I.R., Haddad, L., Lawrence, D., Muir, J.F., Pretty, J., Robinson, S., Thomas, S.M. & Toulmin, C. 2010. Food Security: the challenge of feeding 9 billion people. *Science (New York, N.Y.)*, 327(5967):812-818.

Grote, U. 2014. Can we improve global food security? A socio-economic and political perspective. *Food Security*, 6(2):187-200.

Hawkes, C. & Popkin, B.M. 2015. Can the sustainable development goals reduce the burden of nutrition-related non-communicable diseases without truly addressing major food system reforms? *BMC Medicine*, 13(1):143.

Hu, F.B. 2011. Globalization of diabetes: the role of diet, lifestyle, and genes. *Diabetes Care*, 34(6):1249-1257.

Kwenin, W.K.J., Wolli, M. & Dzomeku, B.M. 2011. Assessing the nutritional value of some African indigenous green Leafy Vegetables in Ghana. *Journal of Animal & Plant Sciences*, 10 (2):1300-1305.

Lado, C. 2001. Environmental and socio-economic factors behind food security policy strategies in Botswana. *Development Southern Africa*, 18(2):141-168.

Legwaila, G.M., Mojeremane, W., Madisa, M.E., Mmolotsi, R.M. & Rampart, M. 2011. Potential of traditional food plants in rural household food security in Botswana. *Journal of Horticulture and Forestry*, 3(6):171-177.

Maunder, E. & Meaker, J. 2007. The current and potential contribution of home-grown vegetables to diets in South Africa. Water SA, 33(3): 401-405.

Maruapula, S.D., Jackson, J.C., Holsten, J., Shaibu, S., Malete, L., Wrotniak, B., Ratcliffe, S.J., Mokone, G.G., Stettler, N. & Compher, C. 2011. Socio-economic status and urbanization are linked to snacks and obesity in adolescents in Botswana. *Public Health Nutrition*, 14(12):2260-2267.

Mojeremane, W. & Tshwenyane, S.O. 2004. Azanza garckeana: A Valuable Edible Indigenous Fruit Tree of Botswana. *Pakistan Journal of Nutrition* 3(5):264.

Monda, K.L., Gordon-Larsen, P., Stevens, J. & Popkin, B.M. 2007. China's transition: the effect of rapid urbanization on adult occupational physical activity. *Social Science &Medicine*, 64(4):858-870.

Muhanji, G., Roothaert, R.L., Webo, C. & Stanley, M. 2011. African indigenous vegetable enterprises and market access for small-scale farmers in East Africa. *International Journal of Agricultural Sustainability*, 9(1):194-202.

Nnyepi, M.S., Gwisai, N., Lekgoa, M. & Seru, T. 2015. Evidence of nutrition transition in Southern Africa. *The Proceedings of the Nutrition Society*: 74(4): 476-86.

Ohiokpehai, O. 2003. Promoting the nutritional goodness of traditional food products. *Pakistan Journal of Nutrition*, 2(4):267-270.

Orech, F.O., Christensen, D.L., Larsen, T., Friis, H., Aagaard-Hansen, J. & Estambale, B.A. 2007. Mineral content of traditional leafy vegetables from western Kenya. *International Journal of Food sciences and Nutrition*, 58(8):595-602.

Penafiel, D., Lachat, C., Espinel, R., Van Damme, P. & Kolsteren, P. 2011. A Systematic Review on the Contributions of Edible Plant and Animal Biodiversity to Human Diets. *Eco Health*, 8(3):381-399.

Popkin, B.M. 2006. Global nutrition dynamics: the world is shifting rapidly toward a diet linked with non-communicable diseases: *American Journal for Clinical Nutrition*, Inc. 84(2):289-98.

Popkin, B.M., Horton, S.H. & Kim, S. 2001. The nutrition transition and prevention of diet-related diseases in Asia and the Pacific: Asian Development Bank Manila. http://www.fao.org/library/library-home/en/. Date accessed 17 July 2017.

Raboloko, M. 2016. Determinants of Urban Household Food Security In Botswana. *Academy of Biomedical and Clinical Science Journal*, 1(1).

Reardon, T. & Gulati, A. 2008. The rise of supermarkets and their development implications. International experience relevant for India. International Food Policy Research Institute Washington, DC USA.

Ruel, M.T., Garrett, J.L., Hawkes, C. & Cohen, M.J. 2010. The food, fuel, and financial crises affect the urban and rural poor disproportionately: a review of the evidence. *The Journal of Nutrition*, 140(1):170S-176S.

Satia-Abouta, J. 2003. Dietary acculturation: definition, process, assessment, and implications. *International Journal of Human Ecology*, 4(1):71-86.

Stadlmayr, B., Charrondiere, U.R., Eisenwagen, S., Jamnadass, R. & Kehlenbeck, K. 2013. Nutrient composition of selected indigenous fruits from Sub-Saharan Africa. *Journal of the Science of Food and Agriculture*, 93(11):2627-2636.

Stamp, P., Messmer, R. & Walter, A. 2012. Competitive underutilized crops will depend on the state funding of breeding programmes: an opinion on the example of Europe. *Plant Breeding*, 131(4):461-464.

Statistics Botswana. 2015. Gross Domestic Product. Gaborone. Botswana. http://www.statsbots.org.bw/sites/default/files/publications/GDP%20Q3%20December%202016.pdf. Date accessed 18 July 2017.

Steyn, N.P. & Mchiza, Z.J. 2014. Obesity and the nutrition transition in Sub-Saharan Africa. *Annals of the New York Academy of Sciences*, 1311:88-101.

Vorster, H.H., Kruger, A. & Margetts, B.M. 2011. The nutrition transition in Africa: can it be steered into a more positive direction? *Nutrients*, 3(4):429-441.

WHO (World Health Organization). 2003. Diet, nutrition and the prevention of chronic diseases. Geneva, Switzerland. http://apps.who.int/iris/bitstream/10665/42665/1/WHO_TRS_916.pdf. Date accessed 15 July 2017.

WHO (World Health Organization). 2015. World Health Statistics; Global health indicators Part 11. Geneva Switzerland.

http://www.who.int/gho/publications/world_health_statistics/2015/en/. Date accessed 23 July 2017.

CHAPTER 2: LITERATURE REVIEW

2.1. Introduction

According to Food and Agricultural Organization (FAO), food insecurity remains a global concern with an unacceptably large number of people still lacking the food they need for an active and healthy life (FAO, 2015). Malnutrition of all forms, including under-nutrition, over nutrition and micronutrient deficiencies persist globally despite an abundance of diverse healthy foods within our surrounding environments, International Food Policy Research Institute (IFPRI, 2016). Food systems are rapidly transforming towards commercialisation and globalisation, adversely affecting diets in both developed and developing countries. There is a change in traditional food consumption towards westernised diets which are characterised by lots of added sugar, fat as well as highly refined foods with decreased fibre (Anand *et al.*, 2015). Traditional and indigenous foods are increasingly neglected and their access has been declining over the years (Bharucha & Pretty, 2010).

Botswana is a country which is diverse in its traditional and indigenous foods, including plants which grow annually, despite erratic and unreliable rainfall, used for food by rural communities during dry spells (Legwaila *et al.*, 2011; Neudeck *et al.*, 2012). Nevertheless, there is limited information available on access to and consumption of TIF and their contribution to household food security, household dietary diversity and specific dietary nutrients intake. Their contribution to vendors' household income also remains unclear. In light of this, the chapter will provide a review of current literature related to food security and malnutrition, TIF utilisation in Africa and Botswana. It will also focus on TIF nutritional value and health aspects, TIF potential contribution to household food security and household dietary diversity. Additionally, in this chapter, the nutrient composition of TIF and encountered challenges, potential contribution of TIF to specific dietary nutrients intake and the importance of vitamin A, iron and zinc will be presented. Furthermore, the chapter will also present literature on marketing, supply chain of TIF and TIF potential contribution to household income. Lastly, the reasons attributed to the decline in use of TIF will be presented.

2.2 Food security and malnutrition

In this section, the definition and concepts of food security and malnutrition will be described, followed by an analysis of the state of food security and malnutrition in the world. Thereafter, food security in the African context and with a specific focus on Botswana, will be discussed.

2.2.1 Definition and concepts of food security and malnutrition

Food security is a concept whose definition and concept of operationalisation has developed over time. However, the definition from the 1996 World Food Summit is the commonly used one and it defines food security as;

Food security ‘‘exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life”(FAO,1996: 4).

With time, the definition of food security was revised and the social aspect was added, thus the definition of food security as describe by FAO now states that;

Food security is “a situation that exists when all people, at all times, have physical social and economic access to sufficient, safe, nutritious food to meet their dietary needs and food preferences for an active and healthy life” (FAO 2009: 1).

In the current definition of food security, the nutrition dimension is integral to the concept of food security that evolved over time (FAO, 2009). Nutrition security is a broader concept than food security. It differs from food security in that it also considers the aspects of adequate caring practices, health and hygiene in addition to dietary adequacy (FAO, 2012). It is defined as;

Nutrition security “a situation that exists when secure access to an appropriately nutritious diet is coupled with a sanitary environment, adequate health services and care, in order to ensure a healthy and active life for all household members” (FAO, 2012: 57).

According to FAO (2009), food security has four dimensions;

- **Food availability**- which is achieved when there is consistent sufficient quantities of food of appropriate quality.

- **Access to food**- this presumes physical access and depends on the purchasing power of households to have adequate resources for acquiring appropriate foods for a nutritious diet from different sources which include market, household gardens or in-kind transfers of food.

- **Food utilisation-** which is the individuals' ability to derive the greatest nutritional benefit from food. This is a biological process that comprises of intake of adequate nutritious diet and the individuals overall health status. It is influenced by several factors which include clean water and sanitation, food safety, food preservation and storage, adequate health care, the manner in which the food is prepared and cultural and individual food preferences.

- **Stability-** which emphasises the importance of having to reduce the risk of adverse effects on the other three dimensions: food availability, access to food or food utilisation (FAO, 2008).

Other terms used within the concept of food security and malnutrition as defined by FAO (2012:57) include the following;

Malnutrition "an abnormal physiological condition caused by deficiencies, excesses or imbalances in energy, protein and/or other nutrients".

Stunting "low height for age, reflecting a sustained past episode or episodes of under-nutrition".

Undernourishment "food intake that is insufficient to meet dietary energy requirements continuously. This term is used interchangeably with chronic hunger, or, in this report, hunger".

Undernutrition "the result of undernourishment, poor absorption and/or poor biological use of nutrients consumed".

Underweight "low weight for age in children, and BMI <18.5 in adults, reflecting a current condition resulting from inadequate food intake, past episodes of undernutrition or poor health conditions".

Wasting "low weight for height, generally the result of weight loss associated with a recent period of starvation or disease".

According to UNICEF, several factors exhibit complex interaction to determine the nutritional status of children as shown in Figure 1.

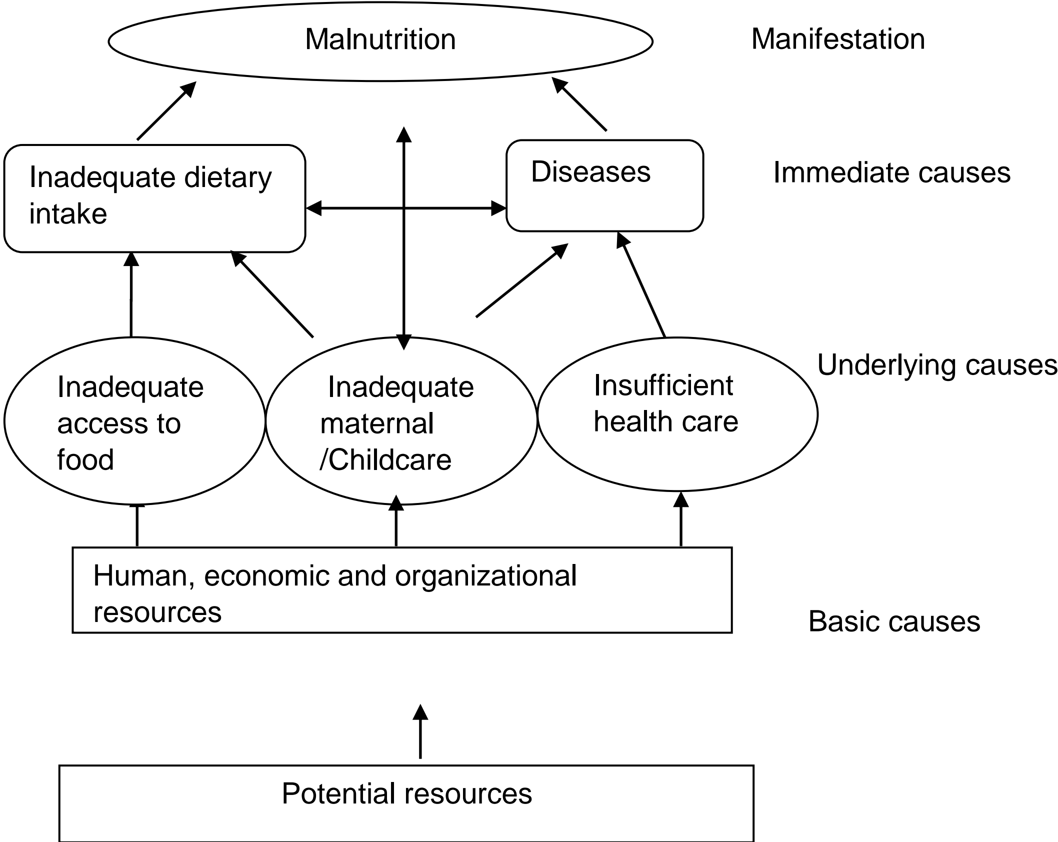


Figure 1: Adapted from UNICEF; conceptual framework on causes of malnutrition (UNICEF, 1998).

2.2.2 The global state food security and malnutrition

Malnutrition, referring to overnutrition, undernutrition and micronutrient deficiencies, is a growing concern globally. FAO's estimates show that about 805 million people were chronically undernourished in 2014, the vast majority of them living in developing countries (FAO, 2015). About 791 million were estimated to be chronically hungry with the highest prevalence of undernourishment reported in Sub-Saharan Africa, which remains the world's most food-insecure region (FAO, 2015). Hunger and the consequences of hunger cause the death of approximately 40 million people each year, around 13 million of them being children (Bokeloh *et al.*, 2009). It was estimated that over 500 million people were obese and about 2 billion were overweight (Ng *et al.*, 2014). More than 40% of the world's population suffer from micronutrient deficiencies, also called the "hidden hunger" (Bokeloh *et al.*, 2009). Roughly 2 billion people, especially women, are affected by iron deficiency, about 1.6 billion people live in regions where iodine deficiency is endemic and approximately 230 million children worldwide suffer from vitamin A deficiency (Bokeloh *et al.*, 2009). Stunting, wasting and

micronutrient deficiencies were estimated to be the cause of death in nearly 3.1 million children annually (Black *et al.*, 2013).

Nearly half of all deaths in children under the age of 5 are attributable to undernutrition which translates into the unnecessary loss of about 3 million young lives per year, United Nations International Children's Emergency Fund (UNICEF, 2016). Undernutrition subjects children to a greater risk of dying from common infections, increases the frequency and severity of such infections, and contributes to delayed recovery. In addition, the interaction between under nutrition and infection can create a potentially lethal cycle of worsening illness and deteriorating nutritional status (UNICEF, 2016). In 2014, 23.8% of children under the age of 5 years worldwide were stunted, 95 million children were underweight, 50 million were wasted and 41 million children were overweight, with Asia and Africa having the highest number of wasted children 69% and Africa 29% respectively (UNICEF, 2016).

Modern agricultural technologies focus on commercial large scale production of limited staple foods, specifically cereals which include rice, wheat and maize to address global food security and hunger, while neglecting the diverse foods available in our environments (IFPRI, 2016). Current debates on food security do not take full account of the potential of indigenous and traditional foods (Power, 2008). It was not until recently, however, that research has been underscored to explore the potential role of traditional and indigenous foods in mitigating the impact of climate change, increased prevalence of NCDs and food insecurity (Hawkes & Popkin, 2015). It has also been highlighted that there is need for food security conceptualisation, policies and programmes to be tailored along incorporating traditional and indigenous foods in the food market systems in improving food security (Power, 2008).

2.2.3 Food insecurity and malnutrition in Africa and Botswana

In Africa, food insecurity is one of the key development challenges of the 21st Century (Crush & Frayne, 2010). This is due to factors such as exploding population growth and climate change, therefore, producing adequate food for combating poverty and hunger is seen as a huge challenge (Garrity *et al.*, 2010). Projections are that higher temperatures and lower rainfall in parts of Africa, coupled with the doubling population, will lead to a 43% increase in food insecurity, and will induce a 60% increase in food aid expenditures during the next two decades (Funk & Brown, 2009). Garrity *et al.* (2010) project an increase of undernourished people in Sub-Saharan African to almost 600 million by 2030. Another factor contributing to food insecurity is the soaring food prices (Sasson, 2012). According to Crush

and Frayne (2010), evidence is also available that indicates that factors directly constraining food supply, access, distribution and consumption can no longer be marginalised. Rapid urbanisation has produced an invisible crisis of urban food security. Despite this, much of the food security interventions focus on rural food security while the plight of urban food security has been neglected. At present, the evidence is so fragmentary and inadequate that it can only lead to misguided interventions at municipal and national level (Crush & Frayne, 2010).

Urban dwellers depend on cash income for food purchase as well as for all their other basic needs such as fuel, water, sanitation, housing and transport, and have little access to other safety nets like agriculture or land to ensure food access in times of crisis and this makes them more vulnerable to food insecurity (Ruel *et al.*, 2010). Furthermore, with respect to foods that are culturally preferable, people living in urban areas present significant challenges to food security because access to traditional foods is more difficult as they depend on market food which is even more expensive (Power, 2008). The issue is complicated by the fact that it is not only access to non-traditional foods but the variety aspect is also compromised for the urban poor due to limited economic access (Ruel *et al.*, 2010).

Food security has been a major concern in Botswana both at national and household level due to the country's low performing agricultural sector and recurring droughts (Lado, 2001; Raboloko, 2016). The climate is semi-arid, with erratic and unreliable rainfall patterns and drought is endemic, contributing to low agricultural food production (Lado, 2001; Mojeremane & Tshwenyane, 2004; Brinkhurst, 2010). However, small scale farming remains the dominant livelihood activity in the rural areas and a substantial source of employment, food and income (Statistics Botswana, 2012), despite persistent under-performance due to harsh agro-ecological and erratic weather conditions that are characterised by poor soil, recurrent droughts and unpredictable weather patterns associated with climate change (Statistics Botswana, 2012). Botswana, in spite of being a middle-income economy, is faced with income inequality (Sekwati *et al.*, 2013; Botlhale, 2015) and consequently, incidences of poverty have been reported both in urban and rural areas - but more rampant in rural areas compared to the urban areas (Sekwati *et al.*, 2013). The number of poor people living in rural areas faced with poverty was 54.3% and of that number, 37.0% lived in urban villages while 8.6% lived in the cities in 2010 (World Bank, 2015).

FAO indicated that the prevalence of undernourished people in Botswana in 2012 was 27.9% (FAO, 2012). African Food Security Urban Network (AFSUN) also reported on urban household food insecurity, specifically in Gaborone, the capital city of Botswana, among low

socio-economic households with 88% of them being food insecure (Acquah *et al.*, 2014) in 2008. According to Raboloko (2016), the determinants of urban household food insecurity in urban Gaborone included: (1) wage income: the higher the wage income the more food secure the households were; (2) household size: the larger the household size, the more increased the competition for limited resources and therefore, such large-sized households were more food insecure compared to smaller-sized households; (3) head of the household: male-headed households were more food secure compared to female-headed households.

Concurrently, all forms of malnutrition, including overnutrition, undernutrition and micronutrient deficiencies are present in Botswana. According to World Health Organization's (WHO), global nutrition report, the prevalence of underweight, wasting, stunting and overweight among children under five years of age in Botswana, was 11.2%, 7.2%, 31.4% and 11.2% respectively, while the prevalence of obesity among adults 18 years and older was 12.7% and 32.3% for men and women respectively, and the prevalence of anaemia among women 15-49 years of age was reported to be 29% (WHO, 2015). Against this background, little is known about the role of TIF in mitigating food insecurity and malnutrition in Botswana. In relation to this, the study presented attempted to investigate the potential role of TIF among the urban and rural low socioeconomic households in Botswana.

2.3 Traditional and indigenous foods

This section begins by describing traditional and indigenous foods as were conceptualised in the present study. Their utilisation globally as well as in Africa and in Botswana follows and thereafter, their various uses in Africa, including Botswana, are described.

2.3.1 Concept and definition of traditional and indigenous foods

The concepts and definitions of traditional and indigenous foods is widely used and varied. There is no agreed universal definition of traditional or indigenous foods, however, the acceptable definition, especially of what can be termed as traditional or indigenous to people has to be confined within a certain origin and culture (Kuhnlein *et al.*, 2009). Some researchers have used the two terms interchangeably while others have come up with different definitions that are applicable within the context of their research.

According to Maunder and Meaker (2007: 403);

Indigenous foods are defined as those "foods that originate and grow in a particular area. They are known locally in an area with respect to the country or region".

With respect to **traditional foods** according to Kuhnlein *et al.* (2009: 3);

Traditional foods are defined as "foods that indigenous people have access to locally without having to purchase them, and within traditional knowledge and the natural environment from farming or wild harvesting".

While according to Ogoye-Ndegwa (2003); Orech *et al.*(2005);

Traditional foods are foods that have been integrated into a community's culture and used over a long period of time, more than a century ago.

According to these researchers, it is clearly acknowledged that for food to be termed as indigenous or traditional to people, it has to be originating in a certain area, been integrated long enough in that community and become part of the culture of those people and has to be obtained locally from the local environment either from farming or harvested from the wild and not purchased. In contrast to definitions of indigenous and traditional foods, Kuhnlein *et al.* defined the concept of market foods as;

Market foods "are foods that enter communities often through global industrially-sponsored retail outlets and which must be purchased. In some circumstances, indigenous people may purchase some of their culturally based traditional foods e.g. wild meat and local cereal varieties from others with land or time to harvest them" (Kuhnlein *et al.*, 2009: 4).

In our study, it was important to integrate and adapt the concept of market foods in to the definition of indigenous and traditional foods because of increasingly globalised food systems, urbanisation, and Botswana being heavily dependent on food imports (Crush & Frayne, 2010). Research shows that supermarkets, mainly South African brands such as, Pick and Pay and Shoprite, are widely spread in both urban and rural areas of Botswana and act as the major food distributors (Acquah *et al.*, 2014). As a result, some of the foods believed to be traditional have become commodities accessed from these supermarkets,

irrespective of their origin. Examples of these foods include sorghum meal, maize, beans, peanuts, sweet potatoes, Setswana (cooked pounded beef), mopane moth caterpillars etc. In this thesis, TIF are therefore defined as**;**

> **Foods that are native or were introduced into Botswana a long time ago, including plant and animal sources, whether locally produced (either domesticated, cultivated) or accessed from the wild. Considering globalisation of food systems, these foods may also be purchased from retail outlets, irrespective of their origin but recognised as part of country's traditional food culture.**

Our definitions were arrived through a consultative process by a panel of nutrition experts, local field assistants and the research team prior to the study. The panel came up with a list of foods differentiating indigenous, traditional and non-indigenous/traditional foods. A list of these foods is presented in Addendum 7.

2.3.2 Utilisation of traditional and indigenous foods in Africa and Botswana

African countries are endowed with variety of traditional or indigenous foods that many rural communities commonly consume (Oiye et al., 2009; Molla et al., 2011). With particular regard to plant food sources, their utilisation is widely reported throughout African communities. For example, according to Cloete and Idsardi (2013), approximately 52% of households use traditional or indigenous foods crops in their diets in South Africa. In Kenya, black nightshade, spider plant and *Amaranthus* are some of the indigenous leafy vegetables commonly consumed (Kimiywe et al., 2007). In most parts of Ethiopia, indigenous foods, especially from the wild, form an integral part of the diet for the population. Some of those commonly utilised by households include *Tamarindus indica L.*, *Syzygium guineense* (Wild.) *DC., Cordia africana Lam.* and *Utrica simensis* (Molla et al., 2011). Indigenous vegetables play a common role as a relish (sauce) (Oniang'o *et al.*, 2004; Neudeck *et al.*, 2012), that is, they are used as a complement for staple diets made mainly from maize meal. Relish is an indispensable part of the African diet (Oniang'o *et al.*, 2004; Smith & Eyzaguirre, 2007) as the main staple cereal is not normally eaten in the absence of relish. In rural parts of South Africa, wild vegetables are an important source of main food (Voster *et al.*, 2007). When several wild vegetable species are cooked together in one meal, they contribute to dietary diversity due to the many vegetable types (Mavengahama *et al.*, 2013). In Uganda, a study on the utilisation of indigenous food plants found that indigenous fruits and vegetables were mainly used in the form of snacks and as a relish (Musinguzi *et al.*, 2006). Other studies have reported that some indigenous food plants have been used for medicinal purposes

(Musinguzi *et al.*, 2006; Acipa *et al.*, 2013; Anywar *et al.*, 2014; Tumwet *et al.*, 2014). Consumption patterns of traditional or indigenous vegetables and fruits differ across countries due to various factors. For example, in South Africa, the consumption pattern of traditional leafy vegetables depends on factors such as the population's indigenous knowledge, poverty levels, urbanisation, and seasons of the year (Dweba & Mearns, 2011; Mavengahama *et al.*, 2013). In Kenya, Kimiywe *et al.* (2007) reported that traditional leafy vegetables availability increases during rainy season, so they become plenteous and cheap. In another study conducted by Musinguzi *et al.* (2006) in Uganda, respondents indicated that they use indigenous vegetables when other relishes are in short supply or there is shortage of food. Despite the varied use of indigenous or traditional vegetables as indicated by previous studies, the use of traditional green leafy vegetables is declining (Voster *et al.*, 2007; Dweba & Mearns, 2011; Matenge *et al.*, 2012; van der Hoeven *et al.*, 2013).

A review by Legwaila *et al.* (2011) reported that Botswana is rich in a wide variety of traditional or indigenous foods, both cultivated and from the wild, and are used by both rural and urban communities for food. These foods are commonly used, especially during the dry spells or during famine as a buffer against food shortages and to sustain livelihoods (Legwaila *et al.*, 2011). Available research reports mostly on traditional or indigenous fruits and vegetables. Some of the indigenous vegetables in Botswana include: *Cleome*, *Amaranthus*, *Corchorus* and *Vigna* spp; examples of fruit are: *Azanza garckeana*, *Adansonia digitata*, *Sclerocarya birrea*, *Strychnos spinosa, Vangueria infausta and Grewia* spp (Legwaila *et al.*, 2011; Neudeck *et al.*, 2012). Traditional leafy vegetables in Botswana are reported as being plentiful during the rainy season but become scarce during the dry season (Legwaila *et al.*, 2011).

According to Legwaila *et al.* (2011), some of the traditional or indigenous fruits and vegetables and other foods like mushroom and bush meat in Botswana are sourced from the wild. These foods are believed to contribute to rural household food basket but are usually not recognised in the national food basket. The use of traditional or indigenous plant foods in Botswana is no different from the rest of Africa. Traditional food plants have been reported as being used for food, snacks, medicine, building materials, fuel and as a beverage (Ohiokpehai, 2003; Legwaila *et al.*, 2011; Neudeck *et al.*, 2012). Some indigenous fruits are also used for income generation by rural communities (Legwaila *et al.*, 2011; Neudeck *et al.*, 2012). Animal skins are processed to make traditional rugs and ostrich eggs can be used in crafts or just as a natural decoration with their inherent beauty (Motlhanka *et al.*, 2008). In addition, in traditional Botswana, wild fruits were collected and given as offerings during wedding ceremonies and some fruits served as ingredients for local traditional brews

(Motlhanka *et al.*, 2008). Furthermore, a selection of wild plants were also used for spiritual and recreational purposes (Neudeck *et al.*, 2012). Literature shows that there are a lot of studies that consider one type/species of traditional or indigenous food. Research that explores household access to and consumption of TIF from dietary intake perspective hardly exists.

Some of the indigenous edible wild fruit plants from *Shorobe* village in Botswana are depicted in Table 1.

Table 1: Some edible wild fruit plants in *Shorobe* village, Northern Botswana

Species	Local Name
Amaranthus	Thepe
Azanza garckeana (F. Hoffm.) Exell & Hillc.	Morojwa
Berchemia discolor (Klotzsch) Hemsl	Motsenstela
Ceropegia sp.	Serowa
Cleome gynandra L.	Leketla/Rothwe
Corchorus olitorius L.	Delele
Cyperus fulgens C.B. Clark.	Monakaladi
Diospyros mespiliformis Hochst. ex A.DC.	Mokutsumo
Ficus sycomorus L.	Mochaba
Fockea angustifolia K. Schum.	Leruswha
Garcinia livingstonei T. Anderson	Motsaodi
Grewia bicolor Juss.	Mogwana
Grewia flava DC.	Moretlwa
Grewia flavescens Juss	Mokgomphatha
Grewia retinervis Burret	Motsotsojane
Hyphaene petersiana Klotzsch ex Mart	Mokolowane
Nymphaea nouchali Burm.f.	Tswii
Rhus quartiniana A. Rich	Moropaphiri
Sclerocarya birrea (A. Rich.) Hochst.	Morula
Urochloa mosambicensis (Hack.) Dandy	Phoka
Vangueriopsis lanciflora (Hiern.) Robyns ex R.D. Good	Mmupudu
Ximenia americana L.	Moretologa

Species	Local Name
Unidentified sp.	Lehubala
Unidentified sp	Mokgothwane
Unidentified sp	Natshwa
Unidentified sp	Tshetlha

Source (Neudeck *et al.*, 2012).

2.4 Nutritional value and health aspects of traditional and indigenous foods

This section presents information on the nutritional value and health aspects attached to traditional or indigenous foods. There is limited data that has reported on the nutritional value of traditional or indigenous foods from animal sources. A lot of the research that has explored this aspect has focussed mainly on traditional or indigenous fruits and vegetables and this will be presented.

Traditional or indigenous leafy vegetables and fruits have been reported as an important source of micronutrients, such as iron, vitamin A (β-carotene) and zinc (Uusiku *et al.*, 2010). Consequently, their consumption has been suggested as one of the sustainable ways of reducing and controlling micronutrient deficiencies (Frison *et al.*, 2011; Penafiel *et al.*, 2011; Mavengahama *et al.*, 2013). In Cameroon, it was reported that five African indigenous vegetables that were selected and analysed for their nutritional value were all found to be rich in Calcium, Magnesium, pottasium, zinc, iron, protein and carotenoids. These included amaranth (*Amaranthus cruentus*), nightshade (*Solanum scabrum*), African eggplant (*Solanum aethiopicum)*, jute mallow (*Corchorus olitorius*) and okra (*Abelmoschus callei*) (Kamga *et al.*, 2013). Other studies reported that African nightshade and the spider plant contain micronutrients such as iron, protein, vitamin C, carotene, magnesium, calcium, fibre, flavonoids and phenols (Yang & Keding, 2009; Mibei *et al.*, 2012). Furthermore, a study conducted in Uganda found that some wild food plant species which included *Amaranthus graecizansSolanum nigrum Crotalaria brevidens Ficus sur* and *Bridelia scleroneura* had a higher protein content in comparison to their cultivated counterparts. This same study reported that the highest concentration of calcium (867.59 mg/100g) was found in *Acalypha bipartita* leaves, compared to 294.18 mg/100g in *Cleome gynandra*(Acipa *et al.*, 2013).

For some micro-nutrient deficiencies such as vitamin A and iron, food-based strategies such as the promotion of production and consumption of indigenous fruits and vegetables, has been recommended (Aphane *et al.*, 2002). According to Oiye and colleagues (2009),

increasing the consumption of African indigenous vegetables (AIVs) in Kenya, and possibly using them instead of kales and cabbages, would go a long way in improving vitamin A intake. When AIVs are prepared properly, in order to maintain the nutritional value and are consumed frequently, they can release micronutrients and make them available, as well as increase the bio-availability and effective absorption of micronutrients in other staple food crops (Musotsi *et al.*, 2005). However, despite the enumerated macro and micronutrient values associated with indigenous and traditional vegetables and fruits, specifically the micronutrient potential, WHO reveals that fruit and vegetable consumption in Sub-Saharan Africa (SSA) is below the recommendation of 400 g/day (Ruel *et al.*, 2005). Additionally, according to the Lancet series 2013, deficiencies of essential vitamins and minerals, especially of vitamin A, iron, zinc and iodine are widespread (Black *et al.,* 2013). Therefore, effort is needed to identify ways of promoting and embracing the use of traditional and indigenous fruits and vegetables as a strategy to alleviate micronutrient deficiencies among populations. Indigenous animal food sources such as caterpillars have also been reported as rich in nutrients. For instance, in Nigeria, Solomon and Prisca (2012), in their analysis of processed edible caterpillars, showed that caterpillars are rich in protein and fat, high in caloric value and contain mineral elements which include sodium, chloride, iron, zinc, calcium and phosphorus.

Research remains scanty on the health aspects of traditional or indigenous animal food sources. Most of the available research has explored the health aspect of some traditional and indigenous plants. With respect to this, research shows that some traditional and indigenous plants have a high potential in improving the immune function of people due to their health-protecting properties (Gupta *et al.*, 2005; Kimiywe *et al.*, 2007; Smith & Eyzaguirre, 2007a). African black nightshade (*S.nigrum*) is a highly valued indigenous vegetable which is consumed for its flavour and perceived health benefits. For instance, black nightshade leaves are consumed to manage diabetes, high blood pressure, anaemia, peptic ulcers, colds, coughs and sight problems (Keding *et al.*, 2007; Kimiywe *et al.*, 2007). According to Tumwet *et al.*, (2014), African indigenous leafy vegetables are associated with various medicinal and immune boosting claims, however, proof of principle studies has not been done and the active ingredients in immune boosting have not been isolated by any study. In Addition, Acipa *et al.* (2013) highlighted that some of the food plants in Uganda were considered by the local community to have medicinal properties such as the African spider flower, and the Rattle pod. Some edible wild plants have abundant phenolic compounds and other natural anti-oxidants (including vitamins and minerals) that have been associated with protection from and/or treatment for medical conditions such as malnutrition, heart disease, cancer and diabetes (Neudeck *et al.*, 2012). In Kenya it was observed that

some phytochemicals in some of the African leafy vegetables may pose toxicity problems when consumed in large quantities or over a long period of time (Orech *et al.*, 2005). However, it is important to investigate their chemical, nutritional, toxicological properties and their bioavailability of micronutrients before they are recommended as an alternative dietary source (Orech *et al.*, 2005).

2.5 Contribution of traditional and indigenous foods to dietary diversity and food security

Dietary diversity is a simple count of food groups consumed over a 24 hour reference period that can be measured at household or an individual level (FAO, 2010). Dietary diversity at household level measures the economic ability of a household to consume variety of foods, and acts as a proxy for household food security while dietary diversity at individual level can be used as an indicator of diet quality (FAO, 2010; Vakili *et al.*, 2013). Previously, it has been documented that increasing sustainable productivity, which integrates indigenous foods, can be one of the strategies to alleviate food insecurity through dietary diversification (Kunyanga *et al.*, 2013). On the other hand, dietary diversification is believed to be one of strategies of ensuring adequate intake of nutrients (Kunyanga *et al.*, 2013). Consideration of access to a variety of indigenous wild foods enhances the diversity of diets and can ensure continuous supply of food throughout the year (Bharucha & Pretty, 2010). Production and promoting the use of traditional and indigenous fruits and vegetables consumption provides diets rich in micronutrients and helps alleviate food insecurity and micronutrient deficiencies (Mavengahama *et al.*, 2013). It is believed that in Sub-Saharan African countries, indigenous leafy vegetables could play an important role in the WHO global initiative to drive increased consumption of vegetables and fruits as a way of alleviating food insecurity (Smith & Eyzaguirre, 2007). There is substantial evidence that both traditional and indigenous foods which comprise of foods from the wild such as vegetables, fruits, mushrooms and bush meat among others, can contribute greatly as part of the global food basket (Bharucha & Pretty, 2010; Legwaila *et al.*, 2011). For instance, wild vegetables are reported to have been the mainstay of human diets for centuries, providing millions of households with important micronutrients, such as vitamins and minerals needed to maintain health and promote immunity against infections (Bharucha & Pretty, 2010). Many traditional indigenous plant foods are comparable to those available in an average market today in terms of nutrient content. With climate variability and uncertainty, there is need to diversify the food systems by including local crops that are adapted to local environments for greater system resilience (Lin, 2011). The promotion of traditional or indigenous foods cannot be overemphasised as

they are less damaging to the environment and address cultural needs and in addition they also preserve the cultural heritage of local communities (FAO, 2014).

It was reported in Uganda that wild food plants, such as swamp hibiscus, African spider flowers, tamarind, black night shade and Jews mallow contribute to local household food security in times of food shortage, especially for the economically disadvantaged children and the elderly (Acipa *et al.*, 2013). A similar observation was noted by Tabuti (2007) who found that the use of wild food plants is significant, especially during periods of acute food shortages and these foods provide nutritional security by adding essential nutrients as well as variety to diets, making staples more appealing to the taste. In Southern Africa, Akinnifesi *et al.* (2006) noted that 60% to 85% of the rural people can face food shortages for 3 to 4 months in a year and use indigenous foods, especially plant sources, to sustain their livelihoods. Edible wild fruit trees in Botswana play an important role in food security, especially to rural households, and are reported to produce high yields, even with little rainfall (Neudeck *et al.*, 2012).

Some of the wild African indigenous vegetables mature early, usually within 3 to 4 weeks, and can be used to fight hunger before other cultivated food crops mature (Mavengahama *et al.*, 2013). Mavengahama *et al.* (2013) further acknowledged that although wild vegetables may be consumed in small quantities, they influence the intake of cereal staples, manage hunger and play a central role in household food security for the poorer rural groups. Wild vegetables are reported to be hardy, require less care and are a rich source of micronutrients (Flyman & Afolayan, 2006). Mavengahama *et al.* (2013) recommend that there is a need to determine the abundance and diversity of indigenous vegetables as a preliminary step towards their domestication.

2.6 Contribution of traditional and indigenous foods to local food biodiversity

As part of the global agenda to tackle food insecurity and malnutrition, an international initiative was launched to promote and conserve local food biodiversity (Boutrif *et al.*, 2008; Maes *et al.*, 2012), which also encompasses indigenous and traditional foods both cultivated and from the wild (Bharucha & Pretty, 2010; Tscharntke *et al.*, 2012). This initiative was initiated in light of dietary simplification attributed to globalisation and modernisation in agriculture, contributing to suboptimal diets, especially in the developing countries (Boutrif *et al.*, 2008; Martins *et al.*, 2011; Vorster *et al.*, 2011; Charrondière *et al.*, 2013). At the same time, it sought to address the emerging wide spread of non-communicable diseases (NCDs) linked to poor, energy rich diets that are highly refined, undiversified and low in nutrient

density (Popkin, 2006; Boutrif *et al.*, 2008; Popkin, 2014). Additionally, it also sought to minimise neglect in the use, loss and the decline of indigenous and traditional nutritionally rich foods (Boutrif *et al.*, 2008; Maes *et al.*, 2012). It has been internationally acknowledged that local food biodiversity can provide sustainable solutions for combating food insecurity and malnutrition through programmes on biodiversity for food and nutrition, sustainable diets initiatives and many national, regional and international programmes and policies (FAO, 2013). Nevertheless, due to its importance, the linkages between biodiversity, food and nutrition should be more widely studied, researched and publicised, and more efforts should be made to mainstream the concept into food, agriculture, health, trade and nutrition sector policies and programmes (FAO, 2013).

Despite this, the worldwide trend is still towards dietary simplification and a loss of food biodiversity due to reliance on a limited number of varieties of staple and other crops, therefore, households continue to be faced with food insecurity and malnutrition (Charrondière *et al.*, 2013). Biodiversity of local foods could be used to reduce rural household's vulnerability to food insecurity through their resilience, sustainable use and as a way of diversifying diets (Boutrif et al., 2008).

2.7 Nutrient composition of traditional and indigenous foods and encountered challenges

Traditional or indigenous foods have long been part of diets in communities worldwide. However, research shows that they are underutilised and their nutritional value is unknown, especially indigenous food crops (Keatinge *et al.*, 2011; Kamga *et al.*, 2013). Data on nutrient composition of traditional or indigenous foods is very limited (Kunyanga *et al.*, 2013). Nutrient food composition data provides detailed information on the nutritional composition of foods (Egan *et al.*, 2007). Food composition data is useful in epidemiological studies on nutrition and disease; food labelling; assessing the nutritional status of population with food consumption surveys; calculating nutrient intakes; diet formulation; development of food-based dietary guidelines; food fortification; policy making for both agriculture, nutrition and food security; and is also needed by the food industry for product development (Egan *et al.*, 2007; Bharucha & Pretty, 2010; Burlingame *et al.*, 2012).

Both single food ingredients and composite foods are major dietary items that should be analysed for their nutritional content (Reinivuo *et al.*, 2009). A composite food contains one or more ingredients (Reinivuo *et al.*, 2009). However, due to wide and ever-changing variety

in ways of making these composite dishes, it is practically impossible to carry out chemical analyses for all composite dishes as it would prove to be very expensive. It is in this light that Reinivuo *et al.*, (2009) suggested analyses of nutrient values for the ingredients of composite foods may be a plausible option as their values can be used for calculating the nutrient values of composite foods.

Environmental factors, genetics, fortification, storage conditions and processing are some of the major factors that influence the composition of foods and this in turn causes variations in the nutrient content of the different varieties of the same food (Charrondière *et al.*, 2013). Uusiku *et al.* (2010) stated that the amount of nutrients reported for the same species from different studies varied widely due to factors like soil type, effect of fertiliser amount and stage of harvesting. Limited data exists regarding the nutritional content of Botswana traditional or indigenous foods. In addition, limited data is available on some of the nutritional contents of a few of the indigenous fruits of Botswana (Amarteifio & Mosase, 2006).

From a global perspective, it is noted with concern that most of the food composition databases do not count local food biodiversity, which also encompasses indigenous and traditional foods (Charrondière *et al.*, 2013). This poses a major challenge in the identification and monitoring of nutrition indicators for local food biodiversity which is critical in promoting local traditional and indigenous foods towards sustainable diets (Charrondière *et al.*, 2013). It is therefore emphasised that nutrient analysis and data dissemination of various local food biodiversity is important and has to be undertaken systematically and used to inform policies that target food security and agriculture using local food biodiversity (Bharucha & Pretty, 2010). Research is needed to increase the documentation on nutrient composition of foods that have been neglected and underutilised for decades (Toledo & Burlingame, 2006). Table 2 and 3 presents some of the nutritional composition of some indigenous fruits of Botswana.

Table 2: Composition (%) and pH (25° C) of some selected indigenous fruits in Botswana

Fruit	Dry matter	Ash	Crude protein	Acid detergent fibre	P^H	Acidity	Vitamin C mg/100g
A. digitate	86	4.6	1.3	16.2	3.06	7.85	141.3
S.birriea	11.6	4.9	3.7	16.3	3.98	0.88	128.3
S. spinose	19.7	4.6	3.3	6.1	3.96	0.77	88.0
V.invausta	23.5	3.9	3.0	39.5	3.38	1.71	67.7

Source (Amarteifio & Mosase, 2006).

Table 3: Mineral content of some indigenous fruits of Botswana

Fruit	Mineral (mg/100g)						
	Ca	K	Mg	Na	P	Fe	Zn
A. *digitat*a	128	1866	121	13.3	50	0.10	0.14
S. birriea	94	2183	158	13.0	0.07	0.88	0.13
S. spinose	56	1370	49	21.7	0.11	0.77	0.22
V. invausta	124	1683	99	13.7	0.09	1.71	0.02

Source (Amarteifio & Mosase, 2006).

2.8 Traditional and indigenous foods contribution to nutrients intake

Consumption of a variety of traditional or indigenous foods is recognised as an important mode of dietary diversification and a direct food-based intervention to address nutrient deficiencies (Frison *et al.*, 2006; Misra *et al.*, 2008). Some previous studies in arctic Canadians among pre-schoolers and adults showed that traditional local animal foods contributed to high levels of micro nutrients intake such as vitamins A and D, iron, magnesium, and zinc (Kuhnlein & Receveur, 2007; Johnson-Down & Egeland, 2010).

It is widely documented that traditional or indigenous foods contribute to various nutrients by several studies from different countries. In Alaska, a study that aimed to determine whether dietary westernisation is associated with intake of selected nutrients among Alaskan natives living in remote communities reported that traditional foods accounted for 22 % of the overall energy intake (Bersamin *et al.*, 2007). The same study also reported that participants in the highest quintile of traditional food intake consumed significantly more vitamin A, D, E, iron, and n-3fatty acids than participants in the lowest quintile, while the intake of vitamin C, calcium, and total dietary fibre decreased with increased consumption of traditional foods (Bersamin *et al.*, 2007). In a related study on traditional food systems and dietary quality for women and children for the Awaju´n tribe in the Peruvian Amazon, higher traditional food diversity was reported and associated with greater protein, fibre, iron, thiamine, riboflavin and vitamin A among women and children; while higher dietary calcium, phosphorus, niacin, vitamin C and folate were correlated with greater diversity scores for the women only. There was no relationship between the total energy intake in either group (Roche *et al.*, 2008). Another study that investigated hunting of wildlife in tropical forests reported that about 20% of protein in many developing countries came from bush meat and fish (Bennett & Robinson, 2000). Ghosh-Jerath *et al.* (2016b) found that many indigenous foods had high levels of

micronutrients like calcium, iron, vitamin A as beta carotene and folate among the Santhal tribal community of Jharkhand, India.

Nevertheless, even with the widely documented contribution of nutrients from traditional or indigenous foods, some studies have reported contradictory findings. A study on the contribution of indigenous foods towards nutrient intake and nutritional status of women in the Santhal tribal community of Jharkhand, India, reported that there was wide variety of indigenous foods reported but dietary recalls revealed low intakes of some nutrients; women consumed adequate energy and protein but micronutrient intake was inadequate for calcium, iron, vitamin B2, folate and vitamin B12. However, the same study reported that women consuming indigenous foods in the past 2 days had significantly higher intakes of calcium and iron than those who did not consume these foods (Ghosh-Jerath *et al.*, 2016a). Literature search shows that in Africa there is limited research that has been undertaken to investigate the potential contribution of traditional or indigenous foods to nutrients intake among populations.

2. 9 Vitamin A, iron and zinc importance

2.9.1 Vitamin A

Vitamin A is required for vision, reproduction, immune function, cellular differentiation and proliferation throughout life (West Jr & Darnton-Hill, 2008). Dietary provitamin A consumed by humans are mainly b-carotene, a-carotene and b-cryptoxanthin and these are commonly found in carrots, sweet potatoes, green leafy vegetables and other fruits and vegetables characterised by their orange to red colour (Courraud *et al.*, 2013). Vitamin A deficiency is defined as plasma retinol concentration <0.70 lmol/L (WHO, 2009), and is a major cause of premature death in developing nations, particularly among children (Maiani *et al.*, 2009). According to the Lancet series 2008, vitamin A deficiency is the greatest cause of mortality in children less than 5 years of age in Sub-Saharan Africa (Black *et al.*, 2008). FAO indicated that although foods of animal origin are the best sources of vitamin A, they are expensive to the majority of poor households, thus, plant food sources such as yellow fruits and vegetables and dark green leafy vegetables act as the major sources of pro-vitamin A (Aphane et al., 2002). The three main strategies used to fight against vitamin A deficiency are supplementation with vitamin A capsules, food fortification with retinyl and dietary diversification through consumption of provitamin A-rich foods which is suggested as a long term strategy (Courraud *et al.*, 2013).

2.9.2 Iron

Iron is an essential trace element which is an intrinsic component of haemoglobin and myoglobin as well as a constituent of heme and non-heme enzymes that participate in

oxidation reduction reactions (La Frano *et al.*, 2014). Iron deficiency is the most widespread micronutrient deficiency in humans (Meng *et al.*, 2005; Zimmermann *et al.*, 2005). Nutritional iron deficiency arises when physiological requirements cannot be met by iron absorption from diet (Zimmermann et al., 2005). Iron bioavailability in plant foods is fairly low due to the inhibitory factors that impair the absorption of iron such as polyphenols (tannins in tea and coffee), oxalic acid, phytates, dietary fibre and calcium phosphate, which becomes an insoluble salt with iron (Hurrell & Egli, 2010). Phytates are commonly found in cereals, bran and legumes, while oxalates are common in chocolate, tea and spinach (Hurrell & Egli, 2010). Iron and zinc inhibit each other's absorption, but only when they are in the same solution, not when they are in the same meal (Whittaker, 1998). Bioavailability of iron is influenced by enhancers of absorption such as ascorbic and citric acid, meat, fish and poultry along with their digestion products (La Frano *et al.*, 2014). The organic acids such as ascorbic and citric acid reduce iron to its ferrous state and produce a soluble iron chelate in the small intestine that improves absorption (La Frano et al., 2014). There are several suggested potential approaches to increasing the bioavailability of iron in plant crops, including conventional breeding and genetic engineering (Hotz & Gibson, 2007). Food processing also increases iron bioavailability by reducing antinutrients. In addition, fermentation increases the concentration of promoters such as citric and lactic acid (Teucher *et al.*, 2004). Iron supplementation, iron fortification of foods, dietary diversification and disease reduction can control iron deficiency in populations (Zimmermann *et al.*, 2005). However, there are technical challenges that limit the amount of bioavailable iron compounds that can be used in food fortification, but according to Zimmermann *et al.* (2005), iron fortification can be an effective strategy against nutritional iron deficiency. Investigating the bioavailability of the nutrient and minerals content of traditional vegetables, both raw and cooked, is important towards a better understanding of their contribution to dietary intake of iron (Kamga *et al.*, 2013; Mavengahama *et al.*, 2013).

In developing countries, most populations subsist on plant-based diets of which the dietary iron is non-haem iron that is less well absorbed compared to heme iron (Hurrell & Egli, 2010). Regarding traditional leafy vegetables, it has been observed that wild vegetables, especially dark green leafy vegetables, contain oxalates, phytates, nitrates, tannins and saponins that reduce the absorption of certain micronutrients such as iron in the body (Flyman & Afolayan, 2006). The low absorption rate of iron is considered to be the main cause for iron deficiency anaemia, especially in the developing countries that subsist on monotonous plant-based diets (Meng *et al.,* 2005). Iron deficiency has substantial health and economic implications, including poor pregnancy outcome, impaired school performance and decreased productivity (Zimmermann *et al.*, 2005).

2.9.3 Zinc

Zinc is an essential micronutrient for enzyme function, DNA and RNA metabolism, protein synthesis, gene expression, cell growth and differentiation, and cell-mediated immunity (Lowe *et al.*, 2009). Some of the major sources of zinc include animal source foods, such as the organs, flesh of beef, pork, poultry, fish and shellfish, and with lesser amounts in eggs and dairy products (Lowe *et al.*, 2009). Plant sources such as cereals and legumes are also considered zinc sources, although the zinc is less bioavailable because of the presence of phytic acid that binds to zinc-forming insoluble complexes which thus inhibit zinc absorption (Gibson *et al.*, 2010). Another dietary component that has a substantial impact on the absorption of zinc is dietary calcium, which inhibits zinc absorption, and protein which enhances absorption (Lestienne *et al.*, 2005).

Other factors that affect zinc absorption include physiological factors such as quantity of zinc ingested which in turn determines the quantity of zinc absorbed and the efficiency of absorption. Other factors are age and the time over which zinc is ingested (Hambidge *et al.*, 2010). The efficiency of absorption of zinc from supplements is much higher than it is from meals (Tran *et al.*, 2004), even in the absence of a dietary inhibitor of zinc absorption (Hambidge *et al.*, 2010). Severe zinc deficiency in humans is associated with stunted growth, immune dysfunction, and poor wound healing (Lowe *et al.*, 2009). Some traditional food processing methods such as soaking, germination and fermentation help in reducing the phytic content in cereals and legumes (Lestienne *et al.*, 2005).

2.10 Potential contribution of traditional and indigenous foods to household income

Although it is evident that selling traditional or indigenous foods could have potential in contributing to household income this aspect is not widely researched and documented. Limited research in this regard is available on traditional or indigenous fruits and vegetables. It is believed that harvesting of wild fruits from forests and semi-domesticated trees, growing on farms and homesteads can substantially boost rural household incomes and employment opportunities in Africa (Ruiz-Pérez *et al.*, 2004; Leakey *et al.*, 2005). The cultivation of home gardens and the collection of wild foods and herbs is generally viewed as rural women's responsibilities and plays an important role in income generation by producing some crops that complement household income *(*Frison *et al.,* 2011*)*. For example, a study that investigated African indigenous vegetables recipe documentation and their role in food security, reported that indigenous vegetable production, especially leafy vegetables, acted as the only source of income among women that helped them sustain welfare of their families (Musotsi *et al.*, 2005). Additionally, a review by Adebooye and Opabode (2005)

showed that trading of indigenous leafy vegetables and fruits plays a key role in income generation especially among rural households. Similarly, according to a study done in Kenya by Mwema *et al.*, (2012) on the contribution of selected indigenous fruits on household income and food security, it was reported that besides indigenous fruit acting as a source of household food especially during the dry seasons, they are also traded for income among the households. Another review by Legwaila *et al.*, (2011) on the potential of traditional food plants in rural households food security in Botswana showed that some indigenous vegetables are traded as an alternative source of income. In Nigeria, it was observed that trading on processed caterpillar can be a good source of additional income for families, and if properly harnessed and produced on a large scale for commercial purposes, can be a good source of livelihoods, thereby alleviating poverty (Solomon & Prisca, 2012). In Uganda, it was reported that selling of some of the indigenous foods provide employment opportunities, especially in rural areas where employment is scarce (Musinguzi *et al.*, 2006).

2.11 Marketing and supply chain of traditional and indigenous foods

Traditional or indigenous foods are marketable, however, their markets are seasonal, especially African leafy vegetables (Musotsi *et al.*, 2005; Legwaila *et al.*, 2011; Neudeck *et al.*, 2012). This is partly due to their increasingly low cultivation and rainfall shortage. (Musotsi *et al.*, 2005). At the same time, farmers involved fail to meet consumer demands due to limited access to a wide variety of clean and certified seeds (Musotsi *et al.*, 2005). It has also been reported that edible wild plants are collected and consumed directly and are not often traded in the markets. They are also undervalued and ignored by government decision makers (Neudeck *et al.*, 2012). Additionally, research shows that indigenous foods, especially the wild foods, despite their value; have been excluded from official statistics on economic values of natural resources (Bharucha & Pretty, 2010). Despite this, Temple and Steyn (2016) highlighted that one of the ways to promote increased consumption of traditional foods is promoting their marketing.

In Botswana, traditional or indigenous foods such as wild fruits, dried leafy vegetables, peanuts and caterpillar worms among others, are sold mainly in informal markets by women and children in rural and urban areas (Legwaila *et al.*, 2011). In urban and peri-urban areas, sales are mostly conducted near shopping centres while in rural areas, sales are conducted from home, door to door, at bus stops and at roadside markets (Legwaila *et al.*, 2011). This observation points out that the market for traditional and indigenous foods is not formalised and well organised and this would be one of the reasons why these foods are not physically available and accessible to most of the people. Formalisation of markets is important

towards their promotion and would also encourage varieties of these foods being sold (Motlhanka *et al.*, 2008). Wild fruits are among the major indigenous foods sold by street vendors in Botswana (Motlhanka *et al.*, 2008).

Despite the market potential of traditional or indigenous foods in Botswana, they have received little attention in terms of research, development and promotion (Legwaila *et al.*, 2011). Research shows that the promotion of use and marketing of these foods would help in creating employment to small scale farmers at the same time, increase food security by promoting the underutilised traditional food species that are more sustainable to local climatic conditions (Moore & Raymond, 2006; FAO, 2014). As part of our study, we attempted to identify the various TIF sold by purposively selected street vendors and their contribution to vendors' households' income in Gaborone.

2.12 Reasons attributed to decline in the use of traditional and indigenous foods

It is widely recognised that traditional and indigenous foods are declining in their use (Flyman & Afolayan, 2006; Bharucha & Pretty, 2010; Gotor & Irungu, 2010). Some of the reported reasons attributing to the decline include negligence by researchers, lack of policy in conserving traditional and indigenous foods and shortage of funding towards their promotion (Yang & Keding, 2009; Gotor & Irungu, 2010; Tumwet *et al.*, 2014). In South Africa, their consumption is affected by the degree of urbanisation, distance to fresh produce markets and season of the year (Vorster *et al.*, 2011), while in Kenya, with regard to leafy vegetables it has been observed that ethnicity influences the choice made to buy and consume traditional leafy vegetables (Kimiywe *et al.*, 2007). Additionally, the introduction of exotic vegetable varieties is also believed to contribute to the decline in production and consumption of indigenous vegetables (Aphane *et al.*, 2002; Musinguzi *et al.*, 2006; Weinberger & Swai, 2006; Smith & Eyzaguirre, 2007).

According to Acipa *et al.* (2013), in a study done on documentation and the nutritional profile of some selected wild food plants of Otwal and Ngai sun counties, Oyam District, Northern Uganda, it was reported that despite the high nutritional values, a general decline in the consumption of wild plants was found. The same study reported that although many families still relied heavily on those plant species, there is a lack of consistent transfer of indigenous knowledge to the younger generations. Other factors contributing to decline in use is the scanty knowledge that is available on their nutritional content and their preparation (Musinguzi *et al.*, 2006; Ayua *et al.*, 2016), as well as their nature of harvesting which, according to Mavengahama *et al.*, (2013), is seen as exploitative. The taste of indigenous foods vegetables has also been identified as a factor contributing to declining utilisation. It is

believed that exotic vegetables are less bitter, hence preferred by younger generations, while other people view African leafy vegetables as inferior in their taste and nutritional value compared to exotic vegetables such as spinach (*Spinacea oleracea*) and cabbage *(Brassicaolearacea*) (Weinberger & Swai, 2006; Ayua *et al.*, 2016). The availability of indigenous vegetables has declined drastically because of excessive cultivation of field crops, which includes chemical elimination of wild vegetables and habitat change (Odhav *et al.*, 2007). In South Africa, it was reported that there is a growing ignorance among young people on the use of traditional leafy vegetables (Odhav *et al.*, 2007).

Nutrition transition is another factor believed to have contributed to the decline in use of traditional foods. In Tanzania for example, Weinberger and Swai (2006) reported that the transition is characterised by a decline in the consumption of traditional food crops and increased consumption of refined and processed foods, fats, sugars and animal foods. The same study added that changing attitudes towards traditional foods, coupled with neglect in research, is affecting the significance of African traditional vegetables in production systems, contributing to neglect and genetic erosion (Weinberger & Swai, 2006). Furthermore, wild food plants are ignored and are associated with poverty. As a result, little effort is geared towards promoting their use (Balemie & Kebebew, 2006).

Indigenous vegetables have, with time, been under-utilised, considered old-fashioned, poor man's food and therefore shameful to consume (Gotor & Irungu, 2010). On the other hand, Adebooye and Opabode(2005) also observed that the diversity of indigenous vegetables and fruits has been eroded as a result of many factors, including environmental, political and socio-economic factors. Consequently, some of the neglected and under-exploited indigenous traditional food plants are becoming extinct as more and more foreign plants are brought under cultivation (Musinguzi *et al.*, 2006). This decline in the use of indigenous vegetables by many rural communities has resulted in poor diets and the increased incidence of nutritional deficiency disorders and diseases in many parts of Africa (Odhav *et al.*, 2007). It is therefore recommended that research is needed to increase the evidence base and fill knowledge gaps with better inventories and more data on the consumption of indigenous foods (Bharucha & Pretty, 2010). FAO highlighted that production and promotion of the germplasm of indigenous vegetable crops in Africa is important to maintain the existing diversity and prevent genetic erosion of suitable traits in many species (Aphane *et al.*, 2002).

Conclusion

Food insecurity and malnutrition in all its forms (under nutrition, over nutrition and hidden hunger) are prevalent globally and in Africa, including in Botswana. Food systems are transforming and there is decreased use of traditional and indigenous foods from the local food environments to increased access of non-traditional foods from supermarkets due to globalisation. At the same time, supermarkets are increasingly becoming outlets for traditional or indigenous foods that may be purchased locally but may also have been imported from the surrounding regions and countries. Diet patterns are changing among populations, consumption patterns are shifting from traditional food based foods towards the westernised diets.

Globally, the world is diverse in traditional and indigenous foods with respect to different agro ecological and regional environments, however, they are on the decline in use. A lot of research that has been done on various aspects of traditional or indigenous foods has focused only on vegetables and fruits and Botswana is no exception. The use of traditional or indigenous foods in Botswana is also declining in use due to nutrition transition and globalisation. Globally, data on nutrient composition of indigenous foods hardly exists. There is limited research on the contribution of traditional or indigenous foods to specific nutrients intake, especially in Africa, and this aspect has never been investigated in Botswana. Data on the economic significance of traditional or indigenous foods to households' income remains scanty. In light of this background, the present study focussed on exploring access to and consumption of TIF and their potential contribution to household food security (access), household dietary diversity, women BMI and their contribution to specific dietary nutrients intake (energy, protein, iron, vitamin A and zinc) among women and children. The present study also investigated the importance of vending TIF with regards to their overall households' income and also the vendors' perceptions of TIF on challenges and opportunities when sourcing and vending TIF. The various aspects investigated in our study considered TIF of all food categories which included fruits, vegetables cereals, milk and milk products, oils and fats, fish and other sea animals, legumes and nuts and seeds, white roots and tubers, meats, sweets, eggs and spices condiment and beverages.

2.13 References

Acipa, A., Kamatenesi-Mugisha, M. & Oryem-Origa, H. 2013. Documentation and Nutritional profile of some selected food plants of Otwal and Ngai sun counties Oyam District, Northern Uganda. *African Journal of Food, Agriculture, Nutrition and Development*, 13(2).7428-7450.

Acquah, B., Kapunda, S. & Legwegoh, A. 2014. The dimensions of urban food insecurity in Gaborone, Botswana. *Urban Forum* 25, 217–226.

Adebooye, O.C. & Opabode, J.T. 2005. Status of conservation of the indigenous leaf vegetables and fruits of Africa. *African Journal of Biotechnology*, 3(12):700-705.

Akinnifesi, F., Kwesiga, F., Mhango, J., Chilanga, T., Mkonda, A., Kadu, C., Kadzere, I., Mithofer, D., Saka, J. & Sileshi, G. 2006. Towards the development of miombo fruit trees as commercial tree crops in southern Africa. *Forests, Trees and Livelihoods*, 16(1):103-121.

Amarteifio, J.O. & Mosase, M.O. 2006. The chemical composition of selected indigenous fruits of Botswana. *Journal of Applied Sciences and Environmental Management*, 10 (2) 43 - 47.

Anand, S.S., Hawkes, C., De Souza, R.J., Mente, A., Dehghan, M., Nugent, R., Zulyniak, M.A., Weis, T., Bernstein, A.M. & Krauss, R.M. 2015. Food consumption and its impact on cardiovascular disease: importance of solutions focused on the globalized food system: a report from the Workshop Convened by the World Heart Federation. *Journal of the American College of Cardiology*, 66(14):1590-1614.

Anywar, G., Oryem-Origa, H. & Mugisha, M.K. 2014. Wild plants used as nutraceuticals from Nebbi district, Uganda. *European Journal of Medicinal Plants*, 4(6):641-660.

Aphane, J., Chadha, M. & Oluoch, M. 2002. Increasing the consumption of micronutrient - rich foods through production and promotion of indigenous foods. http://www203.64.245.61/web_docs/proceedings/indigenous.pdf. Date accessed 17 June, 2017.

Ayua, E., Mugalavai, V., Simon, J., Weller, S., Obura, P. & Nyabinda, N. 2016. Ascorbic acid content in leaves of Nightshade (Solanum spp.) and spider plant (Cleome gynandra)

varieties grown under different fertilizer regimes in Western Kenya. *African Journal of Biotechnology*, 15(7):199-206.

Balemie, K. & Kebebew, F. 2006. Ethnobotanical study of wild edible plants in Derashe and Kucha Districts, South Ethiopia. *Journal of Ethnobiology and Ethnomedicine*, 2(1):1.

Bennett, E.L. & Robinson, J.G. 2000. Hunting of wildlife in tropical forests: implications for biodiversity and forest peoples. http://documents.worldbank.org/curated/en/101611468780290485/Hunting-of-wildlife-in-tropical-forests-implications-for-biodiversity-and-forest-peoples. Accessed 25 January, 2017.

Bersamin, A., Zidenberg-Cherr, S., Stern, J.S. & Luick, B.R. 2007. Nutrient intakes are associated with adherence to a traditional diet among Yupik Eskimos living in remote Alaska Native communities: the CANHR Study. *International Journal of Circumpolar Health*, 66(1).

Bharucha, Z. & Pretty, J. 2010. The roles and values of wild foods in agricultural systems (pp. 2913): The Royal Society., 365 (1554): 2913–2926.

Black, R.E., Allen, L.H., Bhutta, Z.A., Caulfield, L.E., De Onis, M., Ezzati, M., Mathers, C. & Rivera, J. 2008. Maternal and child undernutrition: global and regional exposures and health consequences. *The lancet*, 371(9608):243-260.

Black, R.E., Victora, C.G., Walker, S.P., Bhutta, Z.A., Christian, P., de Onis, M., Ezzati, M., Grantham-McGregor, S., Katz, J., Martorell, R. & Uauy, R. 2013. Series: Maternal and child undernutrition and overweight in low-income and middle-income countries. *The Lancet*, 382:427-451.

Botlhale, E. 2015. The Political Economy of Poverty Eradication in Botswana. *Poverty & Public Policy*, 7(4):406-419.

Boutrif, E., Murphy, S., Charrondière, U.R., Burlingame, B.A., Kuhnlein, H.V. & Smith, I.F. 2008. Expert Consultation on Nutrition Indicators for Biodiversity: Food Composition: Food & Agriculture Org. http://www.fao.org/3/a-a1582e.pdf. Date accessed 17 July, 2017.

Brinkhurst, M. 2010. Fruit of sand: complexities of Botswana's veld plant resources. *Studies by Undergraduate Researchers at Guelph*, 3 (2) 10-22.

Burlingame, B., Charrondiere, U.R., Dernini, S., Stadlmayr, B. & Mondovì, S. 2012. Food biodiversity and sustainable diets: implications of applications for food production and processing. Green technologies in food production and processing. *Springer.* p. 643-657.

Charrondière, U.R., Stadlmayr, B., Rittenschober, D., Mouille, B., Nilsson, E., Medhammar, E., Olango, T., Eisenwagen, S., Persijn, D. & Ebanks, K. 2013. FAO/INFOODS food composition database for biodiversity. *Food Chemistry*, 140(3):408-412.

Cloete, P. & Idsardi, E. 2013. Consumption of indigenous and traditional food crops: perceptions and realities from South Africa. *Agroecology and Sustainable Food Systems*, 37(8):902-914.

Courraud, J., Berger, J., Cristol, J.P. & Avallone, S. 2013. Stability and bio accessibility of different forms of carotenoids and vitamin A during in vitro digestion. *Food Chemistry*, 136(2):871-877.

Crush, J. & Frayne, B. 2010. "The Invisible Crisis: Urban Food Security in Southern Africa." Urban Food Security Series No. 1. Queen's University and AFSUN: Kingston and Cape Town. http://www.afsun.org/wp-content/uploads/2013/09/AFSUN_1.pdf. Date accessed 17 July, 2017.

Crush, J., Hovorka, A. & Tevera, D. 2011. Food security in Southern African cities the place of urban agriculture. *Progress in Development Studies*, 11(4):285-305.

Dweba, T. & Mearns, M. 2011. Conserving indigenous knowledge as the key to the current and future use of traditional vegetables. *International Journal of Information Management*, 31(6):564-571.

Egan, M., Fragodt, A., Raats, M., Hodgkins, C. & Lumbers, M. 2007. The importance of harmonizing food composition data across Europe. *European Journal of Clinical Nutrition*, 61(7):813-821.

FAO (Food and Agricultural Organization).1996. World Food Summit: Rome Declaration on World Food Security and World Food Summit Plan of Action. Rome, Italy. http://www.fao.org/docrep/003/w3613e/w3613e00.htm. Date accessed 15 July, 2017.

FAO (Food and Agricultural Organization). 2009. World Summit on Food Security. *Draft declaration of the world summit on food security;* 16-18 November. Rome, Italy: FAO.

FAO (Food and Agricultural Organization). 2012. World Food Programme, International Fund for Agricultural Development. The State of Food Insecurity in the World: Economic Growth is necessary but not sufficient to Accelerate Reduction of Hunger and Malnutrition. Rome, Italy. http://reliefweb.int/report/world/state-food-insecurity-world-2012-economic-growth-necessary-not-sufficient-accelerate. Date accessed 12 July, 2017.

FAO (Food and Agricultural Organization). 2014. Promotion of underutilized indigenous food resources for food security and nutrition in Asia and the Pacific. Bangkok, Thailand. http://www.fao.org/3/a-i3685e.pdf. Date accessed 28 September, 2016.

FAO (Food and Agricultural Organization). 2008. An introduction to the Basic Concepts of Food Security. Food Security Information for Action. Practical Guides. http://www.fao.org/docrep/013/al936e/al936e00.pdf. Date accessed 4 August, 2016.

FAO (Food and Agricultural Organization). 2010. Guidelines for measuring household and individual dietary diversity. Rome, Italy. http://www.fao.org/docrep/014/i1983e/i1983e00.pdf. Date accessed 15 July, 2017.

FAO (Food and Agricultural Organization). 2012. The State of Food Insecurity in the World: Economic Growth is necessary but not sufficient to Accelerate Reduction of Hunger and Malnutrition. Rome, Italy. http://www.fao.org/docrep/016/i3027e/i3027e.pdf. Date accessed 17 July, 2017.

FAO (Food and Agricultural Organization). 2013. Linkages between Biodiversity, Foods and Nutrition.http://www.Bioversityinternational.org/uploads/tx_news/Chpt7_Linking_biodiversity_and_nutrition.pdf. Date accessed 13 July, 2017.

FAO (Food and Agricultural Organization). 2014. Promotion of underutilized indigenous food resources for food security and nutrition in Asia and the Pacific. http://www.fao.org/3/a-i3685e.pdf. Date accessed 15 September, 2016.

FAO (Food and Agricultural Organization). 2015. The State of Food Insecurity in the World 2015. Meeting the 2015 international hunger targets: taking stock of uneven progress. Rome, Italy. http://www.fao.org/3/a-i4646e.pdf. Date accessed 22 July, 2017.

FAO (Food and Agriculture Organization). 2015. The state of food insecurity in the world 2014: strengthening the enabling environment for food security and nutrition: Rome, Italy. http://www.fao.org/3/a-i4030e.pdf. Date accessed 19 July, 2017.

Flyman, M. & Afolayan, A. 2006. The suitability of wild vegetables for alleviating human dietary deficiencies. *South African Journal of Botany*, 72(4):492-497.

Frison, E.A., Cherfas, J. & Hodgkin, T. 2011. Agricultural biodiversity is essential for a sustainable improvement in food and nutrition security. *Sustainability*, 3(1):238-253.

Frison, E.A., Smith, I.F., Johns, T., Cherfas, J. & Eyzaguirre, P.B. 2006. Agricultural biodiversity, nutrition, and health: making a difference to hunger and nutrition in the developing world. *Food and Nutrition Bulletin*, 27(2):167-179.

Funk, C.C. & Brown, M.E. 2009. Declining global per capita agricultural production and warming oceans threaten food security. *Food Security*, 1(3):271-289.

Garrity, D.P., Akinnifesi, F.K., Ajayi, O.C., Weldesemayat, S.G., Mowo, J.G., Kalinganire, A., Larwanou, M. & Bayala, J. 2010. Evergreen Agriculture: a robust approach to sustainable food security in Africa. *Food Security*, 2(3):197-214.

Ghosh-Jerath, S., Singh, A., Magsumbol, M.S., Lyngdoh, T., Kamboj, P. & Goldberg, G., 2016a. Contribution of indigenous foods towards nutrient intakes and nutritional status of women in the Santhal tribal community of Jharkhand, India. *Public Health Nutrition*, *19*(12), pp.2256-2267.

Ghosh-Jerath, S., Singh, A., Magsumbol, M.S., Kamboj, P. & Goldberg, G., 2016b. Exploring the Potential of Indigenous Foods to Address Hidden Hunger: Nutritive Value of Indigenous Foods of Santhal Tribal Community of Jharkhand, India. *Journal of Hunger & Environmental Nutrition*, *11*(4), pp.548-568.

Gibson, R.S., Bailey, K.B., Gibbs, M. & Ferguson, E.L. 2010. A review of phytate, iron, zinc, and calcium concentrations in plant-based complementary foods used in low-income countries and implications for bioavailability. *Food and Nutrition Bulletin*, 31(2 suppl2):S134-S146.

Bokeloh, G., Maria Gerster-Bentaya, S. & Lioba Weingärtner, R. 2009. Achieving Food and Nutrition Security. InWEnt – Internationale Weiterbildung und Entwicklung gGmbH. Capacity Building International, Germany.

Gotor, E. & Irungu, C. 2010. The impact of Bioversity International's African leafy vegetables programme in Kenya. *Impact Assessment and Project Appraisal*, 28(1):41-55.

Gupta, S., Jyothi Lakshmi, A., Manjunath, M.N. & Prakash, J. 2005. Analysis of nutrient and antinutrient content of underutilized green leafy vegetables. *LWT-Food Science and Technology*, 38(4):339-345.

Hambidge, K.M., Miller, L.V., Westcott, J.E., Sheng, X. & Krebs, N.F. 2010. Zinc bioavailability and homeostasis. *The American Journal of Clinical Nutrition*, 91(5):1478S-1483S.

Hawkes, C. & Popkin, B.M. 2015. Can the sustainable development goals reduce the burden of nutrition-related non-communicable diseases without truly addressing major food system reforms? *BMC Medicine*, 13(1):143.

Hotz, C. & Gibson, R.S. 2007. Traditional food-processing and preparation practices to enhance the bioavailability of micronutrients in plant-based diets. *The Journal of Nutrition*, 137(4):1097-1100.

Hurrell, R. & Egli, I. 2010. Iron bioavailability and dietary reference values. *The American Journal of Clinical Nutrition*, 91(5):1461S-1467S.

IFPRI (International Food Policy Research Institute). 2016. Global Nutrition Report 2016: From Promise to Impact: Ending Malnutrition by 2030. Washington, DC. http://www.ifpri.org/publication/global-nutrition-report-2016-promise-impact-ending-malnutrition-2030. Date accessed 16 September, 2016.

Johnson-Down, L. & Egeland, G.M. 2010. Adequate nutrient intakes are associated with traditional food consumption in Nunavut Inuit children aged 3–5 years. *The Journal of Nutrition*, 140(7):1311-1316.

Jones, A.D., Ngure, F.M., Pelto, G. & Young, S.L. 2013. What are we assessing when we measure food security? A compendium and review of current metrics. *Advances in Nutrition: An International Review Journal*, 4(5):481-505.

Kamga, R.T., Kouamé, C., Atangana, A.R., Chagomoka, T. & Ndango, R. 2013. Nutritional Evaluation of Five African Indigenous Vegetables. *Journal of Horticultural Research*, 21(1):99-106.

Keatinge, J., Yang, R.-Y., Hughes, J.d.A., Easdown, W. & Holmer, R. 2011. The importance of vegetables in ensuring both food and nutritional security in attainment of the Millennium Development Goals. *Food Security*, 3(4):491-501.

Keding, G., Weinberger, K., Swai, I. & Mndiga, H. 2007. Diversity, traits and use of traditional vegetables in Tanzania: AVRDC-World Vegetable Center.

Kimiywe, J., Waudo, J., Mbithe, D. and Maundu, P., 2007. Utilization and medicinal value of indigenous leafy vegetables consumed in urban and peri-urban Nairobi. *African Journal of Food, Agriculture, Nutrition and Development*, *7*(4), pp.1-15.

Kuhnlein, H.V. & Receveur, O. 1996. Dietary change and traditional food systems of indigenous peoples. *Annual Review of Nutrition*, 16(1):417-442.

Kuhnlein, H.V. & Receveur, O. 2007. Local cultural animal food contributes high levels of nutrients for Arctic Canadian Indigenous adults and children. *The Journal of Nutrition*, 137(4):1110-1114.

Kuhnlein, H.V., Erasmus, B. & Spigelski, D. 2009. Indigenous peoples' food systems: the many dimensions of culture, diversity and environment for nutrition and health: Food and Agriculture Organization of the United Nations, Rome.

Kunyanga, C.N., Imungi, J.K. & Vellingiri, V. 2013. Nutritional evaluation of indigenous foods with potential food-based solution to alleviate hunger and malnutrition in Kenya. *Journal of Applied Biosciences*, 67:5277-5288.

La Frano, M.R., de Moura, F.F., Boy, E., Lönnerdal, B. & Burri, B.J. 2014. Bioavailability of iron, zinc, and provitamin A carotenoids in biofortified staple crops. *Nutrition Reviews*, 72(5):289-307.

Lado, C. 2001. Environmental and socio-economic factors behind food security policy strategies in Botswana. *Development Southern Africa*, 18(2):141-168.

Leakey, R.R., Tchoundjeu, Z., Schreckenberg, K., Shackleton, S.E. & Shackleton, C.M. 2005. Agroforestry tree products (AFTPs): targeting poverty reduction and enhanced livelihoods. *International Journal of Agricultural Sustainability*, 3(1):1-23.

Legwaila, G.M., Mojeremane, W., Madisa, M.E., Mmolotsi, R.M. & Rampart, M. 2011. Potential of traditional food plants in rural household food security in Botswana. *Journal of Horticulture and Forestry*, 3(6):171-177.

Lestienne, I., Icard-Vernière, C., Mouquet, C., Picq, C. & Trèche, S. 2005. Effects of soaking whole cereal and legume seeds on iron, zinc and phytate contents. *Food Chemistry*, 89(3):421-425.

Lin, B.B. 2011. Resilience in agriculture through crop diversification: adaptive management for environmental change. *Bioscience*, 61(3):183-193.

Lowe, N.M., Fekete, K. & Decsi, T. 2009. Methods of assessment of zinc status in humans: a systematic review. *The American Journal of Clinical Nutrition*, 89(6):2040S-2051S.

Maes, J., Egoh, B., Willemen, L., Liquete, C., Vihervaara, P., Schägner, J.P., Grizzetti, B., Drakou, E.G., Notte, A.L. & Zulian, G. 2012. Mapping ecosystem services for policy support and decision making in the European Union. *Ecosystem Services*, 1(1):31-39.

Maiani, G., Periago Castón, M.J., Catasta, G., Toti, E., Cambrodón, I.G., Bysted, A., Granado-Lorencio, F., Olmedilla-Alonso, B., Knuthsen, P. & Valoti, M. 2009. Carotenoids: actual knowledge on food sources, intakes, stability and bioavailability and their protective role in humans. *Molecular Nutrition & Food Research*, 53(S2):S194-S218.

Maunder, E. & Meaker, J. 2007. The current and potential contribution of home-grown vegetables to diets in South Africa. Water SA, 33(3): 401-405.

Martins, D., Barros, L., Carvalho, A.M. & Ferreira, I.C.F.R. 2011. Nutritional and invitro antioxidant properties of edible wild greens in Iberian Peninsula traditional diet. *Food Chemistry*, 125(2):488-494.

Matenge, S.T., van der Merwe, D., De Beer, H., Bosman, M.J. & Kruger, A. 2012. Consumers' beliefs on indigenous and traditional foods and acceptance of products made with cow pea leaves. *African Journal of Agricultural Research*, 7(14):2243-2254.

Mavengahama, S., de Clercq, W. & McLachlan, M. 2013. The role of wild vegetable species in household food security in maize based subsistence cropping systems. *Food Security*, 5(2):227-233.

Meng, F., Wei, Y. & Yang, X. 2005. Iron content and bioavailability in rice. *Journal of Trace Elements in Medicine and Biology*, 18(4):333-338.

Mibei, E.K., Ojijo, N., Karanja, S.M. & Kinyua, J.K. 2012. Phytochemical and antioxidant analysis of methanolic extracts of four African indigenous leafy vegetables. *Annals Food Science and Technology*, 13:37-42.

Misra, S., Maikhuri, R., Kala, C., Rao, K. & Saxena, K. 2008. Wild leafy vegetables: A study of their subsistence dietetic support to the inhabitants of Nanda Devi Biosphere Reserve, India. *Journal of Ethnobiology and Ethno medicine*, 4(1):1.

Mojeremane, W. & Tshwenyane, S.O. 2004. Azanza garckeana: A Valuable Edible Indigenous Fruit Tree of Botswana. *Pakistan Journal of Nutrition,* 3 (5): 264-267.

Molla, E.L., Asfaw, Z., Kelbessa, E. & Van Damme, P. 2011. Wild edible plants in Ethiopia: a review on their potential to combat food insecurity. *Afrika Focus*, 24(2):71-121.

Moore C, Raymond RD. 2006. *Back by popular demand: the benefits of traditional vegetables: one community's story*: Bioversity International.

Motlhanka, D.M.T., Motlhanka, P. & Selebatso, T. 2008. Edible indigenous wild fruit plants of Eastern Botswana. *International Journal of Poultry Science*, 7(5):457-460.

Musinguzi, E., Kikafunda, J.K. & Kiremire, B.T. 2006. Utilization of indigenous food plants in Uganda: a case study of South-western Uganda. *African Journal of Food, Agriculture, Nutrition and Development*, 6(2):1-12.

Musotsi, A.A., Sigot, A.J. and Onyango, M.A. 2005. African indigenous vegetables recipe documentation and their role in food security. *Sustainable Horticultural Production in the Tropics*, p 105.

Mwema, C.M., Mutai, B.K., Lagat, J.K., Kibet, L.K. & Maina, M.C. 2012. Contribution of selected indigenous fruits on household income and food security in Mwingi, Kenya. *Current Research Journal of Social Sciences*, 4(6):425-430.

Neudeck, L., Avelino, L., Bareetseng, P., Ngwenya, B.N., Teketay, D. & Motsholapheko, M. 2012. The contribution of edible wild plants to food security, dietary diversity and income of households in Shorobe Village, northern Botswana. *Ethnobotany Research & Applications*, 10:449-462.

Ng, M., Fleming, T., Robinson, M., Thomson, B., Graetz, N., Margono, C., Mullany, E.C., Biryukov, S., Abbafati, C. & Abera, S.F. 2014. Global, regional, and national prevalence of overweight and obesity in children and adults during 1980–2013: a systematic analysis for the Global Burden of Disease Study 2013. *The Lancet*, 384(9945):766-781.

Odhav, B., Beekrum, S., Akula, U.S. & Baijnath, H. 2007. Preliminary assessment of nutritional value of traditional leafy vegetables in KwaZulu-Natal, South Africa. *Journal of Food Composition and Analysis*, 20(5):430-435.

Ogoye-Ndegwa, C. 2003. Traditional gathering of wild vegetables among the luo of Western Kenya-a nutritional anthropology project1. *Ecology of Food and Nutrition*, 42(1):69-89.

Ohiokpehai, O. 2003. Promoting the nutritional goodness of traditional food products. *Pakistan Journal of Nutrition*, 2(4):267-270.

Oiye, S., Shiundu, K. & Oniang'o, R. 2009. The contribution of African Leafy Vegetables (ALVs) to vitamin A intake and the influence of income in rural Kenya. *African Journal of Food, Agriculture, Nutrition and Development*, 9(6): 1309-1324.

Oniang'o, R., Allotey, J. & Malaba, S.J. 2004. Contribution of indigenous knowledge and practices in food technology to the attainment of food security in Africa. *Journal of Food Science*, 69(3):87-91.

Orech, F.O., Akenga, T., Ochora, J., Friis, H. & Aagaard-Hansen, J. 2005. Potential toxicity of some traditional leafy vegetables consumed in Nyang'oma Division, Western Kenya. *African Journal of Food, Agriculture, Nutrition and Development*, 5(1):1-13.

Penafiel, D., Lachat, C., Espinel, R., Van Damme, P. & Kolsteren, P. 2011. A Systematic Review on the Contributions of Edible Plant and Animal Biodiversity to Human Diets. *EcoHealth*, 8(3):381-399.

Popkin, B.M. 2006. Global nutrition dynamics: the world is shifting rapidly toward a diet linked with non-communicable diseases. *American Journal of Clinical Nutrition*, 84(2):289-298.

Popkin, B.M., 2014. Nutrition, agriculture and the global food system in low and middle income countries. *Food Policy*, *47*, pp.91-96.

Power, E.M. 2008. Conceptualizing food security for Aboriginal people in Canada. *Canadian Journal of Public Health*, 99 (2):95-7.

Raboloko, M. 2016. Determinants of Urban Household Food Security in Botswana. *Academy of Biomedical and Clinical Science Journal*, 1, pp17‑21.

Reinivuo, H., Bell, S. & Ovaskainen, M. L. 2009. Harmonisation of recipe calculation procedures in European food composition databases. *Journal of Food Composition and Analysis*, 22(5):410-413.

Roche, M., Creed-Kanashiro, H., Tuesta, I. & Kuhnlein, H. 2008. Traditional food diversity predicts dietary quality for the Awajun in the Peruvian Amazon. *Public Health Nutrition*, 11(05):457-465.

Ruel, M.T., Garrett, J.L., Hawkes, C. & Cohen, M.J. 2010. The food, fuel, and financial crises affect the urban and rural poor disproportionately: a review of the evidence. *The Journal of Nutrition*, 140(1):170S-176S

Ruel, M.T., Minot, N. & Smith, L. 2005. Patterns and determinants of fruit and vegetable consumption in sub-Saharan Africa: a multicounty comparison: Geneva, Switzerland. WHO.

http://www.who.int/dietphysicalactivity/publications/f&v_africa_economics.pdf. Date accessed 18 July, 2017.

Ruiz-Pérez, M., Belcher, B., Achdiawan, R., Alexiades, M., Aubertin, C., Caballero, J., Campbell, B., Clement, C., Cunningham, T. & Fantini, A. 2004. Markets drive the specialization strategies of forest peoples. pp 2-9.

Sasson, A. 2012. Food security for Africa: an urgent global challenge. *Agriculture & Food Security*, 1(1), p.2.

Sekwati, L., Narayana, N. & Raboloko, M. 2013. Understanding the nature of household poverty in Botswana. *Pula: Botswana Journal of African Studies*, 26(1):71-82.

Smith, F.I. & Eyzaguirre, P. 2007. African leafy vegetables: their role in the world health organization's global fruit and vegetables initiative. *African Journal of Food Agriculture Nutrition and Development*, 7(3):1-17.

Solomon, M. & Prisca, N. 2012. Nutritive value of Lepidoptara litoralia (edible caterpillar) found in Jos Nigeria: implication for food security and poverty alleviation. *African Journal of Food Agriculture Nutrition and Development*, 12 (6):6738-6747.

Statistics Botswana. 2012. Annual agricultural survey report. *Gaborone, Botswana:* http://www.statsbots.org.bw/sites/default/files/publications/Agriculture%20Main%20Report%202012.pdf. Date accessed 20 July, 2017.

Steyn, N.P. and Temple, N., 2008. Community based nutrition textbook for South Africa: A right based approach. *Cape Town: South African Medical Research Council FAO/MRC*, pp.101-160.

Tabuti, J.R.S. 2007. Status of non-cultivated food plants in Bulamogi County, Uganda. *African Journal of Ecology*, 45(1):96-101.

Teucher, B., Olivares, M. & Cori, H. 2004. Enhancers of iron absorption: ascorbic acid and other organic acids. *International Journal for Vitamin and Nutrition Research*, 74(6):403-419.

Temple, N.J. & Steyn, N. eds., 2016. *Community nutrition for developing countries*. Athabasca University Press and UNISA Press.

Toledo, Á. & Burlingame, B. 2006. Biodiversity and nutrition: A common path toward global food security and sustainable development. *Journal of Food Composition and Analysis* 19(6):477-483.

Tran, C.D., Miller, L.V., Krebs, N.F., Lei, S. & Hambidge, K.M. 2004. Zinc absorption as a function of the dose of zinc sulfate in aqueous solution. *The American Journal of Clinical Nutrition*, 80(6):1570-1573.

Tscharntke, T., Clough, Y., Motzke, I., Wanger, T.C., Jackson, L., Perfecto, I., Vandermeer, J. & Whitbread, A. 2012. Global food security, biodiversity conservation and the future of agricultural intensification. *Biological Conservation*, 151(1):53-59.

Tumwet, T.N., Kang'ethe, E.K., Kogi-Makau, W. & Mwangi, A.M. 2014. Diversity and immune boosting claims of some African indigenous leafy vegetables in western Kenya. *African Journal of Food, Agriculture, Nutrition and Development*, 14(1):8529-8544.

UNICEF (United Nations International Children's Emergency Fund). 1998. State of the world's children.1998. https://www.unicef.org/sowc98/silent4.htm. Date accessed 20 September, 2016.

UNICEF (United Nations International Children's Emergency Fund). 2016. Undernutrition contributes to nearly half of all deaths in children under 5 and is widespread in Asia and Africa. http://data.unicef.org/nutrition/malnutrition.html#sthash.CFTMMWab.dpuf
Date accessed 3 October, 2016.

Uusiku, N.P., Oelofse, A., Duodu, K.G., Bester, M.J. & Faber, M. 2010. Nutritional value of leafy vegetables of sub-Saharan Africa and their potential contribution to human health: A review. *Journal of Food Composition and Analysis*, 23(6):499-509.

Vakili, M., Abedi, P., Sharifi, M. & Hosseini, M. 2013. Dietary diversity and its related factors among adolescents: a survey in Ahvaz-Iran. *Global Journal of Health Science*, 5(2):181.

Van der Hoeven, M., Osei, J., Greeff, M., Kruger, A., Faber, M. & Smuts, C.M. 2013. Indigenous and traditional plants: South African parents' knowledge, perceptions and uses and their children's sensory acceptance. *Journal of Ethnobiology and Ethnomedicine*, 9(78):1-12.

Vorster, H.H., Kruger, A. & Margetts, B.M. 2011. The nutrition transition in Africa: can it be steered into a more positive direction? *Nutrients*, 3(4):429-441.

Voster, I.H., van Rensburg Willem, J., Van Zijl, J. & Venter, S.L. 2007. The importance of traditional leafy vegetables in South Africa. *African Journal of Food, Agriculture, Nutrition and Development.* 3 (4): 1-8.

Weinberger, K. & Swai, I. 2006. Consumption of traditional vegetables in Central and North-eastern Tanzania. *Ecology of Food and Nutrition*, 45(2):87-103.

West Jr, K.P. & Darnton-Hill, I., 2008. Vitamin A deficiency. In Nutrition and health in developing countries (pp. 377-433). Humana Press. Vitamin A deficiency. Nutrition and health in developing countries. Springer. p. 377-433.

Whittaker, P. 1998. Iron and zinc interactions in humans. *The American Journal of Clinical Nutrition*, 68(2 Suppl):442S-446S.

WHO (World Health Organization). 2009. Global prevalence of vitamin A deficiency in populations at risk 1995-2005: WHO global database on vitamin A deficiency. Geneva, Switzerland. http://apps.who.int/iris/bitstream/10665/44110/1/9789241598019_eng.pdf. Date accessed 11 July, 2017.

WHO (World Health Organization). 2015. World Health Statistics; Global health indicators Part 11. Geneva, Switzerland. http://www.who.int/gho/publications/world_health_statistics/2015/en/. Date accessed 17 July, 2017.

World Bank. 2015. Botswana Poverty Assessment. (88473-BW). http://www.worldbank.org/en/country/botswana/publication/botswana-poverty-assessment-december-2015. Date accessed 13 July, 2017.

Yang, R.-Y. & Keding, G.B. 2009a. Nutritional contributions of important African indigenous vegetables. *African Indigenous Vegetables in Urban Agriculture. Earthscan, London*: 105-144.

Zimmermann, M.B., Chaouki, N. & Hurrell, R.F. 2005. Iron deficiency due to consumption of a habitual diet low in bioavailable iron: a longitudinal cohort study in Moroccan children. *The American Journal of Clinical Nutrition*, 81(1):115-121.

CHAPTER 3

Household access to traditional and indigenous foods positively associated with food security and dietary diversity in Botswana

Salome Nduku Kasimba1[,*], Boitumelo Stokie Motswagole[2], Namukolo Margaret Covic[3] and Nicole Claasen[4]

[1]Centre of Excellence for Nutrition (CEN), North-West University, Potchefstroom Campus, Private Bag X6001, Potchefstroom 2520, South Africa

[2]National Food Technology Research Centre (NFTRC), Kanye, Botswana

[3]Poverty, Health and Nutrition Division, International Food and Policy Research Institute, Addis Ababa; Ethiopia

[4]Africa Unit for Transdisciplinary Health Research (AUTHeR), North-West University, Potchefstroom, South Africa

This manuscript is formatted according to guidelines of Journal of Public Health Nutrition (see addendum one.) with exception of the line numbers and line spaces. This manuscript has been published in the Journal of Public Health Nutrition:
doi:10.1017/S136898001700369X

Submitted 5 April 2017: Final revision received 12 October 2017: Accepted 9 November 2017.

Abstract

Objective: To determine access to traditional and indigenous foods (TIF) and the association with household food security, dietary diversity and women's BMI in low socio-economic households.

Design: Sequential explanatory mixed-methods design, including a random household cross-sectional survey on household food insecurity access (HFIA), household dietary diversity (HDD) and women's BMI, followed by focus group discussions.

Setting: Two rural and two urban areas of Botswana.

Subjects: Persons responsible for food preparation or an adult in a household (n 400); for BMI, non-pregnant women aged 18–49 years (n 253).

Results: Almost two-thirds of households experienced moderate or severe food insecurity (28·8 and 37·3%, respectively), but more than half of women were overweight or obese (26·9 and 26·9%, respectively). Median HDD score was 6 (interquartile range 5–7) out of a total of 12. A positive correlation was found between number of TIF accessed and HDD score ($r=0{\cdot}457$; $P<0{\cdot}001$) and a negative correlation between number of TIF accessed and HFIA score ($r= -0{\cdot}272$; $P<0{\cdot}001$). There was no correlation between number of TIF accessed and women's BMI ($r= -0{\cdot}066$; $P=0{\cdot}297$). TIF were perceived as healthy but with declining consumption due to preference for modern foods.

Conclusions: TIF may potentially have an important role in household food security and dietary diversity. There is need to explore potential benefits that may be associated with their optimal use on food security and nutrition outcomes.

Key words: Traditional and indigenous foods, food security, dietary diversity, food access.

Introduction

Food security, as defined by the FAO, is a situation that exists when 'all people, at all times, have physical, social and economic access to sufficient, safe, nutritious food to meet their dietary needs and food preferences for inactive and healthy life'[1]. For many years, traditional foods from local environments, that include plants and animals, formed part of diets linked to specific regional ecosystems and offered sustainable food and nutrition security[2,3]. Major dietary shifts are occurring globally, from consumption of traditional diets, likely to be more nutrient dense, towards consumption of Westernised diets, which are more energy-dense, with high contents of sugar, salt and saturated fats. This dietary shift, driven by globalisation and urbanisation, is described as 'nutrition transition' and is associated with considerable health consequences, such as obesity and non-communicable diseases like diabetes and high blood pressure[2,4]. Food security has been a major concern in Botswana, both at national and household level, in part due to the country's low performance from the agricultural sector, the arid nature of the climate and recurring droughts[5,6]. Subsistence farming dominates the agricultural sector in Botswana and is depended upon for food, income and employment, especially by the majority of rural dwellers[5]. Foods produced by local farmers include, among others, maize, sorghum, millet, groundnuts, beans and pulses[5]. However, the agricultural production sector is on a downward trend. The 2013 agricultural survey showed that the number of farmers dropped from 121 766 in 2012 to 119

134 in 2013[5]. The sector does not produce enough food to feed the nation and, consequently, the population relies on food imports and purchase of foods[5–7]. The country follows a national food security policy that focuses on food imports instead of domestic food production[8]. It imports more than 80% of the national food supply to ensure physical availability of food supplies to its population[9]. Supermarkets are the major food distributors in Botswana and there is increased physical availability of imported, processed and packaged foods[7,10]. Supermarkets handle about 50–60% of food retail in cities and major urban villages in Botswana[7]. In 2008, a survey by the African Food Security Urban Network showed that 92% of urban poor households depended on supermarkets as their food source[11]. The heavy reliance on imported, often processed, foods may adversely impact on the country's diverse local traditional and indigenous diets and food security, and may promote an upsurge of overweight and obesity and related non-communicable diseases. The country's prevalence of undernourished people (with energy intake below the minimum dietary energy requirement) stated by the FAO in 2015 was 28·7%, while in the whole of Southern Africa it was 6·1%[12]. The decrease in the prevalence of undernourishment in Botswana was only 4% for the period 1990–92 to 2014–15 compared with 28·0% for the Southern African region[12]. The low decrease was attributed to low agricultural productivity[12]. Notwithstanding, the country has diverse local traditional and indigenous foods (TIF), both cultivated and growing wildly[13,14], but often overlooked for food security[14]. Little is known about household access to these TIF and their importance in achieving food and nutrition security. With increased 'supermarketisation globally[15], some of the foods that are acknowledged by locals to be TIF may be purchased from supermarkets and may also be imported from the surrounding regions and countries[16]. In our research, therefore, TIF were defined as foods that are native or were introduced into Botswana a long time ago, including plant and animal sources, whether locally produced (either domesticated or cultivated) or accessed from the wild. Considering the globalisation of food systems, these foods may also be purchased from retail outlets, irrespective of their origin, but recognised as part of the country's traditional food culture. This definition of TIF was arrived at in a consultative process by a panel of nutrition experts, local field assistants and the research team prior to the present study. The objective of our study was to determine access to TIF and the association with household food security (in terms of access), household dietary diversity and women's BMI in low socio-economic households. In the current paper, we first present quantitative results on access to TIF in Botswana households and the association of TIF use with food security (in terms of access), dietary diversity and women's BMI. Qualitative narratives of participants from focus group discussions (FGDs) are then used to provide a more in-depth view into perceptions on access and use of TIF. Merging these

components, the discussion focuses on the role that TIF may play in promoting food security and nutrition and future public health in Botswana.

Methodology

Research setting

Two urban areas (Old Naledi and Area W) and two rural areas (Maun and Tsabong) of Botswana were purposively selected to include predominantly low socio-economic areas and to accommodate the possible variations in availability of TIF in the country. Old Naledi and Area W are situated in Gaborone and Francistown, respectively. Gaborone, the country's largest city and capital, is situated in the South-East District with a population of 227 333[17]. Francistown, located in the North-East District, is the second largest city with a population of about 100 079[17] .Tsabong is situated in the Kgalagadi District and covers a vast area of the Kalahari Desert with a population of 7869[17]. It is characterised by a hot semi-arid climate, low rainfall and a predominantly savannah landscape of grasslands interspersed with woodland. It has sandy soils, not well suited for cultivation but supporting considerable numbers of cattle, goats, other livestock and wildlife[18]. Maun is one of the largest villages in the North-West District with a population of 55 784[17]. It is the tourism capital of Botswana and lies on the southern fringes of the Okavango Delta that presents a different landscape: vast areas of open water and lush, green wetlands with an abundance of wildlife[18].

Study design and sampling

A mixed-methods research approach was followed, applying a sequential explanatory design which involved quantitative data collection in the form of a household survey followed by a qualitative phenomenological approach, collecting data with FGDs[19]. Data were collected between July and September 2015 (winter – dry season). The quantitative data collection involved a cross-sectional household survey, applying a multistage sampling: first, a purposive selection of the four settings (Old Naledi, Area W, Maun and Tsabong); second, five enumeration areas per setting were randomly selected; third, a random selection of twenty plots per area; and finally, one household was selected from each plot. In cases where household members were absent, we revisited the household at a later time. When household members were not willing to participate (n 2), another household was randomly selected in the same plot. The target respondent was the person mostly responsible for food preparation or, if absent, any other adult household member who had eaten in the house the previous day answered on behalf of the other household members. This guideline was adopted from the household dietary diversity instrument of the FAO[20], which was one section of the household survey. If available, one non-pregnant woman, aged 18–49 years,

was selected for weight and height measurements from each of the selected households. In total, 400 households and 253 women were sampled. In the current paper, a household refers to a person or group of persons related or unrelated by blood, residing in the same plot, under the same roof and eating from the same pot[21]. For qualitative data collection, a sub-sample (n 64) was purposively selected from the sample of the household survey to participate in FGDs. Inclusion criteria for participation in both the survey and FGDs were: aged 18 years or older; resident of the study area for at least 3 months prior to the survey; interest in and familiarity with TIF; and willingness to participate. Data saturation was achieved when themes of answers recurred[22] with two FGDs in each setting, resulting in a total of eight FGDs.

Quantitative data collection and analysis

A researcher-administered questionnaire was administered during household visits, composed of three sections:(i) household demographic and socio-economic characteristics, including questions on household size and monthly household income; (ii) household food insecurity access (HFIA), including nine occurrence questions on experienced food insecurity within the past 30 d[23]; and (iii) household dietary diversity (HDD), a non-quantitative 24 h recall to capture foods (meals and snacks) that were prepared in the home and consumed in the home or outside the home; or purchased or gathered outside the home and consumed in the home by household members during the previous day and night[20]. The HFIA scores were categorised into four levels of food security: secure, mildly insecure, moderately insecure and severely insecure[23]. The HDD scores were calculated by summing up the number of food groups consumed by all members of the household, from the following twelve groups: (i) cereals;(ii) white tubers and roots; (iii) fruits; (iv) vegetables;(v) legumes, nut and seeds; (vi) fish and other seafood; (vii) meat; (viii) eggs; (ix) oils and fats; (x) sweets; (xi) milk and milk products; and (xii) spices, condiments and beverages[20]. The households were then categorised into three HDD score categories defined by the research team for the purpose of determining the distribution of the HDD scores: low (0–4 food groups), medium (5–8 food groups) and high (9–12 food groups). Median HDD score was also calculated. To determine household access to TIF, a 1-point value was given to each individual traditional or indigenous food reported by any of the household members in the HDD component. The sum of points indicated the household’s access to TIF. Mixed foods were disaggregated, so the traditional or indigenous ingredients were included. Weight was measured using a Seca Robusta 813 calibrated digital scale (graduation 100 g) without shoes and in minimal clothing to the nearest 0·1 kg. Height was measured with the subject standing upright without shoes and with the head in the Frankfort plane position, using a Seca calibrated stadiometer to the nearest 0·1 cm[24]. Based on the WHO cut-offs, the

following BMI classifications were used: underweight (<18·5 kg/m2), normal (18·5–24·9 kg/m2), overweight (25–29·9 kg/m2) and obese (≥30 kg/m2)[(25)]. Descriptive statistics were applied to summarise demographic and socio-economic household characteristics, food insecurity, household dietary diversity, household access to TIF and women's BMI. Spearman correlations were used to determine the associations of household access to TIF with HDD score, HFIAS score and women's BMI. Statistical significance was set at P<0·05 for all analyses.

Qualitative data collection and analysis

FGDs were conducted in Setswana, the local language, led by a moderator and two facilitators who were taking notes. Guiding questions were: 'What do you consider as TIF in this area?' 'What are the different types of TIF that are found in this area?' 'Are TIF used to the same extent throughout the year?' 'Where do you find these foods in this area? 'What influences the use of TIF in the area?' The FGDs were audio-recorded and the recordings were first transcribed verbatim in Setswana and then translated into English, comparing them with the notes taken to ensure that the meaning of the data was preserved[(19)]. The software ATLAS.ti was used for thematic analysis based on the main research questions, resulting in three main themes and related sub-themes[(26,27)]. Co-coding was carried out with an independent researcher, ensuring increased validity of the coded themes.

Results

Table 1 summarises household characteristics, including demographic and socio-economic characteristics, household food insecurity, household dietary diversity, number of TIF accessed and women's BMI. Food insecurity, in terms of access, was experienced by 80·1% of households, with 14·0, 28·8 and 37·3% being mildly, moderately and severely food insecure, respectively. Severe food insecurity was significantly higher in rural areas compared with urban areas, 51·0 v. 23·5%, respectively (P<0.001). Median HDD score was 6 (interquartile range 5–7) out of a total of 12 and the majority of households (81·0%) fell into the medium HDD category (5–8 food groups) with no significant differences between urban and rural areas (P=0·153). The most commonly consumed food groups were cereals (98·2 %); spices, condiments and beverages (97·2 %); oils and fats (92·5 %); sweets (85·7 %); and vegetables (68·0%; data not shown). A large share of households (56·3%) reported having accessed between three and five TIF the previous day. Households in urban areas had access to a significantly bigger variety of TIF compared with rural areas (P=0·001). Among the participating women, 26·9% were overweight and an equal percentage (26·9%) were obese.

Table 1 Demographic and socio-economic characteristics, food security, dietary diversity, number of traditional and indigenous foods (TIF) accessed and women's BMI, in low socio-economic households from two rural and two urban areas of Botswana, July–September 2015

Household characteristics	Urban (n=200)		Rural (n=200)		Total (n=400)		P-value
	n	%	n	%	n	%	
Household size median; (IQR) *	4(2,6)		5.5	(4,9)	5(3,7)		<0.001
Household income category per month† (BWP)							
0-3000	107	53.5	145	72.5	252	63.0	<0.001
3001-6000	52	26.0	15	7.5	67	16.8	
>6000	21	10.5	18	9.0	39	9.8	
Unknown	20	10.0	22	11.0	42	10.5	
HFIA categories†							
Food secure	55	27.5	25	12.5	80	20.0	<0.001
Mildly insecure	33	16.5	23	11.5	56	14.0	
Moderately insecure	65	32.5	50	25.0	115	28.8	
Severely insecure	47	23.5	102	51.0	149	37.3	
HDD scores categories†							
0-4 food groups (low)	17	8.5	29	14.5	46	11.5	0.109
5-8 food groups (medium)	165	82.5	159	79.5	324	81.0	
9-12 food groups (high)	18	9.0	12	6.0	30	7.5	
HDD score; median (IQR)*	6 (5,7)		6 (5,7)		6 (5,7)		0.153
Mean HDD score*	6.3		6.1		6.2		0.153
Number of TIF accessed†							
0-2 items	58	29.0	94	47.0	152	38.0	0.001
3-5 items	128	64.0	97	48.5	225	56.3	
6-8 items	14	7.0	9	4.5	23	5.8	
BMI categories†	n =117		n =136		n = 253		
Normal weight	45	38.5	54	39.7	99	39.1	0.651
Underweight	6	5.1	12	8.8	18	7.1	
Overweight	34	29.1	34	25.0	68	26.9	
Obese	32	27.4	36	26.5	68	26.9	

BWP, Botswana Pula (1 BWP=£0·0632); HFIA, household food insecurity access; HDD, household dietary diversity.
† Pearson χ2 test was used to test the association of categorical data, urban v. rural areas.
* Independent- Samples T test was used to test the differences for continuous data, urban v. rural areas.

Diversity of foods (traditional and indigenous/non-traditional and non-indigenous) per food group as derived from quantitative and qualitative data

Table 2 presents the number of TIF and non-TIF per food group reported to have been consumed during the previous day (based on HDD data), as well as the number of TIF found in the areas as identified from the FGDs. A total number of forty TIF types was reported from the HDD questionnaire, covering eight out of the twelve food groups, with cereals (n 16) and meats (n 13) having the highest number of reported types. On the other hand, fifty-six non-TIF were reported, representing eleven out of the possible twelve food groups, with cereals (n 16) and spices, condiments and beverages (n 10) being the largest groups in terms of types consumed the previous day. During FGDs, the total number of TIF types identified was 130, covering all food groups, with meats (n 31), fruits (n 23), cereals (n 17) and vegetables (n 14) having the highest reported number of TIF.

Spearman correlation of access to traditional and indigenous foods with household food insecurity status, household dietary diversity and women's BMI

Our findings showed a positive correlation between the number of TIF accessed and HDD score ($r=0·457$; $P<0·001$) and a negative correlation between the number of TIF accessed and HFIA score ($r= − 0·272$; $P<0·001$). No correlation was found between accessed TIF and women's BMI ($r= −0·066$; $P=0·297$).

Table 2 Traditional and indigenous foods (TIF) per food group as identified from quantitative and qualitative data, with examples, and non-TIF per food group as identified from quantitative data, with examples, accessed by low socio-economic households from two rural and two urban areas of Botswana, July–September 2015

	TIF per food group from quantitative (HDD) data		**TIF per food group from qualitative data (FGDs)**			**Non-TIF per food group from quantitative (HDD) data**		
Food group*	**N**	**%**	**N**	**%**	**Examples of TIF per food group (local name with English description in parentheses)**	**N**	**%**	**Examples of non-TIF per food group (English name)**
Cereals	16	40	17	13.0	Paleche (*stiff mealie meal porridge*) Motogo (*unfermented stiff sorghum porridge*) Magunya (*deep fried flour dough*)	16	28.5	Rice Macaroni Spaghetti
Meats	13	32.5	31	23.8	Nama ya kgomo (*beef meat*) Nama ya koko (*chicken meat*) Phane **(***Mopane caterpillar worms*)	5	8.9	Vienna (processed beef) Polony (processed chicken meat) Boerewors (processed beef
Eggs	1	2.5	2	1.5	Mae a koko (*chicken eggs*) Mae a ntshe (*ostrich eggs*)	0	0.0	-
Milk and milk products	1	2.5	5	3.8	Madila (*sour milk*) Mowana yoghurt (*baobab yogurt)* Masi a tonki (*donkey milk*)	3	5.3	Yogurt Cremora (powdered milk) Powdered milk
Vegetable	1	2.5	14	10.8	Delele (*okra leaves*) Morogo wa dinawa (*dried bean leaves*) Thepe (*amaranth leaves*)	8	14.2	Cauliflower Lettuce Cucumber
Legumes nuts and seeds	2	5.0	9	6.9	Dinawa (*beans)* Manoko (*peanuts*) Ietlhodi (*lentils*)	2	3.5	Baked beans Peanut butter

Fruits	3	7.5	23	17.6	Moretlwa (wild *raisin berry*) Makatane (wild *melon)* Moretologa (*monkey orange***)**	2	3.5	Grapes Apples
Spices, condiments and beverages	2	5.0	9	6.9	Morula beer (*fermented morula beer*) Motlopi coffee (*shepherds tree coffee)* Mmilo (*wild medlar juice*)	10	17.8	Coffee Coca-Cola drink Chilli sauce
Whites roots and tubers	0	0	9	6.9	Tswii (*sweet potato from water lily plant*) Mahupu (*truffles)* Leruswa (*wild potatoes*)	2	3.5	Potatoes Crips
Fish and other sea products	0	0	4	3.0	Twene (*catfish*) Tilhapi (*tilapia sp*) Nyeru (*fish, species unidentified*)	1	1.7	Canned fish
Oils and fats	0	0	4	3.0	Ondondivi (*fat from cow's neck*) Dikgadika (*fat from sheep*) Lebebe *(cow's milk cream fat)*	3	5.3	Sunflower oil Olive oil Margarine
Sweets	0	0	3	2.3	Borekhu (*gum from acacia tree*) Ntšhê (*dried sweet reed)* Ntšhê (*fresh sweet reed*)	4	7.1	Sweets Sugar Cake
Total number of food items	40	100	130	100		56	100	

HDD, household dietary diversity; FGDs, focus group discussion.
*TIF groups are based on the twelve FAO food groups for calculating household dietary diversity [20]

Participants' perceptions on traditional and indigenous foods: health, availability and access, and consumption

Three main themes emerged during qualitative analysis, namely: (i) health perceptions; (ii) availability and access; and (iii) declining consumption of TIF and attributed factors. We present the results here under these thematic areas.

Health perceptions of traditional and indigenous foods.

Participants perceived TIF to be healthy, often comparing TIF with modern foods (e.g. cakes, rice, sugar-sweetened beverages), which were perceived as unhealthy. TIF were described as natural foods that do not require chemicals or additives besides salt during the production and processing stages. TIF were also perceived to be positively related to satiety. The following quotes exemplify these perceptions:

> 'Our indigenous foods do not have any added preservatives; these foods are natural.' (Group 1, Old Naledi, 30.07.2015)

> 'These modern foods are not grown properly. They use chemicals for them to grow faster and this might be the reason why we are so sick.' (Group 1, Area W, 07.08.2015)

> 'These modern foods, they are so light. We are not full when we eat them. These rice and spices make us sick.'(Group 1, Tsabong, 28.08.2015)

Availability of and access to traditional and indigenous foods

Participants indicated that TIF were accessed from different sources. TIF could be collected or hunted from the wild, they can be cultivated at home, sold by street vendors, or bought from shops:

> 'We also eat *mosulthwane* [dehulled sorghum] and *mmilo* [wild medlar]. We get them from the wild. (Group 1, Old Naledi, 30.07.2015)

> 'They [indigenous foods] are sold by street vendors and in shops.' (Group 2, Old Naledi, 30.07.2015)

Availability of TIF in relation to seasonality was discussed with similar perceptions among participants of all four study areas. Participants indicated TIF were mainly found during three

seasons (summer, autumn and winter). Some participants mentioned that some leafy vegetables like *morogo wa dinawa* (bean leaves) were commonly available during the rainy season (summer). Some foods such as beans and bean leaves, sweet reed, green leafy vegetables and watermelon were often dried after harvest and preserved for use during the winter (dry period):

> 'We only have melons in autumn and that we like to dry, and we call them*lengangale*.' (Group 1, Maun, 14.08.2015)

Declining consumption of traditional and indigenous foods

Participants described societal progress as a contributing factor to the decline in consumption of TIF. Terms such as 'civilisation, 'globalisation' and 'modernisation' were used and mainly associated with the consumption of modern foods. The young generation particularly was perceived to prefer modern foods and to not show much interest in TIF and traditional meals:

> 'Things have definitely changed; globalisation has taken over. People are so interested in things that are preserved and advertised than to grow their own food and have small gardens at their homes.' (Group 2, Old Naledi, 30.07.2015)

> 'My grandchild said he won't eat these indigenous foods when I cooked them last week. He only tasted and then went to the shop to buy bread and coke.' (Group 1, Tsabong, 28.08.2015)

An increased presence of modern foods in supermarkets, shops and fast-food outlets was also perceived to have caused a reduction in the use of TIF because almost all food products are purchased:

> 'Yes, we also used *legalalatshwene* [herbal tea] but now we buy tea from the supermarket.' (Group 2, Old Naledi, 30.07.2015)

With regard to lifestyle changes, participants mainly described full-time jobs and lack of time as a reason why TIF are not eaten as often as in the past:

'For us to eat these [traditional] foods, we have to plough. But due to other obligations, like working, we cant. So, we go and buy food that is easy to prepare like rice and other easy food.' (Group 1, Area W, 07.08.2015)

Climate conditions with little and unreliable rain was another reason perceived by the participants to have led to the decline in consumption of TIF:

'The rain is very scarce, so people are not planting any more. Planting these foods will be waste of money and seeds.' (Group 2, Old Naledi, 30.07.2015)

Some participants mentioned that government restrictions on hunting to protect wild animals were seen as a barrier to consuming wild meat:

'In the past we ate a lot of meat. It did not matter if they were dead or slaughtered as the law was not so strict with hunting. But now, we have laws that forbid people from hunting.' (Group 1, Maun, 14.08.2015)

Discussion

The objective of the present study was to determine access to TIF and the association with household food security (in terms of access), dietary diversity and women's BMI in low socio-economic households in rural and urban Botswana. Compared with the average monthly household income at national level of BWP 3936·12 (Botswana Pula; 1 BWP= £0·0632) in 2010[28], most households in our study earned an income of less than BWP 3000·00 per month. This is in line with the high levels of food insecurity (in terms of access) found among the households, with rural households being more severely affected than urban households. This is confirmed by national statistics of 2010, indicating that 50·6 and 28·8% of rural and urban households, respectively, reported being worried about having enough food during the past 4 weeks that preceded the survey[28]. Food insecurity seems highly prevalent at household level despite the country being classified as nationally food secure[8]. While Botswana's national food strategy that focuses on economic access to ensure food security can be said to be largely successful at national level[8], this is not the case at household level. Economic access to food requires that households have adequate incomes to access this food. The large number reporting food insecurity both from the present study and national statistics may be an indication of difficulties for a substantial part of the population to attain adequate income to make economic food access a reality, as demonstrated by previous studies[6,29]. This may warrant a dual strategy that promotes production of local

foods adapted to the arid environment of Botswana while at the same time addressing the shortfall in food supply through economic access[30]. The majority of households in the present study presented a relatively low dietary diversity. Median HDD score was 6 (interquartile range 5-7) out of a total of 12, with the largest number of households falling into the medium HDD category (5-8 food groups). Other studies in Botswana confirmed poor dietary diversity in both urban and rural households[7,31,32]. In our study, data were collected during winter (dry period), a time when some foods, especially traditional vegetables and fruits, including those from the wild, have been reported to be in low supply compared with the rainy season[33] a possible reason that could have led to the relatively low dietary diversity. While food insecurity and low to medium dietary diversity have been shown to reflect limited economic access to food[16], overweight and obesity were found in more than half of participating women. Limited economic resources of households in the present study may pose challenges to accessing a variety of nutrient-dense healthy foods, as omnipresent convenience stores may offer cheaper but less healthy food options and lack a variety of fresh and nutrient-dense foods needed for optimal nutrition[34,35]. In Botswana, urbanisation was further linked to unhealthy eating patterns (snacking), fewer servings of traditional foods and overweight and obesity among adolescents[32].The coexistence of all three forms of malnutrition, including undernutrition, overnutrition and micronutrient deficiencies, is a phenomenon increasingly found in developing or transforming countries due to changes in consumption patterns[36]. In our study, more than half of households consumed three to five foods that were classified as indigenous or traditional, indicating that TIF consumption is an integral part of the Botswana diet. The importance of TIF for healthier and more sustainable diets has received increasing attention in the recent past[37,38]. However, it needs to be highlighted that cereals and meat, both reported as TIF and non-TIF, were the most consumed food groups derived from the HDD data. This may contribute to the high prevalence of over nutrition among the participating women as previously alluded. It is important for future studies to further investigate traditional diets by clearly differentiating between various traditional or indigenous foods according to their nutritional value, level of processing, preparation methods and portion sizes. To our surprise, urban households had access to a significantly bigger variety of TIF than those in rural areas. Research suggests that people living in urban areas have limited access to traditional foods as they depend on food retail outlets such as supermarkets, while rural communities are believed to have access to more natural resources[39]. The smaller proportion of people in the lowest income bracket in the urban areas suggests better economic access for these foods in urban areas. In our study, we acknowledged current global food structures and increased 'supermarketisation' in the definition of TIF, resulting in the fact that some of the foods

that are referred by locals to be traditional may be purchased from supermarkets and may also be imported from the surrounding regions or countries. For example, some of the reported TIF, such as unprocessed meat of all types, maize meal, sorghum meal and eggs, are available in supermarkets and easily accessible in urban areas. It would be useful to explore the extent to which TIF are channelled from rural to urban areas through both formal and informal markets. Our qualitative findings showed that the knowledge of TIF is high among the participants, who recalled and described 130 different TIF during group discussions. Findings of the quantitative dietary diversity questionnaire revealed only forty TIF items. This may be because the HDD questionnaire only addressed what was consumed in the past 24 h, while the FGDs list was based on general recall of what is available and could be accessed over a broader and undefined time period. The shorter list from the HDD data may therefore in part also reflect what was accessible during the dry season when the data were collected. Variations in seasonal availability of traditional vegetables and fruits have been reported from research done in Botswana[33]. The FGDs participants also a decline in TIF consumption, stating globalisation and urbanisation as possible reasons and the related increased availability of processed and convenience foods distributed by supermarkets and fast-food restaurants. This finding supports other researchers[40,41], who highlighted that decreased consumption of traditional foods was associated with globalisation, modernisation, supermarkets and fast-food restaurants, and increased availability of modern foods. The FGDs participants perceived the young generation, in particular, as preferring modern foods. Because these 'modern foods' are characterised as energy-dense and nutrient-poor foods which increase the risk of obesity and chronic diseases[42,43], the dietary shift towards modern foods may pose future public health challenges to Botswana as signified by the high prevalence of overweight and obesity observed in the women of this study population. Our findings further showed that access to TIF was positively associated with food security in terms of access and dietary diversity, hence highlighting the potential role of TIF in the context of food security in Botswana. In 2012, the FAO[44] observed that traditional foods are crucial for food and nutrition security, especially for poor families in rural, peri-urban and urban areas, because of their nutritional benefits, affordability, resilience to local growing conditions and cultural acceptability. Other studies in African countries, such as Ethiopia and Kenya, also reported that indigenous food crops are particularly resilient to adverse local environments, highlighting their important role as food alternatives particularly during dry spells[45,46].

Limitations of our study

One limitation of the present study is that there is no unified definition on TIF. While a group of local experts decided on selection criteria for TIF, it is difficult to make a clear distinction between traditional and indigenous foods, particularly in instances where an introduced food has been part of cultural dishes for a long time but yet may be purchased from retail outlets. Hence, we had to define a new concept of TIF, considering global changes in food systems. Furthermore, access to TIF, as collected by means of a household dietary diversity questionnaire, was captured only once; hence, neglecting seasonal availability of TIF. Our study did not quantify the dietary intake of TIF among individual women, but looked at the association between the number of TIF accessed at household level and the women’s BMI. Individual TIF consumption and associations with BMI may require more research, taking account of related energy consumption that is in part influenced by food preparation methods, physical activity and other important variables that are determinants of BMI.

Conclusion

Food insecurity and limited access to diversified diets were found to be highly prevalent in the two urban and two rural areas of Botswana. Large proportions of the study population in rural and urban areas were found to have access to TIF. TIF access increased as HFIA score decreased. Participants demonstrated knowledge of TIF, perceiving them to have health benefits, but also reporting declining consumption trends due to preference for and convenience of modern foods. Although the study found associations between greater access to TIF and better household food security (in terms of access) and higher dietary diversity, there is a need to explore the potential benefits of optimal use of TIF in contributing to food security and nutrition. This should include a focus on the nutrient density of TIF, consumption patterns and portion sizes. Attention should also be given to related energy consumption and physical activity as these may influence nutritional status outcomes.

Acknowledgements

Acknowledgements: The authors wish to thank the study participants and fieldworkers. Financial support: The North-West University in South Africa and National Food Technology Centre (NFTRC) of Botswana are gratefully acknowledged for providing financial support. The funders had no role in the design, analysis or writing of this article. Conflict of interest: The authors declare that they have no competing interest. Authorship: S.N.K. participated in conception and designing of the protocol, formulating the research questions, study design, data collection and data analysis, and is the primary writer of the manuscript. B.S.M. participated in formulating the research questions, study design, data collection,

interpretation of data and reviewing of the manuscript. N.M.C. participated in conception and designing of the protocol, formulating the research questions, study design, guiding the study, interpretation of data and reviewing of the manuscript. N.C. participated in guiding the study, interpretation of the data and critically reviewed the manuscript. Ethics of human subject participation: This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human subjects were approved by the Faculty of Health Sciences, Health Research Ethics Committee, Potchefstroom Campus, North-West University, South Africa (ethics number NWU-00206-14-A1) and the Botswana Health Research and Development Division, Ministry of Health. Written informed consent was obtained from all subjects.

References

1. Food and Agriculture Organization of the United Nations *(2009) Draft Declaration of the World Summit on Food Security. World Summit on Food Security, Rome, 16–18 November 2009.* Rome: FAO.

2. Johns T, Powell B, Maundu P *et al.* (2013) Agricultural biodiversity as a link between traditional food systems and contemporary development, social integrity and ecological health. *J Sci Food Agric* **93**, 3433-3442.

3. Johns T & Eyzaguirre PB (2006) Linking biodiversity, diet and health in policy and practice. *Proc Nutr Soc* **65**, 182-189.

4. Popkin BM, Adair LS & Ng SW (2012) Global nutrition transition and the pandemic of obesity in developing countries. *Nutr Rev* **70**, 3-21.

5. Statistics Botswana (2015) *Annual Agricultural Survey Report 2013*. Gaborone: Statistics Botswana; available at http://www.statsbots.org.bw/sites/default/files/publications/agricreport2013.pdf.

6. Raboloko M (2016) Determinants of urban household food security in Botswana. *J Biomed Clin Sci* **1**, 17-21.

7. Acquah B, Kapunda S & Legwegoh A (2014) The dimensions of urban food insecurity in Gaborone, Botswana. *Urban Forum* **25**, 217-226.

8. Botswana Ministry of Agriculture (2016*) National Agricultural Policy: 1991*. Gaborone: Botswana Ministry of Agriculture.

9. Moseley WG (2016) Agriculture on the brink: climate change, labor and smallholder farming in Botswana. *Land* **5**, 21.

10. Jackson MD, Motswagole BS, Kwape LD et al. (2013) Validation and reproducibility of an FFQ for use among adults in Botswana. *Public Health Nutr* **16**, 1995-2004.

11. Crush J & Frayne B (2011) Supermarket expansion and the informal food economy in southern African cities: implications for urban food security. *J South Afr Stud* **37**,

781‑807.

12. Food and Agriculture Organization of the United Nations, International Fund for Agricultural Development & World Food Programme (2015) *The State of Food Insecurity in the World 2015. Meeting the 2015 International Hunger Targets: Taking Stock of Uneven Progress*. Rome: FAO.

13. Flyman M & Afolayan A (2006) The suitability of wild vegetables for alleviating human dietary deficiencies. *S Afr J Bot* **72**, 492‑497.

14. Legwaila GM, Mojeremane W, Madisa ME et al. (2011) Potential of traditional food plants in rural household food security in Botswana. *J Hortic For* **3**, 171‑177.

15. Reardon T & Gulati A (2008) *The Rise of Supermarkets and Their Development Implications. International Experience Relevant for India. IFPRI Discussion Paper no. 00752*. Washington, DC: International Food Policy Research Institute.

16. Kuhnlein HV, Erasmus B & Spigelski D (2009) *Indigenous Peoples' Food Systems: The Many Dimensions of Culture, Diversity and Environment for Nutrition and Health*.
Rome: FAO.

17. Botswana Census Report (2011) *Botswana Population and Housing Census*. Gaborone: Department of Printing and Publishing Services.

18. Food and Agricultural Organization of the United Nations (2005) AQUASTAT database. Botswana: Geography, climate and population. http://www.fao.org/nr/water/aquastat/countries_regions/Profile_segments/BWA-GeoPop_fra.stm (accessed October 2017).

19. Creswell JW (2008) *Qualitative, Quantitative, and Mixed Methods Approaches*. Thousand Oaks, CA: SAGE Publications, Inc.

20. Food and Agricultural Organization of the United Nations (2010) *Guidelines for Measuring Household and Individual Dietary Diversity*. Rome: FAO; available at http://www.fao.org/fileadmin/user_upload/wa_workshop/docs/FAO-guidelines-dietary-diversity2011.pdf

21. Action Against Hunger (2014) *ACF Nutrition Small Scale SMART Survey Report: Twic East County, Jonglei State, Southern Sudan*. New York: ACF.

22. Guest G, Bunce A & Johnson L (2006) How many interviews are enough? An experiment with data saturation and variability. *Field Method* **18**, 59‑82.

23. Coates J, Swindale A & Bilinsky P (2007) *Household Food Insecurity Access Scale (HFIAS) for Measurement of Food Access: Indicator Guide*. Washington, DC: Food and Nutrition Technical Assistance Project, Academy for Educational Development; available at http://www.fao.org/fileadmin/user_upload/eufao-fsi4dm/doc-training/hfias.pdf

24. Lohman T, Roche A & Martorell R (1988) *Anthropometric Standardization Reference Manual Assessment*. Champaign, IL: Human Kinetics Books.

25. World Health Organization (1995) *Physical Status: The Use of and Interpretation of Anthropometry. Report of WHO Expert Committee. WHO Technical Report Series* no. 854. Geneva: WHO.

26. Vaismoradi M, Turunen H & Bondas T (2013) Content analysis and thematic analysis: implications for conducting a qualitative descriptive study. *Nurs Health Sci* **15**, 398‑405.

27. Braun V & Clarke V (2006) Using thematic analysis in psychology. *Qual Res Psychol* **3**, 77‑101.

28. Statistics Botswana (2013) *Botswana Core Welfare Indicators Survey 2009/10*. Gaborone: Statistics Botswana; available at http://www.statsbots.org.bw/sites/default/files/BCWIS%202009%2010%20MAIN%20REPORT.pdf.

29. Bashir MK, Naeem MK & Niazi SAK (2010) Rural and peri urban food security: a case of district Faisalabad of Pakistan. *World Appl Sci J* **9**, 403‑411.

30. Penafiel D, Termote C, Lachat C et al. (2016) Barriers to eating traditional foods vary by age group in Ecuador with biodiversity loss as a key Issue. *J Nutr Educ Behav* **48**, 258‑268.

31. Maruapula S & Chapman-Novakofski K (2007) Health and dietary patterns of the elderly in Botswana. *J Nutr Educ Behav* **39**, 311‑319.

32. Maruapula SD, Jackson JC, Holsten J et al. (2011) Socioeconomic status and urbanization are linked to snacks and obesity in adolescents in Botswana. *Public Health Nutr* **14**, 2260‑2267.

33. Maruapula SD & Novakofski C (2010) Nutrient intake and adequacy of Batswana elderly. *Afr J Food Agric Nutr Dev* **10**, 1‑12.

34. Frongillo EA & Bernal J (2014) Understanding the coexistence of food insecurity and obesity. *Curr Pediatr Rep* **2**, 284‑290.

35. Drewnowski A (2009) Obesity, diets, and social inequalities. *Nutr Rev* **67**, Suppl. 1, S36‑S39.

36. Hawkes C & Popkin BM (2015) Can the sustainable development goals reduce the burden of nutrition-related non-communicable diseases without truly addressing major food system reforms? *BMC Med* **13**, 143.

37. Food and Agriculture Organization of the United Nations (2010) *Expert Consultation on Nutrition Indicators for Biodiversity. 2. Food Consumption*. Rome: FAO; available at http://www.fao.org/3/a-i1951e.pdf.

38. Burlingame BA & Dernini S (editors) (2010) *Sustainable Diets and Biodiversity. Directions and Solutions for Policy, Research and Action*. Rome: FAO; available at http://www.fao.org/docrep/016/i3004e/i3004e.pdf.

39. Power EM (2008) Conceptualizing food security for Aboriginal people in Canada. *Can J Public Health* **99**, 95‑97.

40. Vorster HH, Kruger A & Margetts BM (2011) The nutrition transition in Africa: can it be steered into a more positive direction? *Nutrients* **34**, 29‑41.

41. Anand SS, Hawkes C, De Souza RJ et al. (2015) Food consumption and its impact on cardiovascular disease: importance of solutions focused on the globalized food system: a

report from the Workshop Convened by the World Heart Federation. *J Am Coll Cardiol* **66**, 1590‐1614.

42. Sharma S, De Roose E, Cao X et al. (2009) Dietary intake in a population undergoing a rapid transition in diet and lifestyle: the Inuvialuit in the Northwest Territories of Arctic Canada. *Can J Public Health* **100**, 442‐448.

43. Erber E, Beck L, De Roose E et al. (2010) Prevalence and risk factors for self - reported chronic disease amongst Inuvialuit populations. *J Hum Nutr Diet* **23**, 43‐50.

44. Food and Agriculture Organization of the United Nations (2012) *Traditional Foods: Better Livelihoods, Dietary Diversity and Health.* Rome: FAO; available at Italy: http://teca.fao.org/technology/traditional-foods-better-livelihoods-dietary-diversity-and-health.

45. Kunyanga CN, Imungi JK & Vellingiri V (2013) Nutritional evaluation of indigenous foods with potential food-based solution to alleviate hunger and malnutrition in Kenya. *J Appl Biosci* **67**, 5277‐5288.

46. Fentahun MT & Hager H (2009) Exploiting locally available resources for food and nutritional security enhancement: wild fruits diversity, potential and state of exploitation in the Amhara region of Ethiopia. *Food Secur* **1**, 207‐219.

CHAPTER 4

Consumption of traditional and indigenous foods and their contribution to nutrients intake among children and women in Botswana

Salome Kasimba [1], Namukolo Covic[2], Boitumelo Motswagole[3], Ria Laubscher[4], Nicole Claasen[5]

[1] Centre of Excellence for Nutrition (CEN), North-West University, South Africa

[2] Poverty, Health and Nutrition Division, International Food and Policy Research Institute, Addis Ababa, Ethiopia

[3] National Food Technology Research Centre (NFTRC), Botswana

[4] Biostatics' Unit, Medical Research, Tygerberg, South Africa

[5] Africa Unit for Transdisciplinary Health Research (AUTHeR), North-West University, South Africa

This manuscript is formatted according to the guidelines of Journal of Ecology of Food and Nutrition

Abstract
Little is known about the contribution of traditional and indigenous foods (TIF) towards nutrients intake in Botswana. This study determined the consumption of TIF and their contribution to nutrients intake among children 2-5 and women 18-49 years in Botswana. TIF accounted for relatively high percentages of energy intake (41%, 36%) in children and women, respectively. The mean intake of vitamin A in children and vitamin A and zinc in women was high from TIF compared non-TIF. Research attention is warranted towards determining the full potential of TIF in contributing to nutrition and health.

Key words: Traditional and indigenous foods, energy, vitamin A, iron and zinc.

Introduction

Traditional foods from local environments have received global attention due to their perceived potential in contributing to better quality and more sustainable diets (FAO, 2013). They are considered healthy and palatable (Trichopoulou et al. 2006), and enhance dietary diversity (Frison, Cherfas and Hodgkin 2011, Misra et al. 2008, Stadlmayr et al. 2011, Burlingame and Dernini 2012), if taken advantage of optimally. Among the arctic Canadians, significant differences in micronutrient intake were reported for households who consumed traditional foods, compared to non-traditional foods (Kuhnlein and Receveur 2007, Johnson-Down and Egeland 2010). Bersamin et al. (2007) reported from their study in Alaska, that participants in the highest quintile of traditional food intake consumed significantly more vitamin A, vitamin D, vitamin E and iron than participants in the lowest quintile. Furthermore, Roche et al. (2008) in Peru and Ghosh-Jerath et al. (2016) in India demonstrated that consumption of diverse indigenous foods was associated with greater consumption of protein, fibre, iron, calcium, thiamine, riboflavin, vitamin A as beta carotene and folate. In Africa, some previous studies reported that traditional foods such as vegetables are rich in nutrients such as calcium, magnesium, potassium, carotenoids, zinc, iron, and protein (Mibei et al. 2012, Yang and Keding 2009, Kamga et al. 2013). However, there is limited research that explores the potential of traditional or indigenous foods to impact dietary nutrients intake among different age categories in Africa.

Botswana is a semi-arid country and drought is endemic (Batisani and Yarnal 2010). Despite this, it is diverse in traditional food plants which grow across seasons (Legwaila et al. 2011). Research shows that these foods are commonly used by rural communities and their importance increases during times of drought and food shortage as a hunger coping strategy (Flyman and Afolayan 2006). Some of the traditional Tswana diets include, sorghum porridge, maize meal, *samp* (dehulled corn), dehulled corn with beans, *seswaa* (pounded beef), *phane* (caterpillar) and pumpkin leaves (Clausen et al. 2005, Maruapula and Chapman-Novakofski 2007). Nutrient deficiency, especially in vitamins and minerals, remains among the main indicators of malnutrition in children and women in Botswana. The prevalence of vitamin A and anaemia among preschool children (26% and 38%, respectively) and pregnant women (19% and 21%, respectively) is of high concern (WHO 2008 and UNICEF 2009). Maruapula et al. (2011) reported that due to urbanisation in Botswana, traditional foods are being abandoned, with increased reliance on non-traditional westernised foods which include ultra-processed foods characterised by high energy and low nutritional quality (Hawkes and Popkin 2015) such as savoury snacks, sweet snacks, and fizzy drinks. Continued consumption of such westernised foods may pose a greater risk of increased nutrient deficiency in Botswana. Inspite of this, information on the consumption of

traditional and indigenous foods (TIF) and their contribution to specific dietary nutrient intake in Botswana remains scanty. This would provide valuable context of determining their potential to contribute towards improved nutrients intake and reduced specific nutrient deficiencies. Hence, this paper aims to determine the consumption and contribution of TIF to dietary intake of energy, protein, vitamin A, iron and zinc among children and women in Botswana. Due to increased global supermaketisation Reardon and Gulati (2008), some of the traditional foods such as maize meal may be purchased locally but may also have been imported from the surrounding regions and countries (Kuhnlein, Erasmus and Spigelski 2009). In this paper therefore, traditional and indigenous foods (TIF) are defined as foods that are native or were introduced into Botswana a long time ago, including plant and animal sources, whether locally produced (either domesticated, cultivated) or accessed from the wild. Considering globalisation of food systems, these foods may also be purchased from retail outlets, irrespective of their origins, but recognised as part of country's traditional food culture. The definition of TIF was arrived at by a panel consisting of local nutrition experts, field assistants and the research team, in a consultative process prior to the study.

Methodology

Study area

The present study was part of a larger, cross-sectional study that explored access to and consumption of traditional and indigenous food (TIF) in low socio-economic households in two urban areas (Old Naledi and Area W) and two rural areas (Maun and Tsabong) in Botswana. The two urban and rural areas were purposively chosen to cater for possible variations in traditional food variety and diversity in the different settings. Old Naledi and Area W are situated in the two major cities in Botswana – Gaborone and Francistown, respectively. Tsabong covers a vast area of the Kalahari Desert while Maun is part of the Okavango Delta (Mwakikagile, 2010).

Study design and sampling

Data was collected between July and September (winter season) 2015. A cross-sectional household survey design was employed with a multistage sampling method to select the households. The first stage was the purposive selection of the four study areas. Then, within each study area, five enumeration areas were randomly selected. This was then followed by a random selection of 20 plots and finally, one household was selected from each plot. One woman aged 18-49 years, if available, and all children 2-5 years in each of the selected households were sampled. A total of 400 households which comprised of 253 women and 173 children were sampled. Women and children were targeted because research shows

that they are among the vulnerable groups to malnutrition partly due to inadequate intake of nutrients resulting from poor food consumption patterns (Girma and Genebo, 2002).

Data collection

A Quantitative Food Frequency Questionnaire (QFFQ) used was adapted from (Jackson et al. 2013). This was a validated questionnaire which consisted of commonly consumed foods among adults in Botswana. It was adapted to include TIF that were not in the list. Trained fieldworkers administered the QFFQ in Setswana, the local language. Participants were asked to report the frequency of consumption for all foods listed on the QFFQ over the previous 30 days, with 8 frequency categories (almost never, once per month, 2- 3 times per month, once per week, 2-4 times per week, 5-6 times per week, once per day, and 2 or more times per day).

Mothers or legal guardians answered the questionnaire on behalf of their children. Coloured photo-books with three different portion sizes of foods developed and validated by the National Food Technology Research Centre (NFTRC) Botswana were used as a guide in estimating the food portion sizes. Pretesting of the QFFQ was done prior to the study in Kanye, a different location which was not part of the four study areas and the results showed that the portion sizes given in the photo-books were suitable for children as well. Foods that were missing in the NFTRC photo-book were estimated using photo-books validated and used by Centre of Excellence for Nutrition (CEN), North-West University, Potchefstroom, South Africa. Since Botswana depends heavily on food imports from South Africa, these were appropriate to use. Standardised household measures such as spoons and cups were also available in the photo-books to help standardise some of the portion sizes.

Statistical Analyses

The FoodFinder software programme, based on South African Food Composition Tables, was used to convert food intake into nutrient intake (Wolmarans 2010). Some of the foods that were not available in the FoodFinder were substituted by others in the South African Medical Research Council (MRC) FoodFinder. In this study unfortified maize meal and bread were considered during analysis. Foods substituted for others in the MRC FoodFinder are presented in addendum 6. Statistical analysis was done in SAS version 9.4. Kolmogorov-smirnov was used to check for normality of data. Data not normally distributed were reported as the median and interquartile range (IQR) while data normally distributed means and standard deviations were reported. Foods consumed were categorised into two groups: TIF and non-TIF based on the TIF definition used in this study. Differences in the intake of the

selected nutrients (energy, protein, iron, zinc and vitamin A) from TIF and non-TIF in women and children were determined using generalised linear models, adjusting for age, sex and area in children and for age and area in women. Variables under analysis were log transformed if skewed. P value for difference was performed considering Bonferroni adjustment. Least geometric squares means and 95% confidence intervals were reported by group. Quartile cut-offs were calculated as the proportion of energy intake from TIF over the overall energy intake for children and women separately in order to compare nutrient intake of diets from lower to higher proportions of TIF. ANOVA and Bonferroni's post hoc was used to test the differences in the intake of the selected nutrients among the quartiles. The top five TIF that contributed to energy, protein, iron, zinc and vitamin A were determined by ranking the mean amount of nutrients provided. Ranks were made separate for children and women. In all the analyses, P value <0.05 was considered significant. The present study focussed on only five nutrients, namely energy, protein and micronutrients (vitamin A, iron and zinc) which are of public health significance and of concern, especially vitamin A and iron, among preschool children and women in Botswana (WHO 2008, UNICEF 2009).

Ethical considerations

Ethical clearance for this study was obtained from the Faculty of Health Sciences, Health Research Ethics Committee, Potchefstroom Campus, North–West University, South Africa; (NWU -00206-14-S1) and the Botswana Health Research and Development Division, Ministry of Health. Signed informed consent was obtained from the participants after being given adequate explanation of the study in their local language. Permission to conduct the study was obtained from community leaders in each study area. Participants had a choice to withdraw from the study at any point.

Results

Demographic characteristics

The study sample composed of 173 children; of which 67 children were aged 2-3 years while 106 were aged between 3-5 years, including boys (n=79) and girls (n=94). More children (116) resided in rural areas compared to urban areas (57). In total, 253 women participated, 126 of them were aged between 18 – 30 years while 127 were aged between 31 - 49 years old. Of all the women, 136 resided in rural areas and 117 in urban areas.

Intake of selected nutrients

Table 1 summarises the intake of selected nutrients from TIF and non-TIF. Our findings show that TIF accounted for relatively high percentages of energy intake (41%, 36%) in

children and women respectively. The findings also show that TIF contributed to more than 50% of vitamin A and zinc in children and women in the overall diet.

Differences in the intake of selected nutrients from TIF and non-TIF

Table 2 summarises the results on the differences in the intake of the selected nutrients from TIF and non-TIF, adjusting for age, gender and area in children, and adjusting for age and area in women. The findings of this study show that children consumed significantly less energy, protein and iron from TIF compared to non-TIF (mean energy from TIF 1480 (1374 – 1594), from non- TIF 2006 (1862 – 2161) P < 0.0001, mean protein from TIF 14.0 (12.8 - 15.3), from non-TIF 16.9 (15.5- 18.5) P = 0.0021, mean iron from TIF 2.7 (2.5 - 3.0), from non-TIF 3.8 (3.5 - 4.2) P < 0.0001). Further, our results show that the consumption of vitamin A mean intake from TIF in children was higher from TIF compared to non- TIF (mean vitamin A from TIF 234 (184 - 299) and from non- TIF 176 (138 - 224) P = 0.0851). The findings in Table 2 further show that children from rural areas consumed significantly higher protein and zinc compared to children from urban areas (mean protein from rural areas 16.5 (15.3 - 17.8), urban areas 14.4 (12.9 -16.0) P = 0.0352 while mean zinc from rural areas 3.0 (2.8 - 3.3) and from urban areas 2.5 (2.2 - 2.8) P = 0.016). Age and gender did not influence the intake of the selected nutrients in children. With respect to women in Table 2, findings show that women consumed significantly higher zinc and vitamin A from TIF compared to non -TIF (mean zinc from TIF 4.9 (4.6 - 5.3), from non- TIF 4.2 (3.9 - 4.5) P = 0.0033, mean vitamin A from TIF 409 (332 - 503) and from non-TIF 295 (240 - 362) P = 0.0286). The results further show that women consumed significantly less energy mean 2023 (1917- 2135), P < 0.0001, less protein mean 24.1 (22.6 - 25.8), P = 0.0476 and less iron mean 4.5 (4.3- 4.9), P < 0.0001 from TIF compared to non TIF. Additionally, the results show that women from rural areas consumed significantly less energy mean 2389 (2269 – 2516), P < 0.0001, protein mean 22.8 (21.4 - 24.3), P < 0.0001, iron mean 4.5 (4.3 - 4.8), P < 0.0001, zinc mean 4.0 (3.8 - 4.3), P < 0.0001 and vitamin A mean 251 (206 – 307), P < 0.0001 compared to women in urban areas. Our findings show that the age of the women showed no effect on the consumption of the selected nutrients.

Intake of selected nutrients across diets with lower to higher proportions of TIF

In Table 3, Bonferroni post-hoc results showed that across quartiles of increasing TIF energy intake (as a percentage of overall diet), significant differences occurred with regard to energy and zinc intake in children's diets. Findings in the same Table 3 show that children in the third quartile, consumed significantly more intake of energy compared to children in the first quartile (P <0.05). Further, children in the second quartile consumed a significantly higher intake of zinc compared to children in the first quartile (P <0.05). In women, our results

showed no difference in the consumption of the selected nutrients across quartiles of increasing TIF energy intake.

TIF consumed that contributed to the selected nutrients (energy protein, iron zinc and vitamin A) in children and women

Table 4 and 5 presents the findings for children and women respectively. Cereals contributed the highest amount of energy in both children and women. Examples of them included maize meal and sorghum which were also among the foods consumed by a larger number of people. Some foods such as peanuts and pumpkin in children and peanuts in women ranked among the top five foods that contributed to energy and vitamin A respectively albeit being consumed by small numbers. Animal foods such as beef, liver, goat and chicken meat among children and women were shown to be rich in diverse nutrients; they provided protein, iron, zinc and vitamin A**.** TIF fruits consumed by children included wild raisins, consumed by 7%, wild meddler (1%) and prickly pear (1%). Examples of fruits consumed by women were watermelon, consumed by 9%, wild raisins (4%), wild meddler (2%), prickly pears (0.8%). However, they did not rank among the top five TIF contributors to nutrient intake (Data not shown on the Tables).

Table 1: Intake of selected nutrients from TIF and non-TIF

Nutrients	**TIF**	**Non- TIF**	**% TIF nutrient intake**
	Median (Q1,Q3)	Median (Q1,Q3)	
		CHILDREN	
Energy (kJ)	1514 (2135,1095)	2257(1489, 2755)	41
Protein (g)	15.3 (10.1, 21.1)	18.5 (12.0, 25.1)	46.3
Iron (mg)	2.8 (1.8, 4.0)	4.1 (2.5, 6.1)	41.5
Zinc (mg)	3.0 (2.1, 4.2)	3.0 (1.6, 4.3)	51.7
Vitamin A (µg)	180 (59, 1377)	166 (96, 422)	57
		WOMEN	
Energy (kJ)	2060 (1511, 2569)	3652 (2710, 4837)	36
Protein (g)	25.2 (17.5, 33.7)	28.7 (18.9, 40.2)	47.7
Iron (mg)	4.7 (3.1, 6.4)	5.9 (3.9, 8.3)	44.9
Zinc (mg)	5.1 (3.5, 6.8)	4.2 (2.7, 6.7)	54.5
Vitamin A (µg)	1010 (43, 3690)	300 (175, 525)	70

Q1 first quartile, Q3 third quartile

Table 2: Differences in the intake of selected nutrients from TIF and non-TIF adjusted for age, sex and area in children, and adjusted for age and area in women.

Model parameters	Energy(kJ)	Protein (g)	Iron (mg)	Zinc (mg)	Vitamin A (µg)
	Mean (95% CI) P value	**Mean (95% CI) P value**	**Mean (95% CI) P value**	**Mean (95% CI) P value**	**Mean (95% CI) P value**
			CHILDREN		
Food source					
TIF	1480 (1374–1594)	14.0 (12.8-15.3)	2.7 (2.5-3.0)	2.7 (2.5-3.0)	234 (184-299)
Non-TIF	2006 (1862–2161) < 0.0001	16.9 (15.5-18.5) 0.0021	3.8 (3.5-4.2) <0.0001	2.8 (2.5-3.1) 0.8794	176 (138-224) 0.0851
Age					
2-3 years	1747 (1608-1897)	15.6 (14.1-17.2)	3.3 (3.0-3.6)	2.8 (2.5-3.1)	197 (151-259)
4-5 years	1700 (1589-1818) 0.6026	15.2 (14.1-16.5) 0.7438	3.2 (3.0-3.5) 0.7468	2.7 (2.5-2.9) 0.5026	209 (167-260) 0.7449
Gender					
Male	1745 (1614-1886)	15.9 (14.5-17.5)	3.4 (3.1- 3.7)	2.9 (2.6-3.2)	235 (182-303)
Female	1702 (1584-1827) 0.6263	14.9 (13.7- 16.2) 0.276	3.1 (2.9 - 3.4) 0.2034	2.6 (2.4-2.9) 0.1603	175 139-222) 0.0843
Area					
Urban	1638 (1498–1790)	14.4 (12.9-16.0)	3.1 (2.8-3.4)	2.5 (2.2-2.8)	204 (152-273)
Rural	1813 (1703–1930) 0.0641	16.5 (15.3-17.8) 0.0352	3.4 (3.2-3.7) 0.0883	3.0 (2.8-3.3) 0.016	202 (164-248) 0.9537

Model parameters	Energy(kJ)	Protein (g)	Iron (mg)	Zinc (mg)	Vitamin A (µg)
	Mean (95% CI) P value	Mean (95% CI) P value	Mean (95% CI) P value	Mean (95% CI) P value	Mean (95% CI) P value
		WOMEN			
Food source					
TIF	2023 (1917-2135)	24.1 (22.6-25.8)	4.5 (4.3-4.9)	4.9 (4.6-5.3)	409 (332-503)
Non- TIF	3455 (3274–3645) <0.0001	26.6 (24.8-28.4) 0.0476	5.8 (5.4-6.2) <0.0001	4.2 (3.9-4.5) 0.0033	295 (240-362) 0.0286
Age					
18-30 years	2670 (2529-2820)	26.0 (24.3-27.9)	5.2 (4.9-5.6)	4.7 (4.4-5.1)	359 (291- 444)
31-49 years	2617 (2483- 2759) 0.6033	24.7 (23.1-26.3) 0.263	5.0 (4.7-5.4) 0.4767	4.3 (4.0-4.7) 0.0904	335 (273 -411) 0.6381
Area					
Urban	2925 (2767-3093)	28.2 (26.3-30.2)	5.8 (5.4-6.2)	5.1 (4.7-5.5)	479 (387-594)
Rural	2389 (2269-2516) < 0.0001	22.8 (21.4-24.3) <0.0001	4.5 (4.3-4.8) < 0.0001	4.0 (3.8-4.3) <0.0001	251 (206–307) <0.0001

P value for difference was performed considering Bonferroni adjustment.

Table 3: Selected nutrient intake of the study participants (children and women) by quartile of TIF energy intake (mean± SD)

TIF energy intake quartiles (as % of overall diet)	1	2	3	4	
		CHILDREN			
N	**43**	**44**	**43**	**43**	**P-value**
Energy (kcal)	3268±1102*	3941±1451	4219±1379*	4113±1611	0.017
Protein (g)	31.0±13.3	38.7±17.5	39.7±15.8	36.8± 17.6	0.064
Iron (mg)	7.0±2.9	8.1±13.8	8.2±3.7	7.6± 3.3	0.388
Zinc (mg)	5.7±2.8*	7.7± 4.1*	7.2±3.0	6.8±3.2	0.045
Vitamin A (µg)	842±1004	1053±1009	1236±1099	1481±1613	0.093
		WOMEN			
N	**63**	**64**	**63**	**63**	**p-value**
Energy (kcal)	6269±2070	6288±1872	5653±2016	5564±2528	0.101
Protein (g)	58.6±20.4	60.5±24.0	55.4±22.7	56.3±33.6	0.681
Iron (mg)	12.6±6.1	12.8±5.3	10.7±3.9	11.2±6.0	0.086
Zinc (mg)	0.4±0.3	0.5±0.3	0.4±0.3	0.5±0.2	0.769
Vitamin A (µg)	1672±1675	2261±1777	2270±2048	2017±1796	0.219

One way Anova -Bonferroni's post hoc tested the quartile groups which differed (significance at P <0.05).

* Shows groups in which significant differences occurred.

Table 4: Top 5 TIF consumed that contributed to selected nutrients (energy, protein, vitamin A, iron and zinc) in children

Food	Total population/mean ± SD individual daily intake	Mean ± SD daily food consumption (g)	Number of children who consumed foods (maximum n=173)
	Energy		
Maize meal	53273/319±305	430±207	167
Sorghum	41223/273±148	407±265	151
Chicken	35376/268±260	104±179	132
Beef	22500/150±97	103±56	150
Peanuts	14100/300±38	81±75	47
	Protein		
Beef	585/3.9±1.1	103±56	150
Liver	333/4.7±1.3	123±80	71
Maize meal	283/1.7±7.8	430±207	167
Sorghum	271/1.8±1.1	407±265	151
Chicken	250/1.9±1.3	104±87	132
	Iron		
Chicken	224/1.7±0.1	104±87	132
Sorghum	45/0.3±0.1	407±265	151
Maize meal	33/0.2±0.0	430±207	167
Beef	30/0.2±0.0	103/56	150
Samp and beans	9/0.1±0.0	208±71	95

Food	Total population/mean ± SD individual daily intake	Mean ± SD daily food consumption (g)	Number of children who consumed foods (maximum n=173)
	Zinc		
Maize meal	668/4.0±0.0	430±207	167
Sorghum	90/0.6±0.2	407±265	151
Beef	51/0.3±0.0	103±56	150
Liver	25/0.3±0.0	123±33	71
Goat	4/0.07±0.0	96±7	55
	Vitamin A		
Chicken	11413/86±0.0	104±87	132
Goat	622/11±0.8	96±7	55
Liver	345/4±0.1	123±33	71
Pumpkin	327/6.8±0.0	133±0.0	48
Peanuts	122/2.5±3	81±3	47

Means* calculated using as n the number of children who consumed the foods.

Table 5: Top 5 TIF consumed that contributed to selected nutrients (energy, protein, vitamin A, iron and zinc) in women

Food	Total population/mean ± SD individual daily intake	Mean ± SD daily food consumption (g)	Number of women who consumed foods (maximum n=253)
	Energy		
Maize meal	116106/523±173	704±234	222
Sorghum	74860/380±205	565±302	19
Chicken	73485/345±235	134±123	213
Beef	56680/260± 133	179±92	218
Peanuts	41385/465±430	125±116	89
	Protein		
Beef	1308/6±3.5	179±92	218
Liver	1008/8±2.6	199±130	126
Goat	720/8±9.3	197±213	90
Maize meal	666/3± 1.3	704±234	222
Chicken	426/2±1.7	134±92	213
	Iron		
Beef	872/4±0.7	179±92	218
Chicken	426/2±0.2	134±123	213
Sorghum	79/0.4±0.3	565±302	197
Liver	75/0.6±0.1	199±130	126
Maize meal	66/0.3±0.1	704±234	222

Food	Total population/mean ± SD individual daily intake	Mean ± SD daily food consumption (g)	Number of women who consumed foods (maximum n=253)
	Zinc		
Goat	450/5.0±1.8	197±213	90
Chicken	234/1.1±0.6	134±123	213
Beef	152/0.7±1.1	179±92	218
Liver	37/0.3±0.5	199±130	126
Maize meal	9/0.04±0.2	704±234	222
	Vitamin A		
Amaranth leaves	29165/307±70	109±78	95
Chicken	25892/121±8	134±123	213
Liver	756/6±0.0	199±130	126
Water melon seeds	684/76±0.0	100±0.0	9
Sorghum	487/2.7±0.0	565±302	197

Means* calculated using n as the number of women who consumed the food.

Discussion

Our study determined the consumption of TIF and their contribution to energy, protein, vitamin A, iron and zinc among children 2-5 years and women 18-49 years, living in low socio-economic households in Botswana. The findings show that participants' overall nutrient intake relied on both TIF and non-TIF. In times of increased presence of westernised, often highly processed foods in supermarkets and shops (Popkin, Adair, and Ng 2012, Johns et al. 2013), the Batswana diet still shows a relatively high percentage of nutrient intake from TIF (TIF accounting for 41% and 36% energy intake in children and women, respectively). The study was unable to compare with intakes in other similar settings because this, to the research team's knowledge, was the first time that this type of analysis has been done in such settings within the Southern African region.

Our results show that in children, the consumption of vitamin A was higher from TIF while women consumed significantly higher zinc and vitamin A from TIF, indicating the role TIF may play in contributing to selected micronutrients intake. This also emphasises the importance of such research in contributing to appropriate and contextualised nutrition education on food choices. A higher intake of protein, iron and zinc was reported among children who consumed traditional foods, compared to non-consumers of traditional foods in Canada (Gagne et al. 2012, Johnson-Down and Egeland 2010). In contrast, another study done in India reported insignificant differences in macronutrient and micronutrient intake in women who consumed indigenous foods, compared to those who did not (Ghosh-Jerath et al. 2016).

The results of this study showed that age category among children and women did not influence the consumption of the selected nutrients. A study among Alaskan Natives however reported that across quintiles of increasing traditional food intake, significant increase in age was observed (Bersamin et al. 2007). In this study, women in rural areas consumed significantly less energy, protein, iron, zinc and vitamin A when compared to women in urban areas. This could be explained due to general lower household income in rural areas and infrastructural challenges in availability and access to food (Ruel et al. 2010). On the other hand, children in rural areas consumed significantly higher protein and zinc. This may point out the importance of investigating intra household food distribution in rural areas that this study did not investigate. Unequal distribution of food within households has been cited as one of the major factors related to inadequate intake of some nutrients among some of the household members (Akerele, 2011). When comparing diets with increasing proportions of TIF (as percentage of energy), children in the third quartile, consumed a

significantly higher intake of energy compared to children in the first quartile while children in the second quartile consumed a significantly higher intake of zinc compared to children in the first quartile, an indication that some nutrients intake may increase with higher proportions of TIF in the diet. This study did not assess differences in nutrients intake when comparing subsamples of the study populations consuming more of particular groups of foods than others - and doing this would generate more useful information. Burlingame and Dernini (2012) emphasized the potential role of traditional and indigenous foods to food security among populations in the context of availability and access to food, especially for poor households. This is confirmed by findings in a recent study in Botswana on households' access to traditional and indigenous foods and the association with food security and dietary diversity which showed that as the number of TIF accessed by households increased, food security (access) increased (Kasimba et al*.* 2017).

In children and women, TIF cereals were the major energy contributors. Our results showed that maize meal and sorghum were the foods consumed in large quantities and by the largest number of children and women which could be attributed to the high energy. Previous research pointed out that populations subsists on staple cereal based high energy giving foods (Arimond et al. 2010, Lowe et al 2007).

Plant food sources such as cereals and legumes are considered poor sources of zinc and iron due to their low bioavailability as a result of the presence of phytates that inhibit their absorption (Meng, Wei, and Yang 2005, Weinberger and Swai 2006, Hunt 2003). However in the present study, maize meal and sorghum appeared among the first five foods that contributed to iron and zinc. As previously alluded, this could be ascribed to the large quantities consumed and also due the large number of people consuming them compared to the other foods. On the other hand, in Botswana, some of the traditional food preparation methods involve fermentation or in recent times, the addition of acid (vinegar or tartaric acid) to mimic the sourness of the fermented foods. Such preparation methods have the potential to positively impact iron bioavailability and the extent to which this might be the case warrants research attention.

Our results further showed that animal and animal products including, beef, chicken, goat meat and liver were the major contributors of protein, iron, zinc and vitamin A in both children and women. The people of Botswana are predominantly pastoral and therefore, meat consumption, is a traditional Tswana practice (Legwegoh and Riley 2014). In our view, this may explain the observed high vitamin A intake from TIF. Previous studies have also shown

that animals and animal products are good sources of iron, zinc and vitamin A, as compared to plant food sources (Lowe, Fekete, and Decsi 2009, La Frano et al. 2014, Aphane, Chadha, and Oluoch 2002).

Some of the TIF were shown to contribute to various nutrients even though they were consumed in small amounts and by fewer people. Examples are peanuts, water melon seeds and pumpkins. This may indicate a lack of awareness on the potential nutritional benefits of these foods or on the other hand, the access not being regular enough or in sufficient quantities. Research shows that consumption of fruits and vegetables contributes greatly to micronutrients intake. In the present study, although there were some TIF fruits and vegetables consumed by women and children, only amaranth and pumpkin featured among the top five foods that contributed to vitamin A. None of the fruits appeared among the top five foods that contributed to micronutrients. A possible explanation could be due to insignificant quantities consumed and due to lack of their availability and access. Seasonality could have influenced the low consumption of fruits and vegetables. The data was collected during winter (dry season) when traditional vegetables and fruits, including those from the wild, have been reported to be low in supply compared to the rainy season, when they have been shown to be plentiful and more readily accessible to more households (Maruapula and Novakofski 2010). Studies also suggest that there are concerns regarding bioavailability and bio accessibility of certain micronutrients, especially in traditional dark green leafy vegetables and fruits due oxalates and phytates (Flyman and Afolayan 2006, Palafox-Carlos, Ayala-Zavala, and González-Aguilar 2011), which makes them unavailable for absorption (Gupta et al. 2005). This study did not determine bio accessibility or bioavailability of nutrients together with determination of micronutrient status since the focus was on intake. The study does however recognise the importance of both bioavailability and bio accessibility in impacting the resulting nutrition status. Previous studies have indeed demonstrated the need for more research on the bioavailability and bio accessibility of micronutrients for both raw and cooked forms of traditional leafy vegetables, towards better understanding their contribution to the dietary intake of micronutrients (Mavengahama, McLachlan, and De Clercq 2013, Kamga et al. 2013). Elsewhere in America, studies demonstrated inadequate intake of fruits and vegetables among children (Heim, Stang, and Ireland 2009, Guenther et al. 2006). In Sub-Saharan Africa (SSA) WHO revealed that the consumption of fruits and vegetables was below the recommendation of 400 g/day (Ruel, Minot and Smith 2005).

Study limitations

Limitations of the present study include that the QFFQ adapted and used showed that the relative validity for iron, and vitamin A (retinol), fruits and dark green leafy vegetables was poor (Jackson et al. 2013). Therefore, results for these micronutrients and foods should be interpreted with caution. We also acknowledge the fact that participants were required to report all the foods they consumed in a month. As such, recall bias due to greater time lapse may have influenced dietary intake information to either over- or underestimations. However, this is a standard method of estimating dietary intake. We also collected the dietary intake data for children; responses were given by their parents or caregivers, which was second hand information and therefore subject to some inaccuracies. In addition, due to food composition tables not being available for Botswana, South African food composition tables were used for nutrient analyses. Botswana relies heavily on food imported from South Africa and therefore, the South African food composition food table was appropriate for use. We do, however, acknowledge that there were some foods that were traditional or indigenous to Botswana that were missing from the South African food composition food table that had to be substituted with others of the same type, again an approach we considered in order due to the absence of nutrient composition of traditional or indigenous foods globally as highlighted by (Charrondière et al., 2013). With respect to maize meal, there is probably some people who consumed fortified maize meal as some of it comes fortified from South Africa thus the micronutrient value of this food should be done with caution. The QFFQ was only administered once and hence did not consider seasonal differences which may have been important in capturing seasonality of TIF.

Conclusion and future research

Our study shows that TIF are an important part of the diet of Batswana children and women; and that they may present useful potential to contribute to nutrients intake such as energy, vitamin A and zinc. We found that traditional meat and other animal products contributed to both macro- and micro-nutrient intake among children and women while nutrient intake from traditional and indigenous vegetables and fruits were found to be low. Selected TIF such as peanuts, water melon seeds and pumpkin seemed to have a high potential to impact some micronutrients intake, albeit being consumed by few participants and in small quantities. This pioneering study in determining the quantitative consumption and dietary nutrients intake from TIF in Botswana poses several aspects needing consideration. It calls for further research in exploring the full potential of TIF towards improved nutrients intake. Longitudinal studies that take into account seasonality and wider categories of age and other

geographical regions are recommended. Further research is needed to determine nutrient content of TIF towards developing food composition tables that include TIF.

Acknowledgements

Acknowledgements: The authors wish to thank the field workers and all the participants in the study. *Financial support*: This was a collaborative study between North-West University Potchefstroom Campus, South Africa and National Food Technology Centre (NFTRC) Botswana. The two institutions are gratefully acknowledged for providing financial support for the study. *Conflict of interest*: The authors declare that they have no competing interest. *Authorship*: S.N.K participated in conception and designing of the protocol, formulation of the research question, study design, data collection, data analysis and was the primary writer of the manuscript. N.M.C. participated in conception and designing of the protocol, formulation of the research question, study design, guided the study as well as by interpretation of data and reviewing of the manuscript. N.C. participated in interpretation of data, gave guidance in writing and reviewing of the manuscript. R. L participated in statistical analysis. B.S.M. participated in the formulation of the research question, study design, data collection, interpretation of data and reviewing of the manuscript. *Ethics of human subject participation:* This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human subjects/patients were approved by the Faculty of Health Sciences, Health Research Ethics Committee, Potchefstroom Campus, North–West University South Africa- Ethics number (NWU -00206-14-S1). Written informed consent was obtained from all subjects.

References

Aphane, J., M. Chadha, and M. Oluoch 2002. Increasing the consumption of micronutrient - rich foods through production and promotion of indigenous foods. http://www203.64.245.61/web_docs/proceedings/indigenous.pdf (accessed July 17, 2017).

Arimond, M., D. Wiesmann, E. Becquey, A. Carriquiry, M. C. Daniels, M. Deitchler, and N. Fanou-Fogny. 2010. "Simple Food Group Diversity Indicators Predict Micronutrient Adequacy of Women's Diets in 5 Diverse, Resource-Poor Settings–."*The Journal of Nutrition*140, no. 11: 2059S-2069S. doi.org/10.3945/jn.110.123414.

Akerele, D. 2011. Intra-household food distribution patterns and calorie inadequacy in South-Western Nigeria. *International Journal of Consumer Studies* 35(5):545-551. doi: 10.1111/j.1470-6431.2010.00981.x.

Batisani, N., and B. Yarnal. 2010. "Rainfall variability and trends in semi-arid Botswana: implications for climate change adaptation policy." *Applied Geography* 30 (4):483-489. doi:10.1016/j.apgeog.2009.10.007.

Bersamin, A., S. Zidenberg-Cherr, J. S. Stern, and B. R., Luick. 2007. "Nutrient intakes are associated with adherence to a traditional diet among Yupik Eskimos living in remote Alaska Native communities: the CANHR Study." *International Journal of Circumpolar Health* 66 (1): 62-70. doi.org/10.3402/ijch.v66i1.18228.

Burlingame, A. B., and S. Dernini. 2012. "Sustainable diets and biodiversity." International Scientific Symposium Biodiversity and Sustainable Diets United against Hunger : Rome, Italy.

Charrondière, U. R., B. Stadlmayr, D. Rittenschober, B. Mouille, E. Nilsson, E. Medhammar, T. Olango, S. Eisenwagen, D. Persijn, and K. Ebanks. 2013. FAO/INFOODS food composition database for biodiversity. *Food Chemistry*, 140(3):408-412. doi.org/10.1016/j.foodchem.2012.08.049.

Clausen, T., K. E. Charlton, K. S. M. Gobotswang, and G. Holmboe-Ottesen. 2005. "Predictors of food variety and dietary diversity among older persons in Botswana." *Nutrition* 21 (1):86-95. doi: 10.1016/j.nut.2004.09.012.

FAO (Food and Agricultural Organization). 2013. Linkages between Biodiversity, Foods and Nutrition. Rome. Italy. http://www.fao.org/docrep/meeting/027/mg285e.pdf (accessed May 2017).

Flyman, M. V., and A. J. Afolayan. 2006. "The suitability of wild vegetables for alleviating human dietary deficiencies." *South African Journal of Botany* 72 (4):492-497. doi:10.1016/j.sajb.2006.02.003.

Frison, E. A., J. Cherfas, and T. Hodgkin. 2011. "Agricultural biodiversity is essential for a sustainable improvement in food and nutrition security." *Sustainability* 3 (1):238-253. doi.org/10.3390/su3010238.

Gagne, D., R. Blanchet, J. Lauziere, É. Vaissière, C. Vézina, P. Ayotte, S. Déry, and H.T. O'Brien. 2012. "Traditional food consumption is associated with higher nutrient intakes in Inuit children attending childcare centres in Nunavik." *International Journal of Circumpolar Health* 71:1-9. doi:10.3402/ijch.v71i0.18401.

Ghosh-Jerath, S., A. Singh, M.S., Magsumbol, T. Lyngdoh, P. Kamboj, and G. Goldberg. 2016. "Contribution of indigenous foods towards nutrient intakes and nutritional status of women in the Santhal tribal community of Jharkhand, India." *Public Health Nutrition*1-12. doi:10.1017/S1368980016000318.

Ghosh-Jerath, S., Suparna, A., Singh, Melina, S. Magsumbol, Preeti Kamboj, and G. Goldberg. 2016. "Exploring the Potential of Indigenous Foods to Address Hidden Hunger: Nutritive Value of Indigenous Foods of Santhal Tribal Community of Jharkhand, India." *Journal of Hunger & Environmental Nutrition*:11 (4): 548-568. doi: 10.1080/19320248.2016.1157545.

Girma, W., and T.Genebo. 2002. Determinants of Nutritional Status of Women and Children in Ethiopia. Calverton, Maryland, USA: ORC Macro.

Guenther, P. M., K.W. Dodd, J. Reedy, and S. M. Krebs-Smith. 2006. "Most Americans eat much less than recommended amounts of fruits and vegetables." *Journal of the American Dietetic Association* 106 (9):1371-1379. doi:10.1016/j.jada.2006.06.002.

Gupta, S., A. J. Lakshmi, M. N. Manjunath, and J. Prakash. 2005. "Analysis of nutrient and antinutrient content of underutilized green leafy vegetables." *LWT-Food Science and Technology* 38 (4):339-345. doi:10.1016/j.lwt.2004.06.012.

Hawkes, C., and B. M. Popkin. 2015. "Can the sustainable development goals reduce the burden of nutrition-related non-communicable diseases without truly addressing major food system reforms?" *BMC Medicine* 13 (1):143. doi:10.1186/s12916-015-0383-7.

Heim, S., J. Stang, and M. Ireland. 2009. "A garden pilot project enhances fruit and vegetable consumption among children." *Journal of the American Dietetic Association* 109 (7):1220-1226. doi.org/10.1016/j.jada.2009.04.009.

Hunt, J. R. 2003. "Bioavailability of iron, zinc, and other trace minerals from vegetarian diets." *The American Journal of Clinical Nutrition* 78 (3 Suppl):633S-639S. doi:org.nwulib.nwu.ac.za/10.1093/ajcn/78.3.633S.

Jackson, M. D., B. S. Motswagole, L. D. Kwape, R. Kobue-Lekalake, T. B. Rakgantswana, T. Mongwaketse, M. Mokotedi, and J. Jackson-Malete. 2013. "Validation and reproducibility of an FFQ for use among adults in Botswana." *Public Health Nutrition* 16 (11):1995-2004. doi:10.1017/S1368980012004636.

Johns, T., B. Powell, P. Maundu, and P. B. Eyzaguirre. 2013. "Agricultural biodiversity as a link between traditional food systems and contemporary development, social integrity and ecological health." *Journal of the Science of Food and Agriculture* 93 (14):3433-3442. doi: 10.1002/jsfa.6351.

Johnson-Down, L., and G. M. Egeland. 2010. "Adequate nutrient intakes are associated with traditional food consumption in Nunavut Inuit children aged 3–5 years." *The Journal of Nutrition* 140 (7):1311-1316. doi:10.3945/jn.109.117887.

Kamga, R. T, C. Kouamé, A. R. Atangana, T. Chagomoka, and R. Ndango. 2013. "Nutritional Evaluation of Five African Indigenous Vegetables." *Journal of Horticultural Research* 21 (1):99-106. doi: 10.2478/johr-2013-0014.

Kasimba, S. N., B. S. Motswagole, N. M. Covic, and N. Claasen, N. 2017. "Household access to traditional and indigenous foods positively associated with food security and

dietary diversity in Botswana." *Public Health Nutrition* 1-9. doi:10.1017/S136898001700369X.

Kuhnlein, H. V., and O. Receveur. 2007. "Local cultural animal food contributes high levels of nutrients for Arctic Canadian Indigenous adults and children." *The Journal of Nutrition* 137 (4):1110-1114.

Kuhnlein, H.V., B. Erasmus, and D. Spigelski 2009. Indigenous peoples' food systems: the many dimensions of culture, diversity and environment for nutrition and health: Food and Agriculture Organization of the United Nations, Rome, Italy.

La Frano, M. R., F. F. de Moura, E. Boy. B. Lönnerdal, and B. J. Burri. 2014. "Bioavailability of iron, zinc, and provitamin A carotenoids in biofortified staple crops." *Nutrition Reviews* 72 (5):289-307. doi:10.1111/nure.12108.

Legwaila, G. M., W. Mojeremane, M. E. Madisa, R. M. Mmolotsi, and M. Rampart. 2011. "Potential of traditional food plants in rural household food security in Botswana." *Journal of Horticulture and Forestry* 3 (6):171-177. doi: 10.3945/ajcn.2009.27230G

Legwegoh, A. F., and L. Riley. 2014. "Food, place, and culture in urban Africa: comparative consumption in Gaborone and Blantyre." *Journal of Hunger and Environmental Nutrition* 9 (2):256-279. doi: 10.1080/19320248.2013.845868.

Lowe, N. M., K. Fekete, and T. Decsi. 2009. "Methods of assessment of zinc status in humans: a systematic review." *The American Journal of Clinical Nutrition* 89 (6):2040S-2051S. doi: 10.3945/ajcn.2009.27230G.

Low, J. W., M. Arimond, N. Osman, B. Cunguara, F. Zano, and Tschirley D. 2007. "A food-based approach introducing orange-fleshed sweet potatoes increased vitamin A intake and serum retinol concentrations in young children in rural Mozambique." *The Journal of nutrition*137, no. 5 : 1320-1327.doi.org/10.1093/jn/137.5.1320.

Maruapula, S., and K. Chapman- Novakofski. 2007. "Health and dietary patterns of the elderly in Botswana." *Journal of Nutrition Education and Behavior* 39 (6):311-319. doi: 10.1016/j.jneb.2007.07.007.

Maruapula, S. D., and C. K. Novakofski. 2010. "Nutrient intake and adequacy of Batswana elderly." *African Journal of Food, Agriculture, Nutrition and Development* 10 (7).

Maruapula, S. D., J. C. Jackson, J. Holsten, S. Shaibu, L. Malete, B. Wrotniak, S. J. Ratcliffe, G. G. Mokone, N. Stettler, and C. Compher. 2011. "Socio-economic status and urbanization are linked to snacks and obesity in adolescents in Botswana." *Public Health Nutrition* 14 (12):2260-2267. doi:10.1017/S1368980011001339.

Mavengahama, S., M. McLachlan, and W. De Clercq. 2013. "The role of wild vegetable species in household food security in maize based subsistence cropping systems." *Food Security* 5 (2):227-233. doi: 10.1007/s12571-013-0243-2.

Meng, F., Y. Wei, and X. Yang. 2005. "Iron content and bioavailability in rice." *Journal of Trace Elements in Medicine and Biology* 18 (4):333-338. doi:10.1016/j.jtemb.2005.02.008.

Mibei, K. Elias K, N.K., Ojijo, S. M., Karanja, and J. K., Kinyua. 2012. "Phytochemical and antioxidant analysis of methanolic extracts of four African indigenous leafy vegetables." *Annals Food Science and Technology* 13:37-42.

Misra, S., R. K. Maikhuri, C. P. Kala, K. S. Rao, and K. G. Saxena. 2008. "Wild leafy vegetables: A study of their subsistence dietetic support to the inhabitants of Nanda Devi Biosphere Reserve, India." *Journal of Ethnobiology and Ethnomedicine* 4 (1):1. doi:10.1186/1746-4269-4-15.

Mwakikagile G. 2010. Botswana: Profile of a Nation: Continental Press Dar es Salaam Tanzanaia;

Palafox-Carlos, H., J. F. Ayala-Zavala, and G. A. González-Aguilar. 2011. "The role of dietary fiber in the bioaccessibility and bioavailability of fruit and vegetable antioxidants." *Journal of Food Science* 76 (1):6-15. doi: 10.1111/j.1750-3841.2010.01957.

Popkin, B. M., L. S. Adair, and S.W. Ng. 2012. "Global nutrition transition and the pandemic of obesity in developing countries." *Nutrition Reviews* 70 (1):3-21. doi:10.1111/j.1753-4887.2011.00456.x.

Roche, M. L., H. M. Creed-Kanashiro, I. Tuesta, and H. V. Kuhnlein. 2008. "Traditional food diversity predicts dietary quality for the Awajun in the Peruvian Amazon." *Public Health Nutrition* 11 (05):457-465. doi: 10.1017/S1368980007000560.

Reardon, T., and Gulati, A. 2008. The rise of supermarkets and their development implications. International experience relevant for India. International Food Policy Research Institute Washington, DC USA.

Ruel, M. T., N. Minot, and L. Smith 2005. Patterns and determinants of fruit and vegetable consumption in sub-Saharan Africa: a multicountry comparison: WHO Geneva. http://cdrwww.who.int/dietphysicalactivity/publications/f&v_africa_economics.pdf (accessed Otober 22, 2016.

Ruel, M. T., J. L. Garrett, C. Hawkes, and M. J. Cohen. 2010. "The food, fuel, and financial crises affect the urban and rural poor disproportionately: a review of the evidence." *The Journal of Nutrition* 140 (1):170S-176S. doi:10.3945/jn.109.110791.

Stadlmayr, B., E. Nilsson, B. Mouille, E. Medhammar, B. Burlingame, and U. R. Charrondiere. 2011. "Nutrition indicator for biodiversity on food composition-A report on the progress of data availability." *Journal of Food Composition and Analysis* 24 (4-5):692-698. doi:10.1016/j.jfca.2010.09.009.

Trichopoulou A., E. Vasilopoulou, K. Georga, S. Soukara, V. Dilis. Traditional foods: Why and how to sustain them. *Trends in Food Science & Technology.* 2006 Sep 1;17(9):498-504. doi:10.1016/j.tifs.2006.03.005.

UNICEF (United Nations International Children's Emergency Fund). 2009. "State of the World's Children Health. Maternal and new-born health. http://www.unicef.org/sowc09/docs/SOWC09-FullReport-EN.pdf (accessed October 22, 2016).

Weinberger, K., and I. Swai. 2006. "Consumption of traditional vegetables in Central and Northeastern Tanzania." *Ecology of Food and Nutrition* 45 (2):87-103. doi: 10.1080/03670240500530626.

WHO (World Health Organization). 2008. "Worldwide Prevalence of Anemia1993–2005: WHO Global Database on Anaemia. http://www.who.int/nutrition/publications/micronutrients/anaemia_iron_deficiency/9789241596657/en/(accessed October 23, 2017).

Wolmarans, P. 2010. Medical Research Council Food Composition Tables. FoodFinder. http://safoods.mrc.ac.za/foodcomp.htm (accessed May 18, 2017).

Yang, R., and G. B. Keding. 2009. "Nutritional contributions of important African indigenous vegetables."African indigenous vegetables in urban agriculture*. Earthscan, London*:105-144.

CHAPTER 5

Street vending of traditional and indigenous food and the potential contribution to household income, food security and dietary diversity: The case of Gaborone, Botswana

Salome Kasimba [1], Namukolo Covic [2], Boitumelo Motswagole [3], Marike Cockran [4] and Nicole Claasen [5]

[1] Centre of Excellence for Nutrition (CEN), North-West University, Potchefstroom Campus, Private Bag X6001, Potchefstroom 2520, South Africa
[2] Poverty, Health and Nutrition Division, International Food and Policy Research Institute, Addis Ababa; Ethiopia
[3] National Food Technology Research Centre (NFTRC), Kanye, Botswana
[4] South Africa Statistical Consultation Services, North-West University, Potchefstroom, Africa
[5] Unit for Transdisciplinary Health Research (AUTHeR), North-West University, Potchefstroom, South Africa

Please address all inquiries to the corresponding author: Salome Kasimba, Centre of Excellence for Nutrition, North-West University, South Africa; Potchefstroom Campus; Private Bag X6001; Potchefstroom; 2520. Tel:+27 (0)18299 4011; Fax +27 (0)18299 2464; E-mail: salnkasimba@gmail.com

This journal is formatted according to the guidelines of Journal of Hunger and Environmental Nutrition

Abstract
Street vending of traditional and indigenous foods (TIF) remains largely unexplored on its potential contribution to household income, household food security (access) and household dietary diversity (HDD) within urban vendor households. Little is known about the related food supply chains. This study explored the relationship between vending TIF and household income, household food security (access) and HDD for TIF vendors in Gaborone and the related TIF supply chain. A positive correlation was found between monthly income from sale of TIF and overall household income ($r = 0.594$, $P = 0.004$) and between number of TIF varieties for sale and HDD ($r = 558$, $P = 0.002$). A supply chain of TIF crossing boarders emerged. Efforts are needed to promote more optimal linkages with TIF supply chains to leverage the potential benefits of TIF towards improved household income, and more nutritious diets.

Key words: Traditional foods, indigenous foods, income, food security, food access, dietary diversity, street food vendors.

Introduction

Botswana is characterised by a semi-arid climate, with an erratic and unreliable rainfall pattern.[1] Drought is endemic in the country and this has led to low agricultural food production for many years.[1-3] Food security remains a major concern at national and household level in Botswana.[4] According to the Botswana core welfare indicators survey 2009/2010, 28.8% of urban households and 50.6% of rural households reported worries about not having enough food during the past four weeks preceding the survey.[3] The urban poor population in Gaborone seems to be the most affected, with household food insecurity rates of 88% as reported by the African Food Security Urban Network (AFSUN) in 2008.[5] There is little or no urban agriculture in Gaborone and its contribution as a source of food to the urban poor was reported to be insignificant.[5, 6] In addition, rural-urban food transfers in Gaborone has been noted to be inconsequential.[7] Hence, households in Gaborone, including the low-income residents, predominantly depend on economic access to foods[8] with supermarkets being the major food sources.[9]

Meanwhile, Botswana is seen as one of the best economic performing countries in Sub-Saharan Africa.[10] However, the high rates of economic growth, have been attributed predominantly to one sector – diamond mining. Current statistics show that mining alone contributed 24.0% of the GDP in 2014.[11] Employment opportunities are limited and unemployment stood at 18.0% in 2012.[10] In 2010, 19.3% of the population lived below the population datum line.[3] Informal sector activities that provide income for poor households have increased significantly in the country by an astounding 72.3% from 1999 – 2007.[12] Street food vending, including the vending of traditional foods, is one of the informal sector activities that can generate self-employment and income in response to the unemployment and poverty.[13] In the recent years the importance of traditional and indigenous foods for nutritious, better quality and more sustainable diets has received global attention.[14] Sustainable diets are defined as those diets with low environmental impact which contribute to food security and to healthy lives for present and future generations.[15] The resilience of traditional or indigenous food plants and animals to adverse local environments and resistance to plant and animal diseases make them an important part of food security, particularly during dry spells.[16-19]

Supermarkets are widely increasing globally [20], consequently, some of the foods that are acknowledged by locals to be traditional may be purchased from supermarkets and may also be imported from the surrounding regions and countries. [21] In our research therefore, traditional and indigenous foods (TIF) were defined as foods that are native or were

introduced into Botswana a long time ago, including plant and animal sources, whether locally produced (either domesticated, cultivated) or accessed from the wild. Considering the globalisation of food systems, these foods may also be purchased from retail outlets, irrespective of their origin but recognised as part of country's traditional food culture. The definition of TIF was arrived at in a consultative process by a panel of nutrition experts, local field assistants and the research team prior to the study. Some of the traditional Tswana foods or dishes include, sorghum porridge, maize meal, samp (dehulled corn), dehulled corn with beans, seswaa (pounded cooked beef), phane (mopane moth caterpillars), pumpkin leaves and fruits such as mowana (*Adansonia digitata),*morula *(Sclerocarya birrea),* and moretlwa *(Grewia Flava).* [22-25]

In light of Botswana's undiversified economy, high unemployment, rainfall variability and food insecurity, especially among the urban poor, the potential of vending TIF deserves more attention as an alternative way of making a living. However, little is known about street vending of TIF and its contribution to household income, household food security (access), household dietary diversity and the related TIF supply chains. Therefore, the present study was designed to develop a greater understanding of the relationship between street vending of TIF and the vendor's overall household's income, household food security (access), household dietary diversity and the related TIF supply chains in Gaborone, Botswana.

Materials and methods

Study area

The study was conducted in Gaborone City along the streets of three malls, the Botswana Building Society Mall, the Main Mall and the Rail Park Mall at the bus rank. Gaborone was purposively selected because it is Botswana's largest city and the nation's capital that accommodates the largest number of rural- urban migrants.[26] It is also highly urbanising and faced with the challenge of urban food insecurity.[27] It is common to find TIF being sold along the streets and alleys around some shopping malls. The capital city has a population of 227,333 people out of a national population of 2, 021, 000 i.e. 11.2% of the national population.[28]

Study design and sampling

A mixed methods research approach was followed, applying a sequential explanatory study design[29] which involved quantitative data collection in the form of structured interviews with purposively selected TIF street vendors. Qualitative data collection followed in the form of focus group discussions (FGDs). Data collection was done between August and November

2015. The quantitative data collection came first and it involved structured interviews with 27 purposively selected vendors who sold raw or cooked TIF. Qualitative data collection was conducted two months later with a sub sample of 18 participants who were recruited during quantitative data collection. The criteria for the selection of the FGD participants were that participants (either male or female) had to be at least 18 years or older; should have been involved in the vending of TIF for at least three months prior to the study and be familiar with TIF. In total, three FGDs were conducted, comprising of six participants each.

Quantitative data collection and analysis

Interviews were conducted with street TIF vendors at their stalls using a researcher-administered structured questionnaire. Before the start of the interviews, trained field workers sought written informed consent from the participants after giving adequate information about the research, including the purpose of the research. The explanation was in the local language (Setswana) and the participants were also given written information sheet written in Setswana which they could refer to if needed. Every participant that expressed a willingness to participate had to sign the written consent form before the interview started. The questionnaire consisted of five sections: (i) demographic and socio-economic characteristics which consisted of questions on household size, monthly household income and education level, (ii) types of TIF varieties the participant sold, (iii) monthly income earned from selling TIF, (iv) questions on household food insecurity (access) and (v) household dietary diversity. The latter two sections were based on Food and Nutrition Technical Assistance (FANTA) guidelines on household food insecurity access scale (HFIAS)[30] and the Food and Agricultural Organization of the United Nations (FAO) household dietary diversity questionnaire[31] respectively and the respondent answered on behalf of the other household members. The HFIAS included nine occurrence questions and these were asked within a recall period of 30 days preceding the study. The respondents were first asked an occurrence question, that is - whether the condition in question happened at all in the past 30 days and this required a yes or no answer. If the respondent answered yes to an occurrence question, the frequency of occurrence question was asked to determine whether the condition happened rarely (once or twice), sometimes (three to ten times) or often (more than ten times) in the past 30 days.[30] The HFIA score for each household was then calculated by adding the codes for each frequency of occurrence question. The maximum score for a household was 27 and the minimum score was 0. The higher the score, the more food insecure a household is and the lower the score the less food insecure a household is[30]. Finally, the households were categorised into 4 levels of food insecurity; secure, mildly, moderately and severely food insecure.[30]

The HDD questionnaire[31] was administered to measure household dietary diversity as an indication of household access to different types of food. The HDD was based a non-quantitative 24-hour recall to capture foods (meals and snacks) that were prepared in the home and consumed in the home or outside the home or purchased outside the home and consumed in the home by any of the household members during the previous day and night.[31] HDD scores were calculated by adding the number of food groups consumed by all members of the household, out of twelve groups: 1) Cereals, 2) white tubers and roots, 3) fruits, 4) vegetables, 5) legumes, nut and seeds; 6) fish and other seafood's; 7) meat, 8) eggs, 9) oils and fats, 10) sweets, 11) milk and milk products, and 12) spices, condiments and beverages.[31] The households were then categorised into three dietary diversity score categories defined by the research team: low (0-4 food groups), medium (5-8 food groups) and high (9-12 food groups) for the purpose of determining the distribution of the scores. Median HDD score was also calculated.

The Shapiro-Wilk test and Q-Q plots were used to check for normality of data. Data not normally distributed were reported as the median and interquartile range (IQR). Descriptive statistics were used to summarise demographic and socio-economic characteristics, HFIA categories, HDD categories, median HDD score, type of TIF varieties displayed for sale and the amount of money earned in a month from the sale of TIF. Spearman correlations were used to determine the association between monthly income from the sale of TIF and overall monthly household income, HFIA scores and HDD scores. Spearman correlations were also used to determine the association between the number of TIF varieties displayed for sale and overall household income, HFIA scores and HDD scores. For all the analysis, statistical significance was set at $P < 0.05$.

Qualitative data collection and analysis

Three FGDs were conducted and these consisted of a sub-sampling of the vendors from each of the study sites to get in-depth insight on the contribution of selling TIF on the vendor's household income, availability and access to TIF, as well the challenges vendors faced in selling TIF on streets. Written consent for the FGD participation that included audio recordings was sought by trained field workers. The FGDs were then conducted in Setswana, which is the national language in Botswana, led by a moderator and two assistant facilitators who were taking notes. The following guiding questions were applied:

(i) What are the foods considered as TIF in this area?

(ii) What is your view on the contribution of selling these foods to the income of your household?

(iii) How does the income you get from selling TIF compare to the income you get from other income generating activities that you may be involved in?

(iv) Where do the TIF that you sell come from?

(v) Have you seen any changes in the demand of TIF and if so, to which reasons can that be attributed?

The voice recordings from FGDs were transcribed verbatim, comparing them with the notes taken to ensure that the meaning of the data was preserved.[29] The transcripts were then translated from Setswana to English for analysis, with focus on preserving the meaning rather than language accuracy. The data was coded and co-coded by an independent researcher and collated to potential themes following thematic analysis.[32, 33] ATLAS.ti version 7 was used.

Ethical considerations

Ethical clearance for this study was obtained from the Faculty of Health Sciences, Health Research Ethics Committee, Potchefstroom Campus, North–West University, South Africa; (NWU -00206-14-S1) and the Botswana Health Research and Development Division of the Ministry of Health. Signed informed consent was obtained from participants after being given adequate explanations in their local language. Participants had a choice to withdraw from the study at any point.

Results

Table 1 shows the vendors' characteristics, household food insecurity (access) and dietary diversity. The highest level of education attained by most of the vendors (63%) was junior secondary school education (grade 10) and a very small number went past high school level (tertiary education) (7.4%). The largest share of the vendors' households (37%) earned less than P 3000.00 (BWP) per month. Median monthly income amount from the sale of TIF was P2400.00 (BWP). About three quarters of the vendor households (74%) were food insecure with 18.5%, 33.3% and 22.2% being mildly, moderately and severely food insecure, respectively. Household dietary diversity results indicated that the majority of the households (51.9%) fell into the lowest group of HDD score (0-4 food groups) while median HDD score was 4 (3, 6).

Table 2 presents the various types of the TIF varieties that were sold. These included both raw and cooked foods and dishes. More types of raw foods were mainly sold (n=23) compared to cooked foods and dishes (n=13). Examples of those commonly sold raw were; peanuts (*manoko*), Jugo beans (*ditloo*) and dried bean leaves (*morogo wa dinawa*). Commonly sold cooked foods and dishes were beans with dried fresh maize (*dikgobe tsa lechotlho*), dehulled corn and beans (*dikgobe*), sorghum meal (*bogobe jwa mabele*), sorghum and melon (*bogobe jwa lerotse*).

Table 3 shows the spearman correlation of monthly income from sale of TIF and overall monthly household income; HFIA scores and HDD scores; number of TIF varieties for sale and overall household income; HFIA scores and HDD scores. A positive correlation was found between monthly income from the sale of TIF and overall household income (r = 0.594 P = 0.004) and between number of TIF varieties for sale and HDD (r = 558, P = 0.002). No correlation was found between monthly income from the sale of TIF and HFIA scores (r = 0.140, P = 0.535) and the number of TIF varieties for sale and HFIA scores (r = 0.136, P = 0.498).

The three main themes that emerged during qualitative analysis were (i) TIF as a source of household income, (ii) availability and access to TIF, (iii) challenges faced in street vending of TIF.

TIF as a source of income: During FGDs, participants confirmed that TIF contribute largely to their household income and are a valuable livelihood strategy. This income enables them to meet most of their families' daily needs as well as supporting other family members who are often dependent on the same income. The following quotes represent these perceptions:

> 'Yes, we get profit from selling these foods (TIF), this enables us to buy everything we want.' (*Group 2, BBS mall, 20.11.2015*)

> 'We are here and trying to make a living, so we are making money.' (*Group 3, Bus rank, 20.11.2015*)

> 'My sister is not working, so I am a sole bread winner at home and my children are solely dependent on this money.' (*Group 3, Bus rank, 20.11.2015*)

‘I am a single mom and I make a living from selling on the streets, so I can say I have really survived from the selling of these foods. Yes, I have managed to pay school fees for my children with the money that I make from selling TIF and I have been selling TIF for a very long time. All my children have finished school and they now work for themselves.’ *(Group 2, BBS mall, 20.11.2015)*

‘I can’t remember when I started selling but I worked as a domestic worker before coming to sell on the streets but I can tell you that I make profit. My children have not been getting paid from their work, so I have to make ends meet at the end of the day.’ *(Group 2, BBS mall, 20.11.2015)*

Availability and access of TIF: It was discussed that availability was related to seasons, with different TIF being available in different seasons of the year, either summer (rain season) or winter (dry season). Access to TIF was either gained through sourcing from the wild (including plants and animals), planting in fields or yards, or purchased from local shops and supermarkets.

‘Yes, we know our traditional foods, some are from the wild such as, *mogorogorwane* (wild orange), *moretlwa* (wild raisins), *mowana* (baobab fruit), *moretologa* (monkey orange), *mmupudu* (Moepel) *and thepe* (amaranth).’ (*Group 2, BBS mall, 20.11.2015*)

‘The ones from the wild are *thepe* (Amaranth), *mmupudu* (Moepel) *mogorogorwane* (wild orange), and *lerotshe* (melon).’(*Group 3, Bus rank, 20.11.2015*); ‘We get *phane* (Mopane moth caterpillars) from the field.’ *(Group 2, BBS mall, 20.11.2015)*

‘I plant my own *Makgomane* (cooking melon).’ (Group 3, Bus rank, 20.11.2015); ‘When there is a lot of rain, we sell fruits and vegetables. In winter, we sell less but we sell a lot of fruits from the wild during summer and that is when a large number of people participate in the selling.’ *(Group 1, Main mall, 20.11.2015)*

‘The dried amaranth is sold all year round.’ *(Group 3, Bus rank, 20.11.2015)*

The TIF that were reported to be commonly purchased were meat, maize, sweet potatoes and *manoko* (peanuts).

‘I buy meat from the butcher, cook and sell it.’ *(Group 2, BBS mall, 20.11.2015)*

‘We buy maize from the shops that comes from South Africa*.’* (Group 3, Bus rank, 20.11.2015)

‘I do get sweet potatoes from Zambia.’ *(Group 2, BBS mall, 20.11.2015)*

‘Some people get peanuts (*manoko*) from Zambia and they buy in bulk and sell to us when we are run out of stock.’ *(Group 2, BBS mall, 20.11.2015)*

‘We buy them, but when it rains, all we grow is beans, maize, and when our neighbouring countries have good rain we also buy from them*.’ (Group 1, Main mall, 20.11.2015)*

Challenges faced in vending of TIF: The major challenge in selling of TIF reported by the participants was high competition among vendors, especially during rainy season, due to plenty of produce.

‘Selling TIF is helping a lot but now we are so many people who sell on the streets.’ (*Group 1, Main mall, 20.11.2015*)

‘We are so many here, the competition is high. As a result we are not making enough profit.’ (*Group 1, Main mall, 20.11.2015*)

‘We make money, yes, but we have a challenge when it rains we don’t sell a lot.’ (*Group 2, BBS mall, 20.11.2015*)

The participants also mentioned there is poor market infrastructure of traditional or indigenous foods which limits the marketing of their foods.

‘Are you going to help us get new places to sell these foods (TIF) because we are struggling when it rains. May be you can help us sell our foods into other countries just like we buy foods from other countries.’ (*Group 3, Bus rank, 20.11.2015*)

The participants further reported that having inadequate food to cook at home causes them to take some of the TIF stock to prepare at home as food for their families, which effectively reduces their profits.

‘I would say because sometimes at home we don’t have any food to cook we are forced to take the beans that we sell and cook at home for food - this then reduces the stock and hence the profit that we make.’ *(Group 2, BBS mall, 20.11.2015)*

Discussion

This study explored the relationship between vending TIF and overall vendors’ household income, household food security (access), household dietary diversity for purposively selected TIF vendors and the related TIF supply chain. Quantitative results showed that income from TIF contributed substantially to household income while qualitative data from FGDs confirmed that selling TIF contributed largely to vendors’ livelihoods, with some participants reporting that it acted as the main source of household income. Our research findings suggest that selling TIF can play an important role in providing livelihood among those participating in this trade. Median income per month from selling TIF (BWP 2400.00) was higher when compared to the monthly minimum wage of BWP 1200.00 in several industries in Botswana[34], however, it is lower when compared to the 2009/2010 national average household income of BWP 3936.12.[3] This suggests that although vending TIF may present a potential livelihood means, the income levels are relatively low. The low income levels in our study are in line with the high levels of food insecurity (access) as was shown by many of our study sample (74.0%). Previous research confirmed that most urban dwellers, including those in Gaborone, Botswana, rely predominantly on economic access to food.[5, 35, 36] The findings from this research corroborates with these researchers. Income may therefore be an important aspect in attaining food security in urban Botswana, especially with the arid nature of the country that limits own food production. This perspective is confirmed by Raboloko[37] in a recent study on determinants of urban household food insecurity in urban Gaborone which reported that as wages increased, household food security improved. AFSUN in 2008 investigated the extent and nature of food insecurity in Gaborone’s three poorer areas: Old Naledi, White Bontleng and Broadhurst and reported that in these three areas, 88 % of the households were food insecure.[5] This research’s results and AFSUN’s findings may be an indication that almost a decade later, food insecurity among the urban poor households in Gaborone seems to persist and may therefore be of concern.

Our findings further showed a low HDD of between 0-4 food groups among more than half (59.1%) of the vendors’ households with a median HDD score of 4 (3, 6) out of a possible total of 12. AFSUN [5] reported a HDD score of 5 or lower among 32 % of the urban poor households in Gaborone. The relatively low HDD in our study could also have been due to

economic constraints among the households. According to Ruel[35], economic access determines the capability of a household to purchase a variety of foods. The selling of TIF contributed a large proportion to household income, however, we found no correlation between monthly income from sale of TIF and HFIA scores, indicating there are other factors at play. This may be because there are other sources of income that may fill the gap, an aspect that this study did not determine. We found a strong positive correlation between the number of TIF varieties the vendors sold and HDD scores. This highlights that the selling of TIF may not just be a livelihood strategy in terms of income, but also a coping strategy with food insecurity as was confirmed by our qualitative findings which showed that in times of food shortages at home, participants took some of their selling stock and cooked for their families.

Supporting and promoting better market opportunities for TIF could play a significant role in improving food security and dietary diversity by providing an alternative food-purchasing environment as opposed to supermarkets. However, although highly visible, the informal food sector in Botswana has received little or no attention, with supermarkets acting as the major food source for the majority of the population, including the poor households in Gaborone.[5] The fact that FGDs alluded to vendors sourcing some of the traditional foods they sell from supermarkets is testament to this phenomena. Supermarkets sell a variety of foods which also include traditional foods such as maize meal at significantly lower prices than most of the other food outlets within Gaborone.[38] However, the foods in the supermarkets may not be affordable for the poorer urban households because of the bigger size packages and their related prices involved. Indeed, research has shown that the urban poor do not benefit from bulk buying due to low income, so they buy food in small quantities, facilitated by the informal sector[39, 40] a finding confirmed in the poor urban environments of South Africa.[36] An interesting aspect that came to light from the FGDs is that the supply chain for the vendors crosses boarders. The vendors discussed that some of the TIF they sell came from as far away as Zambia. The implication is that there is perhaps a poorly recognised food supply chain associated with TIF vending that should be explored. It is only by understanding the nature of the associated supply chains that means of promoting developments to positively impact the related livelihoods could be leveraged. An area that may lack recognition is that informal TIF vending in Gaborone may have the potential to improve food security and dietary diversity by promoting consumption of neglected perceived nutritious, traditional and indigenous foods by making them available and accessible in the food supply chain. According to International Plant Generic Resource Institute (IPGRI), some of the traditional foods such as vegetables and fruits are categorised as neglected, yet they

are important in improving the health and nutrition of urban and rural poor households.[41] Many of the foods that fall into this category of neglected foods are included in the list of TIF that are subject to vending. Examples are bean leaves *(morogowa dinawa),* okra, pumpkin, lentils and fruits such as baobab. As alluded to previously, vendors will need more support in terms of formalising markets for TIF. In many African countries, including Botswana, street vending is perceived as a menace that causes disorganisation and overcrowding in the cities.[13, 42, 43] According to Joseph,[44] no formalised well organised market places that have been identified in Gaborone, specifically for street food vending. Additionally, council laws in Gaborone do not recognise street food vending, therefore, vendors are denied registration and viewed as illegal operators.[13]As a result, most vendors position themselves anywhere conducive to run their businesses.[13] Under such circumstances, the businesses are likely to remain unstable and may not thrive well. A study that compared the implication of rising supermarkets to informal food sources in India reported that informal traditional food sellers are believed to sell foods of low quality, limited variety and at unpleasant shopping environments, which gives them a disadvantage when competing with supermarkets.[45] In contrast, a recent study by Kasimba et al[46] that investigated the association of household access to TIF with household food security and dietary diversity in urban and rural low socio-economic households in Botswana found that TIF were perceived as healthy and superior when compared to non-TIF. Therefore, TIF vending in Gaborone warrants support in setting up formal TIF markets in clean environments that will influence household food security and dietary diversity by promoting availability and accessibility of TIF. Other benefits of supporting and promoting TIF vending could be the promotion of cultural and food heritage, as well as drought resistant food crops that could be used for food during the dry seasons. This may be suitable for a country like Botswana where rainfall is erratic.[1] Traditional foods are nutritious, unique, affordable, adapted to local growing conditions and preserve cultural traditions[14]. Therefore, traditional foods are crucial, not just for food security but also for more in providing more sustainable diets, especially for poor families in rural, peri-urban and urban areas.[14] Promoting increased TIF consumption with related agricultural interventions may further support small-scale farmers by introducing these products and developing markets for their produce. IPGRI highlighted that local agriculture among small-scale farmers is stimulated by promoting the use of traditional foods, which helps improve their livelihoods.[41]

The main limitation of this study is the small sample size which was solely depended on identifying individuals involved in the vending of TIF. Similarly, it would also have been useful to collect information from other parts of the country, including rural areas, in an effort to establish possible regional differences. This may also have given a clearer indication of the

supply chain associated with TIF vending. It also needs highlighted that the present did not collect data on other sources of income among the TIF vendors. It would be important for future studies to investigate this to get a deeper understanding of the economic potential in vending TIF in relation to overall household income, food security and dietary diversity.

Conclusion and recommendation

Vending TIF may have the potential to contribute to household income, household food security and household dietary diversity among the households involved in this trading activity. The study, however, calls for attention to factors related to the TIF supply and how these could be developed to the benefit of the vendors. The research team further recommends more research towards the promotion of nutrition-sensitive value chains of underutilised traditional and indigenous foods that can promote smallholder farmers and micro-entrepreneurs in income-generation, while at the same time, contributing to availability and access to TIF believed to have the capability of providing better quality diets for the urban population in the long term.

Acknowledgements

Acknowledgements: The authors wish to thank all the field workers who participated in the study. *Financial support*: This was a collaborative study between North-West University Potchefstroom Campus, South Africa and National Food Technology Centre (NFTRC) Botswana. The two institutions are gratefully acknowledged for providing financial support for the study. *Conflict of interest*: The authors declare that they have no competing interest. *Ethics of human subject participation:* This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human subjects were approved by the Faculty of Health Sciences, Health Research Ethics Committee, Potchefstroom Campus, North–West University, South Africa - Ethics number (NWU -00206-14-S1). Written informed consent was obtained from all subjects.

Table 1: Characteristics of street vendors of TIF in Gaborone

Characteristics of Vendors n=27	n (%)
Education level of respondents	
None	1 (3.7)
Primary school (7 years of schooling)	4 (14.8)
Junior school (3 years of schooling)	17 (63)
Senior secondary (2 years of schooling)	3 (11.1)
Tertiary education (1 year and above)	2 (7.4)
Median household size (IQR [a])	3 (2,5)
Monthly household income in BWP [b]	
0-3000	10 (37)
3001-9000	9 (33.3)
>9000	5 (18.5)
Unknown	3 (11.1)
Median income per month from sale of TIF in BWP (IQR [a])	2400 (950, 5000)
Minimum income per month from sale of TIF	500
Maximum income per month from sale of TIF	14700
Household food insecurity access scale (HFIAS) categories [c]	
Food secure	7 (25.9)
Mildly food insecure	5 (18.5)
Moderately food insecure	9 (33.3)
Severely food insecure	6 (22.2)
Household dietary diversity (HDD) score food group [d] categories	
Low (0-4 food groups)	14 (51.9)
Medium (5-8 food groups)	12 (44.4)
High (9-12 food groups)	1 (3.7)
Median HDD score (IQR[a])	4 (3,6)

TIF varieties displayed for sale	(n%)
Median number of TIF varieties displayed for sale [e] (IQR[a])	7 (4,9)
Minimum number of TIF varieties displayed for sale [e]	1
Maximum number of TIF varieties displayed for sale [e]	14

a. IQR – inter quartile range.
b. Income is given in Botswana Pula; 1BWP = 0.10 US dollar.
c. HFIAS categories are based on Food and Nutrition Technical Assistance (FANTA) guidelines, see[30].
d. Food groups are based on FAO guidelines for measuring HDD see FAO[31].
e. Number of TIF varieties displayed for sale are considered during time of conducting interview.

Table 2: Types of TIF varieties for sale by TIF vendors in Gaborone (n=27)

Setswana name of food	English/ Scientific name	Food group	Number of vendors (%)
		Raw foods	
Manoko	Peanuts	Legume	13 (48.1)
Ditloo	Jugo beans	Legume	13 (48.1)
Morogo wa dinawa	Bean leaves	Vegetable	10 (37.0)
Thepe	Amaranth leaves	Vegetable	9 (33.3)
Dipotata	Sweet potatoes	Root tuber	8 (29.6)
Dinawa tsa Setswana	Setswana beans	Legumes	5 (18.5)
Delele	Okra	Vegetable	4 (14.8)
Black eyed beans	Black eyed beans	Legume	4 (14.8)
Rothwe	Spider plant leaves	Vegetable	4 (14.8)
Mae a koko	Free range chicken eggs	Egg	3 (11.1)
Mosutlhwane	Dehulled sorghum grains	Cereal	2 (7.4)
Tshwaramasiela beans	Beans species	Legume	2 (7.4)
Ntshe	Sweet reed	Sweets	2 (7.4)
Letlhodi	Lentils	Legume	2 (7.4)
Nakedi beans	Beans species	Legume	2 (7.4)
Porongwane beans	Beans species	Legume	1 (3.7)
Maeatshilwana beans	Beans species	Legume	1 (3.7)
Moreokgotsheng	Beans species	Legume	1 (3.7)
Lekwesha	Pumpkin	vegetable	1 (3.7)
Motsentsela	(*Berchemia discolor (*Klotzsch)	Fruit	1 (3.7)
Mowana	Baobab fruit	Fruit	1 (3.7)
Moritela tshwene	Beans species	Legume	1 (3.7)
Dicheru	Morula nut	Nut	1 (3.7)
		Cooked foods and dishes	
Dikgobe tsa lechotlho	Beans with dried fresh maize	Legume/cereal	13 (48.1)
Dikgobe	Beans and dehulled corn	Legume/cereal	7 (25.9)
Bogobe jwa mabele	Sorghum meal	Cereal	7 (25.9)
Bogobe jwa lerotse	Sorghum and melon	Cereal/fruit	5 (18.5)
Seswaa	Pounded beef	Meat	5 (18.5)
Serobe	Tripe	Meat	3 (11.1)
Kabu	Dried boiled maize	Cereal	3 (11.1)
Mmidi	Maize on the cob	Cereal	3 (11.1)
Phaphatha	Roasted bread	Cereal	2 (7.4)
Koko ya Setswana	Chicken meat (free range)	Meat	2 (7.4)
Samp	Dehulled corn	Cereal	2 (7.4)
Dobi	Sorghum porridge with milk	Cereal/ milk	1 (3.7)
Nama ya podi	Goat meat	Meat	1 (3.7)

Types of TIF varieties for sale by TIF vendors in Gaborone are considered during time of conducting interview.

Table 3: Spearman correlation of monthly income from sale of TIF and overall monthly household income; HFIA scores and HDD scores; number of TIF varieties for sale and overall household income; HFIA scores and HDD scores

		Overall household income per month	HFIA scores	HDD scores
Income from TIF	correlation coefficient	0.594**	0.140	-0.065
	P-value	0.004	0.535	0.773
Number of TIF varieties for sale	correlation coefficient	-0.318	0.136	0.558**
	P-value	0.106	0.498	0.002

**Correlation is significant at the 1% level.

References

1. Batisani N, Yarnal B. Rainfall variability and trends in semi-arid Botswana: implications for climate change adaptation policy. *Appl Geogr* 2010; 30(4): 483- 489. doi.org/10.1016/j.apgeog.2009.10.007.

2. Brinkhurst, Marena FE. "Fruit of sand: complexities of Botswana’s veld plant resources." *SURG.* 2010; 3(2): 10-22.

3. Statistics Botswana. Botswana core welfare indicators survey:2009/10. Statistics Botswana http://www.statsbots.org.bw/sites/default/files/BCWIS%202009%2010%20MAIN%20REPORT.pdf. Published 2013. Accessed November 7, 2017.

4. Acquah B, Kapunda S. *The State of Food Insecurity in Gaborone, Botswana*: Southern African Migration Programme; 2016.

5. Acquah B, Kapunda S, Legwegoh A. The dimensions of urban food insecurity in Gaborone, Botswana. *Urban Forum. 2014;* 25: 217-226. doi 10.1007/s12132-014-9222-8.

6. Mosha AC. Urban agriculture in Botswana. *Commonwealth Journal of Local Governance*. 2016; 18: 48-67. doi.org/10.5130/cjlg.v0i18.4842.

7. Frayne B, Pendleton W, Crush J, Acquah B, Battersby-Lennard J, Bras E, et al. The state of urban food insecurity in southern Africa: *Urban food security series*. 2010;2.

8. Legwegoh AF, Hovorka AJ. Assessing food insecurity in Botswana: the case of Gaborone. *Development in Practice*. 2013;23(3):346-358. doi.org/10.1080/09614524.2013.781128.

9. Crush J, Hovorka A, Tevera D. Food security in Southern African cities The place of urban agriculture. *Progress in Development Studies.* 2011;11(4):285-305. doi.org/10.1177/146499341101100402.

10. International Monitory Fund. Botswana. Country report no. 12/235, International Monetary Fund. 2012. https://www.imf.org/external/pubs/ft/scr/2012/cr12235.pdf. Published August, 2012. Accessed November 5, 2017.

11. Botswana Ministry of Agriculture (2016) National Agricultural Policy: 1991. Gaborone: Botswana Ministry of Agriculture.

12. Kapunda SM, Moffat BD. Employment trends and poverty reduction: The case of the informal sector in Botswana. *Journal of Social and Economic Policy*. 2014;11(1):1-12.

13. Nakisani Carol C-M, Ongori H. An assessment of challenges faced by microenterprises in Botswana: A case of street food vendors in Gaborone. *International Journal of Learning and Development.* 2013;3(5):56-73.

14. Food and Agricultural Organization of the United Nations. Traditional foods: better livelihoods, dietary diversity and health. TECA. 2012. http://teca.fao.org/technology/traditional-foods-better-livelihoods-dietary-diversity-and-health. Published November, 2012. Accessed November 4, 2017.

15. Burlingame BA, Dernini S. Sustainable diets and biodiversity. Proceedigs of the International Scientific Symposium Biodiversity and Sustainable Diets United against Hunger; November, 3–5, 2010; Rome, Italy.

16. Keding G, Weinberger K, Swai I, Mndiga H. *Diversity, traits and use of traditional vegetables in Tanzania*. AVRDC-WorldVegetableCenter; 2007.

17. Food and Agricultural Organization. *Expert Consultation on Nutrition Indicators for Biodiversity. Food Composition*, Book 1. Rome. 2008.

18. Kunyanga CN, Imungi JK, Vellingiri V. Nutritional evaluation of indigenous foods with potential food-based solution to alleviate hunger and malnutrition in Kenya. *J. Appl. Biosci.* 2013;67:5277-5288.

19. Yang R-Y, Keding GB. African indigenous vegetables in urban agriculture . Charlie M. Shackleton, Margaret W. Pasquini, Axel W. Drescher eds. *Nutritional contributions of important African indigenous vegetables*. London, UK: Earthscan; 2009:105-143.

20. Reardon T & Gulati A. The rise of supermarkets and their development implications. *International experience relevant for India*. Vol. 752. Washington, DC USA: IFPRI. 2008. 1-61.

21. Kuhnlein HV, Erasmus B, Spigelski D. *Indigenous peoples' food systems: the many dimensions of culture, diversity and environment for nutrition and health*. Rome: Food and Agriculture Organization of the United Nations; 2009.

22. Legwaila GM, Mojeremane W, Madisa ME, Mmolotsi RM, Rampart M. Potential of traditional food plants in rural household food security in Botswana. *J. Hortic. For*. 2011;3(6):171-177.

23. Neudeck L, Avelino L, Bareetseng P, Ngwenya BN, Teketay D, Motsholapheko M. The contribution of edible wild plants to food security, dietary diversity and income of households in Shorobe Village, northern Botswana. *Ethnobotany Research & Applications*. 2012;10:449-462.

24. Clausen T, Charlton KE, Gobotswang KS, Holmboe-Ottesen G. Predictors of food variety and dietary diversity among older persons in Botswana. *Nutrition*. 2005;21(1):86-95. doi.org/10.1016/j.nut.2004.09.012.

25. Maruapula S, Chapman-Novakofski K. Health and dietary patterns of the elderly in Botswana. *J Nutr Educ Behav.* 2007;39(6):311-319. doi.org/10.1016/j.jneb.2007.07.007.

26. Mwakikagile G. *Botswana: Profile of a Nation*: Continental Press Dar es Salaam Tanzanaia; 2010.

27. Crush J, Frayne B. *The invisible crisis: urban food security in Southern Africa*: AFSUN Cape Town; 2010.

28. Botswana Census Report. Botswana population and housing census. http://www.statsbots.org.bw/sites/default/files/publications/Population%20and%20Housing%20Census%202011.pdf. Published 2011. Accessed November 18, 2017.

29. Creswell JW. Qualitative, Quantitative, and Mixed Methods Approaches. *Thousand Oaks*, CA: SAGE Publications,Inc. 2008.

30. Coates J, Swindale A, Bilinsky P. Household Food Insecurity Access Scale (HFIAS) for measurement of food access: indicator guide. Washington, DC: Food and Nutrition Technical

Assistance Project, Academy for Educational Development. http://www.fao.org/fileadmin/user_upload/eufao-fsi4dm/doc-training/hfias.pdf. Published August 2007. Accessed November 8, 2017.

31. Food and Agricultural Organization (2010) Guidelines for measuring household and individual dietary diversity. Rome, Italy. http://www.fao.org/fileadmin/user_upload/wa_workshop/docs/FAO-guidelines-dietary-diversity2011.pdf. Published 2011. Accessed November 9, 2017.

32. Vaismoradi M, Turunen H, Bondas T. Content analysis and thematic analysis: Implications for conducting a qualitative descriptive study. *Nurs Health Sci.* 2013;15(3):398-405. 10.1111/nhs.12048.

33. Braun V, Clarke V. Using thematic analysis in psychology. *Qual Res Psycho*. 2006; 3(2):77-101. doi.org/10.1191/1478088706qp063oa.

34. Minimum wages in Botswana. 2017. https://mywage.com/main/salaries/minimum-wages/minimum-wages-in-botswana/minimum-wages. WageIndicator 2017. Accessed November 13, 2017.

35. Ruel MT, Garrett JL, Hawkes C, Cohen MJ. The food, fuel, and financial crises affect the urban and rural poor disproportionately: a review of the evidence. *J Nutr*. 2010;140(1):170S-6S. doi:10.3945/jn.109.110791.

36. Battersby J. Urban food insecurity in Cape Town, South Africa: An alternative approach to food access. *Dev South Afr* 2011;28(4):545-561. doi.org/10.1080/0376835X.2011.605572.

37. Raboloko M. Determinants of urban household food security in Botswana. 2016; *J Biomed Clin Sci* 1, 17-21.

38. Lane K, Hovorka A, Legwegoh A. Urban food dynamics in Botswana: insights from Gaborone's Central Business District. *African Geographical Review*. 2012;31(2):111-125. doi: 10.1080/19376812.2012.715975.

39. Food and Agricultural Organization of the United Nations. The informal food sector. Briefing guide for mayors, city executives and urban planners, in developing countries and countries in transition. http://www.fao.org/3/a-y4312e.pdf. Published 2003. Accessed November 13, 2017.

40. Timalsina KP. An urban informal economy: Livelihood opportunity to poor or challenges for urban governance. *Global Journal of Human-Social Science Research.* 2011;11(2).

41. Moore C, Raymond RD. *Back by popular demand: the benefits of traditional vegetables: one community's story*: Bioversity International; 2006.

42. Njaya T. Operations of street food vendors and their impact on sustainable urban life in high density suburbs of Harare, in Zimbabwe. *Asian Journal of Economic Modelling.* 2014; 2 (1): 18-31.

43. Muyanja C, Nayiga L, Brenda N, Nasinyama G. Practices, knowledge and risk factors of street food vendors in Uganda. *Food Control.* 2011;22 (10):1551- 1558. doi:10.1016/j.foodcont.2011.01.016.

44. Joseph MC. Beyond modernist planning: understanding urban street vending in Botswana. Paper presented at the International RC21 conference 2011. Session: 5 Governance and diversity in cities ; July, 7-9, 2011; Amsterdam, Netherlands.

45. Reardon T, Gulati A. *The rise of supermarkets and their development implications. International experience relevant for India*. New Delhi: International Food Policy Research Institute; 2008. IFPRI Discussion Paper 00752.

46. Kasimba SN, Motswagole BS, Covic NM, Claasen N. "Household access to traditional and indigenous foods positively associated with food security and dietary diversity in Botswana." *Public Health Nutr* (2017): 1-9. doi:10.1017/S136898001700369X.

CHAPTER 6: CONCLUSION AND RECOMMENDATIONS

6.1 Introduction

This chapter presents a summary of the main findings of this study. Summary of main findings of the first article are presented first, followed by the second article then thereafter the third article. Lastly, general conclusions and recommendations based on the main findings of the study are presented.

6.2.1 Household access to traditional and indigenous foods positively associated with food security and dietary diversity in urban and rural areas in Botswana.

Our study found a high prevalence of food insecurity (access) (80.1%) among low socio-economic households with 14.0%, 28.8% and 37.3% being mildly, moderately or severely food insecure respectively. Severe food insecurity (access) was significantly higher in rural areas compared to urban areas (P < 0. 001). Our findings further revealed that median household HDD score was 6(5, 7) out of a total of 12 while the majority of households (81.0%) fell into a medium HDD score (5-8 food groups) with no significant differences between urban and rural areas (P = 0.153).

Results from HDD data showed that the largest share of households (56.3%) accessed between three to five TIF in the previous day, an indication that TIF consumption forms integral part of the Batswana diet. The research team expected participating rural households to have access to higher variety of TIF but contrary to this expectation, households in urban areas had access to a significantly higher variety of TIF. Access to a higher variety of TIF among urban households could have been due to availability of some of the foods we categorised as TIF (based on our definitions) in supermarkets such as beef, fish, beans and maize meal among others. Focus Group Discussions (FGDs) listed about 130 known TIF, a reflection of vast knowledge among participants. Some examples were compiled (see Chapter 3 Table 2). The importance of traditional and indigenous foods in addressing food insecurity has been internationally recognised (FAO, 2012). Similarly, this study showed that access to TIF was positively associated with household food security (access) and dietary diversity, hence, the findings highlight the potential role TIF may play in improving household food security (access) and household dietary diversity. We found no correlation between the number of accessed TIF and women BMI. However, our study did not determine dietary energy intake that is in part influenced by food preparation methods along with physical activity, an important determinant of BMI which was not a focus in this study.

With regards to participants' perceptions of TIF use, three main themes emerged and these were (i) health perceptions, (ii) availability and access, and (iii) declining consumption of TIF and attributed factors. TIF were perceived as healthy when compared to non- TIF supermarket foods such as cakes, rice and sugar-sweetened beverages. In terms of availability and access, availability to TIF was discussed mainly in terms of seasonality. FGDs revealed that TIF are mainly found during three seasons (summer, autumn and winter) while in terms of access, participants explained that TIF are accessed from different sources which included hunting (especially the animal sources) from the wild, cultivated at home, or sold by street vendors or in shops. Despite this, the participants added that consumption of TIF was on the decline. Although the study found associations between greater access to TIF and better household food security (access) and higher household dietary diversity, there is a need to explore the potential benefits of optimal use of TIF in contributing to food security and nutrition.

6.2.2 Consumption of traditional and indigenous foods and their contribution to nutrient intake among children 2-5 years and women 18-49 years old in Botswana

Our study showed that amidst times of declining use of traditional foods and increasing use of westernised diets (Popkin *et al.*, 2012; Johns *et al.*, 2013), our study participants consumed both TIF and non- TIF. TIF accounted for relatively high percentages of energy intake (41 %, 36%) in children and women, respectively. Our results showed that the intake of vitamin A in children was higher from TIF (mean 234 (184 - 299) compared to non-TIF (mean 176 (138 - 224) $P = 0.0851$. In women, our findings showed that the intake of vitamin A and zinc were significantly higher from TIF compared to non-TIF (zinc from TIF mean 4.9 (4.6 - 5.3), non- TIF mean 4.2 (3.9 - 4.5) $P = 0.0033$, vitamin A from TIF mean 409 (332 - 503), non-TIF mean 295 (240 - 362) $P = 0.0286$. Furthermore, our results showed that across quartiles of increasing TIF energy intake, children in the third quartile consumed significantly higher intakes of energy compared to children in the first quartile $P < 0.05$. In addition, the results also showed that children in the second quartile consumed a significantly higher intake of zinc compared to children in the first quartile $P < 0.05$. These findings present the useful potential TIF may have in contributing to nutrients intake such as energy, vitamin A and zinc. However, this study calls for further research in exploring the full potential in TIF towards improved nutrients intake. Longitudinal studies that take into account seasonality and wider categories of age and other geographical regions are recommended.

6.2.3 Street vending of traditional and indigenous food and the potential contribution to household income, food security and dietary diversity: The case of Gaborone, Botswana

In this study, quantitative results showed that income from TIF contributed substantially to household income which was also confirmed from FGDs. However, the median income per month is lower when compared to 2009/2010 national average household income of BWP 3936.12 (Statistics Botswana, 2010). This suggests that although vending TIF may present a potential livelihood means, the income levels are relatively low. Our findings further showed that almost three quarters of vendors households' (74%) were food insecure. Median HDD score was 4(3, 6) out of a total of 12 while the majority of the households (51.9%) fell into the lowest group of HDD score (0-4) food groups. The low income levels in this study are in line with the high levels of food insecurity and low household dietary diversity observed among vendors' households. Research shows that most urban dwellers, including those in Gaborone, rely particularly on income to access food (Ruel *et al.*, 2010; Battersby, 2011; Acquah *et al.*, 2014). This study found a positive correlation between monthly income from sale of TIF and overall household income (r = 0.594, P = 0.004) and between the number of TIF varieties for sale and HDD (r = 558, P = 0.002). This highlights that the selling of TIF may not just be a livelihood strategy in terms of income, but also a coping strategy with food insecurity. In this study, although the selling of TIF contributed a large proportion of household income, we found no correlation between monthly income from sale of TIF and HFIA scores, indicating there are other factors at play. This may be because there are other sources of income that may fill the gap, an aspect that the study did not determine. From the FGDs, it was mentioned that supply chains for TIF crossed boarders. The vendors discussed that some of the TIF they sell came from as far away as Zambia. The implication is that there is perhaps a poorly recognised food supply chain associated with TIF vending that should be explored. Both raw and cooked TIF were sold (see Chapter 5 Table 2). Vending TIF may have the potential to contribute to household income, food security and dietary diversity among the households involved, however, this study calls for attention to factors related to the supply chains of TIF and how these could be developed for the benefit of the vendors.

6.3 Study limitations

1. One limitation of this study was that there was no unified definition of traditional and indigenous foods. While a group of local experts decided on selection criteria for TIF, it was difficult to make a clear distinction between TIF and non-TIF in instances

where an introduced food has been part of cultural dishes for long periods of time and may be purchased from retail outlets, hence, the research team had to define a new concept.

2. Access to TIF was determined by means of a dietary diversity questionnaire - this was only captured once during one particular season; hence, neglecting seasonal availability of TIF. Therefore, seasonality may have contributed to fewer varieties of TIF being accessible to the households compared to other seasons.

3. The QFFQ adapted and used showed that the relative validity of iron and vitamin A (retinol), fruits and dark green leafy vegetables was poor (Jackson et al. 2013). Therefore, results for these micronutrients and foods should be interpreted with caution.

4. We used a 30 day QFFQ that required participants to report all the foods they consumed in a month, therefore, due to recall bias, this would have influenced the dietary intake to either over or underestimations.

5. Due to food composition tables not being available for Botswana, South African food composition tables were used for nutrient analyses. Botswana relies heavily on food imports from South Africa, therefore, the South African food composition food table were appropriate for use. We do however acknowledge that there were some foods that were traditional or indigenous to Botswana that were missing from the South African food composition food table that had to be substituted with others of the same type. This was in order due to the absence of nutrient composition of traditional or indigenous foods globally as highlighted by (Charrondière *et al.*, 2013).

6. This study did not investigate the dietary intake of TIF among individual women but looked at the association between the number of TIF accessed at household level and the women BMI. Individual TIF consumption and association with BMI may require more research.

7. The study did not establish other sources of income among the TIF vendors. The study recommends future studies to establish this for comparison purposes and get a deeper understanding of the economic potential in vending TIF in relation to overall household income, food security and dietary diversity.

8. Our study results cannot be generalised to the whole of Botswana due to the smaller sample sizes involved. However, the sample sizes given for the quantitative data and the qualitative component of the study were considered adequate to achieve the study objectives (statistical consultation from Dr Suria Ellis, statistical section, North-West University.

6.4 Conclusion

This study showed that food insecurity in terms of access and low diversified diets were found to be highly prevalent in both urban and rural areas of Botswana and among the vendors' households. Large proportions of the households in the two rural and the two urban areas were found to have access to TIF. This study highlights that TIF may present a useful potential in contributing to household food security (access), household dietary diversity and nutrients intake, especially energy, vitamin A and zinc. In addition, the study highlights that vending TIF may contribute significantly to vendors' household income and vendors' household dietary diversity. However, there is a need to explore the potential benefits of optimal use of TIF in contributing to household food security (access), household dietary diversity, improved nutrients intake and vendors' household income. This should also include attention to related energy consumption and physical activity as these may influence nutrition status outcomes. In addition, attention and research is required in understanding the factors that relate to the supply chains of TIF and how these could be developed for the benefit of the vendors.

6.5 Recommendations

1. Our findings showed that TIF formed integral part of the Batswana diets. The research found associations of greater access to TIF with better household food security (access) and higher household dietary diversity. Our findings further demonstrated the vital role TIF may play in contributing to selected nutrients, particularly energy, vitamin A and zinc. However, the study calls for further research to explore the full potential of TIF towards improved household food security, improved household dietary diversity and nutrients intake. Longitudinal studies that take into account seasonality and wider categories of age and other geographical regions are recommended. Additionally, the research recommends more qualitative research to gain an in-depth understanding of TIF contribution to health as well as a

solid appreciation of the reasons attributed to their declining use in order to leverage their benefits and reintroduce them back to communities.

2. The results also showed that households in urban areas had access to significantly bigger variety of TIF compared to rural households. The research recommends future studies to explore the extent to which TIF are channelled from rural to urban areas through both formal and informal markets.

3. The research also showed that the supply chain of TIF crossed borders. The recommendation is for further research that pays attention to factors relating to the supply chains of TIF and how these could be developed for the benefit of vendors.

4. Further research attention is also needed to determine the nutrient content of TIF towards developing food composition tables that include TIF.

5. Literature showed that previous research on TIF has focused mainly on TIF fruits and vegetables. The research team therefore recommends supporting research on a wider variety of TIF which will provide a more holistic understanding of TIF in various aspects.

6.4 References

Acquah B, Kapunda S, Legwegoh A, (2014) The Dimensions of Urban Food Insecurity in Gaborone, Botswana. *Urban Forum*; Springer 25, 217–226.

Battersby, J. 2011. Urban food insecurity in cape town, South Africa: an alternative approach to food access. *Development Southern Africa*, 28(4):545-561.

Charrondière, U.R., Stadlmayr, B., Rittenschober, D., Mouille, B., Nilsson, E., Medhammar, E., Olango, T., Eisenwagen, S., Persijn, D. & Ebanks, K. 2013. FAO/INFOODS food composition database for biodiversity. *Food Chemistry*, 140(3):408-412.

Food and Agriculture Organization of the United Nations (2012) *Traditional Foods: Better Livelihoods, Dietary Diversity and Health.* Rome: FAO; available at Italy: http://teca.fao.org/technology/traditional-foods-better-livelihoods-dietary-diversity-and-health.

Jackson, M. D., B. S. Motswagole, L. D. Kwape, R. Kobue-Lekalake, T. B. Rakgantswana, T. Mongwaketse, M. Mokotedi, and J. Jackson-Malete. 2013. "Validation and reproducibility of an FFQ for use among adults in Botswana." *Public Health Nutrition* 16 (11):1995-2004.

Johnson-Down, Louise, and Grace M Egeland. 2010. "Adequate nutrient intakes are associated with traditional food consumption in Nunavut Inuit children aged 3–5 years." *The Journal of Nutrition* 140 (7):1311-1316.

Popkin BM, Adair LS, Ng SW (2012) Global nutrition transition and the pandemic of obesity in developing countries. *Nutrition Review* 70**,** 3-21.

Ruel, M.T., garrett, J.L., Hawkes, C. & Cohen, M.J. 2010. The food, fuel, and financial crises affect the urban and rural poor disproportionately: a review of the evidence. *The Journal of Nutrition*, 140(1):170s-176s.

Statistics Botswana. Botswana core welfare indicators survey 2009/10. Statistics Botswana. Gaborone. www.cso.gov.bw. 2013;1. Accessed July 20, 2017.

6.5 List of Addenda

Addendum 1: Instructions for authors Journal of Public Health nutrition

Public Health Nutrition (PHN) provides an international, peer-reviewed forum for the publication and dissemination of research with a specific focus on nutrition-related public health. The Journal publishes original and commissioned articles, high quality meta-analyses and reviews, commentaries and discussion papers for debate, as well as special issues. It also seeks to identify and publish special supplements on major topics of interest to readers.

SCOPE

The scope of *Public Health Nutrition* includes multi-level determinants of dietary intake and patterns, anthropometry, food systems, and their effects on health-related outcomes. We welcome papers that:

Address **monitoring and surveillance** of nutritional status and nutritional environments in communities or populations at risk

Identify and analyse behavioral, sociocultural, economic, political, and environmental **determinants of nutrition-related public health**

Develop **methodology** needed for assessment and monitoring

Inform efforts to improve **communication of nutrition-related information**

Build workforce capacity for effective public health nutrition action

Evaluate or discuss the effectiveness of **food and nutrition policies**

Describe the development, implementation, and evaluation of **innovative interventions and programs** to address nutrition-related problems

Relate diet and nutrition to **sustainability** of the environment and food systems

Papers that do not fall within the scope as described above may be directed to more appropriate journals. We prefer papers that are innovative (do not repeat research already undertaken elsewhere) and relevant to an international readership.

ARTICLE TYPES

PHN publishes Research Articles, Short Communications, Review Articles, Letters to the Editors, Commentaries and Editorials. Research Articles, Short Communications and Review Articles should be submitted to http://mc.manuscriptcentral.com/phnutr. Please contact the Editorial Office on phn.edoffice@cambridge.org regarding any other types of submission.

A typical paper should be no more than 5000 words long, not including the abstract, references, tables, figures and acknowledgements. Papers submitted as Short Communications should consist of no more than 2000 words, plus a maximum of 3 tables OR figures.

For systematic reviews and meta-analyses, the journal endorses the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Statement (see British Medical Journal (2009) 339, b2535). Such submissions should follow the PRISMA guidelines and authors should include the PRISMA checklist with their submission (see instructions below).

Letters or commentaries are welcome that discuss, criticise or develop themes put forward in papers published in PHN or that deal with matters relevant to it. They should not be used as a means of publishing new work. Acceptance will be at the discretion of the Editorial Board, and editorial changes may be required. Wherever possible, letters from responding authors will be included in the same issue.

SUBMISSION AND REVIEW PROCESS

PHN uses ScholarOne Manuscripts for online submission and peer review. As part of the online submission process, authors are asked to affirm that the submission represents original work that has not been published previously; that it is not currently being considered by another journal; and that each author has seen and approved the contents of the submitted manuscript.

At submission, authors must nominate at least four potential referees who may be asked by the Editorial Board to help review the work. PHN uses a double-blind review process, and manuscripts are normally reviewed by two external peer reviewers and a member of the Editorial Board.

Revisions must be resubmitted within 2 months or they will be deemed a new paper. When substantial revisions are required after review, authors are normally given the opportunity to do this once only; the need for any further changes should reflect only minor issues.

PUBLISHING ETHICS

PHN adheres to the Committee on Publication Ethics (COPE) guidelines on research and publications ethics. The Journal considers all manuscripts on the strict condition that:

The manuscript is your own original work, and does not duplicate any previously published work;

The manuscript has been submitted only to the journal - it is not under consideration or peer review or accepted for publication or in press or published elsewhere;

All listed authors know of and agree to the manuscript being submitted to the journal; and

The manuscript contains nothing abusive, defamatory, fraudulent, illegal, libellous, or obscene.

Text taken directly or closely paraphrased from earlier published work that has not been acknowledged or referenced will be considered plagiarism. Submitted manuscripts in which such text is identified will be withdrawn from the editorial process. Any concerns raised about possible plagiarism or other violations of ethical guidelines in an article submitted to or published in PHN will be investigated fully and dealt with in accordance with the COPE guidelines.

DETAILED MANUSCRIPT PREPARATION INSTRUCTIONS

Language

Papers submitted for publication must be written in English and should be as concise as possible. We recommend that authors have their manuscript checked by an English language native speaker before submission, to ensure that submissions are judged at peer review exclusively on academic merit.

We list a number of third-party services specialising in language editing and / or translation, and suggest that authors contact as appropriate. Use of any of these services is voluntary, and at the author's own expense.

Spelling should generally be that of the *Concise Oxford Dictionary* (1995), 9th ed. Oxford: Clarendon Press. Authors are advised to consult a current issue in order to make themselves familiar with PHN as to typographical and other conventions, layout of tables etc.

Authorship

The Journal conforms to the International Committee of Medical Journal Editors (ICMJE) definition of authorship. Authorship credit should be based on:

Substantial contributions to conception and design, data acquisition, analysis and/or interpretation;

Drafting the article or revising it critically for important intellectual content; and

Final approval of the version to be published.

The contribution of individuals who were involved in the study but do not meet these criteria should be described in the Acknowledgments section.

Ethical standards

All submissions must abide by the guidelines in the World Medical Association (2000) Declaration of Helsinki: Ethical Principles for Medical Research Involving Human Subjects, with notes of clarification of 2002 and 2004 (http://www.wma.net/en/30publications/10policies/b3/), the Guidelines on the Practice of Ethics Committees Involved in Medical Research Involving Human Subjects (3rd ed., 1996; London: The Royal College of Physicians) and the Guidelines for the Ethical Conduct of Medical Research Involving Children, revised in 2000 by the Royal College of Paediatrics and Child Health: Ethics Advisory Committee (Arch Dis Child (2000) 82, 177–182).

PRISMA Checklist

For systematic reviews and meta-analyses, PHN requires completion of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist (www.prisma-statement.org/). This policy includes all systematic reviews, including those for observational studies. A completed copy of the checklist should be submitted along with the manuscript, with page numbers noted as required. When a given item has not been addressed, authors must provide an explanation.

Editors and reviewers will not evaluate manuscripts based on the number of items checked off in the checklist. The purpose of the PRISMA guidelines is to recommend a critical set of items that should typically be reported in a manuscript. The guidelines are meant to improve transparency by helping authors improve the quality of their reporting. More clarity in reporting will facilitate review of your manuscript and increase its value to readers.

Cover Letter

Authors are invited to submit a cover letter including a short explanation of how the article advances the field of public health nutrition in terms of research, practice, or policy, and of its relevance to an international readership. The text for the cover letter should be entered in the appropriate box as part of the online submission process.

Title Page

Authors must submit a title page online **as a separate file to their manuscript**, to enable double-blind reviewing. For the same reason, the information on the title page should not be included in the manuscript itself. The title page should include:

The title of the article;

Authors' names, given without titles or degrees;

Name and address of department(s) and institution(s) to which the work should be attributed for each author, with each author's institution(s) identified by a superscript number (e.g. A.B. Smith1);

Name, mailing address, email address, telephone and fax numbers of the author responsible for correspondence about the manuscript;

A shortened version of the title, not exceeding 45 characters (including letters and spaces) in length;

Disclosure statements, as outlined below. These must be included on the title page and **not in the manuscript file**, to enable double-blind reviewing; if the paper is accepted, they will be inserted into the manuscript during production.

Acknowledgments

Here you may acknowledge individuals or organizations that provided advice and/or support (non-financial). Formal financial support and funding should be listed in the following section.

Financial Support

Please provide details of the sources of financial support for all authors, including grant numbers. For example, "This work was supported by the Medical research Council (grant number XXXXXXX)". Multiple grant numbers should be separated by a comma and space, and where research was funded by more than one agency the different agencies should be separated by a semi-colon, with "and" before the final funder. Grants held by different authors should be identified as belonging to individual authors by the authors' initials. For example, "This work was supported by the Wellcome Trust (A.B., grant numbers XXXX, YYYY), (C.D., grant number ZZZZ); the Natural Environment Research Council (E.F., grant number FFFF); and the National Institutes of Health (A.B., grant number GGGG), (E.F., grant number HHHH)".

This disclosure is particularly important in the case of research supported by industry, including not only direct financial support for the study but also support in kind such as provision of medications, equipment, kits or reagents without charge or at reduced cost and provision of services such as statistical analysis. **All such support**, financial and in kind, should be disclosed here.

Where no specific funding has been provided for research, please provide the following statement: "This research received no specific grant from any funding agency, commercial or not-for-profit sectors."

In addition to the source of financial support, please state whether the funder contributed to the study design, conduct of the study, analysis of samples or data, interpretation of findings or the preparation of the manuscript. If the funder made no such contribution, please provide

the following statement: "[Funder's name] had no role in the design, analysis or writing of this article."

Conflict of Interest

The Journal adheres to the definition of conflicts of interest given by the ICMJE guidelines. A conflict of interest exists when an author has interests that might inappropriately influence his or her judgement, even if that judgement is not influenced. Financial relationships such as employment, consultancies, or honoraria, are the most easily identifiable conflicts of interest. However, non-financial conflicts can also exist as a result of personal relationships, academic competition, and personal or intellectual beliefs.

Having a conflict of interest is not in itself wrong, and not all relationships may lead to an actual conflict of interest. However, PHN requires full disclosure about any relevant relationships, even if the author or reviewer does not believe it affects their judgment. These disclosures can then be used as a basis for editorial decisions. One question that provides some guidance in deciding which relationships merit declaration as potential conflicts of interest is this: if a relationship is not disclosed, would a reasonable reader feel misled? **When in doubt, full transparency is the best course of action**. Perceived conflicts of interest are as important as actual conflicts of interest, and undeclared conflicts (perceived as well as actual) can undermine the credibility of both the journal and the authors.

So that others can make judgements about potential conflicts, please provide details of **all known financial and non-financial (professional and personal) relationships with the potential to bias the work**. Where no known conflicts of interest exist, please include the following statement: "None."

Authorship

Please provide a very brief description of the contribution of each author to the research. Their roles in formulating the research question(s), designing the study, carrying it out, analysing the data and writing the article should be made plain.

Ethical Standards Disclosure

Manuscripts describing experiments involving human subjects must include the following statement: "This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human subjects/patients were approved by the [name of the ethics committee]. Written [or Verbal] informed consent was obtained from all subjects/patients." Where verbal consent was obtained, this must be followed by a statement such as: "Verbal consent was witnessed and formally recorded."

Manuscript Format

The requirements of PHN are in accordance with the Uniform Requirements for Manuscripts Submitted to Biomedical Journals produced by the ICMJE, and authors are encouraged to consult the latest guidelines, which contain useful, general information about preparing scientific papers. Authors should also consult the CONSORT guidelines for reporting results of randomised trials.

For detailed instructions regarding **mathematical modelling**, **statistical analysis** and **nomenclature requirements**, please refer to the Appendix to these instructions.

Typescripts should be prepared with 1.5 line spacing and wide margins (2 cm), the preferred font being Times New Roman size 12. At the ends of lines, words should not be hyphenated unless hyphens are to be printed. **Line numbering and page numbering are required**.

Manuscripts should be organised as follows:

Abstract

Each paper must open with a structured abstract of **not more than 250 words**. The abstract should consist of the following headings: Objective, Design, Setting, Subjects, Results, Conclusions. All the headings should be used, and there should be a separate paragraph for each one. The abstract should be intelligible without reference to text or figures.

Keywords

Authors should list at least four keywords or phrases (each containing up to three words).

Introduction

It is not necessary to introduce a paper with a full account of the relevant literature, but the introduction should indicate briefly the nature of the question asked and the reasons for asking it.

Methods

For manuscripts describing experiments involving human subjects, the required ethical standards disclosure statement must be included **on the title page only** as described above. It will then be inserted into this section of the manuscript during production.

Results

These should be given as concisely as possible, using figures or tables as appropriate. Data should not be duplicated in tables and figures.

Discussion

While it is generally desirable that the presentation of the results and the discussion of their significance should be presented separately, there may be occasions when combining these sections may be beneficial. Authors may also find that additional or alternative sections such as 'conclusions' may be useful.

References

References should be numbered consecutively in the order in which they first appear in the text using superscript Arabic numerals in parentheses, e.g. 'The conceptual difficulty of this approach has recently been highlighted(1,2)'. If a reference is cited more than once, the same number should be used each time. References cited only in tables and figure legends should be numbered in sequence from the last number used in the text and in the order of mention of the individual tables and figures in the text.

Names and initials of authors of unpublished work should be given in the text as 'unpublished results' and not included in the References. References that have been published online only but not yet in an issue should include the online publication date and the Digital Object Identifier (doi) reference, as per the example below.

At the end of the paper, on a page(s) separate from the text, references should be listed in numerical order using the Vancouver system. When an article has more than three authors

only the names of the first three authors should be given followed by '*et al.*' The issue number should be omitted if there is continuous pagination throughout a volume. Titles of journals should appear in their abbreviated form using the NCBI LinkOut page. References to books and monographs should include the town of publication and the number of the edition to which reference is made. References to material available on websites should follow a similar style, with the full URL included at the end of the reference, as well as the date of the version cited and the date of access.

Examples of correct forms of references are given below.

Journal articles

Rebello SA, Koh H, Chen C *et al.*(2014) Amount, type, and sources of carbohydrates in relation to ischemic heart disease mortality in a Chinese population: a prospective cohort study. *Am J Clin Nutr***100**, 53-64.

Villar J, Ismail LC, Victora CG *et al.* (2014) International standards for newborn weight, length, and head circumference by gestational age and sex: the Newborn Cross-Sectional Study of the INTERGROWTH-21st Project. *Lancet***384**, 857-868.

Alonso VR & Guarner F (2013) Linking the gut microbiota to human health. *Br J Nutr***109**, Suppl. 2, S21–S26.

Bauserman M, Lokangaka A, Gado J et al. A cluster-randomized trial determining the efficacy of caterpillar cereal as a locally available and sustainable complementary food to prevent stunting and anaemia. *Public Health Nutr*. Published online: 29 January 2015. doi: 10.1017/S1368980014003334.

Books and monographs

Bradbury J (2002) Dietary intervention in edentulous patients. PhD Thesis, University of Newcastle.

Ailhaud G & Hauner H (2004) Development of white adipose tissue. In *Handbook of Obesity. Etiology and Pathophysiology*, 2nd ed., pp. 481–514 [GA Bray and C Bouchard, editors]. New York: Marcel Dekker.

Bruinsma J (editor) (2003) *World Agriculture towards 2015/2030: An FAO Perspective*. London: Earthscan Publications.

World Health Organization (2003) *Diet, Nutrition and the Prevention of Chronic Diseases*. Joint WHO/FAO Expert Consultation. WHO Technical Report Series no. 916. Geneva: WHO.

Keiding L (1997) *Astma, Allergi og Anden Overfølsomhed i Danmark – Og Udviklingen 1987–199l (Asthma, Allergy and Other Hypersensitivities in Denmark, 1987–1991)*. Copenhagen, Denmark: Dansk Institut for Klinisk Epidemiologi.

Sources from the internet

Nationmaster (2005) HIV AIDS – Adult prevalence rate. http://www.nationmaster.com/graph-T/hea_hiv_aid_adu_pre_rat (accessed June 2013).

Tables

Tables should be placed in the main manuscript file at the end of the document, not within the main text. Be sure that each table is cited in the text. Tables should carry headings

describing their content and should be comprehensible without reference to the text. Tables should not be subdivided by ruled lines.

The dimensions of the values, e.g. mg/kg, should be given at the top of each column. Separate columns should be used for measures of variance (SD, SE etc.), the ± sign should not be used. The number of decimal places used should be standardised; for whole numbers 1.0, 2.0 etc. should be used. Shortened forms of the words weight (wt) and height (ht) may be used to save space in tables.

Footnotes are given in the following order: (1) abbreviations, (2) superscript letters, (3) symbols. Abbreviations are given in the format: RS, resistant starch. Abbreviations in tables must be defined in footnotes in the order that they appear in the table (reading from left to right across the table, then down each column). Symbols for footnotes should be used in the sequence: *†‡§||¶, then ** etc. (omit * or †, or both, from the sequence if they are used to indicate levels of significance).

For indicating statistical significance, superscript letters or symbols may be used. Superscript letters are useful where comparisons are within a row or column and the level of significance is uniform, e.g. '[a,b,c]Mean values within a column with unlike superscript letters were significantly different (P<0•05)'. Symbols are useful for indicating significant differences between rows or columns, especially where different levels of significance are found, e.g. 'Mean values were significantly different from those of the control group: *P<0•05, **P<0•01, ***P<0•001'. The symbols used for P values in the tables must be consistent.

Figures

Figures should be supplied as separate electronic files. Figure legends should be grouped in a section at the end of the manuscript text. Each figure should be clearly marked with its number and separate panels within figures should be clearly marked (a), (b), (c) etc. so that they are easily identifiable when the article and figure files are merged for review. Each figure, with its legend, should be comprehensible without reference to the text and should include definitions of abbreviations.

We recommend that only TIFF, EPS or PDF formats are used for electronic artwork. Other formats (e.g., JPG, PPT and GIF files and images created in Microsoft Word) are usable but generally NOT suitable for conversion to print reproduction. For further information about how to prepare your figures, including sizing and resolution requirements, please see our artwork guide.

In curves presenting experimental results the determined points should be clearly shown, the symbols used being, in order of preference, ○, ●, Δ, ▲, □, ■, ×, +. Curves and symbols should not extend beyond the experimental points. Scale-marks on the axes should be on the inner side of each axis and should extend beyond the last experimental point. Ensure that lines and symbols used in graphs and shading used in histograms are large enough to be easily identified when the figure size is reduced to fit the printed page.

Colour figures will be published online free of charge, and there is a fee of £250 per figure for colour figures in the printed version. If you request colour figures in the printed version, you will be contacted by CCC-Rightslink who are acting on our behalf to collect colour charges. Please follow their instructions in order to avoid any delay in the publication of your article.

Supplementary material

Additional data (e.g. data sets, large tables) relevant to the paper can be submitted for publication online only, where they are made available via a link from the paper. The paper should stand alone without these data. Supplementary Material must be cited in a relevant place in the text of the paper.

Although Supplementary Material is peer reviewed, it is not checked, copyedited or typeset after acceptance and it is loaded onto the journal's website exactly as supplied. You should check your Supplementary Material carefully to ensure that it adheres to journal styles. Corrections cannot be made to the Supplementary Material after acceptance of the manuscript. Please bear this in mind when deciding what content to include as Supplementary Material.

License to Publish form

Authors or their institutions retain copyright of papers published in PHN. The corresponding author is asked to complete a License to Publish form on behalf of all authors, and upload this with the manuscript files **at the time of submission**. The form includes confirmation that permission for all appropriate uses has been obtained from the copyright holder for any figures or other material not in the authors' copyright, and that the appropriate acknowledgement has been made to the original source. If the manuscript is not accepted, the form will be destroyed.

Open Access

Authors in PHN have the option to publish their paper under a fully Open Access agreement, upon payment of a one-off Article Processing Charge. In this case, the final published Version of Record will be made freely available to all in perpetuity under a creative commons license, enabling its re-use and re-distribution. This Open Access option is only offered to authors upon acceptance of an article for publication.

Authors choosing the Open Access option are required to complete the Open Access License to Publish form. More information about Open Access in PHN, including the current Article Processing Charge, can be found on our website.

Accepted Manuscripts

PDF proofs are sent to authors in order to make sure that the paper has been correctly set up in type. Only changes to errors induced by typesetting/copy-editing or typographical errors will be accepted. Corrected proofs should be returned within 2 days by email to Gill Watling at gillwatling@btinternet.com. If corrected proofs are not received from authors within 7 days the paper may be published as it stands.

Offprints

A PDF file of the paper will be supplied free of charge to the corresponding author of each paper, and offprints may be ordered on the order form sent with the proofs.

CONTACT

Prospective authors may contact the Editorial Office directly on +44 (0) 1223 327954 (telephone) or phn.edoffice@cambridge.org.

Additionally, more information about the journal, including recent issues, can be found at http://journals.cambridge.org/phn.

APPENDIX: MATHEMATICAL MODELLING, STATISTICS AND NOMENCLATURE

Addendum 2: Instructions for authors Journal of Ecology of Food and Nutrition

Thank you for choosing to submit your paper to us. These instructions will ensure we have everything required so your paper can move through peer review, production and publication smoothly. Please take the time to read and follow them as closely as possible, as doing so will ensure your paper matches the journal's requirements. For general guidance on the publication process at Taylor & Francis please visit our Author Services website.

Please note that Ecology of Food and Nutrition uses CrossCheck™ software to screen papers for unoriginal material. By submitting your paper to Ecology of Food and Nutrition you are agreeing to any necessary originality checks your paper may have to undergo during the peer review and production processes.

Submission of Manuscripts

Ecology of Food and Nutrition receives all manuscript submissions electronically via its ScholarOne Manuscripts site located at: http://mc.manuscriptcentral.com/gefn. ScholarOne Manuscripts allows for rapid submission of original and revised manuscripts, as well as facilitating the review process and internal communication between authors, editors and reviewers via a web-based platform. ScholarOne Manuscripts technical support can be accessed via http://scholarone.com/services/support. If you have any other requests, please contact Sunil Khanna, the journal's Editor, at efn.editor@oregonstate.edu.

Preparation of Manuscripts

All parts of the manuscript should be typewritten, double-spaced, with margins of at least one inch on all sides. Number manuscript pages consecutively throughout the paper. Although manuscript length may vary according to the type of paper or subject matter, Ecology of Food and Nutrition publishes manuscripts that are generally in the range of 6,000–7,000 words (including all supplementary materials). Authors should also supply a shortened version of the title suitable for the running head, not exceeding 50 character spaces. Each article should be summarised in an abstract of not more that 100 words. Avoid abbreviations, diagrams, and reference to the text. Authors are reminded that publications reporting results from research involving human subjects are required to include a statement in the Methods section of their manuscript that the study protocol has been approved by an Institutional Review Board (IRB) in the Institution where the study was conducted. Furthermore, such a statement should include documentation that informed consent was obtained from the study subjects or their parents when children are involved.

Authors are responsible for obtaining permission to reproduce copyrighted material from other sources and are required to sign an agreement for the transfer of copyright to the publisher. As an author, you are required to secure permission if you want to reproduce any figure, table, or extract from the text of another source. This applies to direct reproduction as well as "derivative reproduction" (where you have created a new figure or table which derives substantially from a copyrighted source). All accepted manuscripts, artwork, and photographs become the property of the publisher.

Illustrations

Illustrations submitted (line drawings, halftones, photos, photomicrographs, etc.) should be clean originals or digital files. Digital files are recommended for highest quality reproduction and should follow these guidelines:

300 dpi or higher

sized to fit on journal page

EPS, TIFF, or PSD format only

submitted as separate files, not embedded in text files

Color Reproduction

Color art will be reproduced in color in the online publication at no additional cost to the author. Color illustrations will also be considered for print publication; however, the author will be required to bear the full cost involved in color art reproduction. Please note that color reprints can only be ordered if print reproduction costs are paid. Print Rates: $900 for the first page of color; $450 per page for the next three pages of color. A custom quote will be provided for articles with more than four pages of color. Art not supplied at a minimum of 300 dpi will not be considered for print.

Tables and Figures

Tables and figures should not be embedded in the text, but should be included as separate files. A short descriptive title should appear above each table with a clear legend and any footnotes suitably identified below. All units must be included. Figures should be completely labeled, taking into account necessary size reduction. Captions should be typed, double-spaced, on a separate sheet.

References

Ecology of Food and Nutrition uses The Chicago Manual of Style, 15th ed. The full list of references should be collected at the end of the paper in alphabetical order. In the text, references should be cited by author's last name and date of publication in parentheses (Smith 1979). List 1–2 authors on every mention; list 3 authors on the first mention and only the first author and "et al." on subsequent mentions; and list 4 or more authors by the first author and "et al." on all mentions. In the references, list all author names for up to 10 authors; list only the first 7 and "et al." for references with 11 or more authors. First initials precede last names for all author names except the first author. Use "and" not "&" in all text citations and the references.

Journal: Annegers, J. F. 1974. Protein quality of West African foods. Ecology of Food and Nutrition 3:125–130.

Book: Hill, A. B. 1989. Statistical methods in clinical and preventative medicine. New York: Oxford University Press.

Chapter in a Book: Ruffner, J. D., and W. W. Steiner. 1973. Evaluation of plants for use in critical sites. In Ecology and reclamation of devastated land, ed. R. J. Hutnick and G. Jones, 3–12. New York: Gordon and Breach.

Proofs and Complimentary Policy

The corresponding author will receive proofs, which should be proofread and returned within 48 hours of receipt. Corrections are limited to printer's errors—no substantial author's changes will be made. Authors for whom we receive a valid email address will be provided an opportunity to purchase reprints of individual articles, or copies of the complete print issue. These authors will also be given complimentary access to their final article on Taylor & Francis Online.

Addendum 3: Content and style guidelines for the Journal of Hunger and Environmental Nutrition

Instructions for authors

Thank you for choosing to submit your paper to us. These instructions will ensure we have everything required so your paper can move through peer review, production and publication smoothly. Please take the time to read and follow them as closely as possible, as doing so will ensure your paper matches the journal's requirements. For general guidance on the publication process at Taylor & Francis please visit our Author Services website.

SCHOLARONE MANUSCRIPTS™

This journal uses ScholarOne Manuscripts (previously Manuscript Central) to peer review manuscript submissions. Please read the guide for ScholarOne authors before making a submission. Complete guidelines for preparing and +

q-+

your manuscript to this journal are provided below. -+-+

Aims and Scope

Journal of Hunger & Environmental Nutrition is the premier peer-reviewed journal among professionals interested in nutrition, food and water security, health, agriculture and the environment.

Journal of Hunger & Environmental Nutrition:

- provides a distinguished venue for the publication of original articles prepared by scholars and practitioners in the field and reviewed by qualified peers
- publishes manuscripts that advance knowledge across the range of research and practice issues in nutrition, food and water security, health, agriculture and the environment
- supports the professional growth of researchers and practitioners in these areas.

Journal of Hunger & Environmental Nutrition studies the growing connection and interdependence between the environment, food, nutrition, and health. It comprehensively examines local, national and international hunger and environmental nutrition issues—specifically food access, food security, food production, agriculture, and the interconnectedness on nutrition and health. The journal is designed to provide current research and application information on public policy, legislation, and regulation related to sustainable ecosystems and the link with maintaining optimal nutrition and well-being for all people.

Please note that ***Journal of Hunger & Environmental Nutrition*** uses CrossCheck™ software to screen papers for unoriginal material. By submitting your paper to ***Journal of Hunger & Environmental Nutrition*** you are agreeing to any necessary originality checks your paper may have to undergo during the peer review and production processes.

Submission of Manuscripts:

Journal of Hunger & Environmental Nutrition receives manuscript submissions electronically via its ScholarOne Manuscripts site located at http://mc.manuscriptcentral.com/when. ScholarOne Manuscripts allows for rapid submission of original and revised manuscripts and facilitates the review process and internal communication between authors, editors, and reviewers via a web-based platform. ScholarOne technical support can be accessed at http://scholarone.com/services/support/. If you have any other requests, please contact the journal's Editor, Dr. Marie Boyle Struble, at mstruble@cse.edu.+-

The manuscripts should be double-spaced (including endnotes and references). Leave one-inch margins on all four sides. Set all notes as endnotes. Submit a cover page with the manuscript, indicating only the article title and an ABSTRACT of about 100 words (below the abstract provide 3-10 key words for indexing purposes); (this is used for anonymous refereeing). Include a **second "title page"** with the manuscript. The **second "title page" should** include the title; full authorship; an ABSTRACT of about 100 words (below the abstract provide 3-10 key words for indexing purposes); a header or footer on each page with abbreviated title and page number of total (e.g., pg 2 of 7); and an introductory note with authors' academic degrees, professional titles, affiliations, mailing and e-mail addresses, and any desired acknowledgment of research support or other credit.

Reports of original research ("Research Articles") should be approximately 25 typed pages (including references and abstract). Reports of results from a small or non-representative sample or report on secondary results from a larger study ("Research Briefs") should be approximately 14 typed pages. Program and/or project "snapshots" that give a program or project's mission, objectives, implementation process, outcomes, and evaluation ("Field Notes") should be no longer than 250-500 words. Timely expressions of sensible criticism or reaction to published material ("Letters to the Editor") should be no longer than 200 words. Lengthier manuscripts may be considered, but only at the discretion of the Editor. Sometimes lengthier manuscripts may be considered if they can be divided up into papers for publication in successive journal issues.

INCONSISTENCIES MUST BE AVOIDED. Be sure you are consistent in your use of abbreviations, terminology, and in citing references, from one part of your paper to another. Words should be underlined only when it is intended that they be typeset in italics.

If your paper is accepted by the editor contingent upon changes that are mandated by anonymous specialist referees and/or members of the editorial board and if the editor returns your manuscript for revisions, you are responsible for retyping any sections of the paper to incorporate these revisions (if applicable, revisions should also be put on disk).

Each manuscript must be accompanied by a statement that it has not been published elsewhere and that it has not been submitted simultaneously for publication elsewhere. Authors are responsible for obtaining permission to reproduce copyrighted material from other sources and are required to sign an agreement for the transfer of copyright to the publisher. All accepted manuscripts, artwork, and photographs become the property of the publisher.

Prior to publication, all accepted papers are edited for style and grammar by Taylor & Francis's copyeditors.

References

References should be presented in a separate section at the end of the document, in accordance with *AMA Manual of Style* (10th ed.) guidelines. The references should be listed and numbered based on the order of their first citation. Every reference should be assigned its own unique number. References should not be repeated in the list, with each mention given a different reference number, nor should multiple references be combined under a single reference number. Superscripted digits should be used for in-text citations Superscripted citations should only follow terminal punctuation (e.g., periods, commas, closed quotation marks, question marks, exclamation points). Reference numbers should not be subscripted.

Author listings in references should be formatted as indicated below.

1 author	Smith A.
2 to 6 authors	Smith A, Jones B, Smythe C, Jonesy D, Smitty E, Jonesi F.
7 or more authors	Smith A, Jones B, Smythe C, et al.

Models from US National Library of Medicine (NLM) resources (e.g., MEDLINE, Index Medicus)should be employed for abbreviating journal titles in the reference section. Examples of common reference types appear below.

Journal article	12. Taylor J, Ogilvie BC. A conceptual model of adaptation to retirement among athletes: a meta-analysis. *J Appl Sport Psychol.* 1994;6(1):1–20. doi:10.1080/10413209408406462.
Book	2. Duke JA. *Handbook of Phytochemical Constituents of GRAS Herbs and Other Economic Plants*. Boca Raton, FL: CRC Press; 2001.
Book with titled volume and edition	18. Bowlby J. *Loss: Sadness and Depression.*Vol. 3 of *Attachment and Loss.* 3rd ed. New York, NY: Basic Books; 1982.
Edited book chapter	34. Gordon S, Lavallee D. Career transitions in competitive sport. In: Morris T, Summers J, eds. *Sport Psychology: Theory, Applications and Issues*. 2nd ed. Brisbane, Australia: Wiley; 2004:584–610.
Edited book chapter with volume and edition	26. Remael A. Audiovisual translation. In: Gambier Y, van Dooslaer L, eds. *Handbook of Translation Studies*. Vol. 1. 2nd ed. Amsterdam, Netherlands: John Benjamins; 2012:12–17.
Online/Website	8. United States Census Bureau. American housing survey: 2013 detailed tables . United States Census Bureau Web site. http://www.census.gov/newsroom/press-releases/2014/cb14-tps78.html. Published October 16, 2014. Accessed October 21, 2014.
Dissertation/Thesis	26. Allison N. *Bacterial Degradation of Halogenated Aliphatic Acids* [dissertation]. Nottingham, UK: Trent Polytechnic; 1981.

Conference presentation	4. Alfermann D, Gross A. Coping with career termination: it all depends on freedom of choice. Paper presented at: 9th Annual World Congress on Sport Psychology; January 23, 1997; Netanya, Israel.
Paper/Report	55. Grigg W, Moran R, Kuang M. *National Indian Education Study*. Washington DC: National Center for Education Statistics; 2010. NCES publication 2010-462.
Newspaper	22. Protzman, F. Clamor in the East: East Berliners explore land long forbidden. *New York Times*. November 10, 1989:A1, A14.
Patent	67. Pfeifer A, Muhs A, Pihlgren M, Adolfsson O, Van Leuven F, inventors; AC Immune S.A, Katholieke Universiteit Leuven, assignees. Humanized tau antibody. US patent 9,657,091. May 23, 2017.
Computer software with developer	10. Noguera J, Cumby C. *SigmaXL* [computer software]. Version 8.0. Kitchener, Canada: SigmaXL, Inc; 2017.
Computer software without developer	76. *SPSS Amos* [computer software]. Version 22.0. Armonk, NY: IBM; 2013.

Illustrations

Illustrations submitted (line drawings, halftones, photos, photomicrographs, etc.) should be clean originals or digital files. Digital files are recommended for highest quality reproduction and should follow these guidelines:

- 300 dpi or higher
- sized to fit on journal page
- EPS, TIFF, or PSD format only
- submitted as separate files, not embedded in text files.

Color Reproduction

Color art will be reproduced in color in the online publication at no additional cost to the author. Color illustrations will also be considered for print publication; however, the author will be required to bear the full cost involved in color art reproduction. Please note that color reprints can only be ordered if print reproduction costs are paid. Print Rates: $900 for the first page of color; $450 per page for the next three pages of color. A custom quote will be provided for articles with more than four pages of color. Art not supplied at a minimum of 300 dpi will not be considered for print. Please ensure that color figures and images submitted for publication will render clearly in black & white conversion for print.

Tables and Figures

Tables and figures should not be embedded in the text, but should be included as separate files. A

short descriptive title should appear above each table with a clear legend and any footnotes suitably identified below. All units must be included. Figures should be completely labeled, taking into account necessary size reduction. Captions should be typed, double-spaced, in a separate file. In the text file, skip extra lines and indicate where these figures are placed. For final hardcopy submission, tables and figures should be on disk or CD-ROM accompanying your manuscript.

Proofs

Page proofs are sent to the designated author using Taylor & Francis' Central Article Tracking System (CATS). They must be carefully checked and returned within 48 hours of receipt.

Reprints and Issues

Authors for whom we receive a valid email address will be provided an opportunity to purchase reprints of individual articles, or copies of the complete print issue. These authors will also be given complimentary access to their final article on Taylor & Francis Online.

Open Access

Taylor & Francis Open Select provides authors or their research sponsors and funders with the option of paying a publishing fee and thereby making an article permanently available for free online access – *open access* – immediately on publication to anyone, anywhere, at any time. This option is made available once an article has been accepted in peer review. Full details of our Open Access program

Taylor & Francis Statement on Ethics

We expect all authors submitting to a Taylor & Francis journal to adhere to the following ethical guidelines:

- All authors must warrant that their article is their own original work, which does not infringe the intellectual property rights of any other person or entity, and cannot be construed as plagiarizing any other published work, including their own previously published work.
- All authors named on the paper are equally held accountable for the content of a submitted manuscript or published paper.
- The corresponding author must ensure all named co-authors consent to publication and to being named as a co-author. All persons who have made significant scientific or literary contributions to the work reported should be named as co-authors.
- Authors must not submit a manuscript to more than one journal simultaneously.
- Authors should not submit previously published work, nor work which is based in substance on previously published work, either in part or whole.
- Authors must appropriately cite all relevant publications. Information obtained privately, as in conversation, correspondence, or discussion with third parties, should not be used or reported in the author's work unless fully cited, and with the permission of that third party.

- Authors must make available all necessary formal and documented ethical approval from an appropriate research ethics committee, including evidence of anonymization and informed consent from the client(s) or patient(s) studied, if appropriate.

- Authors must follow national and international procedures that govern the ethics of experimentation on humans and animals. Research reported in the paper must be conducted in an ethical and responsible manner, in full compliance with all relevant codes of experimentation and legislation. All papers which report in vivo experiments or clinical trials on humans or animals must include a written statement in the Methods section that such work was conducted with the formal approval of the local human subject or animal care committees, and that clinical trials have been registered as legislation requires.

- Authors must include all appropriate warnings concerning any specific and particular hazards that may be involved in carrying out experiments or procedures described in the article or involved in instructions, materials, or formulae in the article; include explicitly relevant safety precautions, and cite, if an accepted standard or code of practice is relevant, a reference to the relevant standard or code.

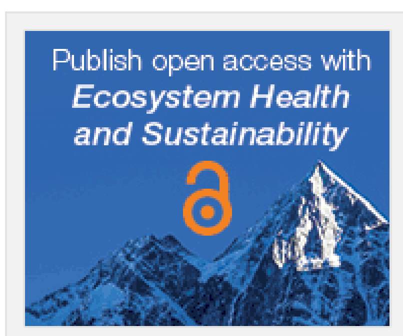
- If required, authors must facilitate access to data sets described in the article.

- Authors must avoid making defamatory statements in submitted articles which could be construed as impugning any person's reputation.

- Authors must declare any potential conflict of interest – be it professional or financial – which could be held to arise with respect to the article.

- Authors must disclose all sources of funding for the research reported in the paper.

- If asked to provide a list of suggested reviewers, authors must provide the correct details for suitable reviewers with the appropriate experience to review, ensuring that the suggested reviewers do not have a conflict of interest.



Browse journals by subject

Back to top

- Area Studies
- Arts
- Behavioral Sciences
- Bioscience
- Built Environment
- Communication Studies
- Computer Science
- Development Studies
- Earth Sciences
- Economics, Finance, Business & Industry
- Education
- Engineering & Technology
- Environment & Agriculture
- Environment and Sustainability
- Food Science & Technology
- Geography
- Health and Social Care
- Humanities
- Information Science
- Language & Literature
- Law
- Mathematics & Statistics

- Medicine, Dentistry, Nursing & Allied Health
- Museum and Heritage Studies
- Physical Sciences
- Politics & International Relations
- Social Sciences
- Sports and Leisure
- Tourism, Hospitality and Events
- Urban Studies

Information for

- Authors
- Editors
- Librarians
- Societies

Open access

- Overview
- Open journals
- Open Select
- Cogent OA

Help and info

- Help
- FAQs
- Press releases
- Contact us
- Commercial services

Connect with Taylor & Francis

Copyright © 2017 Informa UK Limited Privacy policy & cookies Terms & conditions Accessibility

Registered in England & Wales No. 3099067
5 Howick Place | London | SW1P 1WG

Addendum 4: Ethics PhD study

Private Bag X6001, Potchefstroom
South Africa 2520

Tel: 018 299-1111/2222
Web: http://www.nwu.ac.za

Faculty of Health Sciences
Tel: 018-299 2092
Fax: 018-299 2088
Email: Minrie.Greeff@nwu.ac.za

6 May 2015

Dr N Covic
Nutrition

Dear Dr Covic

APPROVAL LETTER:

ETHICS APPLICATION: NWU-00206-14-S1 (N COVIC-S KASIMBA) "BOTSWANA UTILIZATION OF INDIGENOUS FOODS AND POTENTIAL CONTRIBUTION TO NUTRIENT INTAKE AND LIVELIHOODS"

Thank you for amending your application. All ethical concerns have now been addressed and ethical approval is granted until 30/12/2017.

Please note that any changes to the approved application must be submitted to the Health Research Ethics Committee for approval before implementation.

Yours sincerely

Prof Minrie Greeff
HREC Chairperson

Current details: (13210572) C:\Users\13210572\Documents\HREC\HREC - Applications\2014 HREC Applications\Applications 11 - November 2014\NWU-00206-14-S1 (N Covic-S Kasimba)\NWU-00206-14-S1 (N Covic-S Kasimba) - Approval letter\NWU-00206-14-S1 (N Covic-S Kasimba) - Approval letter docm
6 May 2015

File reference: 9.1.5.3

Ethics PhD study Ministry of Health Botswana

TELEPHONE: 363 2766
FAX: 391 0647
TELEGRAMS: RABONGAKA
TELEX: 2818 CARE BD

Republic of Botswana

MINISTRY OF HEALTH
PRIVATE BAG 0038
GABORONE

REFERENCE NO: HPDME 13/18/1 IX (525) **07 September 2015**

Health Research and Development Division

Notification of IRB Review: New application

Dr. Namukolo Covic
North-West University
Faculty of Health Sciences
Private Bag X6001
Potchefstroom
2522

Protocol Title: **UTILIZATION OF INDIGENOUS FOODS AND POTENTIAL CONTRIBUTION TO NUTRIENT INTAKE AND LIVELIHOODS IN BOTSWANA**

HRU Approval Date:	07 September 2015
HRU Expiration Date:	06 September 2016
HRU Review Type:	HRU reviewed
HRU Review Determination:	Approved
Risk Determination:	Minimal risk

Dear Sir/Madam

Thank you for submitting new application for the above referenced protocol. The permission is granted to conduct the study.

This permit does not however give you authority to collect data from the selected sites without prior approval from the management. Consent from the identified individuals should be obtained at all times.

The research should be conducted as outlined in the approved proposal. Any changes to the approved proposal must be submitted to the Health Research and Development Division in the Ministry of Health for consideration and approval.

Furthermore, you are requested to submit at least one hardcopy and an electronic copy of the report to the Health Research, Ministry of Health within 3 months of completion of the study. Approval is for academic fulfillment only. Copies should also be submitted to all other relevant authorities.

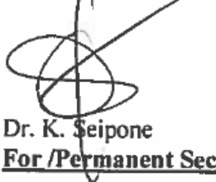
Continuing Review
In order to continue work on this study (including data analysis) beyond the expiry date, submit a Continuing Review Form for Approval at least three (3) months prior to the protocol's expiration date. The Continuing Review Form can be obtained from the Health Research Division Office (HRDD), Office No. 7A.7 or Ministry of Health website: www.moh.gov.bw or can be requested via e-mail from Mr. Kgomotso Motlhanka, e-mail address: kgmmotlhanka@gov.bw As a courtesy, the HRDD will send you a reminder email about eight (8) weeks before the lapse date, but failure to receive it does not affect your responsibility to submit a timely Continuing Report form

Amendments
During the approval period, if you propose any change to the protocol such as its funding source, recruiting materials, or consent documents, you must seek HRDC approval before implementing it. Please summarize the proposed change and the rationale for it in the amendment form available from the Health Research Division Office (HRDD), Office No. 7A 7 or Ministry of Health website: www.moh.gov.bw or can be requested via e- mail from Mr. Kgomotso Motlhanka, e-mail address: kgmotlhanka@gov.bw . In addition submit three copies of an updated version of your original protocol application showing all proposed changes in bold or "track changes".

Reporting
Other events which must be reported promptly in writing to the HRDC include:
- Suspension or termination of the protocol by you or the grantor
- Unexpected problems involving risk to subjects or others
- Adverse events, including unanticipated or anticipated but severe physical harm to subjects.

If you have any questions please do not hesitate to contact Mr. P. Khulumani at pkhulumani@gov.bw, Tel +267-3914467 or Lemphi Moremi at lamoremi@gov.bw or Tel: +267-3632754. Thank you for your cooperation and your commitment to the protection of human subjects in research.

Yours faithfully



Dr. K. Seipone
For /Permanent Secretary

Vision: *Model of Excellence in Quality Health Services*
Values: *Botho, Equity, Timeliness, Customer Focus, Teamwork, Accountability*

Addendum 5: Editors certificate

33 Little Gables
Duzi Street
Little Falls
Roodepoort
1726

05 August 2017

To whom it may concern

RE: Utilisation of traditional and indigenous foods and their potential contribution to consumers' nutrition and vendors' income in Botswana

This serves to confirm that I undertook the editing of the main body of the above-mentioned thesis on behalf of SN Kasimba. This excluded checking references and List of Addenda. I gave her firm changes, which she applied as well as recommendations to improve readability.

Should you have any queries, please contact me on 083 442 7715

Kind regards

Elizabeth Sibanda
083 442 7715

Addendum 6: TIF foods substituted with other foods from the MRC FoodFinder

TIF foods substituted with other foods in the MRC FoodFinder

TIF Food item		
Name in Setswana	**Name in English**	**Food substituted with**
Mogorogorwane	Wild orange	Oranges
Morogo wa dinawa	Beans leaves	Pumpkin leaves
Seswaa	Pounded beef	Minced meat
Morogo wa ditonki	Wild amaranth	Amaranth leaves
Nama ya tonki	Donkey meat	Beef meat
Tswii	Wild potato	Potatoes
Mowana	Baobab fruit	Oranges
Rothwe	Spider plant leaves	Pumpkin leaves
Lerotse	Wild melon	Water melon
Moretlwa	Wild raisins	Raisins
	Impala meat	Goat meat
	Kukama	Goat meat

Addendum 7: list of traditional and indigenous foods (TIF) and non-TIF

Indigenous foods and dishes	
Setswana name	**English or Scientific name**
Bogobe jwa mabele	Sorghum meal stiff porridge
Mosulthwane	Dehulled sorghum grains
Bogobe jwa lerotse	Sorghum and melon meal
Thepe	Amaranth leaves
Rothwe	Spider plant leaves
Lerotse	Wild water melon
Seswaa	Pounded beef
Mae a ntshe	Ostrich eggs
Mae a kgaka	Guinea fowl eggs
Morogo wa dinawa	Bean leaves
Tswii	Sweet potato from water lily plant
Mahupu	Truffles
Leruswa	Wild potatoes
Morogo wa ditonki	Wild amaranthus
Delele	Okra
Morogo wa lepushe	Pumpkin leaves
Dithotse tsa lephutshe	Pumpkin seeds
Ntšhê	Sweet reed
Mowana	Baobab fruit
Mowana yoghurt	Baobab yogurt
Lekwesha	Wild pumpkin
Morula	Sclerocarya birrea
Motoroko	Prickly pears
Morojwa	African chewing gum
Mmilo	Wild meddler
Moretologa	Monkey orange
Moretlwa	Wild raisin berry
Motsotsojane	Grewia flavescens Juss
Mogorogorwane	Strychnos cocculoides
Mokongwa,	Ricinodendron rautanenji
Motsiara	Terminalia prurioides,
Motsotsojane	Grewia flavescenes
Mokoyo	Ficus abutilifolia
Mogwagwa	Strychnos madagarscariensis
Moretologa	Ximenia Americana
Mowana	Adansonia digitata
Mochaba	Ficus sycomorus
Motlopi coffee	Shepherds tree coffee
Motsiara tea	Terminalia prunioides
Morupaphiri	Rhus tenuinervis
Mmilo juice	Wild medlar juice
Moretlwa	Grewia flava
Mokgomphata	Grewia flavescens
Mokgalo	Ziziphus mucronata
Mmupudu	Vangueriopsis lanciflora (Hiern.)
Dicheru	Morula nut
Mohanana	(unidentified)

Monaba	(unidentified)
Motatane	(unidentified)
Maphoko	(unidentified)
Lerophela	(unidentified)
kganyane,	(unidentified)
Tuane	(unidentified)
Mokgotlthane	(unidentified)
Morara	(unidentified)
Manthofi	(unidentified)
Morara	(unidentified)
Mokabi	(unidentified)
Wild birds	
Game meat	
Traditional foods and dishes	
Paleche	Maize meal stiff porridge
Magunya	Deep fried flour dough,
Mmidi	Maize on the cob
Samp	Dehulled corn
Dikgobe	Dehulled corn with beans
Dikgobe tsa lechotlho	Beans with dried fresh maize
Phaphata	Roasted bread
Lebelebele	Millet porridge
Dipotata	Sweet potatoes
Red peas	Red peas
Kabu	Dried boiled maize
Black eye beans	Black eye beans
Serobe	Tripe
Ditloo	White Bambara groundnuts
Manoko	Peanuts
Dinawa tsa Setswana	Setswana beans
Letlhodi	Lentils
Dobi	Sorghum porridge with milk
Dikgobe tsa lechotlho	Beans with dried fresh maize
Dithotse tsa lerotse	Pumpkin seeds
Mashi	Whole milk
Madila	Fermented milk
Masi ya pudi	Goat milk
Masi ya tonki	Donkey milk
Koko	Traditional chicken meat
Mae a koko	Traditional chicken eggs
Nama ya Kgomo	Beef meat
Nama ya podi	Goat meat
Paraga	Fish species
Lerotse	Water melon
Makatane	Wild melon
Ogondivi	Fat from the neck of cow
Lebebe	Cow’s milk cream fat
Dikgadika	Fat from sheep
Lemepe	Honey from bees
Bojalwa jwa mabele	Traditional beer
Legalalatshwene	Herbal tea

Bojalwa jwa morula	Morula beer
Gemmere	Ginger drink
	Tomatoes
	Mutton meat
	Bream fish
Non- TIF	
Malutu	Fortified a fortified pre-cooked sorghum soya meal
Tsabana	fortified extruded sorghum-soy meal
Coarsely crushed corn kernels	Meal rice
	White bread
	Brown bread
	Pasta
	Breakfast cereals
	Potatoes
	Baked beans
	Tuna fish
	Texturized vegetable protein e.g. soy chunks
	Sugar beans
	Evaporated milk
	Skimmed milk
	Powdered milk
	Condensed milk
	Soy milk
	Cheese
	Ice cream
	Yorghurt
	Cream cheese
	Minced meat
	Corned beef
	Processed meats such as sausage, vienna, polony etc.
	Canned fish
	Salted fish
	Carrots
	Spinach
	Rape
	Chomolia
	Broccoli
	Cauli flower
	Lettuce
	Cucumber
	Pepper
	Cabbage
	Beet root
	Orange grape fruit
	Pawpaw
	Mango
	Banana
	Apple
	Peach
	Pear

	Lemon
	Kiwi fruit
	Strawberry
	Pineapple
	Guava
	Butter
	Salad dressing mayonnaise
	Cheese snacks
	Margarine
	Sweets
	Sugar
	Soda or sweetened beverages
	Fruit juices
	Cookies
	Biscuits
	Cakes
	Sugarcane
	Beer
	Whisky
	Wine
	Coffee
	Tea
	Chocolate

Addendum 8: Study questionnaires

Demographic Socioeconomic Questionnaire

Household code---------------------------Setting------------------Location------------

Household plot number --------------Name of interviewer ----------- Date of interview------------

Respondent Name---------------Respondent Tel number...............

1. Marital status of respondent (Tick one):

1	2	3	4	5	6	7
Single	Married	Divorced	Separated	Widowed	Cohabitation	Other Please Specify

2. Education level of respondent

1	2	3	4	5	6
None	Primary School	Junior school	Senior secondary	Tertiary Education	Don't know

3. Gender of Head of Household ☐ M ☐ F

4. Occupation of household head....................

5. Number of people you are staying with in the same household.................

6. Household income per month (including wages, rent, sales of vegs, etc. State grants) *(Tick one only)*	1	2	3	4	5	6	7	8
	None	< P600	P600 – 1500	P1501-3000	P3001-6000	P6001-9000	>P900 0	Don't know

7. How much money is spent on food weekly? *(Tick one only)*	1	2	3	4	5	6	7	8	9	10
	P0- P50	P50- P100	P100 - P150	P150 - P200	P200 - P250	P250 - P300	P300 - P350	P350 - P400	Over P400	Don't know

8. Where do you get drinking	1	2	3	4	5

water most of the time? (*Tick one*)	Own Tap	Communal Tap	River, Dam	Borehole, Well	Other: Specify
9. What type of toilet does this household have? (*Tick one*)	1	2	3	4	5
	Flush	Pit	Bucket, Pot	Ventilated Improved Pit latrine (VIP)	Other (Specify)

10. What fuel is used for cooking most of the time? (*You can tick more than one*)	1	2	3	4	5	6
	Electric	Gas	Paraffin	Wood/ Coal	Sun	Open Fire

Tick one block only for every question	Self	Spouse	Father	Mother	Sibling	Aunt	Uncle	Cousin	Friend	Other
	1	2	3	4	5	6	7	8	9	10
11. Who is mainly responsible for food preparation in the house										
12. Who decides on what types of food are bought for the household?										
13. Who decides how much is spent on food?										

Household and Dietary Diversity Questionnaire

Respondent (Person responsible for food preparation)

Please describe the foods (meals and snacks) that were prepared at home and eaten or drank from home or carried and eaten away from home yesterday by any household member during the day and night. Include also foods that were purchased and eaten at home by any house hold member. Start with the first food or drink in the morning

Time	Dish	Ingredient	Source for obtaining food 1=Purchase 2=Domesticate 3=Cultivate 4=Wild 5=Borrowed 6=Other specify	Source 1=Plant 21)animal insect 22)animal non insect	Type I=Indigenous 2=Traditional 3=Non-TIF
Breakfast			1 2 3 4 5 6	1 21 22	1 2 3
			1 2 3 4 5 6	1 21 22	1 2 3
			1 2 3 4 5 6	1 21 22	1 2 3
			1 2 3 4 5 6	1 21 22	1 2 3
			1 2 3 4 5 6	1 21 22	1 2 3
			1 2 3 4 5 6	1 21 22	1 2 3
Snack			1 2 3 4 5 6	1 21 22	1 2 3
			1 2 3 4 5 6	1 21 22	1 2 3
			1 2 3 4 5 6	1 21 22	1 2 3
			1 2 3 4 5 6	1 21 22	1 2 3
Lunch			1 2 3 4 5 6	1 21 22	1 2 3
			1 2 3 4 5 6	1 21 22	1 2 3
			1 2 3 4 5 6	1 21 22	1 2 3

			1 2 3 4 5 6	1 21 22	1 2 3
			1 2 3 4 5 6	1 21 22	1 2 3
Snack			1 2 3 4 5 6	1 21 22	1 2 3
			1 2 3 4 5 6	1 21 22	1 2 3
			1 2 3 4 5 6	1 21 22	1 2 3
Dinner			1 2 3 4 5 6	1 21 22	1 2 3
			1 2 3 4 5 6	1 21 22	1 2 3
			1 2 3 4 5 6	1 21 22	1 2 3
			1 2 3 4 5 6	1 21 22	1 2 3
Snack			1 2 3 4 5 6	1 21 22	1 2 3
			1 2 3 4 5 6	1 21 22	1 2 3
			1 2 3 4 5 6	1 21 22	1 2 3
			1 2 3 4 5 6	1 21 22	1 2 3
% of indigenous food exposure(indi+tra					

FAO adapted Household and Dietary Diversity Questionnaire.

Question number	Food group	Examples	Yes (1)	No (2)
1	Cereals	Corn/maize, rice, wheat, sorghum, millet or any other grains or foods made from these (e.g. bread, noodles, porridge or other grain products) e.g. other locally available grains............................		
2	White tubers and roots	White potatoes, white yams, white cassava, or other foods made from roots including local foods......................		
3	Vegetables	Vitamin A rich vegetables and tubers(pumpkin, carrots, squash, or sweet potatoes that are orange inside + other locally available vitamin A rich vegetables (e.g. red sweet pepper) including wild ones + locally available vitamin A rich leaves such as amaranth, cassava leaves, kale,		

		spinach etc. other vegetables (e.g. tomato, onion, eggplant), including wild vegetables		
4	Fruits	Vitamin A rich fruits dark yellow or orange (ripe mangoes, cantaloupe, apricots (fresh or dried), ripe papaya, dried peaches, passion fruits + other locally available vitamin A rich, other fruits, bananas, avocado, baobab pulp apple, black berry black currant, lemon etc including wild fruits		
5	Meat	liver, kidney, heart or other organ meats or blood-based foods. Also beef, pork, lamb, goat, rabbit, wild game, chicken, duck, or other birds		
6	Eggs	chicken, duck, guinea fowl or any other egg		
7	Fish and other seafood	fresh or dried fish or shellfish		
8	Legumes, nuts and seeds	Beans, peas, lentils, nuts, seeds or foods made from these		
9	Milk and milk products	Milk, cheese, yogurt or other milk products		
10	Oils and fats	Oil, fats or butter added to food or used for cooking		
11	Sweets	Sugar, honey, sweetened, soda, sweetened juice or sugary foods such as chocolates, candies, cookies and cakes		
12	Spices, condiments and beverages	Spices (black pepper, salt) condiments (soy sauce, hot sauce), coffee, tea, alcoholic beverages or local examples		

Household Food Insecurity Access Scale (HFIAS) Questionnaire

Respondent (Person responsible for food preparation)

We would like to ask you questions to describe the behaviours and altitudes regarding food insecurity in your household for the past 30 days. Please can you provide us with the following information?

No	Question	Response options	Code
1.	In the past four weeks, did you worry that your household would not have enough food	0 = No (skip to Q2) 1=Yes	….|___|
1.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	….|___|
2.	In the past four weeks, were you or any household member not able to eat the kinds of foods you preferred because of lack of resources?	0 = No (skip to Q3) 1=Yes	….|___|
2.a	How often did this happen	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten	….|___|

		times in the past four weeks)	
3.	In the past four weeks, did you or any household member have to eat a limited variety of foods due to a lack of resources?	0 = No (skip to Q4) 1 = Yes	….|___|
3.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	….|___|
4.	In the past four weeks, did you or any household member have to eat some foods that you really did not want to eat because of a lack of resources to obtain other types of food?	0 = No (skip to Q5) 1 = Yes	….|___|
4.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	….|___|
5.	In the past four weeks, did you or any household	0 = No (skip to Q6) 1 = Yes	….|___|

	member have to eat a smaller meal than you felt you needed because there was not enough food?		
5.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	….|___|
6.	In the past four weeks, did you or any other household member have to eat fewer meals in a day because there was not enough food?	0 = No (skip to Q7) 1 = Yes	….|___|
6.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	….|___|
7.	In the past four weeks, was there ever no food to eat of any kind in your household because of lack of resources to get food?	0 = No (skip to Q8) 1 = Yes	….|___|
7.a	How often did this happen?	1 = Rarely (once or twice in the past four	….|___|

		weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	
8.	In the past four weeks, did you or any household member go to sleep at night hungry because there was not enough food?	0 = No (skip to Q9) 1 = Yes	….|___|
8.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	….|___|
9.	In the past four weeks, did you or any household member go a whole day and night without eating anything because there was not enough food?	0 = No (questionnaire is finished) 1 = Yes	….|___|
9.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten	….|___|

		times in the past four weeks)	

The HFIAS score for each household will be calculated by summing the codes for each frequency-of-occurrence question. The maximum score for a household will be 27 (That is if the household response to all nine frequency-of-occurrence questions was often coded with response code of 3) and the minimum score will be 0 (That is if the household responded no to all occurrence questions). The HFIAS Score (0-27) will be the sum frequency-of-occurrence question response code (Q1a + Q2a + Q3a + Q4a + Q5a + Q6a + Q7a + Q8a +Q9a).

A 30 day quantitative food frequency questionnaire

I will now ask you questions about all the foods that you ate in the past 30 days. Please tell me if you consumed them, their amounts and frequency of the consumption. Let us start with cereals. One adult woman of reproductive age 18-49 years and all children 2-5 years in the household

Food Frequency Questionnaire											
Think about your recent eating habits and how often you eat each of the following foods											
Cereals	Almost never	Once/mth	2-3/mth	Once/wk	2-4/wk	5-6/wk	Once /day	2+/day	Portion size in a day	Source 1-Indigenous 2-traditional 3-Non-TIF	Preparation method
White bread (loaf)										3	
Brown bread										3	
Phaphatha										2	
Fat cakes										2	
Madombi										3	
Rice (Refgrain) (white/brown										3	
Pasta- white or brown										3	

Sorghum meal										1	
Mabele/ lesasaoka										2	
Mosutlhwane										1	
Malutu										3	
Tsabana										3	
Mmidi (maize on the cob)										2	
Samp										2	
Mealie rice										3	
Lechotlho										2	
Mageu										2	
Mealie meal										2	
Dikgobe/Lehata										2	
Breakfast cereals (cornflakes, oat meal, wheat porridge etc)										3	
Lebelebele										2	
Bogobe jwa lerotse										1	
White tubers and	Almost	Once/mth	2-	Once/wk	2-	5-	Once	2+/da	Portio	source	

roots	never		3/mth		4/wk	6/wk	/day	y	n size		
Baked, boiled, fried or mashed potato										3	
Sweet potato										2	
Lerophela										1	
Leruswa										1	
Modi wa motopi										1	
Others											
legumes nuts and seeds	Almost never	Once/mth	2-3/mth	Once/wk	2-4/wk	5-6/wk	Once /day	2+/da y	Portio n size	source	
Red peas										2	
Baked beans										3	
Black eye beans										2	
Tswana beans										2	
Bambara nuts ditloo										2	
Peanuts (manoko										2	
Green beans										3	
Texturized vegetable protein (soy mince/chunks)										3	
Green peas										3	

Letlhodi										2	
Sugar beans										3	
Dithotse tsa lerotse										2	
Milk and Milk products	Almost never	Once/mth	2-3/mth	Once/wk	2-4/wk	5-6/wk	Once /day	2+/day	Portion size	source	
Whole milk										2	
Evaporated milk										3	
Skimmed milk										3	
Powdered milk										3	
Condensed milk										3	
Soya milk										3	
Madila/ Mayere										2	
Cheese										3	
Ice cream										3	
Yoghurt										3	
Cream cheese										3	
Masi a ngomo/pudi/nku										2	
Mowana										1	
Meat (organ meat and flesh meat)	Almost never	Once/mth	2-3/mth	Once/wk	2-4/wk	5-6/wk	Once /day	2+/day	Portion size	source	

Chicken without skin										2	
Chicken with skin										2	
Beef										2	
Mutton(lamb)										2	
Nama ya podi (goat)										2	
Pork										2	
Mince meat										3	
Serobe										1	
Seswaa										1	
Liver(ox, chicken, goat)										2	
Kidney										2	
Gizzards										2	
Corned beef										3	
Processed meats e.g. sausage, corned beef, poony, vienna										3	
Others (birds, game meat, lizards, insects											

Birds										1	
Game meat											
Insects										1	
Eggs	Almost never	Once/mth	2-3/mth	Once/wk	2-4/wk	5-6/wk	Once /day	2+/da y	Portio n size	source	
Mae a koko										1	
Mae a kgaka										1	
Lee la mptshe										1	
OTHER											
Fish and other sea food	Almost never	Once/mth	2-3/mth	Once/wk	2-4/wk	5-6/wk	Once /day	2+/da y	Portio n size	source	
Canned fish (sardines)										3	
Salted fish										3	
Tuna fish										2	
Bream										2	
Paraga										2	
Other types of fish											
Vegetables	Almost never	Once/mth	2-3/mth	Once/wk	2-4/wk	5-6/wk	Once /day	2+/da y	Portio n size	source	

Tomato										2	
Carrot										3	
Pumpkin/ butternut										2	
Maraka/makgomane										2	
Lerotse										2	
Spinach										3	
Rape										3	
Chomolia										3	
Morogo wa dinawa										1	
Broccoli										3	
Cauliflower										3	
Lettuce										3	
Cucumber										3	
Avocado										3	
Pepper(Green/red/yell ow										3	
Mushroom										3	
Cabbage										3	
Tswii										1	
Thepe										1	

Rothwe										1	
Morogowaditonki										1	
Setlepetlepe										1	
Morogowalephushe										2	
Ledelele										1	
Nxuma										1	
OTHER VEGETABLES											
Onion										2	
Beetroot										3	
Fruits	Almost never	Once/mth	2-3/mth	Once/wk	2-4/wk	5-6/wk	Once /day	2+/day	Portion size	source	
Orange										3	
Grapefruit										3	
Pawpaw										3	
Mango										3	
Banana										3	
Apple										3	
Peach										3	
Pears										3	
Watermelon										2	

Grapes										3	
Morula										1	
Lemon										3	
Motoroko										1	
Kiwi										3	
Strawberry										3	
Mabele adinonyane										1	
Guava										3	
Pineapple										3	
Morojwa										1	
Mmilo										1	
Moretlwa										1	
Mogwana										1	
Mogwagwa										1	
Mokgomphatha										1	
Mowana										1	
Mogorogorwane										1	
Monkgatau										1	
Ntshatsha										1	
Mokongwa										1	

Mokgalo										1	
Motlopi										1	
Motsiara										1	
Motsotsoojane										1	
Mopipi										1	
Motsentsela										1	
Sekhura										1	
Monapa										1	
Magwolwane										1	
Mmilo										1	
Ditsheru										1	
Mokoyo										1	
Kganyane										1	
Tuane										1	
Mokgotlhwane										1	
Manthofi										1	
Morara										1	
Motlhakola										1	
Mokabi										1	
Legalalatswene										1	

Mmopudu										1	
Moruda										1	
Motatane										1	
Maphoko										1	
Monaba										1	
Mongongo										1	
Tsaudi										1	
Mohanana										1	
Mochaba										1	
Other Fruits											
Oils and fats	Almost never	Once/mth	2-3/mth	Once/wk	2-4/wk	5-6/wk	Once /day	2+/day	Portion size	source	
Butter										3	
Salad dressing										3	
Mayonnaise										3	
Cheese snacks										3	

Margarine										3	
Ogondivi										2	
Lobebe										2	
Kgomo/pudi/nku										2	
Others											
Sweets	Almost never	Once/mth	2-3/mth	Once/wk	2-4/wk	5-6/wk	Once /day	2+/day	Portion size	Source	
Sweets/candy										3	
Sugar (e.g. added to tea)										3	
Soda or sweetened beverages										3	
Diet sodas										3	
Fruit juices										3	
Fruit drinks										3	
Cookies/biscuits										3	
Cakes										3	
Lemepe										2	
Mooka										1	
Ntshe										2	
Sugarcane										3	

Boreku										1	
Others											
spices, condiments and Beverage	Almost never	Once/mth	2-3/mth	Once/wk	2-4/wk	5-6/wk	Once /day	2+/day	Portion size	source	
Beer										3	
Rum/Whiskey/Gin										3	
Wine										3	
Coffee										3	
Tea(five roses)										3	
Herbal Tea (Rooibos)										3	
Chocolate drink										3	
Bojalwa jwa mabele										2	
Bojalwa jwa morula										2	
Lekewesha (finger millet bojalwa)										2	
Bojalwa jwa madila										2	
Motlopi juice										1	
Motlopi coffee										1	
Motsiara tea										1	

Khadi										1	
Mmilo juice										1	
Mosakajwane										1	
Others											
Gemmere										2	

Women anthropometric assessment Form

One Non pregnant women (18-49)

Name	Code	Date of birth	Weight in Kilograms				Height in centimetres			
			First reading	Second reading	Third reading	Average	First reading	Second reading	Third reading	Average

Vendors' structured questionnaire

Demographic socioeconomic questionnaire

Household code---------------------------Setting------------------Location------------

Household plot number ---------------Name of interviewer ------------ Date of interview-------------

Respondent Name----------------Respondent Tel number...............

1. Marital status of respondent (Tick one):

1	2	3	4	5	6
Single	Married	Divorced	Separated	Widowed	Other Please Specify

2. Education level of respondent

1	2	3	4	5	6
None	Primary School	Junior school	Senior secondary	Tertiary Education	Don't know

3. Gender of Head of Household ☐ M ☐ F

4. Occupation of household head.....................

5. Number of people you are staying with in the same household..................

6. What types of TIF are you involved in selling? To be filled in the table below

Specific foods	Where do you get them from? 1=Purchase 2=Domesticate 3=Cultivate 4=Wild 5=Borrowed 6=Other specify	plant or animal source 1 = Animal 2= Plant	Primary source 1=Domesticate 2=Cultivate 3=Wild	Which food sells most	Why do you think it sells most?
	1 2 3 4 5 6	1 2	1 2 3		
	1 2 3 4 5 6	1 2	1 2 3		
	1 2 3 4 5 6	1 2	1 2 3		
	1 2 3 4 5 6	1 2	1 2 3		
	1 2 3 4 5 6	1 2	1 2 3		
	1 2 3 4 5 6	1 2	1 2 3		
	1 2 3 4 5 6	1 2	1 2 3		
	1 2 3 4 5 6	1 2	1 2 3		
	1 2 3 4 5 6	1 2	1 2 3		

7. How much money do you earn in a month from selling these indigenous and traditional foods?

8. Household income per month (including wages, rent, sales of vegs, etc. State grants) *(Tick one only)*	1	2	3	4	5	6	7	8
	None	< P600	P600 – 1500	P1501-3000	P3001-6000	P6001-9000	>P9000	Don't know

9. What is the value (in terms of money) for TIF foods that you do use in the household weekly? *(Tick one only)*	1	2	3	4	5	6	7	8	9	10
	P0- P50	P50- P100	P100- P150	P150- P200	P200- P250	P250- P300	P300- P350	P350- P400	Over P400	Don't know

Question	1	2	3	4	5	6
10. Type of dwelling: (*You can tick more than one block if necessary*)	Brick, Concrete	Traditional mud	Tin	Plank, Wood	Other, specify	
11. Number of rooms in house (excluding bathroom, toilet and kitchen, if separate):						
12 Number of people per living/sleeping room (*Tick one*)	0-2 persons	3-4 persons	More than 4			
13. Where do you get drinking water most of the time? (*Tick one*)	Own Tap	Communal Tap	River, Dam	Borehole, Well	Other: Specify	
14. What type of toilet does your household have? (*Tick one*)	Flush	Pit	Bucket, Pot	Ventilated Improved Pit latrine (VIP)	Other (Specify)	
15. What fuel is used for cooking most of the time? (*You can tick more than one*)	Electric	Gas	Paraffin	Wood/ Coal	Sun	Open Fire

FGD guides for household survey and vendors cross sectional study

A (SURVEY)

Interviewer name ………… Date of interview ………….. Setting ……………………

Location ……….. Focus group code ………. length of interview……………..

I am____________ from National Food Technology Research Centre (NFTRC) Botswana a researcher working together with the North-West University to collect information on utilisation of traditional and indigenous foods and potential contribution to consumers' nutrition and vendors' income in Botswana. The aim of the project is to contribute valuable knowledge on the extent of use of TIF at household level in Botswana and the related contribution to household income and livelihoods both in urban and rural settings. We would like to hear your views about the TIF that are available in this area. We welcome all your views as there are no wrong or right answers. During the discussion session we will do audio recording to ensure that all views are captured correctly.

Anyone with a comment or question?

QUESTIONS

Let us talk about what you consider to be TIF in this area

What are the different types of TIF that are there?

Are the TIF used to the same extent throughout the year or month?

Can we discuss the different uses of these foods?

Let us talk about where you find these foods in the area.

What influences the use of these TIF in the area?

Thank you very much for your participation!

B (VENDORS)

Interviewer name ……….. Date of interview……………………

Focus group code …………… length of interview ………………………..

I am_____________from National Food Technology Research Centre (NFTRC) Botswana a researcher working together with the North-West University to collect information on utilisation of traditional and indigenous foods and potential contribution to consumers' nutrition and vendors' income in Botswana. The aim of the project is to contribute valuable knowledge on the extent of use of TIF at household level in Botswana and the related contribution to household income and livelihoods both in urban and rural settings. We would like to hear your views about the TIF that are available in this area and your experiences of selling TIF. We welcome all your views as there are no wrong or right answers. During the discussion session we will do audio recording to ensure that all views are captured correctly.

Anyone with a comment or question?

QUESTIONS

Let us talk about what you consider to be TIF in this area

What are the different types of TIF that are there?

Now let us talk about them in relation to income generation

Have you seen any changes in demand of these TIF?

Which TIF sell most and why do you think so?

Can we discuss where the foods that you sell come from and where you get them from?

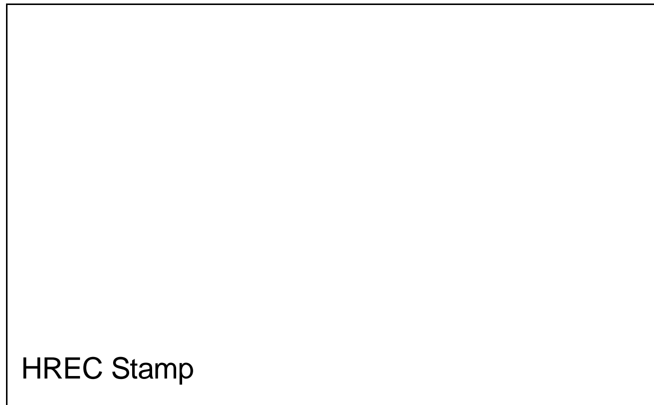
What is your view on the contribution of the foods to the income of your household?

How does the income you get from selling TIF compare to the income you get from other income generating activities you may be involved in?

Thank you very much for your participation!

Addendum 9: Consent forms

Consent forms for household survey and vendors' cross-sectional study



Participant information leaflet and consent form: for household survey and vendors cross-sectional questionnaires (HDDQ, HFIAS, vendors' structured questionnaire, and demographic socioeconomic questionnaire)

TITLE OF PROJECT:Utilisation of traditional and indigenous foods and potential contribution to consumers' nutrition and vendors' income in Botswana.

REFERENCE NUMBERS: NWU-00206-14-S1

PRINCIPAL INVESTIGATOR: Dr Namukolo Covic

ADDRESS:

North-West University

Faculty of Health Sciences

Private Bag X6001

Potchefstroom

2522

CONTACT NUMBER: Co- Principal Investigator- Dr Motswagole (72101198)

You are being invited to take part in a research project to gather information on use of indigenous foods in Botswana. Some of the information gathered will be used to train Post graduate students at North-West University. Please take some time to read the information presented here, which will explain the details of this project. Please ask the researcher any

questions about any part of this project that you do not fully understand. It is very important that you are fully satisfied that you clearly understand what this research entails and how you could be involved. Also, your participation is entirely voluntary and you are free to decline to participate. If you say no, this will not affect you negatively in any way whatsoever. You are also free to withdraw from the study at any point, even if you do agree to take part.

This study has been approved by the Health Research Ethics Committee of the Faculty of Health Sciences of the North-West University (NWU-00206-14-S1) and will be conducted according to the ethical guidelines and principles of the international Declaration of Helsinki and the ethical guidelines of the National Health Research Ethics Council. It might be necessary for the research ethics committee members or relevant authorities to inspect the research records.

What is this research study all about?

This study will be conducted in Gaborone, Francistown Maun and Kgalagadi and will involve a cross-sectional household survey by experienced health researchers trained in conducting community surveys. They will interview household participants who will be included in this study.

The objectives of this research are:

Determine extent of TIF utilisation at household level in the given survey areas.

Determine possible associations between use of TIF at household level and selected nutrition and food security indicators for both rural and urban survey sites.

Determine the contribution of selected sold TIF to vendors household income as a livelihoods means of households involved in such activities

Determine the contribution of reportedly consumed selected TIF to nutrient intake of energy, protein, Vitamin A, iron and zinc based on quantitative food frequency questionnaire data.

Why have you been invited to participate?

You have been invited to participate because you have been residing in a surveyed household in this research area therefore you would be able to give us useful information about different TIF which are available and are consumed in the area.

You have also complied with the following inclusion criteria in that:

You are18 years and above, and of good mental capacity.

You may be involved in selling of TIF.

You will be excluded if: you have not been residing here for more than 3 months or not in good mental capacity.

What will your responsibilities be?

You will be expected;

To provide information on your experience on availability of foods for your household in the last 30 days

To provide us with information on foods consumed by your household members in last 24 hours.

To answer questions about the member composition of your household their occupation, education etc.

To provide information on your selling and buying of TIF and their contribution to your household income and livelihood.

The interview may take one to two hours of your time to complete the consent forms and the interview.

We may also consider you to form part of focus group discussions later. These will help us get more information about the use of TIF by individuals and households in the area. For this we would ask for your participation separately. We will seek separate consent for the focus group discussions.

Will you benefit from taking part in this research?

There is no direct benefit to you as a participant.

The indirect benefit will be that the information you provide us will help National Food Technology Research Centre (NFTRC) on how best to promote the use of TIF in Botswana and to make recommendations on needs for conservation of the foods in the country.

Are there risks involved in your taking part in this research?

This study was approved by the North-West University Health Research Ethics Committee (HREC)(NWU00206-14-S1). However you are welcomed to ask any questions or seek further clarification from Dr Motswagole Co principal investigator at 72101 198 at NFTRC in Botswana.

What will happen in the unlikely event of some form of discomfort occurring as a direct result of your taking part in this research study?

Should you have unanticipated discomfort as a result of participating in this research you may inform or seek clarification from DrMotswagole Co-principal investigator for this project at NFTRC. The telephone number is 72101 198

You may feel uncomfortable when asked questions about your household income and questions on how you experience food security in your home. Should you not wish to respond to any of the questions you are free not to do so.

Who will have access to the data?

Anonymity will be maintained on all information collected as no names of individuals will be used.

Confidentiality will be ensured on all information we collect from you in this survey. Reporting of findings will be anonymous and even in case of all publications no names will be used and the information that will be used to compile the dissertation by the students or the other researcher no names of individuals will be reported at any point. Data will be kept safe and secure by locking hard copies in locked cupboards in the researcher's office and for electronic data it will be password protected. Data will be stored for seven and half years. NFTRC will be given a copy of the data sets.

Payment

No payment will be provided for participation and it will solely be on a voluntary basis.

If there anything else that you should want to know or do

You can contact *DrMotswagole –Co principal investigator at 72101198*

If you have any further queries or encounter any problems.

You can contact the Health Research Ethics Committee via Mrs Carolien van Zyl at +27 (0)18 299 2094; carolien.vanzyl@nwu.ac.za if you have any concerns or complaints that have not been adequately addressed by the researcher.

You will receive a copy of this information and consent form for your own records.

How will you know about the findings?

The results of the study will be shared to the research participants when completed. NWU in collaboration with NFTRC will disseminate the study findings to the communities where the research was done. This will be done though the village elders or the municipal councillors.

Declaration by participant

By signing below, I …………………………………..…………. agree to take part in a research study entitled: Utilisation of traditional and indigenous foods and potential contribution to consumers' nutrition and vendors' income in Botswana.

I declare that:

I have read this information and consent form and it is written in a language with which I am fluent and comfortable.

I have had a chance to ask questions to both the person obtaining consent, as well as the researcher and all my questions have been adequately answered.

I understand that taking part in this study is voluntary and I have not been pressurised to take part.

I may choose to leave the study at any time and will not be penalised or prejudiced in any way.

I may be asked to leave the study before it has finished, if the researcher feels it is in my best interests, or if I do not follow the study plan, as agreed to.

Signed at (*place*) ....……......……………. on (*date*) …………...……….. 20....

Signature of participant Signature of witness

Declaration by person obtaining consent

I *(name)* ……………………………………………..……… declare that:

I explained the information in this document to …………………………………..

I encouraged him/her to ask questions and took adequate time to answer them.

I am satisfied that he/she adequately understands all aspects of the research, as discussed above

I did/did not use an interpreter.

Signed at (*place*) ....……......……………. on (*date*) …………...……….. 20....

Signature of person obtaining consent Signature of witness

Declaration by researcher

I *(name)* ……………………………………………..……… declare that:

I explained the information in this document to …………………………………..

I encouraged him/her to ask questions and took adequate time to answer them.

I am satisfied that he/she adequately understands all aspects of the research, as discussed above

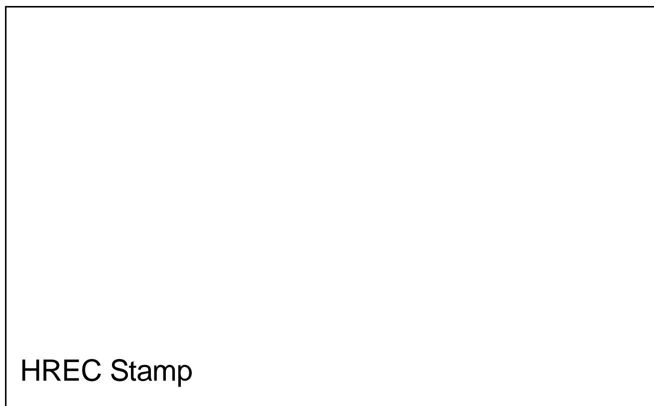
I did/did not use an interpreter.

Signed at (*place*) .... on (*date*) .... 20....

Signature of researcher

Signature of witness

Consent forms for household and vendors FGDs



HREC Stamp

Participant information leaflet and consent form: for (household and vendors focus group discussions)

TITLE OF PROJECT: Utilisation of traditional and indigenous foods and potential contribution to consumers' nutrition and vendors' income in Botswana.

REFERENCE NUMBERS: NWU-00206-14-S1

PRINCIPAL INVESTIGATOR: Dr Namukolo Covic

ADDRESS:

North-West University

Faculty of Health Sciences

Private Bag X6001

Potchefstroom

2522

CONTACT NUMBER: Co- Principal Investigator- Dr Motswagole (72101198)

You are being invited to take part in a research project to gather information on use of TIF in Botswana. Some of the information gathered will be used to train Post graduate students at North-West University. Please take some time to read the information presented here, which will explain the details of this project. Please ask the researcher any questions about any part of this project that you do not fully understand. It is very important that you are fully satisfied that you clearly understand what this research entails and how you could be involved. Also, your participation is entirely voluntary and you are free to decline to participate. If you say no, this will not affect you negatively in any way whatsoever. You are also free to withdraw from the study at any point, even if you do agree to take part.

This study has been approved by the Health Research Ethics Committee of the Faculty of Health Sciences of the North-West University (NWU-00206-14-S1) and will be conducted according to the ethical guidelines and principles of the international Declaration of Helsinki and the ethical guidelines of the National Health Research Ethics Council. It might be necessary for the research ethics committee members or relevant authorities to inspect the research records.

What is this research study all about?

This study will be conducted in Gaborone, Francis town, Maun and Kgalagadi and will involve Focus Group Discussions with experienced health researchers trained in conducting Focus Group Discussions with participants who will be included in this study.

The objectives of this research are:

Determine extent of TIF utilisation at household level in the given survey areas.

Determine possible associations between use of TIF at household level and selected nutrition and food security indicators for both rural and urban survey sites.

Determine the contribution of selected sold TIF to vendors household income as a livelihoods means of households involved in such activities

Determine the contribution of reportedly consumed selected TIF to nutrient intake of energy, protein, Vitamin A, iron and zinc based on quantitative food frequency questionnaire data.

Why have you been invited to participate?

You have been invited to participate because you have been residing in the research area therefore you will give us information on the different TIF which are available in your area

You have also complied with the following inclusion criteria: you are18 years above, you make use of these foods frequently and you are of good mental capacity.

You may be involved in selling of TIF

You will be excluded if: you have not been residing here for more than 3 months or not in good mental capacity

What will your responsibilities be?

You will be expected

Give us information on your experience on availability of different TIF and their uses in this area.

Give us forty five minutes to one hour to participate in focus group discussions about your past experience with TIF use in your area and also at your household.

If you are involved in selling TIF, you will give us information on buying and selling of TIF and their contribution to your household income and livelihood.

If you are involved in selling TIF, you will also give us information on the sources of the TIF you sell.

Will you benefit from taking part in this research?

There is no direct benefit to you as a participant.

The indirect benefit will be: the information you provide us with will help National Food Technology Research Centre (NFTRC) on how best to promote the use of TIF in Botswana.

Are there risks involved in your taking part in this research?

This study was approved by the North-West University Health Research Ethics Committee (HREC)(NWU. -00206-14-S1). However you are welcomed to ask any questions or seek further clarification from Dr Motswagole –Co principal investigator at 72101198

What will happen in the unlikely event of some form of discomfort occurring as a direct result of your taking part in this research study?

Should you have unanticipated discomfort as a result of participating in this research you may inform or seek clarification from Dr Motswagole Co-principal investigator for this project at NFTRC. The telephone number is 72101198

You may feel uncomfortable when asked questions about your income and household income and questions on how you experience food security in your home. Should you not wish to respond to any of the questions you are free not to do so

There will also be audio recording during the focus group discussion for us to have an accurate record of the discussions. Therefore you will also let us know if you are comfortable for the audio recording to take place.

Who will have access to the data?

Anonymity will be maintained on all information collected as no names of individuals will be used.

Only partial confidentiality can be ensured on all information we collect from you in this discussion because other participants will be involved in the discussion. Reporting of findings will be anonymous and even in case of all publications no names will be used in the information used to compile the thesis by the students or the other researchers. No names of individuals will be reported at any point. Data will be kept safe and secure by locking hard copies in locked cupboards in the researcher's office and for electronic data it will be password protected. Data will be stored for seven and half years. NFTRC will be given a copy of the data sets.

Payment

Pula 50 will be given as taxi fare reimbursement to all Focus Group Discussion participants and no other kind of payment will be done as participation is solely on a voluntary basis

If there is anything else that you need to know

You can contact *Dr Motswagole –Co principal investigator at 72101198 at NFTRC*.

If you have any further queries or encounter any problems.

You can contact the Health Research Ethics Committee via Mrs Carolien van Zyl at +27 (0)18 299 2094; carolien.vanzyl@nwu.ac.za if you have any concerns or complaints that have not been adequately addressed by the researcher.

You will receive a copy of this information and consent form for your own records.

How will you know about the findings?

The results of the study will be shared to the research participants when completed.NWU in collaboration with NFTRC will disseminate the study findings to the communities where the research was done. This will be done though the village elders or the municipal councillors.

Declaration by participant

By signing below, I ……………………………….…………. agree to take part in a research study entitled: Utilisation of traditional and indigenous foods and potential contribution to consumers' nutrition and vendors' income in Botswana.

I declare that:

I have read this information and consent form and it is written in a language with which I am fluent and comfortable.

I have had a chance to ask questions to both the person obtaining consent, as well as the researcher and all my questions have been adequately answered.

I understand that taking part in this study is voluntary and I have not been pressurised to take part.

I may choose to leave the study at any time and will not be penalised or prejudiced in any way.

I may be asked to leave the study before it has finished, if the researcher feels it is in my best interests, or if I do not follow the study plan, as agreed to.

Signed at (*place*) ....…........…………….. on (*date*) …………....……….. 20....

Signature of participant Signature of witness

Declaration by person obtaining consent

I *(name)* ……………………………………………..……… declare that:

I explained the information in this document to …………………………………..

I encouraged him/her to ask questions and took adequate time to answer them.

I am satisfied that he/she adequately understands all aspects of the research, as discussed above

I did/did not use an interpreter.

Signed at (*place*) ....…........……………. on (*date*) …………...……….. 20....

Signature of person obtaining consent   Signature of witness

Declaration by researcher

I *(name)* ……………………………………………..……… declare that:

I explained the information in this document to …………………………………..

I encouraged him/her to ask questions and took adequate time to answer them.

I am satisfied that he/she adequately understands all aspects of the research, as discussed above

I did/did not use an interpreter.

Signed at (*place*) ....…........…………….. on (*date*) …………....……….. 20....

Signature of researcher Signature of witness

Consent form: for anthropometry component and QFFQ for women 18-49 years

HREC Stamp

Participant information leaflet and consent form: for anthropometry component and QFFQ for adult women 18-49 years

TITLE OF PROJECT: Utilisation of traditional and indigenous foods and potential contribution to consumers' nutrition and vendors' income in Botswana.

REFERENCE NUMBERS: NWU-00206-14-S1

PRINCIPAL INVESTIGATOR: Dr Namukolo Covic

ADDRESS:

North-West University

Faculty of Health Sciences

Private Bag X6001

Potchefstroom

2522

CONTACT NUMBER: Co- Principal Investigator-Dr Motswagole (72101198)

You are being invited to take part in a research project to gather information on use of TIF in Botswana. Some of the information gathered will be used to train Post graduate students at North-West University. Please take some time to read the information presented here, which will explain the details of this project. Please ask the researcher any questions about any part of this project that you do not fully understand. It is very important that you are fully satisfied that you clearly understand what this research entails and how you could be involved. Also, your participation is entirely voluntary and you are free to decline to participate. If you say no, this will not affect you negatively in any way whatsoever. You are also free to withdraw from the study at any point, even if you do agree to take part.

This study has been approved by the Health Research Ethics Committee of the Faculty of Health Sciences of the North-West University (NWU-00206-14-S1) and will be conducted according to the ethical guidelines and principles of the international Declaration of Helsinki and the ethical guidelines of the National Health Research Ethics Council. It might be necessary for the research ethics committee members or relevant authorities to inspect the research records

This study has been approved by the Health Research Ethics Committee of the Faculty of Health Sciences of the North-West University (NWU -00206-14-S1) and will be conducted according to the ethical guidelines and principles of the international Declaration of Helsinki ad the ethical guidelines of the National Health Research Ethics Council. It might be necessary for the research ethics committee members or relevant authorities to inspect the research records.

What is this research study all about?

This study will be conducted in Gaborone, Francis town Maun and Kgalagadi and will involve cross-sectional household survey with experienced health researchers trained in conducting community surveys with household participants who will be included in this study.

The objectives of this research are:

Determine extent of TIF utilisation at household level in the given survey areas.

Determine possible associations between use of TIF at household level and selected nutrition and food security indicators for both rural and urban survey sites.

Determine TIF contribution to household income and livelihoods of households involved in such activities

Determine the contribution of reportedly consumed selected TIF to nutrient intake of energy, protein, Vitamin A, iron and zinc based on quantitative food frequency questionnaire data

Why have you been invited to participate?

You have been invited to participate because you have been residing in this research area in a surveyed household therefore you will be required to give us information about your eating of TIF which are available in your area.

You have also complied with the following inclusion criteria: you are18 years and above, and of good mental capacity.

You are an adult woman of reproductive age 18-49 years

You will be excluded if: you have not been residing here for more than 3 months or not in good mental capacity

If you are pregnant.

What will your responsibilities be?

You will be expected

You will allow us take your weight and height (this will be done by trained field assistants, *National Food Technology Research Centre* (NFTRC) researchers and the PhD student.

You will give us information on the various kinds of foods you ate for the last 30 days and help us quantify the amount eaten.

You will give us one to two hours of your time to complete the consent forms and also to interview you.

Will you benefit from taking part in this research?

The only direct benefit will be that your weight and height will be measured and this information will be provided to you.

The indirect benefit will be: the information you provide us with will help NFTR on how best to promote the use of indigenous foods in Botswana.

Are there risks involved in your taking part in this research?

This study was approved by the North-West University Health Research Ethics Committee (HREC)(NWU. -00206-14-S1). However you are welcomed to ask any questions or seek further clarification from DrMotswagole –Co principal investigator at NFTRC, Kanye, 72101198

What will happen in the unlikely event of some form of discomfort occurring as a direct result of your taking part in this research study?

Should you have unanticipated discomfort as a result of participating in this research you may inform or seek clarification from DrMotswagole Co-principal Investigator for this project at NFTRC. The telephone number is 72101198

When your weight and height will be taken you will be asked to be in light clothing and to remove your shoes and you may experience discomfort with this but you are free to indicate if the assessment should continue or not.

As you will be asked questions about what you ate in the last 30 days you might feel uncomfortable to remember and you can choose not to respond if you experience discomfort.

Who will have access to the data?

Anonymity will be maintained on all information collected as no names of individuals will be used.

Confidentiality will be ensured on all information we collect from you. Reporting of findings will be anonymous and in case of publications no names will be used and the information that will be used to compile reports and by the PhD student to compile her thesis no names of individuals will be reported. Data will be kept safe and secure by locking hard copies in locked cupboards in the researcher's office and for electronic data it will be password protected. Data will be stored for seven and half years. NFTRC will be given a copy of the data sets

Payment

You will receive no payment for participation it is a voluntary exercise

If there is anything else that you should know or do

You can contact *Dr Motswagole –Co principal investigator at 72101198*

If you have any further queries or encounter any problems.

You can contact the Health Research Ethics Committee via Mrs Carolien van Zyl at +27 (0)18 299 2094; carolien.vanzyl@nwu.ac.za if you have any concerns or complaints that have not been adequately addressed by the researcher.

You will receive a copy of this information and consent form for your own records.

How will you know about the findings?

The results of the study will be shared with the research participants when completed.NWU in collaboration with NFTRC will disseminate the study findings to the communities where the research was done. This will be done though the village elders or the municipal councillors.

Declaration by participant

By signing below, I …………………………………..…………. agree to take part in a research study entitled: Utilisation of traditional and indigenous foods and potential contribution to consumers' nutrition and vendors' income in Botswana.

I declare that:

I have read this information and consent form and it is written in a language with which I am fluent and comfortable.

I have had a chance to ask questions to both the person obtaining consent, as well as the researcher and all my questions have been adequately answered.

I understand that taking part in this study is voluntary and I have not been pressurised to take part.

I may choose to leave the study at any time and will not be penalised or prejudiced in any way.

I may be asked to leave the study before it has finished, if the researcher feels it is in my best interests, or if I do not follow the study plan, as agreed to.

Signed at (*place*) ....…........…………….. on (*date*) …………....……….. 20....

Signature of participant   Signature of witness

Declaration by person obtaining consent

I *(name)* …………………………………………..……… declare that:

I explained the information in this document to …………………………………..

I encouraged him/her to ask questions and took adequate time to answer them.

I am satisfied that he/she adequately understands all aspects of the research, as discussed above

I did/did not use an interpreter.

Signed at (*place*) ....…........…………….. on (*date*) …………....……….. 20....

Signature of person obtaining consent   Signature of witness

Declaration by researcher

I *(name)* ………………………………………………..……… declare that:

I explained the information in this document to …………………………………..

I encouraged him/her to ask questions and took adequate time to answer them.

I am satisfied that he/she adequately understands all aspects of the research, as discussed above

I did/did not use an interpreter.

Signed at (*place*) ....…......……………….. on (*date*) …………...……….. 20....

Signature of researcher   Signature of witness