ASSESSMENT OF HOUSEHOLD FOOD CONSUMPTION CHANGES AND DEMAND IN THE DEMOCRATIC REPUBLIC OF CONGO

BY

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DECLARATION

This thesis is my original work and has not been submitted for an award of a degree in any other university.

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DEDICATION

This work is dedicated to my family.

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ABSTRACT

All member countries of the United Nations are committed to achieving the Sustainable Development Goal 2 “zero hunger”. Compared to other regions, Africa has seen little progress regarding the reduction malnutrition. In the Democratic Republic of Congo (DRC), there are millions of people suffering from extreme food insecurity and malnutrition. In recent years, DRC has experienced substantial economic growth, however, it is not accompanied by nutrition improvement. Economic growth is usually expected to enhance nutritional status. However, this has not been the case in DRC. DRC has huge potential, but unable to feed its population. The government of DRC and its partners usually focus on peace, stability and food aids to resolve the issue of food insecurity and malnutrition. Very little attention is directed towards improving the quality of food and nutritional diversify of food consumed by households. Moreover, DRC has no concrete agenda to improve food security and nutrition. Therefore, knowledge on the vulnerability of households regarding food insecurity, diet consumption, nutrient intake and food demand is key in the prioritisation of interventions. Thus, this study analysed the food budget share and the food composition and mapped the nutrient deficiencies as well as their changes between 2005 and 2012 for urban and rural areas for 26 provinces of DRC. To generate the evidence required to design and implement efficient food policies, the study estimated the demand elasticities for food and the Engels curves using the QUAIDS model and the Quadratic Engel curves respectively for urban and rural areas. This study utilized two rounds of National Household Surveys collected in 2005 and 2012. Results of the study suggest that households spend 75% of their budget on food, and about 80 per cent of that budget is spent on cereals, root and tubers as well as meat and fish. The overall nutrient intake analysis suggests hidden hunger all over the country, with a negative nutrient intake change. The estimated income elasticities suggested that most of the food groups were normal goods. In the urban areas, the own-price elasticities suggested that vegetables, milk, meat and fish, main staples and oil were price elastic while in the rural areas, pulses, vegetables,

milk and oil were price elastic, whereas the main staples group were inelastic. The results of the cross-price elasticities in both urban and rural areas showed that all the food groups are complements to the main staples and substitutes to meat and fish.

Therefore, the study recommends policy that focus on increase in the income of households and infrastructural development within and between provinces while including nutrition aspects in the school curriculum. Furthermore, a price subsidy should be provided on all micro-nutrient food items for easy of affordability and consumption among households. Hence, a further study on the households' food consumption and demand should be carried out on a provincial level.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS AND ABBREVIATIONS

AIDADS	An Implicitly Directly Additive Demand System
AIDS	Almost Ideal Demand System
CAADP	Comprehensive Africa Agriculture Development Programme
CMD	Cassava Mosaic Disease
DRC	Democratic Republic of Congo
FAO	Food and Agriculture Organization of the United Nations
FEWS NET	Famine Early Warning Systems Network
GDP	Gross Domestic Product
IAD	Indirect Addilog Model
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
LES	Linear Expenditure System
NEPAD	New Partnership for Africa's Development
PIGLOG	Price-Independent Generalized Logarithmic
PRSs	Poverty Reduction Strategies
QUAIDS	Quadratic Almost Ideal Demand System
SDGs	Sustainable Development Goals
UNDP	United Nation for Development Programme
UNICEF	United Nations International Children's Emergency Fund
UNU	United Nations University
USAID	United States Agency for International Development
USD	United States Dollar
WFP	World Food Programme
WHO	World Health Organization

CHAPTER ONE : INTRODUCTION

1.0 Background

In recent times, almost all the member countries of the United Nations are committed to achieving the Sustainable Development Goal (SDG) 2 of zero hunger. However, achieving this goal has been a major challenge all over the world. Food security and nutrition is pivotal in this process of attaining a world without hunger in all its forms, therefore, requires special in the development of relevant policies to bring about sustainable growth and development. Food security and nutrition is also a key driver of economic growth (Hendriks, 2018).

In an international and continental setting, African governments have committed to a number of international agreements and initiatives such as the SDGs[1] and the Maputo Declaration (CAADP-NEPAD) to revitalise the agricultural sector of Africa. The Malabo declaration which focus on enhancing and accelerating agriculture transformation in Africa and Agenda 2063, which aims at achieving a better life for the people in Africa. The agreements and initiatives are all attempts to achieve zero hunger, as well as improving nutrition. The concrete approaches that have been proposed to accomplish these initiatives and agreements are Multi-stakeholders partnership, Sector-wide-approaches and Poverty Reduction Strategies (PRSs) (African Union, 2003, 2014, 2015). Through these approaches, African governments try to synchronise the public sector as well as other stakeholders to manage a specific sector, such as the agricultural sector more coherently and efficiently. However, contextualizing food security and nutrition politically becomes the responsibility of each government to implement policies that will help to achieve the three main objectives of food security and nutrition policy: social, economic growth (in terms of increased income) and the promotion of sustainable livelihoods (African Union, 2003, 2014, 2015; Hendriks, 2018).

[1] https://www.un.org/sustainabledevelopment/sustainable-development-goals/ visited 19 November 2018

Nutrition is a complex issue in terms of its measurement and in terms of ensuring and guaranteeing that all people, at all times, have access to sufficient and affordable food that meets their dietary, social and health requirements. It is the basis of a functioning body in terms of both physiological and mental condition and development (Hendriks, 2015; Whitney and Rolfes, 2018).

Most importantly, the commitment to the SDG 2 influences the governments' declaration of nutrition as a central component in policy actions. Moreover, the importance of the agricultural sector has changed over this commitment. Currently, agriculture is not only considered as a source of food but also has important implications on assets and wealth accumulation. Considering that, the commitment is not only to feed the people but also to nourish and improve people's livelihood (Hendriks, 2018).

Improving nutrition is essential for economic and social development. This is best explained by the nutrition cycle, starting with the genesis of life. Malnutrition of a pregnant woman has significant impacts on her foetus. As a consequence, the infant may be undernourished from birth and become sensitive to severe infections leading to impairment of physiological and mental development. Concrete effects of malnutrition include underweight, wasting (thinness) or stunting (shortness), overweight, obesity, or overweight and stunted at the same time called "double burden of malnutrition". Whichever the case, the infant cannot develop appropriate motor skills; not only in his/her physical development but also in his/her mental development and this will affect all domains of his/her life. In the case of micronutrient deficiencies, depending on the deficiency, children might have anaemia (iron deficiency), goitre (iodine deficiency), blindness (vitamin A deficiency) among others (Hendriks, 2015, 2018; Whitney and Rolfes, 2018).

These aspects are all indicators of impaired economic and social development. Even for young people, a poor diet is associated with significant health risks like heart disease, hypertension, osteoporosis, certain types of cancer, and Type 2 diabetes. Moreover, malnutrition of older people has substantial disadvantages for social and economic development as well since older people will

have to combat gastrological disease, mental disease such as dementia, and depression. Malnutrition leads to a considerable amount of the budget of an individual to be used for health care (Popkin *et al.*, 2012; Hendriks, 2018; Resnick *et al.*, 2018). Malnutrition can be both a lack of nutrient or an excess of it; hence it is a global issue from rich to poor countries (Schmidhuber and Shetty, 2005).

While most regions in the world seem to have made some progress towards the reduction of malnutrition prevalence, Africa has made the least progress in terms of relative improvement on food security and nutrition (FAO *et al.*, 2018). About 22.2% of children under 5 years old in Africa are stunted, 7.5% are wasting, while 5.6% are overweight. Women of reproductive age with anaemia are about 32.6%, and adults' obesity prevalence is about 13.2% (FAO *et al.*, 2018). Ceteris paribus, the eradication of malnutrition by 2030 is unrealistic and need a lot of attention. According to the FAO *et al.* (2018), nutrition problems in Africa are multiple and overlapping. Hence, Nutrition should be the number one priority for all countries (Hendriks, 2017).

Reports on Global Hunger Index between 2009 and 2011 attributed low scores to DRC. Sachs *et al.* (2018) also reported that the Democratic Republic of Congo (DRC) ranks among the last four countries with the lowest SDG 2 score of 34.8. However, in recent times, there is limited evidence/data to distinctively describe the situation of food security and nutrition in DRC (Grebmer *et al.*, 2013; Grebmer *et al.*, 2014; Grebmer *et al.*, 2015; Grebmer *et al.*, 2016; Grebmer *et al.*, 2018). OCHA (2017) reports that the humanitarian situation of DRC has dramatically deteriorated and 10% of the population need humanitarian assistance. From 2016 to 2017 there has been an increase of 30% in the number of people facing severe food insecurity. Approximately 7.7 million people in DRC face severe food insecurity and malnutrition and severe acute malnutrition also affects about 2 million children in DRC.

USAID (2018) in its food assistance fact sheet 2018 reported that numerous parts of DRC are encountering prolonged poverty and conflict, leading to an increase in internal migration, chronic

food insecurity and limited livelihood activities. Due to violence and instability, urgent food and relief need is required in the country; especially in Kasaï area as well as Ituri, North Kivu, South Kivu and Tanganyika areas. With the ongoing Ebola episode in Ituri and North Kivu, the situation is becoming more complicated[2]. Similarly, the Famine Early Warning Systems Network (FEWS NET) projected that crisis levels of acute food insecurity would persist beyond 2019[3] (USAID, 2018).

1.1 Statement of Research Problem

Despite the huge agricultural potential of DRC, the country is still unable to feed its population. USAID (2019) reported that the total food for peace contribution for the past three years is about 401.6 million U.S. dollars representing about 145 thousand metric tons of food and this is yet not enough to tackle the issue of food access in the country. According to the Integrated Food Security Phase Classification (IPC) Global Partners (2019), analysis shows that, out of a population of 81.3 million people, about 16.8, 27.4, 9.8 and 3.4 million people are classified as generally food secure (IPC1), stressed borderline food insecure (IPC2), acute food and livelihood crisis (IPC3) and humanitarian emergency (IPC4) respectively.

Over the years, the government of DRC and its development partners have placed more emphasis on peace, stability and food aids as solutions to food insecurity and malnutrition. However, very little attention has been directed towards improving the quality of food consumed and nutritional diversity at household level, and yet these are very important in preventing hidden hunger. Moreover, DRC has no concrete agenda to improve food security and nutrition (IPC GLOBAL PARTNERS, 2017).

Although economic growth is essential for improving the nutritional status of people previous

[2] https://www.usaid.gov/democratic-republic-congo/food-assistance visited 21 November 2018
[3] http://fews.net/southern-africa/democratic-republic-congo/key-message-update/november-2018 visited 21 November 2018

studies and reports by international organisations and researchers in DRC have reported that the rate of reduction in malnutrition is less than the rate of economic growth (DFAE, 2017; UNICEF, 2017). For instance, Marivoet *et al.* (2018) found that the rate of reduction of the incidence of underweight declined for both women and children in the urban areas. They also found a higher variability in the economy indicating that the change in the economy is not unique to all provinces.

In addition, Marivoet *et al.* (2017) who conducted a study on the relationship between diet, the number of calories intake and household food consumption found that food consumption score at regional level is at an acceptable level. However, the authors did not provide any information on nutrition status and nutrients deficiencies.

A number of studies have estimated the economic development in DRC. However, there is limited information on household behaviour or choice of diet in order to understand their motivation for the selected food types. In other words, there is a lack of information on how the food basket in the household changes with changes in the household income and food prices (Marivoet *et al.*, 2018). It is worth noting that Ulimwengu *et al.* (2012) conducted a study on the demand for food in DRC. However, the authors used a single data set of 2005 and did not disaggregate the study area into urban and rural areas, which is likely to conceal some important policy information. Also, the analysis did not capture the temporal aspect. Thus, there is a need to conduct a demand study that targets both urban and rural provinces.

The conclusion drawn from different studies and reports mentioned above clearly indicates an issue of malnutrition in the DRC with little or no improvement over time. However, the characteristics of different regions when it comes to the vulnerability towards food insecurity, access to food and nutrient deficiencies were not clearly defined. Thus, there is a need to conduct a study to show those differences. DRC is characterised by regional disparities among provinces, urban and rural areas, which makes it challenging to make a single policy for the whole country. Hence the need for more disaggregate studies.

1.2 Objectives

The purpose of this study was to assess the consumption changes of selected food groups and their response to changes in household income and food prices for urban and rural areas in the Democratic Republic of Congo.

Specific objectives:

(i) To determine the food budget share and level of food consumption

(ii) To analyse the change of the food budget share and level of consumption

(iii) To map the change of nutrient deficiencies in food consumed

(iv) To analyse the effects of changes in food prices and household's income on food demand

1.3 Research hypotheses

The study tested the following hypotheses:

(i) The budget share and the households' level of food consumption is low.

(ii) The change in the food budget share and households' level of food consumption is decreasing.

(iii) Nutrient intake is deficient

(iv) Food prices and household income do not affect the demand for food.

1.4 The Significance of the Study

The analysis of the food budget share and the level of food consumption is very useful to identify and classify individuals and communities in DRC. This classification is done according to their vulnerability to shocks such as an epidemic outbreaks, war, droughts or any other factors that could affect food prices and household income level (Lele et al., 2016). The food budget share, the level of food consumption and their changes, can similarly be used for support and national monitoring.

These indicators can be utilised by the government of DRC, in combination with other indicators, to measure food insecurity and nutrition, and vulnerability to future shocks (Rose, 2012).

Analysing the changes for both the budget share and the level of food consumption is essential as it informs non-governmental organisations and governments to determine changes in food security and nutrition of a country or a community. An assessment of the nutrient deficiencies and their changes will also provide scientific evidences that will be very useful for the design of the guidelines for developing national plans of action. A well-informed national plan of action on nutrition would help in the development of effective nutrition policy to improve the household nutritional status and promoting appropriate diets and healthy lifestyles (Chen *et al.*, 2013).

The demand analysis will significantly contribute to the development of appropriate food policies in DRC. It has meaningful implications on income and price change, substituting relationship between different food groups which is of highest importance for the policymakers in the area of food policy (Huq and Arshad, 2010). Moreover, studying food demand is essential in the formulation of consumer behaviour models toward food (Babu *et al.*, 2017).

Finally, to improve food security and nutrition, the government has decided to finance primarily agricultural projects. The findings of this study will enable the government to be efficient in financing those projects. Moreover, the study will contribute to research in the field of food security and nutrition. As such, it is expected to produce unavailable knowledge on this subject. Thus, informing other researchers who are willing to work on related topics.

CHAPTER TWO : LITERRATURE REVIEW

2.0 Introduction

Economists and sociologists define food consumption differently. For economists, food consumption is an approach within the context of the budget allocation on food. For sociologists, food consumption is an approach within the context of food culture and consumption habits, meal structures and meal patterns. Food consumption is more of a socio-historical approach in terms of consumption patterns[4].

However, for better understanding of food consumption this study combines the two approaches. The concepts like household, Engel curve, income and price elasticities of the food demand and vulnerability to food insecurity and malnutrition are clearly explained by emphasising their importance in the analysis of the food consumption.

2.1 Food budget share and food consumption

The food expenditure share provides information about households' economic vulnerability to food insecurity. This aligns with Engel's law which states that income is inversely related to food budget shares (Engel, 1857). Smith and Subandoro (2007) suggest that households, which spend more than 75 per cent of their income on food are considered to be "*very highly vulnerable to food insecurity"*. The households that spend between 65 and 75 per cent of their budget on food are considered to be "*highly vulnerable to food insecurity*". Those between 50 and 65 per cent are considered to be "*moderately vulnerable to food insecurity"*. Finally, those spending less than 50 per cent are considered to be "*less vulnerable to food insecurity"*.

Chauvin *et al.* (2012) analysed the food budget shares of nineteen African countries and found that on the average, households in the urban and rural regions of these countries spend between 58 per

[4] https://kurser.ku.dk/course/LLEK10297U visited 17 December 2018

cent and 67 per cent of their income on food, respectively. While Tanzania was at the highest end with an average of 85 per cent, South Africa was at the lowest extreme, with an average of 40 per cent. Based on the classification of Smith and Subandoro (2007), it can be inferred from the findings of Chauvin *et al.* (2012) that only South Africa showed less vulnerability to food insecurity as compared to the other African countries. Countries such as Madagascar and Tanzania were *"very highly vulnerable to food insecurity"*. However, countries such as Ethiopia, Kenya, and Nigeria required some particular attention to attain South Africa's status as they were considered to be *"highly vulnerable to food insecurity"*.

Chauvin *et al.* (2012) and Muhammad *et al.* (2013) found that cereals represent the highest share of the food budget, followed by fruit and vegetables in terms of diet composition. Both studies, however, included roots and tubers in the fruit and vegetables food group. This could be a misleading approach in the African context because root and tubers constitute the main staple foods in Africa as opposed to developed countries. Dubois *et al.* (2014) conducted a study on the possibility of using prices and the attributes of different regions to explain the international differences in the purchases of foodstuffs by making a cross-country comparison. Their results showed significant differences in food expenditures between developed countries and developing countries. They attributed the difference to the variations in income between developed and developing countries (Dubois *et al.*, 2014).

There is a close relationship between food purchased and the nutritional status of individuals. The differences in food purchased discussed earlier may explain the nutritional difference between developed and developing countries in a general context. FAO *et al.* (2018) and Anríquez *et al.* (2013) reported an increase in malnutrition with a high incidence in developing countries and attributed it to food spike between 2007 and 2008 as well as climate change. Price and income have been identified as significant determinants of food consumption, which invariably determines nutritional adequacy (Anríquez *et al.*, 2013). However, there are some other key determinants such

as land access, trade and agriculture policies, taste, preferences and culture (Ackah *et al.*, 2007; Babu *et al.*, 2017).

In the early 1980s, food insecurity and nutrition were attributed to inadequate supply of food. However, Sen (1982) postulated that famine or food issues were not largely an availability issue but could be attributed to the low purchasing power of particular individual, households or communities. In recent times, reports have shown that famine could be attributed to other factors such as natural disasters (severe droughts mainly in Africa), the malevolent exercise of state power (case of the Soviet Union and China), and conflict (case of Somali). During the FAO world summit in 1996, some concerns were raised on the utilisation of food, whereby wasting and stunting were attributed to dietary quality.

Marivoet and Ulimwengu (2018) reported that the issue of obesity in developing countries was due to urbanisation, rise in income levels and sedentary lifestyles. Notwithstanding, the question of triple burden (underweight, stunting and micronutrient deficiencies) requires that the social, cultural, and political contexts of each region should be taken into consideration. Hendriks (2015) argued that micronutrient deficiencies; wasting, stunting and obesity negatively affect productivity, well-being, human capacities and health care expenditures.

For developing countries, accurate food policies are required not only to fight against starvation, acute hunger, chronic hunger or hidden hunger by improving food production as well as balanced food access. Accurate food policies also aim to promote sustainable livelihoods as well as encourage and strengthen savings, asset ownership and insurance, which could be relied on in times of food shortages (Hendriks, 2015).

2.2 Review of methods of demand analysis

Since the 1960s, consumer food demand has been at the centre of many studies. In the 1960s and 1980s, the double log and semi-log models were mostly used. However, the utilization of these

models violate the Engel aggregation condition, which is a serious concern when the complete demand systems are estimated (Zellner, 1962; Ullah and Fatima, 2016). Later on, the Linear Expenditure System was used and it was credited with several advantages. However, it has the disadvantage of not permitting goods to be inferior, substitutes and demand elastic (De Boer and Paap, 2009; Ullah and Fatima, 2016). Apart from these models, many other models have been used to analyse consumer food demand (Babu *et al.*, 2017). These models include the Indirect Addilog Model (IAD), the Rotterdam Model, the Generalized Addilog Demand System Model, the Almost Ideal Demand System Model and the Quadratic Almost Ideal Demand System (QUAIDS) have been used to tackle the previous issues (Babu *et al.*, 2017).

Houthakker (1960) derived the Linear Expenditure System (LES) function starting from an implicitly indirectly additive utility; hence, the model became the Indirect Addilog Model also called An Implicitly Directly Additive Demand System (AIDADS). The weakness of the AIDADS model is that the fitted budget shares do not necessarily lie in the interval of 0 and 1, and that negativity cannot be imposed (De Boer and Missaglia, 2005).

The demand analysis relying on the differential approach was introduced by Theil (1965) and Barten (1966). The differential approach allows the budget share to always be positive and summed to unity. Theil (1965) introduced the Rotterdam model, and it has almost similar advantages as AIDS. Nevertheless, Barnett and Seck (2008) found that the Rotterdam model does not perform well when the substitution between goods are high.

The Almost Ideal Demand System AIDS as proposed by Deaton and Muellbauer (1980) has been used in many studies of consumer demand and have been reputed to provide good results (Barnett and Kanyama, 2013; Bilgic and Yen, 2013; Verbič *et al.*, 2014; Babu *et al.*, 2017). It additionally merges the theoretical advantages of each of the Rotterdam and translog models (Barnett and Kanyama, 2013). However, the QUAIDS has been preferred over the AIDS because it covered all the advantages of the AIDS. Additionally, it has attractive proprieties of allowing the

characterisation of goods as luxuries at low levels of total expenditure and as necessities at higher levels of expenditure. These additional features of the QUAIDS model have been proven to be empirically essential in describing household budget behaviour (Banks *et al.*, 1996, 1997).

2.3 Food consumption demand

Many factors play a role in the demand for food by individuals or households. Dubois *et al.* (2014) carried out a study on how prices and attributes explain international differences in food purchases. They made a cross-country comparison for developing countries. To explain these differences, a demand system for food and nutrients was estimated while also performing counterfactual simulations, in which they calculated the households' responses, based on prices and nutritional characteristics from other countries. They concluded that, as much as prices and nutritional features are relevant when making purchase decisions, there are still other important external factors to be considered, such as the economic environment. Nevertheless, they noted that there are significant differences in food expenditures between developed countries and developing countries. These differences are obviously because developed countries are high-income earners as compared to developing countries, where the minimum wage is relatively low, particularly for most Sub-Saharan African countries.

Another important component, as shown by Chouinard *et al.* (2007), is the tax. The researchers estimated a demand system for dairy products, and simulations were used to capture the effect of taxes. The result showed that a tax rate as low as 10% of the percentage of fat content has a negative impact on fat consumption by less than 1%. Fat consumption can generate a lot of tax revenue. However, this may affect the poor and elderly negatively as the burden will fall on them. The study of Chouinard *et al.* (2007) used the QUAIDS as proposed in this current study. It showed how the QUAIDS could be utilised for food price policies.

Moreover, FAO *et al.* (2018) have reported an increase in malnutrition. Due to food price spike between 2007 and 2008, various studies have attributed the undernourishment to that increase in price. These studies showed that when prices go up, food affordability reduced, and many people, especially in developing countries do not have access to food (Anríquez *et al.*, 2013; Vellakkal *et al.*, 2015; Arndt *et al.*, 2016). Anríquez *et al.* (2013) analysed the short-term effects of a staple food price increase on nutritional attainment using cross-country inquiry. They found that food price spikes reduce both the mean consumption of dietary energy and deteriorate the distribution of food calories, consequently, worsening the nutritional status of populations. According to Babu *et al.* (2017), access to agricultural land helps to obtain adequate dietary levels in both developed and developing countries. Abler (2010) conducted a study on demand growth in developing countries, and his results were the same as those of Anríquez *et al.* (2013). The result showed that commodity prices are a significant determinant of food consumption and nutritional adequacy.

Ackah *et al.* (2007) conducted a study on food consumption in Ghana, emphasising the impact of trade and agricultural reforms on food demand. Moreover, Ackah and Appleton (2007) were interested in measuring the total welfare effect, which includes both static and dynamic responses. They estimated a complete demand system with AIDS specification for household survey data. The estimated parameters were used to simulate the effect of price changes on distribution. Their results indicate that the distributional burden of higher food prices falls mainly on the urban poor. From these studies conducted through different methods; it can conclude that even though there are many drivers of food consumption demand, the price of the food is a critical component in both developed countries and developing countries such as DRC.

More even, Duquesne *et al.* (2010) showed how the price of food affect the choice and the nutritional status of people in Kinshasa. They conducted a study on three districts in the capital of DRC, Kinshasa and found that households choose the cheapest food in the market. They found out that the most inexpensive foods are rich in calories but very poor in protein leading to an

unbalanced diet for those households. They also emphasised that Kinshasa imports a considerable quantity of food consumed by the population and these foods are cheaper but very poor nutritionally.

Logan (2006) studied the relationship between food and income late in the nineteenth Century for American and British households. He found that the income elasticity of dairy products was higher than those of fatty products. Similarly, the income elasticities of fruit and vegetables were higher than those of fibre. However, the income elasticities of cereals were lower than that of meat.

Logan (2006) findings are very similar to the results of Colen *et al.* (2018) who studied income elasticities for food, calories and nutrients across Africa. They built a meta-sample on food-income elasticities, nutrient-income elasticities and calorie-income elasticities. The Meta sample was extracted from 66 primary studies covering 48 African countries. Their results showed that the income elasticities of staple foods were lower, however, for more aspirational foods, the income elasticities tend to be higher.

However, the situation is quite different in European countries as can be seen in the work of Wyrzykowski (2014), who conducted a study on the income elasticity of food demand in Poland. Moreover, dairy products, cereal as well as bread were perfectly priced inelastic. However, the magnitude of the coefficient of the price elasticity was very stronger for fruit and fish. Lechene (2000) also conducted a study on the income and price elasticities of foods consumed in a household, using the National Food Survey over the period 1988 and 2000. He found that households in United Kingdom were sensitive to food price changes. These findings are in line with Colen *et al.* (2018), who also found households in Africa to be sensitive to food price changes.

2.4 Factors affecting nutrition

Sen (1982) explained that household food insecurity and malnutrition is the result of a complex system of "vulnerability factors", primarily due to a lack of purchasing power and in the face of

crises, the lack of resilience of households. Households can find themselves in a situation of food insecurity and malnutrition when their livelihoods improve, but their nutrition does not follow the change. This is a situation that is persistent in DRC, like many other developing countries (Duquesne *et al.*, 2010; Muteba Kalala, 2014). Besides, countries that face nutrition transition are progressively confronted with new nutritional challenges and have to revisit established food policies for any advancing people's well-being and economic prosperity (Ecker and Fang, 2016). Nutrition transition occurs when the food environment fails to support healthy intake and when consumer's food choices are restricted to high energy, high-fat food alternatives with severely negative consequences for nutrition and health (Hendriks, 2018).

The nutrition transition is a descriptive term for shifts in dietary patterns, usually at the community or population level. As discussed in the introduction, malnutrition in all its forms either overnutrition or undernutrition, double burden or triple burden, have an implication on the economy of the individual or the country and vice versa (Popkin *et al.*, 2012; Steyn and McHiza, 2014; Ecker and Fang, 2016; Babu *et al.*, 2017).

The most critical determinant of nutrition transition that a country experience is an economic change (Webb and Block, 2012; Babu *et al.*, 2017). The economic change consists of economic growth or economic decline. However, their effect on nutrition depends on many other factors. The outcome of an economic transformation on the nutritional status of individuals in the country rely on the policies that are in place. Hence, the policies have to consider the national, regional, community and individual level (Haggblade *et al.*, 2016). Moreover, the geographical location is also essential in the sense that rural and urban residents differ in their access to food, nutrition, and health.

Webb and Block (2012) in their study on the impacts of supporting the agriculture during economic transformation on poverty and undernutrition found that when the income of the country increases, over-nutrition becomes a critical nutritional and health problem. In the case of

developing countries, many researchers have found that economic growth leads to an increase in obesity (Popkova *et al.*, 2018). For instance, Ghana, the first country to eradicate extreme poverty in Africa, has experienced economic growth since the 1990s. However, the nutritional status in Ghana has not improved in the sense that the number of obese individuals have increased (Ecker and Fang, 2016) as in many other countries in Africa.

Women and men are, however, not affected the same way in the case of an increase in income. Conklin *et al.* (2018) examined the effect of the rise in the minimum wage on women weight. They have found that an increase in income, reduced the number of underweight at the same time increased the number of obese in the 24 low-income countries considered for the study. Moreover, women were still deficient in some micronutrient such as iron.

Poor people and the rich are nutritionally affected differently by economic growth. Marques *et al.* (2018) assessed the interaction between food consumption, economic growth and sustainable development, in 77 countries distinguished by their income group over eighteen years using the Autoregressive Distributed Lad model. They have found that meat consumption mostly increases in an impoverished region with economic growth. Meat consumption is considered as an excellent proxy to estimate protein evaluation of food security and nutrition.

High consumption of meat leads to an increase in the prevalence of the disease in the community (Babu *et al.*, 2017). Poor people, who are mainly found in the rural areas are more likely to trade quality for quantity when their income increases. This is confirmed by Pérez-Ferrer *et al.* (2018) who studied the nutrition transition in Mexico, whereby, women were likely to be more obese than men with increases in income. Additionally, education was a key component, and the result showed that in association with knowledge, the prevalence of women obesity was different in urban and rural area. Parra *et al.* (2015) conducted a study in Colombia on the nutrition transition over ten years and found that the rate of overweight/obesity to be higher than the economic growth in the country. Therefore, for economic growth and increases in household's income to improve

nutritional outcomes require appropriate nutrition policies and intervention strategies at national levels. To contrast Hendriks (2015) argued that economic decline, or decrease in income lead to some changes in household behaviour. The household will try to respond to the shift by some coping strategies that, in many situations, lead to a hidden hunger due to inadequate intake of nutrient.

2.5 Theoretical framework

2.6.1 Household: The decision-making unit

According to the new household economic theory, a household can be an individual or a group of individuals who share their resources in pursuing a mutual well-being. In other words, the theory assumes that it is a group of people, who aim to improve their mutual welfare (Bryant and Zick, 2005). In the same study of the economic organization of the household, Bryant and Zick (2005) stated that human and financial resources, are both included in household resources. Household activities involve the use of resources in order to derive the satisfaction that can be either indirect or direct. Consumption is one of the activities that gives direct satisfaction to the household. The satisfaction can also be immediate or in the future a part form being direct or indirect. An activity like consumption derives immediate satisfaction while investment or savings are for future goals.

Households always want to maximize satisfaction, subject to certain constraints. Those constraints are sociocultural, institutional, technical and economic. Sociocultural constraints are social and cultural norms affecting the activities, resources and satisfaction received. Laws and regulations determine and direct the household behaviour hence the institutional constraint. The technical constraint is related to the laws of physics, chemistry and biology. Finally, economic constraints are limited assets, income and time.

This study considered that in order to attain optimum nutrition choices, the household decision on the demand for nutrients depends on two essential characteristics. The primary attribute could be

a set of preferences for food and non-food items that the household will afford and is willing to purchase, given its income and market prices. The other attribute correlates to the goals of the social unit revealed in terms of the preferences it has for goods (Bryant and Zick, 2005).

2.6.2 Demand theory

This study was guided by the modern theory of demand analysis advanced by Edgeworth, Antonelli, and Pareto, and corrected by Slutsky, Hicks and Allen, and Hicks (Edgeworth, 1881; Slutsky, 1915; Pareto, 1927; Hicks and Allen, 1934; Hicks, 1946; Ricci, 1951). The theory postulated that individual consumers allocate income on expenditures bundles as if they have an ordered and fixed set of preferences described by an indifference map that he maximises subject to their income and the costs they must pay (Basmann, 1956). It was adopted for this study because it has been used for policy interventions to improve the nutritional status of particular individuals, households, or individuals within households such as infants and pregnant women. In the context of this study, the theory holds that individual consumer responds to price movement by changing both the quantity and quality of food consumed.

There are different types of demand systems. They include; the Linear Expenditure System (LES), the Indirect Addilog Model (IAD), the Rotterdam Model, the Transcendental Logarithmic Demand System Model, the Generalized Addilog Demand System Model, the Almost Ideal Demand System Model, and the Quadratic Almost Ideal Demand System QUAIDS (Babu *et al.*, 2017)

The almost Ideal Demand System, as proposed by Deaton and Muellbauer (1980), has been used in many studies of consumer demand. This is because it allows an optional first-order estimate for any demand system. It also satisfies the axioms of choice, aggregates perfectly over consumers, features a useful form that is according to household budget data and easy to predict and test the exact constraints of demand theory (Barnett and Kanyama, 2013; Bilgic and Yen, 2013; Verbič *et al.*, 2014; Babu *et al.*, 2017). It additionally merges the most effective of the theoretical advantages

of each the Rotterdam and translog models (Barnett and Kanyama, 2013). However, for this study, the QUAIDS was used because it covered all the advantages of the AIDS. In addition to that, it has attractive properties of allowing goods with the characteristics of luxuries at low levels of total expenditure and of necessities at higher levels of spending. This has been proven to be empirically essential to describe household budget behaviour (Banks *et al.*, 1996, 1997).

CHAPTER THREE : RESEARCH METHODOLOGY

3.0 Conceptual framework

The conceptual framework in Figure 1 shows the direct relationship between economic changes and household nutritional status. Food insecurity and malnutrition are multidimensional issues. They can be measured in multiple ways such as hunger, food budget share, nutrient deficiencies, and demand for food. with variable outcomes ranging from mental issues, to the collapse of the country's economy due to famine. Thus, addressing food insecurity and malnutrition requires a multidimensional approach (USAID, 2014). Therefore, adequate macroeconomic food policies do not guarantee achieving food security and nutrition.

In fact, a country can have adequate policies but at household level, people are food insecure and malnourished. Babu and Pinstrup-Andersen (1994) argued that a nation might have adequate food at the macro level designed for the entire population, but households might not be able to access food, probably due to a low purchasing power. Nevertheless, good policies at the aggregate level can directly improve the household income as well as the purchasing power of the population. This implies that household budget allocation will be affected. And according to the Engel Law, there will be a decrease in the budget allocated to food; furthermore this will reduce the vulnerability of households towards security (Engel, 1857; Smith and Subandoro, 2007). The reduction in the vulnerability of households towards food insecurity will invariably determine their choice of food. Ruel and Alderman (2013) argued that even wealthy families have malnourished people, partially because of issues of prioritisation of the household in terms of nutrition, which primarily originates from the bad choice of nutrient or food due to the lack of information on the benefits of nutrition. Thus, the reduction of poverty or broad economic growth does not automatically improve the nutrition status of the population.

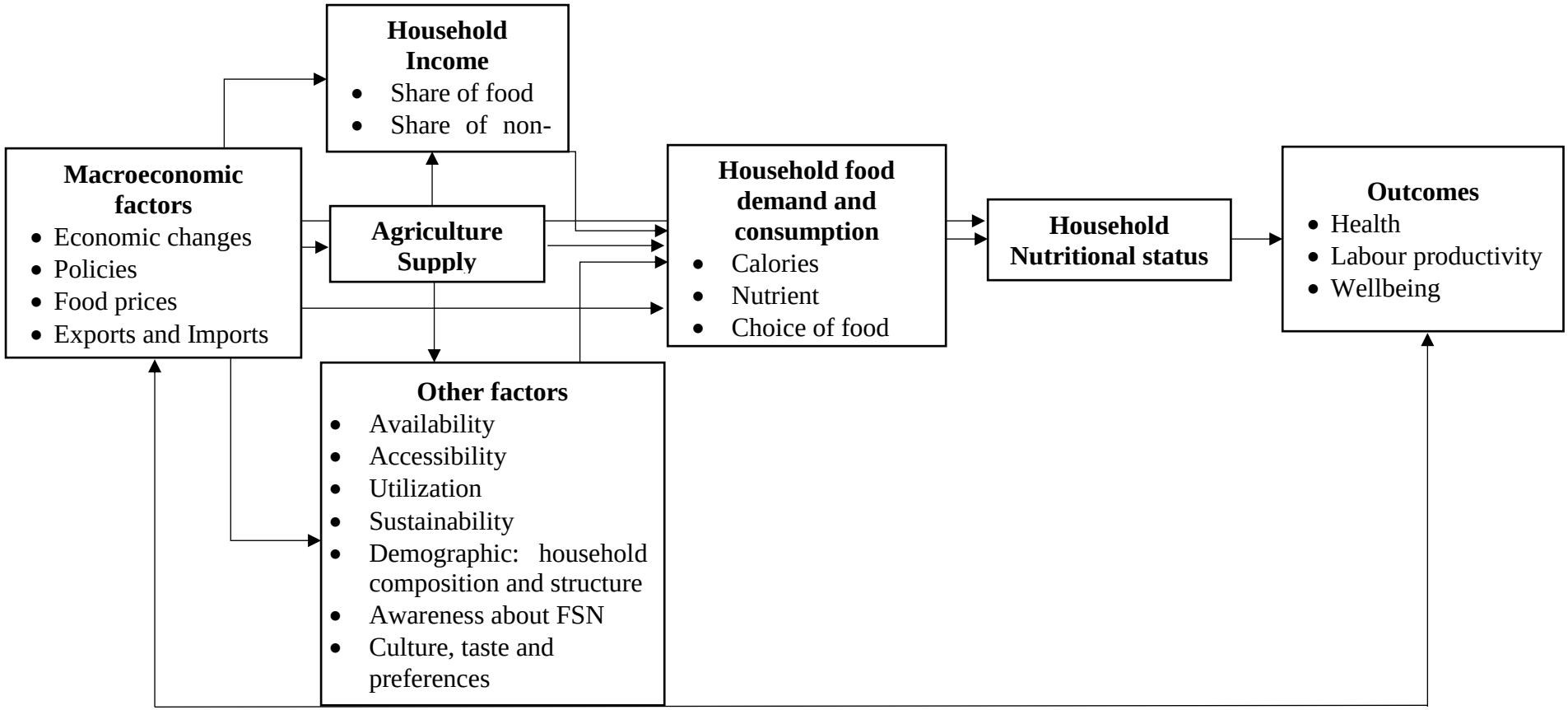

Figure 1: Conceptual framework showing the linkage between factors affecting the nutrient demand of household

Assuming a healthy population, an adequate selection of food will bring about the nutritional transition in term of dietary intake, leading to an improvement in the diet. Improvement in nutritional dietary intake and health status brings about improved nutritional status. Thompson and Amoroso (2014) argue that improving the choice of food to a more healthy and diversified diet help to improve the nutritional status of household and individual.

Improving nutritional status of the population improves their health and therefore their productivity and enhance the quality of labour which leads to increase per capita income and consequently leads to economic growth. Shekar *et al.* (2006) stated that addressing the food insecurity and malnutrition, moving nutrition as fundamental to development, has high economic returns and can boost the process of poverty alleviation and economic growth. However, this is merely an assumption. In some instances, economic development may not be accompanied by an improvement in nutritional status due to the fact that nutrition is a multidimensional issue.

3.1 Study area

The study was conducted in the Democratic Republic of Congo, located in Central Africa. It is the second-largest country of Africa covering an area of 2,345,000 km^2 and the eleventh largest in the world (Wikipedia contributors, 2018). With a population of over 86 million and a population growth of 3.24%, it is the fourth most populated nation in Africa and seventeenth in the world. However, DRC is among the countries in Africa with the lowest population density of about 38 people per km^2 with urban population of 45%.[5]

In 2015, the National Assembly of DRC adopted the laws regarding the limits of the provinces. The eleven provinces at that time were further divided into twenty-six. Figure 2 represents the new and the old provinces of DRC.

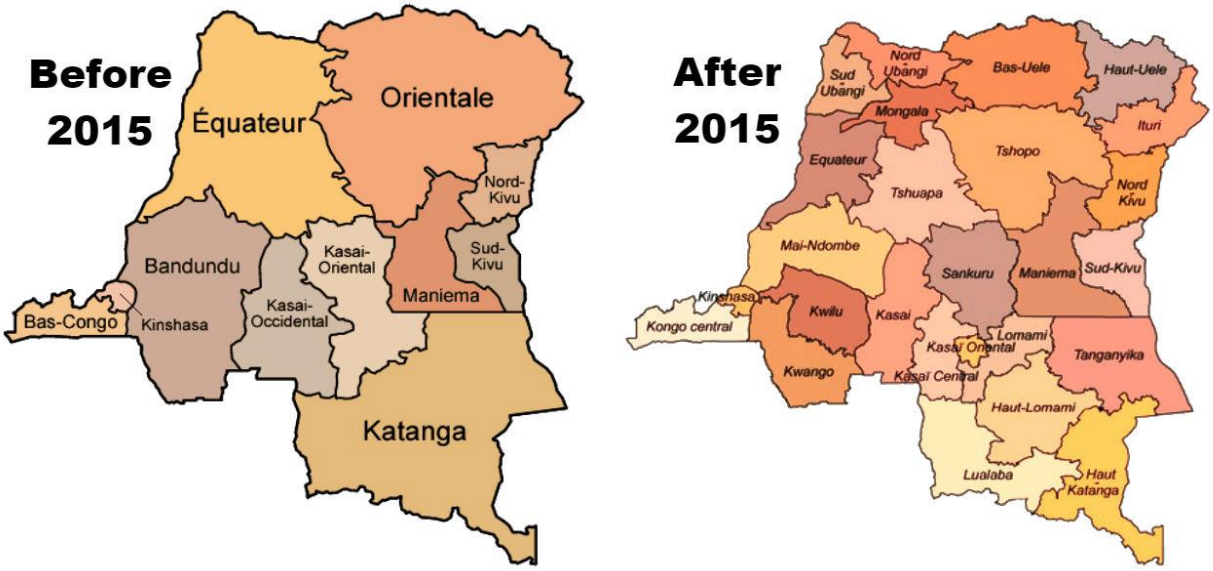

Figure 2: DRC map of old and new provinces[6].

Note: Provinces such as Equateur, Kasai Occidental, Kasai oriental still exist in 2015 but they are not the same as the one in 2015.

[5] http://www.worldometers.info/population/countries-in-africa-by-population/ visited on the 30 September 2019
[6] https://africacenter.org/spotlight/congo-drc-oversight-institutions-how-independent/ visited on the 18 December 2018

The DRC borders the Central African Republic and South Sudan to the north; Uganda, Rwanda, Burundi and Tanzania to the east; Zambia to the south; Angola to the southwest; and the Republic of the Congo and the Atlantic Ocean to the west. DRC is characterized by its wealth of exceptional natural resources (forests, mines, water resources, biodiversity, energy), its dense hydrographic network of which the Congo River basin is the most dominant (3.7 million km²). The informal sector is the major source of income in the country.

The national food balance of DRC for the years 2017 and 2018 were presented in Table 1. The national food balance shows a negative balance of 6.9 million tons (a deficit of 22%). Moreover, the deficits in total legumes (beans, peanut, soya, cowpeas) and total cereals (maize, rice, millet, sorghum) inclusive of the import is about 83% and 75% respectively. This assessment confirms that food insecurity is more a problem of access than availability. However, it raises the question of the quality of food available.

Table 1: DRC national food balance 2017/2018

	Total cereals	Total legumes	Total tubers	Total
Food Available	2,760,994	718,425	20,282,887	23,762,305
Need for human consumption	14,068,800	4,220,640	13,189,500	31,478,940
Excess (+) Deficit (-)	-10,560,724	-3,484,952	7,103,383	-6,942,292

Source: DRC Ministry of Agriculture (2018).

Note: Cereals (maize, rice, millet, sorghum), legumes (beans, peanut, soya, cowpeas), tubers (cassava, sweet potatoes, taro, Irish potatoes). Unit: kilogram.

The food habits of DRC population vary widely. This variability is a function of the ancestral customs, the natural resources of a particular region and the sources of income available to its inhabitants and their stability. For instance, in the western part of DRC, cassava remains a staple food throughout the year. It is consumed in two essential forms; *"Luku"* and *"chikwangue"* (Duquesne *et al.*, 2010). In the Northern part, banana and fish are the main foods. Banana is

consumed in different ways. It is eaten grilled under ash, fried in oil, cooked in water and reduced to pasta (lituma). In the Eastern part, there is a high diversity in their consumption of root and cereals. Nevertheless, the food consumed are accompanied with beans. In the southern part, there is a high level of maize consumption as pasta (*ugali*) (Arsène *et al.*, 2015; Bokombola *et al.*, 2018).

Malnutrition has been reported to have negative effect on the GDP of the country. It was reported by the WFP (2016) that about USD1,771 billion of the GDP (4,56%) was lost in 2014 due to malnutrition. Between 2010 to 2014, there were 729,160 child deaths due to undernutrition. These deaths accounted for 31.5% of all under-five mortality cases in this period, limiting the country's ability to achieve one of its main development goals of reducing child mortality. Chronic malnutrition also has negative effects on children's educational outcomes by increasing the risk of repetition and abandonment, consequently it reduces their productive abilities when these children reach working age. In the DRC, 49.8% of working-age adults (15-64 years) suffered from stunted growth in childhood age (WFP, 2016).

3.2 Research design

This study adopted a historical research design. The design involves exploring, explaining and understanding past phenomenon or events from already available data (Creswell and Creswell, 2017). A historical research design is ideally suitable for studies in which the objective is to determine causes, changes and effects of past phenomenon, making it possible to explain the present, predict and control the future. The design, therefore, makes it possible to make predictions and inference on the relationship between economic characteristics and the nutritional changes of households. Moreover, it is useful where primary data cannot be collected.

3.3 Sampling and data collection

The study used secondary data of two independent rounds of data from the National Household Surveys (Enquête 1-2-3) collected in 2004-2005 and 2012-2013. For the collection of data, both

surveys followed the same methodology called “1-2-3 survey” or “Enquête 1-2-3”. The numbers represent the main objective of the survey: “1” employment, “2” the informal sector and “3” consumption. This study relied on the data from the third phase (Institut National de la Statistique, 2014; Marivoet *et al.*, 2018). This study utilised data on total expenditures of 33,490 different households comprising 12,087 households for the 2005 round and 21,403 households for 2012. The 1-2-3 survey employed stratified, cluster, random and systematic sampling techniques, with the purpose of seeking representation per sector (statutory cities, provincial towns and villages) at the provincial level (Institut National de la Statistique, 2014; Marivoet and De Herdt, 2017; Marivoet *et al.*, 2018). The sampling design was based on 11 provinces. However, in 2015, the country was divided into 26 provinces. Using the localisation of different households, the International Food Policy Research Institute (IFPRI) researchers associated each household to the new province. Unfortunately, for Tshuapa, Mai-Ndombe, Sankuru, Tanganyika, Haut Lomami and Bas-Uele, no household was surveyed for the urban areas in 2005. Their changes were not interpreted and discussed in this study. Moreover, the province of Kinshasa does not formally have a rural area; hence, the results relate to urban areas only. In order to correct the weights and cope with sampling problems, Marivoet & De Herdt (2017) added another step to the sampling technique; the post-stratification, which helps to ensure equitable representation of the population in the sample. The post-stratification ensured that subgroups are proportionate represented in order to ensure the significance of inferences made from the households’ budget data. As the data are not panel, it is difficult to analyse the impact of variables that vary over time (fixed effects) or the impact of the variation across entities assumed to be uncorrelated and random with the independent variables (random effect) at the household level. In other words, the study could not observe how the change of variables affect the status of the households over time. Nevertheless, the random and the fixed effects could not be captured in the urban and rural areas for the provinces. Furthermore, analysis related to the changes, the intake and expenditures could

be conducted. The data for this study were provided by IFPRI researchers. For the purpose of the study, the data were cleaned and the relevant variable were selected for the analysis.

3.4 Methods of data analysis

Data were analysed using both the descriptive analysis and inferential analysis. The inferential analysis was used to draw conclusions concerning the relationships and differences in research results. To assess if changes were statistically significant, the study used the t-test. A negative sign shows a reduction in budget allocation and the reverse was true with a positive sign. All the analysis was made using Stata 14 and Excel 2016.

a) Food budget share

In economics, the food budget share has been strongly linked to Engel's law relying on the negative relationship between the income/total expenditure and the food budget share. The law stipulates that poor households spend a larger share of their income on food. In other words, a large share of the total expenditure of poor households is allocated to food (Engel, 1857). However, it is worth noting that this law is not applicable in all situations. As opposed to Houthakker (1957), who stipulated that Engel's law should be the best-established law in economics, nevertheless for some reasons, this study questioned the unanimity of the law. In 1857, Engel was not aware of the utility-based demand function that was developed by Walras and Jevons in the 1870s (Chakrabarty and Hildenbrand, 2011).

Moreover, Engel's aim was to find out the relationship that exist between the individual and household consumption. He estimated the food budget share as the food budget divided by the income (Engel, 1857; Gardes, 2007). However, when adding other variables to the model, the Engel's law does not hold. Clements and Si (2017) found that given that diet diversity tends to rise with income, not only does the proportion of food drop with higher income but probably the expenditure will spread more evenly throughout food items, offering a much more nutritious diet.

They also found that higher incomes lead to a gradual shift from lesser-quality food items to a much more costly, plausibly more tasty and healthy foods.

Furthermore, households with the same income but having different characteristics such as the household size will spend differently on foods similarly, households with the same features and the same income, being in two different societies with different standards of living will also spend differently on food (Gardes, 2007; Chakrabarty and Hildenbrand, 2011; Clements and Si, 2017). The Engel's law remains very useful in economics; however, it holds only for stratified subpopulations in which all measurable non-revenue exogenous variables such as prices, presence of non-food items, household characteristics, and demographics are assumed constant.

In the context of this study, the budget share was analysed and discussed according to the classification of Smith and Subandoro (2007) to provide the vulnerability status towards food security of households in different regions and in each province. The Engel's law was used to explain the differences over the country. The food budget share used the following formula (Smith and Subandoro, 2007):

$$Food\ budget\ share\ (\%) = \left(\frac{food\ expenditure}{total\ expenditure}\right) * 100 \quad (1)$$

$$change = Food\ budget\ share_{2012} - Food\ budget\ share_{2005} \quad (2)$$

b) Household food consumption

- *Clustering*

In order to analyse the household's food consumption, the first step was to cluster provinces. The aim was to classify regions in the 26 provinces into Clusters having similar diet to enable a more manageable analysis of food consumption than for individual provinces. The aim of the cluster analysis was to maximize the variability between the cluster and minimise the variability within the clusters.

There are two approaches that are mainly used for clustering due to their ease of determining each object's cluster membership: hierarchical and non-hierarchical. The hierarchical clustering analysis uses distance (Euclidean distance) between the objects to form clusters. There are different algorithms that are used for the hierarchical clustering analysis. The most popular algorithms are the methods of complete linkage (furthest neighbour), single linkage (nearest neighbour), average linkage, centroid linkage, Ward's linkage and median linkage. The dendrogram graphically represents the distance between clusters at every level of the analysis. Finally, the researcher chooses the number of clusters that give the best meaning to the data (Fraley and Raftery, 1998; Murtagh and Legendre, 2011; Xie *et al.*, 2016). For this study, the Wald's linkage algorithm was used because it is known to be more efficient (Dinov, 2018).

In order to define a more homogeneous diet, this study grouped the clustered provinces using calorie shares intake from each food group for 2012 as indicators. Calories shares for different food groups were chosen instead of the different budget shares of different food groups to avoid the issues of the price difference (in term of money) that can be different across locations. The calorie shares allowed to get clusters characterized by exactly the same diet.

The squared Euclidean distance used the following formula (Kumar *et al.*, 2014):

$$D_{ES}(x_i, x_j) = \sum_{l=1}^{16} (x_{il} - x_{jl})^2 \quad (3)$$

Where,

$D_{ES}(x_i, x_j)$ squared Euclidean distance between two provinces.

x_{il} is the calorie share of the l-th food group of the i-th province

x_{jl} is the calorie share of the l-th food group of the j-th province.

The smaller the $D_{ES}(x_i, x_j)$ value, the greater the degree of similarities between provinces.

The Clusters that show the similarities in the calories intake were represented by Figure 3 for urban areas and Figure 4 for rural areas.

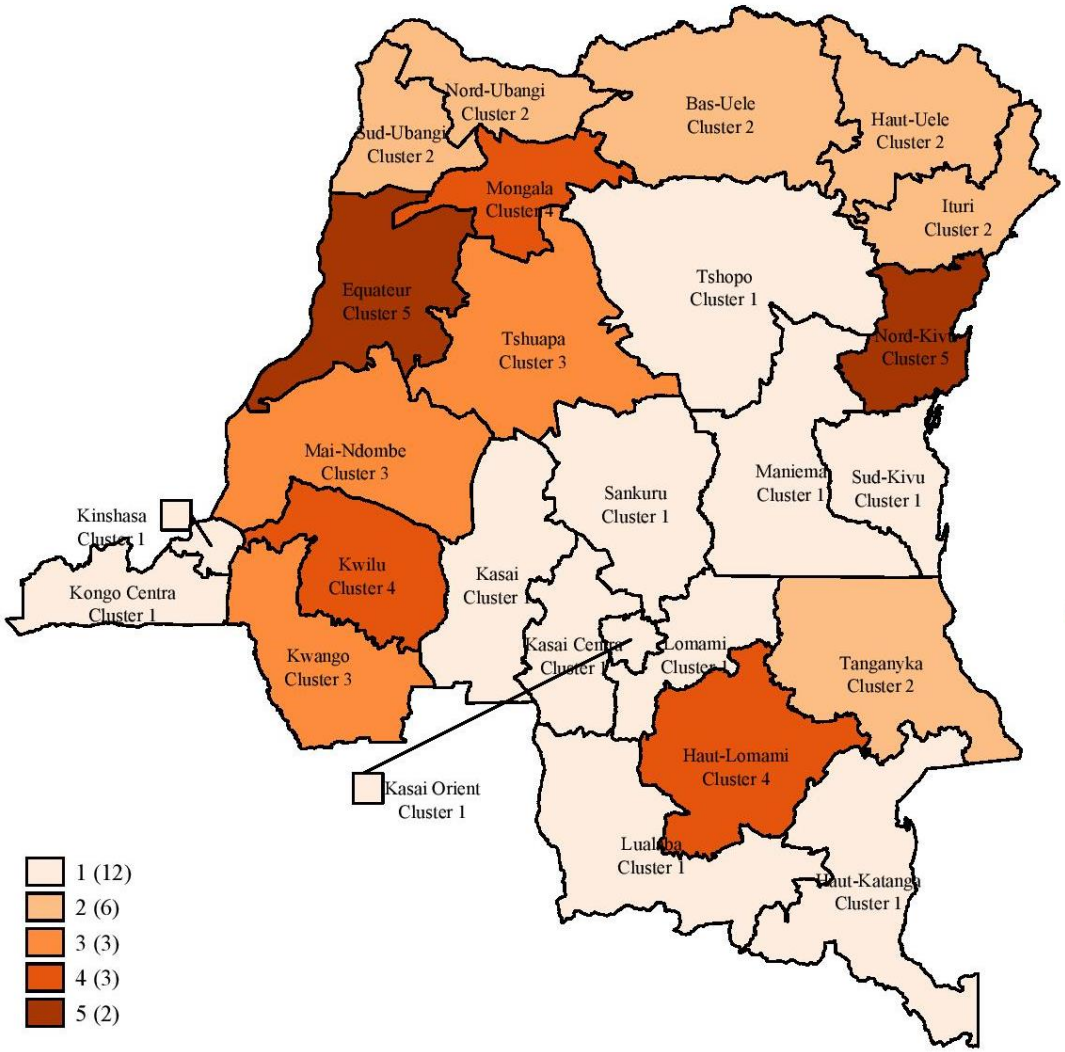

Figure 3: Urban food consumption cluster

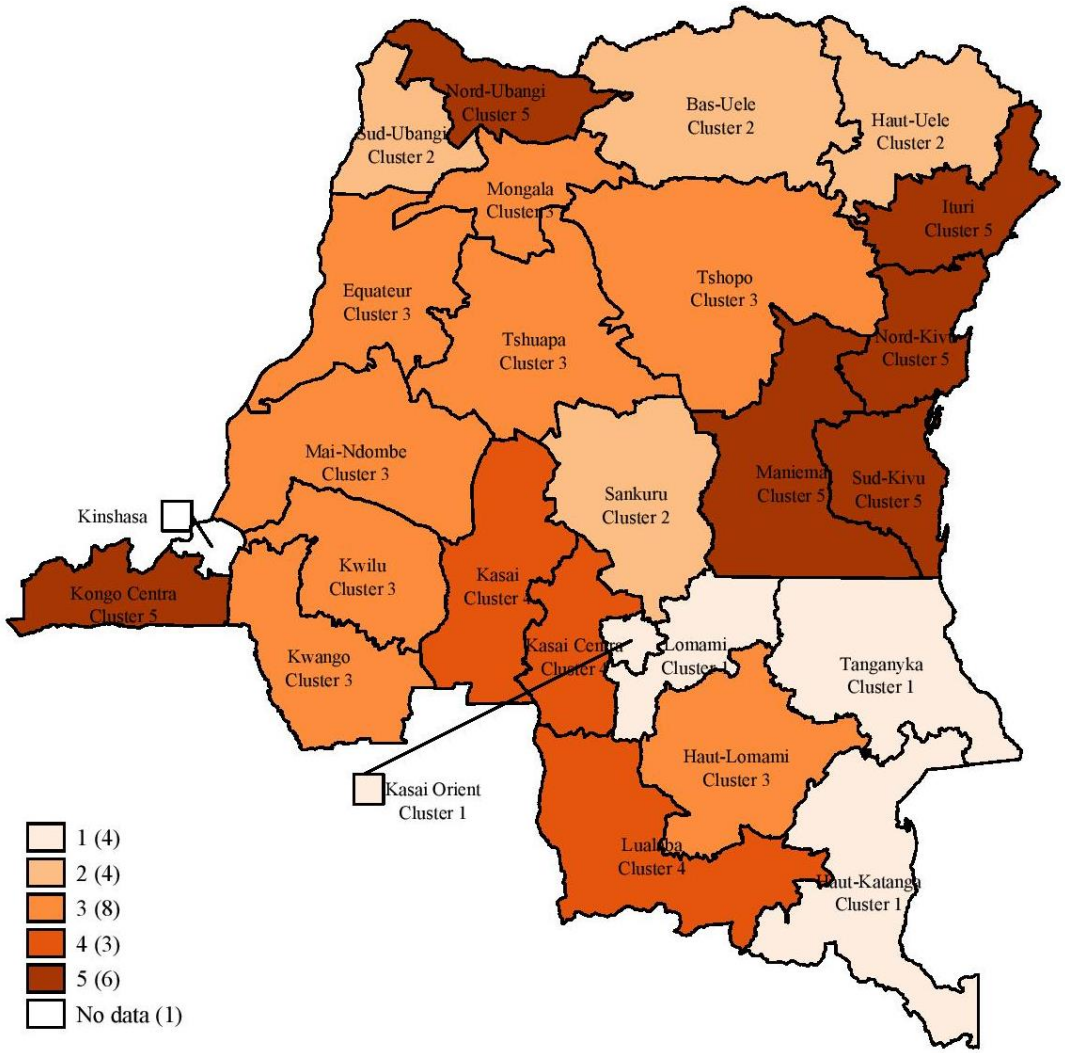

Figure 4: Rural food consumption cluster

a) Urban areas

- Cluster 1: Kinshasa, Kongo Central, Kasai Central, Kasai, Sankuru, Kasai Oriental, Lomami, Tshopo, Maniema, South Kivu, Lualaba and Haut Katanga.
- Cluster 2: Sankuru, South Ubangi, Bas Uele and Haut Uele.
- Cluster 3: Tshuapa, Mai-Ndombe and Kwango.
- Cluster 4: Kwilu, Mongala and Haut Lomami.
- Cluster 5: North Kivu and Equateur.

b) Rural areas:

- Cluster 1: Kasai Oriental, Lomami, Tanganyika and Haut Katanga.
- Cluster 2: Tanganyika, South Ubangi, North Ubangi, Bas Uele, Haut Uele and Ituri.
- Cluster 3: Kwango, Kwilu, Mai-Ndombe, Tshuapa, Equateur, Mongala, Tshopo and Haut-Lomami.
- Cluster 4: Kasai, Kasai Centrale and Lualaba.
- Cluster 5: Kongo Centrale, North Ubangi, Maniema, Ituri, South Kivu and North Kivu.

The five Clusters are quite similar to the findings of Marivoet (2016). However, few differences occur the clustering of Marivoet (2016) was based on 2005 calories share intake while for this study, the grouping was based on 2012 calories share intake.

The similarities and dissimilarities between provinces depend on the price, the reliance on a particular food, the proximity, openness of the provinces to other countries and culture (Marivoet, 2016).

- *Food consumption and change*

The budget share for each food group by region and for each province was analysed and clustered.

The food consumption used the formula:

$$w_i = \frac{Expfoodg_i}{Exp_{food}} * 100, \quad i \in [1,16] \tag{4}$$

Where,

$w_i$is the budget share of food group i

$Expfg_i$ is the food group i expenditure

Exp_{food} is the food expenditure.

$$change = w_{i2012} - w_{i2005} \tag{5}$$

c) Estimation of nutrient Intake

This study estimated the nutrient deficiencies based on the recommended intake levels by sex and age. The estimation was done according to the reports of the FAO/WHO/UNU (2004), WHO (2004) and the World Health Organization and United Nations University (2007). Moreover, as suggested by Marivoet and Ulimwengu (2018), this study considered a 30 year old male as reference for the Adult Male Equivalent scale. The research assumed his physical activity as a moderate lifestyle. An adult male of 30-year-old was selected because the nutrient required for their healthy life is generally greater than the other members of the family except for pregnant women. Hence, meeting the nutritional status of such a man assumes that the nutritional status of other members of the family has been achieved.

The daily intake requirements were therefore 2,750 Kilocalories (Kcal), 50 grams (g), 600 micrograms (mcg), 1000 milligrams (mcg), 14 milligrams (mg), 27.4 milligrams (mg), 400 micrograms (mg) and 2.4 micrograms (mg) for calories, protein, vitamin A, calcium, zinc, iron, folate and Vitamin B12 respectively. These nutrients were selected because they are more problematic in developing countries (WHO, 2004).

d) Expenditure and price elasticities

The income and price elasticities were estimated for each food group using the QUAIDS. The QUAIDS is derived from a generalisation of the Price-Independent Generalized Logarithmic PIGLOG preference, starting from an indirect utility function of the form (Banks *et al.*, 1996, 1997):

$$\ln V = \left\{ \left[\frac{\ln m - \ln a(p)}{b(p)} \right]^{-1} + \lambda(p) \right\}^{-1} \tag{6}$$

Where,

$(\ln m - \ln a(p))/b(p)$ is the utility function of a demand system with budget shares linear in log total expenditure.

m is the household income

$a(p), b(p)\ and\ \lambda(p)$ are functions of the vector price

In order to ensure the homogeneity property of the indirect utility function, it requires that $a(p)$ is homogenous of degree one in p, and $b(p)$ and $\lambda(p)$ homogenous of degree zero in p.

$\ln a(p)$ has a translog form and $b(p)$ is a simple Cobb-Douglas aggregator.

$$\ln a(p) = \alpha_0 + \sum_j \alpha_j \ln P_j + \frac{1}{2} \sum_i \sum_j \gamma_{ij} \ln P_i \ln P_j \tag{7}$$

$$b(p) = \prod_{i=1}^{n} p_i^{\beta_i} \tag{8}$$

$$\lambda(p) = \sum_{i=1}^{n} \lambda_i \ln p_i \; where \; \sum_i \lambda_i = 0 \tag{9}$$

Using Roy's identity to the indirect utility function, the budget shares was be given as:

$$w_i = \alpha_i + \sum_j \gamma_{ij} \ln p_j + \beta_i \ln \left[\frac{m}{a(p)}\right] + \frac{\lambda_i}{b(p)} \left\{\ln \left[\frac{m}{a(p)}\right]\right\}^2 + \varepsilon_i \quad (10)$$

W_i are the estimated budget share of the i[th] food group in the total food expenditure, $\alpha_i, \beta_i, \lambda_i, \partial_{ik}\ and\ \gamma_{ij}$ are parameters to be estimated, m = total expenditure, and p_j are food item j prices.

- α_i intercept capturing the demographic variables.
- γ_{ij} shows the effects of a 1% change in the prices of item j on a budget of group *i*,
- β_i illustrates whether goods are luxuries or necessities,
- λ_i determines the effects of quadratic term,
- ε_i is the error term.

The coefficients of the quadratic term must be price dependent.

For theoretical consistency,

$$\sum \alpha_i = 1; \sum \beta_i = 0; \sum \gamma_{ij} = 0\ and\ \gamma_{ij} = \gamma_{ji} \quad (11)$$

where *j* represents the food groups in the demand system and therefore $J - 1 = 7$ the expenditure share equations. In our system of food demand, this study had eight commodity groups and hence five equations. The parameters of the eighth commodity group are derived by imposing the following constraints.

The Equation (11) represents the theoretical constraints of addition, homogeneity and symmetry. Moreover, that should remain for the QUAIDS model to indicate a system of demand equations, which sum up to the total expenditure $\sum w_i = 1$, satisfy Slutsky symmetry and are homogeneous to degree zero in total expenditure and prices.

The demographic effects through the intercept in Equation (10) is given as:

$$\alpha_i = \rho_{i0} + \sum_j \rho_{ij} d_j \tag{12}$$

where d_j is the j^{th} demographic variable of which there are J.

To calculate the QUAIDS model elasticities, Equation (10) was differentiated with respect to $\ln m$ and $\ln p_j$, respectively to obtain:

$$\mu_i \equiv \frac{\partial w_i}{\partial \ln m} = \beta_i + \frac{2\lambda_i}{b(p)}\left\{\ln\left[\frac{m}{a(p)}\right]\right\} \tag{13}$$

$$\mu_{ij} \equiv \frac{\partial w_i}{\partial \ln p_j} = \gamma_{ij} - \mu_i\left(\alpha_j + \sum_k \gamma_{jk} \ln p_k\right) - \frac{\lambda_i \beta_j}{b(p)}\left\{\ln\left[\frac{m}{a(p)}\right]\right\}^2 \tag{14}$$

The elasticities can be computed as:

$$\eta_{im} = \frac{\mu_i}{w_i} + 1 \tag{15}$$

$$\eta_{ij}^M = \frac{\mu_{ij}}{w_i} - \delta_{ij} \tag{16}$$

Using the Slutsky equation:

$$\eta_{ij}^h = \eta_{ij}^M + \eta_{im} w_i \tag{17}$$

Where:

η_{im} is the Expenditure elasticities, η_{ij}^M represents the Marshallian elasticities, η^h represents the Hicksian elasticities, $\delta_{ij}$is the Kronecker delta.

- *Application and interpretation of the demand analysis on food*

The QUAIDS model allows for the estimation of the expenditure elasticity (Equation 8) which represents the relative change of demand with respect to the relative change in expenditure. Own price elasticity, on the other hand, is the measure of the percentage change in the quantity

demanded of good *"i"* from a one per cent change in the price of good *"j" (ceteris paribus)*. If *"i"* and *"j"* are the same then it is own-price elasticity. Otherwise, it is cross-price elasticities.

The uncompensated (Marshallian) elasticity deals with how demand changes when price changes, holding money income constant. On the other hand, the compensated (Hicksian) elasticity deals with how demand changes when price changes, holding "real income" or utility constant.

One of the most often used indicators in the socioeconomic analysis is the elasticity of demand (Wyrzykowski, 2014). In economics, the response of an economic variable due to a change in another is measured by the elasticities[7] (Nicholson and Snyder, 2011; Varian, 2014). Thus, one can explain the elasticity of demand for food as the measurement of how food demand changes in response to income or price; that is, income and price elasticities respectively.

- *Income elasticity of the demand for food*

In nutrition policy, policymakers intend to reach the optimum nutritional well-being. To do so, they try to respond to questions related to how much the income of households should be raised. The income elasticity can be used for future consumption patterns or changes. The starting point in responding to that question is to understand the relationship that exists between income and nutrition or income and food consumption. Here the critical aspect is to understand what happens to the nutrition/food consumption when the income changes (Babu *et al.*, 2017).

Price remaining constant, the measure of the change in food demand in response to a change in income is given by the income elasticity of demand. Therefore, the percentage change in the quantity demanded due to a unit percentage change in income is the income elasticity. Three cases are possible when calculating income elasticity (Varian, 2014). When the income elasticity is greater than one, the demand for food is *income elastic* meaning that the food demand increases

[7] https://en.wikipedia.org/wiki/Elasticity_(economics) visited 13 December 2018

more than proportionately with increase in income. When the income elasticity is less than one, the demand for food is *income inelastic* meaning that the food demand decreases with an increased income (Babu *et al.*, 2017). Moreover, when the income elasticity for a given food group is negative, it means that the food group is inferior. This implies that the household demand for that food group decreases with an increase in income. If it is equal to zero, then there is no correlation between income and the food group. When it is positive, it means that the food group is associated with normal goods. It is a necessity good when it is less than one and a luxury good when it is greater than one (Nicholson and Snyder, 2011; Varian, 2014).

(v) Price elasticity of food demand

The price elasticity of demand also called the own-price elasticity of demand measures the proportionate change in quantity demanded in response to a proportionate change in the good's own price (Nicholson and Snyder, 2011). In order to measure the impact of food price on consumption, this study used the price elasticity of demand for food. It explains how people respond to changes in price when there is a wide variety of food on the market. When the effect is small then the demand is inelastic, and when it is high then the demand is elastic. However, mathematically, the price elasticity is negative but it is mostly taken in an absolute value. When the price elasticity of demand is equal to "-1" then the quantity demanded and the price of a given food group changes in the same proportion, which means that the expenditure for food remains the same no matter the price change. When it is less than "-1" the change in quantity demanded is greater than the price changes, which means that the increase in the price of a food group causes the total spending to decrease. Finally, if the price elasticity of demand is greater than minus one then the quantity demanded is less than the price change. Consequently, the demand is inelastic, meaning that the demand of a food group goes in the same direction as the price. A food group can be considered a necessity when the demand is inelastic and luxury when it is elastic.

(vi) Engel Curves of food demand

It is important to have a good understanding of the difference between the Engel's curve of the demand for food and income elasticity of the demand for food. The Engel's curve illustrates how the choice of food (group) consumption changes with an increase in household income. However, income elasticities provide measures of the percentage changes in food (group) consumption due to a on per cent change in household's income (Ecker and Fang, 2016). In other words, the Engel's curves provide evidence on how food consumption is likely to change in case of the rise in income. The shape of the curve gives the pattern of the change.

Ecker and Fang (2016) found that in Ghana the shape of the estimated Engel's curves suggested that the consumption of all food groups increases almost linearly with the rise in income. The slope of the Engel's curves suggested that the consumption of the animal-source foods in both urban and rural area of Ghana increases faster than other food groups. The Engel's curves for the consumption of nuts and pulses were almost flat showing that their consumption is most likely to remain the same when there is a rise in income.

e) Estimation of Engel's Curves

When preferences and prices are held constant, all the points of the Engel's Curves represent the quantities demanded of the goods at different levels of income or total expenditure (Engel, 1857; Babu *et al.*, 2017). In other words, the Engel's curves illustrate the associations between food group consumption levels and income levels across households, providing evidence on how food group consumption is likely to change when income rises (Banks *et al.*, 1997). For estimation, the Engel's curves ought to have some desirable properties. Those properties need to satisfy the budget constraint, being able to represent luxuries, necessities and inferior goods (Yu, 2017).

There are four forms of functions of Engel's curve: Linear, Double logarithmic, Semi logarithmic, logarithmic reciprocal and Working-Leser. For the purpose of this study, to represent the Engel's

curves, quadratic Working-Leser form was used. The Working-Leser form was introduced by Working (1943) and Leser (1963). Even though literature has suggested that the Working Leser model is suitable for food items, it assumes that the relation between food item expenditure share and expenditure should be linear. Due to this limitation, the quadratic representation was, therefore, preferred. This enables a given good to be a luxury good at a certain level of income and a necessity good at another (Banks et al., 1997).

The Working-Leser equation form is:

$$w_i = a + blnx_i + \varepsilon_i \tag{18}$$

Where, w_i are the estimated budget share of the ith food group in the total food expenditure. $x_i$are the household total expenditure.

In order to obtain the quadratic form from the Working-Leser form, quadratic term of the ln of the household total expenditure was simply added in Equation (19):

$$w_i = a + blnx_i + c(lnx_i)^2 + \varepsilon_i \tag{19}$$

In order to assess the household demand and the Engel's curves, food items were categorised into eight food groups commonly used by the World Food Program. The aggregated food groups including main staples, pulses, vegetables, fruits, fish and meat, milk, sugar and oil as presented in Table 2 were utilised for the demand analysis and the Engel Curves.

- *Food groups*

The food groups that were considered for the purpose of this study were represented in Table 2. The study considered 16 food groups as suggested by the FAO for the analysis of the food consumption and 8 food groups as suggested by the WFP for the demand analysis (Kennedy *et al.*, 2011). The difference was due to the issues of missing prices of some food items while considering the 16 food groups.

Table 2: Food groups and food items

	Aggregate Food groups	Food groups	Foods Items usually consumed
1	**Main staples**	**Cereals** **Roots and tubers**	Cereals such as rice, maize flour, sorghum, bread, dry corn (husked), etc. Plantains, roots and tubers such as cassava flour, potatoes, etc.
2	**Pulses**	**Legumes, nuts and seeds**	Beans, soya, groundnuts.
3	**Vegetables**	**Vitamin A-rich vegetables and tubers** **Dark green leafy vegetables** **Other vegetables**	Vegetables, Cassava leaves and others leave
4	**Fruit**	**Fruits rich in vitamin A** **Other fruits**	Orange, mango, pineapple, apple, avocado, etc.
5	**Meat and fish**	**Flesh meat** **Organ meat** **Fish and seafood** **Eggs**	Pork, poultry, goat, beef, egg, frozen fish (mpiodi), dried/smoked fish, salted fish (Bitoyo), fried sardine (ndakala), etc.
6	**Milk**	**Milk and dairy products**	Milk, cheese, yoghurt and other dairy product
7	**Oil**	**Oils and fats**	Palm oil, butter, fats, oils
8	**Sugar**	**Sweets**	Sweets, honey and sugar products
		Spices, beverages	

Source: Authors adapted from the World Food Programme (2008)

CHAPTER FOUR : RESULTS AND DISCUSSION

4.0 Income spent on food at the household level

Changes in food budget share for both rural and urban areas of the DRC for 2005 and 2012 are presented in Table 3.

Table 3: Food budget shares in DRC

Provinces	Urban			Rural		
	2005	2012	Change	2005	2012	Change
	Mean (%)	Mean (%)	(%)	Mean (%)	Mean (%)	(%)
Kinshasa	58.2	63.3	5.1***	-	-	-
Kongo Central	63.7	67.4	3.7***	70.4	83.5	13.1***
Mai-Ndombe	-	62.8	-	67.5	77.5	10.0***
Kwilu	65.9	63.7	-2.2*	73.8	76.0	2.2**
Kwango	66.7	73.9	7.2***	75.8	81.6	5.8***
Equateur	63.4	72.5	9.1***	68.4	81.7	13.3***
South Ubangi	63.7	75.1	11.4***	65.4	84.0	18.6***
North Ubangi	72.3	73.4	1.1	65.2	82.0	16.8***
Mongala	72.6	73.5	0.9	72.8	78.9	6.1***
Tshuapa	-	62.0	-	69.2	66.6	-2.6
Tshopo	64.5	75.0	10.5***	69.9	76.0	6.1***
Bas Uele	-	75.7	-	81.0	83.5	2.5*
Haut Uele	77.7	84.7	7.0***	75.8	85.3	9.5***
Ituri	62.5	68.3	5.8**	75.2	82.7	7.5***
North Kivu	57.8	72.0	14.2***	74.0	84.0	10.0***
South Kivu	63.8	69.7	5.9***	79.3	80.5	1.2
Maniema	69.2	77.7	8.5***	70.9	81.0	10.1***
Lualaba	63.3	65.9	2.6	69.9	83.8	13.9***
Haut Lomami	-	74.8	-	73.4	77.9	4.5***
Tanganyika	-	66.4	-	78.1	84.0	5.9***
Haut Katanga	62.8	61.1	-1.7	75.1	78.4	3.3**
Kasaï Oriental	61.6	76.0	14.4***	71.6	87.6	16.0***
Sankuru	-	74.4	-	75.9	73.2	-2.7*
Lomami	72.3	71.0	-1.3	68.5	85.0	16.5***
Kasaï	66.0	70.2	4.2***	72.8	78.0	5.2***
Kasaï Central	67.5	76.0	8.5***	72.6	76.7	4.1***

* significant at 10%, ** significant at 5%, *** significant at 1%.

Source: Authors' computation from Enquête 1-2-3 data 2005 and 2012. (The source remains to be the author in all the Tables and Figures that follow).

Table 3 shows that the food budget share in urban areas in 2012 were highest in Haut Uele with 84.7% and at the lowest in Haut Katanga with 61.1%. The low food budget share in Haut Katanga

urban areas could be due to the high level of income in the province (Ngombe *et al.*, 2015). In rural areas, the highest food budget share was in Kasai-Oriental at 87.6% and the lowest was in Tshuapa with 66.6%. This shows that almost all the provinces were either highly food insecure or very vulnerable to food deprivation in rural areas.

Furthermore, from 2005 to 2012 in urban areas, the budget allocated to food in Kinshasa, Kongo Central, Kwilu, Kwango, Equateur, South Ubangi, Tshopo, Haut Uele, Ituri, North Kivu, South Kivu, Maniema, Kasai-Oriental, Kasai and Kasai-Centrale significantly increased by 5.1%, 3.7%, -2.2%, 7.2%, 9.1%, 11.4%, 10.5%, 7.0%, 5.8%, 14.2%, 5.9%, 8.5%, 14.4%, 4.2% and 8.5% respectively. It is important to note that a remarkable increase in the budget share allocated to food in Goma (urban North Kivu) could be due to the volcanic eruption that the city experienced in 2002 which has had a long term effect on the population (Büscher and Vlassenroot, 2010).

While for rural areas in Kongo Central, Mai-Ndombe, Kwilu, Kwango, Equateur, South Ubangi, North Ubangi, Mongala, Tshopo, Bas Uele, Haut Uele, Ituri, North Kivu, Maniema, Lualaba, Haut-Lomami, Tanganyika, Haut Katanga, Kasai Oriental, Sankuru, Lomami, Kasai and Kasai-Centrale, the food budget sgare significantly increased by 13.1%, 10.0%, 2.2%, 5.8%, 13.3%, 18.6%, 16.8%, 6.1%, 6.1%, 2.5%, 9.5%, 7.5%, 10.0%, 10.1%, 13.9%, 4.5%, 5.9%, 3.3%, 16.0%, -2.7%, 16.5%, 5.2% and 4.1%, respectively. Surprisingly, Sankuru was the only province with a decrease in the food budget allocated share. This could be because Sankuru is among the few provinces which have not been affected by conflict (IOM, 2018).

The overall increase in the food budget share in almost all the provinces shows that over time, the vulnerability of households towards food insecurity was increasing for both urban and rural areas. The increase in the food budget share also indicates an increase in the prevalence of poverty in the country (Coulombe and Wodon, 2012).

The findings of this research are in line with the research of Dickinson *et al.* (2003), and Smith and Subandoro (2007) who found that food expenditures account for a relatively large share of household income in developing countries. Also, the findings were in line with the work of Chauvin *et al.* (2012), who found that urban households in most African countries spend a lower share of their income on food compared to rural regions. The findings are in contrast to the work of Hawk (2013) who found that urban households spent 7% more on food than rural households in the United States.

The reason for the high budget share allocated to food could be attributed to the lower level of household income. The differences found between urban and rural households could be attributed to the gap that exists between the level of income in urban and rural areas. Also, the inadequate connection between the urban and the rural areas and between provinces could be due to the lousy infrastructures leading to a poor communication within and between provinces, which creates a high differences in the prices within regions (Marivoet *et al.*, 2018). In other words, the difference in food budget share between the rural and urban households could be due to the poor road network leading to low market commmunication and inter-spatial price differences. The price difference could also explain the differences in the food budget allocations between provinces.

The argument on the food price differences is in line with Marivoet (2016) who argued that the high budget share allocation of food could also be explained by the low consumption of nonfood items. This explanation is the most plausible for the case of DRC. It contradicts the Engel law because the high budget share allocated to food does not only depend on the income level but also on the availability of nonfood items. However, the people in rural areas, where mining activity is predominant, usually earn high-incomes. A considerable share of the income goes to food items due to the lack of other options. This finding is similar to the work of Van Den Boom *et al.* (2015), who also found that lesser consumption of nonfood item is not due to taste or preferences but mainly due to the lack of nonfood item. These non-food items include transports services such as

public and public ransportation, technological elements and essential services like electricity, water, health, etc.

Moreover, the Engel law cannot be used as an appropriate proxy to compare provinces in DRC due to the price difference between and within provinces (Marivoet, 2016). The price differences makes it difficult to compare provinces or regions as the Engel law only holds with the assumption that price is constant. Provinces such as Kwango, Equateur, South Ubangi, North Ubangi, Mongala, Tshopo, Bas-Uele, Haut Uele, Maniema, Haut Lomami, Kasai Oriental, Sankuru, Lomami and Kasai Centrale allocate more than 70% of the budget to food. The high food allocation in these provinces could be due to the fact that the provinces are landlocked, thus, reducing their capacity to trade. Another reason for the high allocation of the budget to food could be explained by the low agricultural production and productivity in the country (Archambaud and Gondard-Delcroix, 2018). Although a large share of food consumed emanates from household production, especially in rural areas, households still need to buy food to diversify their diet. Despite the low purchasing power of the rural households, the food items are relatively expensive due to the low food output in the country. Families, therefore, end up spending a considerable amount of their budget on food (Marivoet *et al.*, 2018). The low agricultural productivity and production may be due to the different wars that the country has experienced which is associated with the lack of effective policies. The low agricultural production and conflicts considerably reduce the purchasing power of households (Jules *et al.*, 2016; Archambaud and Gondard-Delcroix, 2018).

The positive changes in the food budget share over time could be explained by the fact that the economic growth portrayed at the macro level in the country is not observable at the household level (Marivoet *et al.*, 2018). It mainly depends on the living location of the household (Ural Marchand, 2017). Notably, the change in Kinshasa shows that the food budget share had increased, probably due to a reduction of opportunities and employment in that region. The reduction of

opportunies and job employment could be attributed to over population resulting from an increase in the number of immigrants (National Institute of Statistic, 2014; 2015). Also, this change could be attributed to the fact that food supply in Kinshasa is highly dependent on agricultural produce from other provinces and food imports. Consequently, any shock that affects trade and production in neighbouring provinces would most likely affect the market price and the welfare of the people[8].

Lubumbashi (second city) also experienced an increased number of inmigrants over the past two years. However, the standard of living remained relatively high, which could due to the existence of mining companies in the province. Rural households in the Haut Katanga were very vulnerable to food deprivation due to the poor communication between urban and rural areas (Marivoet *et al.*, 2018). Moreover, this change and pattern of food consumption are mostly consistent with regional differences in the prevalence of poverty and household food insecurity (Marivoet *et al.*, 2018).

4.1 Households food consumption at the provincial level

Food groups on which households spent their income by cluster are presented in Table 4 for urban areas and Table 5 for rural areas.

[8] https://www.radiookapi.net/societe/2012/11/27/kinshasa-hausse-des-prix-des-produits-en-provenance-de-goma visited on 5th February 2019

Table 4: Urban food consumption

Food groups	Cluster 1			Cluster 2			Cluster 3			Cluster 4			Cluster 5		
	2005	2012	Diff.	2005	2012	Diff.	2005	2012	Diff.	2005	2012	Diff.	2005	2012	Diff.
	Mean (%)	Mean (%)	(%)	Mean (%)	Mean (%)	(%)	Mean (%)	Mean (%)	(%)	Mean (%)	Mean (%)	(%)	Mean (%)	Mean (%)	(%)
Cereals	28.8	28.1	-0.6	12.6	16.7	4.1	5.5	7.8	2.3	11.6	15.2	3.6	13.5	13.7	0.2
Roots and tubers	14.2	12.1	-2.1	20.9	18.1	-2.8	37.0	24.9	-12.1	21.8	13.6	-8.2	21.3	20.3	-0.9
Legumes, nuts and seeds	5.7	4.6	-1.1	7.1	6.8	-0.4	8.1	4.3	-3.8	4.8	7.3	2.5	8.4	8.1	-0.4
Vitamin A rich vegetables and tubers	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1
Dark green leafy vegetables	6.2	6.8	0.5	8.9	7.4	-1.6	6.4	7.0	0.6	9.1	6.7	-2.4	5.3	6.8	1.5
Other vegetables	4.3	5.5	1.2	6.3	4.4	-1.8	2.1	3.4	1.3	6.3	5.6	-0.7	5.2	5.9	0.6
Fruits rich in vitamin A	0.0	0.1	0.1	0.1	0.0	-0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.1	0.1
Other fruits	0.3	0.6	0.3	0.9	0.8	-0.2	0.5	0.9	0.4	0.7	0.3	-0.3	0.7	0.6	-0.1
Flesh meat	5.3	8.1	2.8	9.1	8.6	-0.5	8.8	14.0	5.2	6.0	4.7	-1.3	8.0	8.5	0.5
Organ meat	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	-0.1	0.1	0.0	-0.1	0.0	0.0	0.0
Fish and seafood	15.1	16.5	1.4	11.8	12.5	0.7	12.7	18.4	5.7	21.8	20.3	-1.5	17.4	19.8	2.4
Eggs	0.0	0.1	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.1	0.0	-0.1	0.1	0.1	0.0
Milk and dairy products	0.5	0.9	0.4	0.1	0.2	0.1	0.2	0.2	0.0	0.1	0.2	0.1	0.4	0.6	0.2
Oils and fats	8.9	7.3	-1.7	9.7	12.8	3.1	5.5	6.6	1.1	6.7	7.3	0.6	7.2	6.5	-0.7
Sweets	1.9	2.0	0.0	3.7	2.3	-1.5	2.1	1.0	-1.1	1.0	1.3	0.4	3.1	2.1	-1.0
Spices, beverages	8.8	7.3	-1.5	8.9	9.6	0.6	11.1	11.6	0.5	10.4	17.4	7.0	9.6	7.3	-2.3

Table 5: Rural food consumption

Food groups	Cluster 1			Cluster 2			Cluster 3			Cluster 4			Cluster 5		
	2005	2012	Diff.	2005	2012	Diff.	2005	2012	Diff.	2005	2012	Diff.	2005	2012	Diff.
	Mean (%)	Mean (%)	(%)	Mean (%)	Mean (%)	(%)	Mean (%)	Mean (%)	(%)	Mean (%)	Mean (%)	(%)	Mean (%)	Mean (%)	(%)
Cereals	17.7	17.3	-0.4	16.3	17.6	1.3	6.5	9.6	3.1	16.7	19.6	2.8	6.5	12.9	6.5
Roots and tubers	26.5	18.0	-8.5	23.9	23.0	-0.9	27.9	25.6	-2.2	18.1	21.4	3.2	31.7	23.5	-8.3
Legumes, nuts and seeds	6.1	2.3	-3.8	6.3	4.0	-2.3	6.5	5.4	-1.1	5.2	3.0	-2.2	10.4	7.9	-2.5
Vitamin A rich vegetables and tubers	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dark green leafy vegetables	7.2	6.2	-1.0	6.8	6.2	-0.7	7.8	7.6	-0.2	6.8	8.4	1.6	6.7	6.4	-0.3
Other vegetables	2.9	3.5	0.6	3.5	3.5	0.0	5.0	5.5	0.5	2.1	3.3	1.2	5.7	6.0	0.3
Fruits rich in vitamin A	0.0	0.3	0.3	0.0	0.1	0.1	0.1	0.2	0.1	0.0	0.1	0.1	0.2	0.1	-0.2
Other fruits	0.6	0.6	0.0	0.8	1.1	0.3	1.3	1.2	-0.1	0.7	0.7	0.0	1.1	0.9	-0.2
Flesh meat	6.6	11.3	4.7	9.6	10.6	0.9	10.0	11.9	2.0	12.7	11.6	-1.1	7.8	8.1	0.3
Organ meat	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fish and seafood	13.5	18.0	4.5	10.3	12.0	1.7	13.4	14.5	1.2	13.9	12.6	-1.3	10.5	11.6	1.1
Eggs	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.1	0.0	0.1	0.1
Milk and dairy products	0.1	0.1	0.1	0.1	0.1	-0.1	0.0	0.3	0.2	0.4	0.2	-0.3	0.0	0.2	0.1
Oils and fats	7.6	9.0	1.4	8.9	10.2	1.3	6.2	7.2	0.9	10.0	8.8	-1.2	8.6	9.5	0.9
Sweets	0.9	1.4	0.5	1.3	1.8	0.6	1.4	2.0	0.7	2.3	1.8	-0.5	0.9	2.1	1.1
Spices beverages	10.3	12.0	1.7	12.2	9.9	-2.3	13.9	9.0	-4.9	11.0	8.5	-2.5	9.6	10.7	1.2

In urban areas (Table 4), from 2005 to 2012, the budget share allocated to cereals increased by 4.1%, 2.3%, 3.6% and 0.2% in Clusters 2 to 5 respectively. However, in Cluster 1 the budget share for cereals reduced by 0.6% between 2005 and 2012. For roots and tubers, it decreased by 2.1%, 2.8%, 12.1%, 8.2% and 0.9% in Clusters 1 to 5 respectively. For flesh meat, it increased by 2.8%, 5.2%, and 0.5% in Clusters 1, 3 and 5 respectively. On the other hand, the budget share for flesh meat decreased by 0.5% and 1.3% in Clusters 2 and 4 respectively. For fish and seafood, the budget share increased by 1.4%, 0.7%, 5.7% and 2.4% for Clusters 1, 2, 3 and 5 respectively. However, it reduced by 1.5% in Cluster 4 from 2005 to 2012.

In rural areas (Table 5), the results showed that the budget share allocated to cereals between 2005 and 2012 increased by 1.3%, 3.1%, 2.8% and 3.7% in Clusters 2 to 5 respectively. Nevertheless, it decreased by 0.5% in Cluster 1. For roots and tubers, it increased by 3.2% in Cluster 4. However, in Clusters 1,2,3 and 5 the budget share for roots and tubers reduced by 8.5%, 0.9%, 2.2% and -8.3% respectively. The results also showed that budget share for flesh meat increased by 4.7%, 0.9%, 2.0% and 0.3% in Clusters 1, 2, 3 and 5 respectively. However, it reduced by 1.1% in Cluster 4. Additionally, budget share for fish and seafood in Clusters 1, 2, 3 and 5 increased by 4.5%, 1.7%, 1.2% and 1.1% respectively but reduced by 1.3% in Cluster 4.

The results (Table 4) suggest that households in the urban areas in Cluster 1 spent about 28% of their food expenditure on cereals making it the most important food purchased. Also, in Cluster 1, the next most essential food group purchased by households were Roots and tubers, as well as fish and seafood. For Cluster 2, cereals as well as roots and tubers were the essential food purchased followed by fish and seafood. Households spent about 25% of their food expenditure on roots and tubers making it the most important food bought in Cluster 3. Flesh meat as well as fish and seafood were the next essential food purchased in Cluster 3. For Cluster 4, fish and seafood were the most important food purchased. Households spent roughly 20% of their food expenditure on fish and seafood. Cereals, roots and tubers as well as spices and beverages were the next most

important food bought. Lastly, for Cluster 5 root and tubers as well as fish and seafood were the most essential food purchased followed by Cereals.

In rural areas (Table 5), roots and tubers were the most important food purchased for all the Clusters. The result further shows that cereals as well as fish and seafood were the next most important food purchased in Clusters 1, 2 and 5. With regards to Clusters 3 and 4, the next most important food purchased were flesh-meat as well as fish and seafood.

From the findings, it can be observed that the food budget share was not evenly allocated among the various food groups in all the Clusters. In almost all the Clusters about 80 per cent of the budget was allocated to cereals, roots and tubers, flesh-meat, fish and seafood, oils and fats as well as spices and beverages. On the other hand, less than 5 per cent was allocated to fruits, organ meat, egg as well as milk and dairy product. This could be due to the fact that most African households spend more on staple food than they spend on fruits and milk. This result corroborates the findings of Kyle and Swinnen (1994), who indicated that in many African countries, households spend more of their money on basic foods. The plausible reason behind the high consumption of oil and fat and spices and beverages apart from the staple foods could be to improve the aroma and the taste of the food.

The budget share for fish (third most important) could be attributed to the hydrographic wealth of DRC. For instance, in Cluster 3, the presence of rivers and multitudes of small lakes offer a bigger potential for fishing[9] (Action Against Hunger, 2007; Nicolaï, 2013). In Kwilu province for example, fishing constitutes 50% of economic activities[10] (Action Against Hunger, 2007). Moreover, the results showed an increasing change in the budget allocated to fish between 2005 and 2012 in almost all the Clusters. This is because before 2004, the number and production of

[9] http://universitekamina.blogspot.com/2009/11/district-du-haut-lomami.html by Prof. Kabyla Ilunga visited 15 April 2019
[10] https://open.enabel.be/en/COD/1993/320/u/tout-le-monde--l-levage-de-poisson--masi-manimba.html by Julie Claassens visited 15 April 2029

livestock decreased by 30% and 20% respectively. This was attributed to some socioeconomic crisis, causing meat to be scarce and expensive; hence, increasing the consumption of fish (Kane *et al.*, 2004).

Furthermore, cereals were highly consumed in Cluster 1. This could be due to the culture of the provinces in that Cluster. Majority of the provinces in Cluster 1 are closer to and depend on Zambia for maize supply. Sob *et al.* (2017) and Marivoet (2016) argue that the budget allocated to cereals is high in the Southern part of the country because the provinces in the region are highly dependent on maize imported from Zambia.

However, in rural areas, roots and tubers were highly consumed in the northern and western provinces. This can be explained by the fact that cassava constitutes the main source of energy in the country and the variety of products that it offers (such a fresh root, chikwangues, cosettes, and paste). This result is confirmed by Ngonde[11] and Marivoet (2016) who found that about seventy per cent of the population consume cassava. However, the consumption of roots and tubers remarkably decreased in almost all the clusters. This may be due to the reduction of cassava production as a result of the Cassava Mosaic Disease (CMD), which has highly reduced its production. Kabemba *et al.* (2017) emphasised that the CMD has been a key factor in food issues in DRC based on its negative implication on yield (FEWS NET, 2017).

In all the Clusters, between 5 to 10 per cent of the budget was allocated to the dark green leafy vegetable, which shows that this food group is fundamental as well. This could be because of the high consumption of cassava leaves. Kabemba *et al.* (2017) found that more than 80 per cent of the population consume cassava leaves and it can be considered as a staple food as well. The CMD could be the reason for the reduction of the budget allocated to the dark green leafy vegetables in some Clusters. In addition, the low budget allocation could be due to the harvesting of green leafy

[11] http://www.fao.org/docrep/005/Y9422E/y9422e0b.htm visited 05 February 2019.

vegetables from own farms. Households allocated a very little budget to fruits, eggs, milk and dairy products as well as sweets because of the scarcity of those products in the country.

From the results, it can be concluded that there is no difference between diet composition across urban and rural areas in general. However, in urban areas, there were balances between the consumption of cereals, roots and tubers while in rural areas, there were very high consumption of roots and tubers.

4.2 Mapping of the level of nutrient intake in DRC provinces

4.3.1 Calories

Daily calories intake for an adult male in 2012, and the changes between 2005 and 2012, are presented in Figure 5 and Figure 6. A low energy intake hinders human physical activities, and subsequently, productivity. The primary sources of energy in DRC are cereal, root and tubers as well as fat and oil (Ulimwengu *et al.*, 2012). The required intake for an adult male is 2750 Kcal per day, however, the energy intake is highly associated with the age and weight of the person (WHO, 2004).

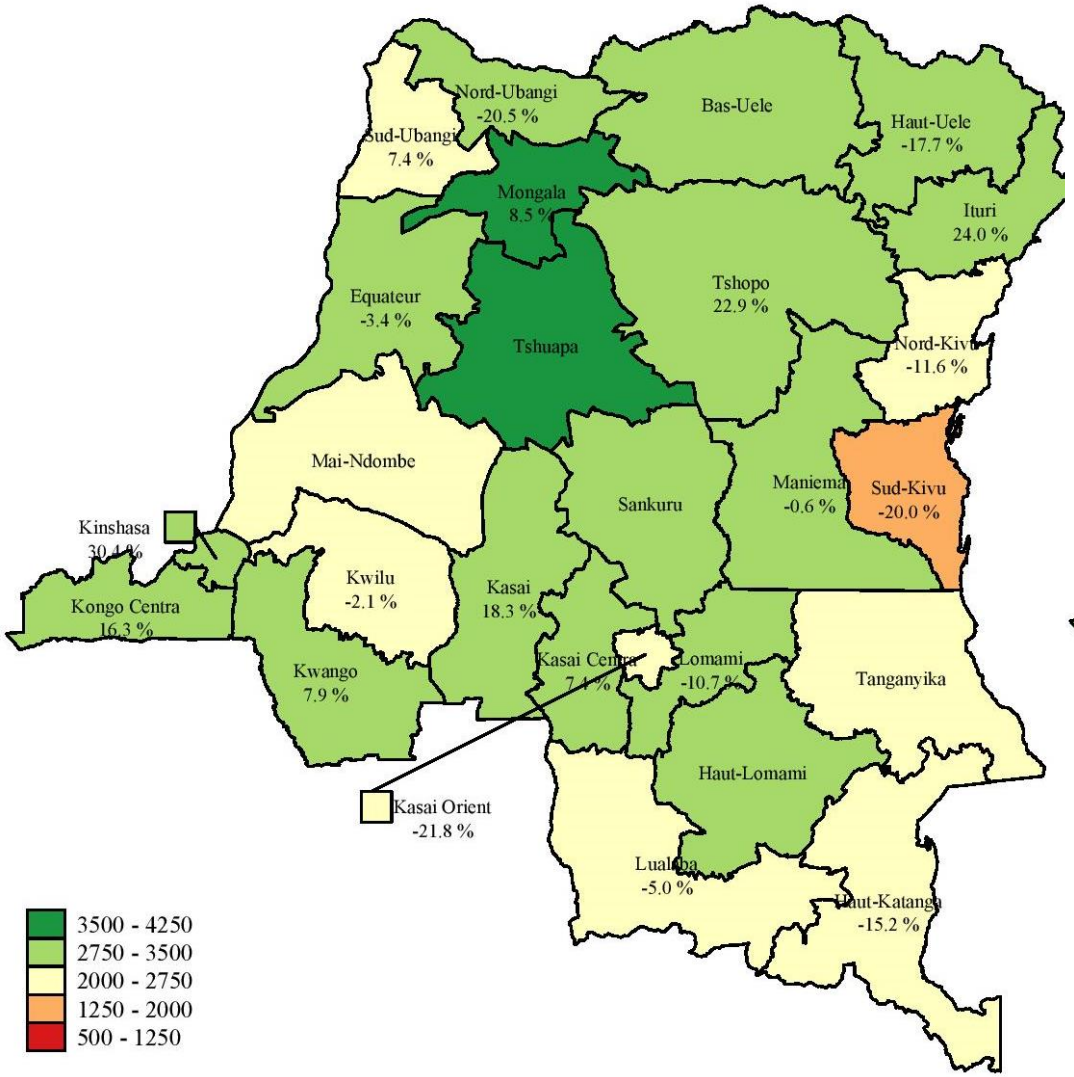

Figure 5: Urban calories daily intake and changes per adult male in 2012

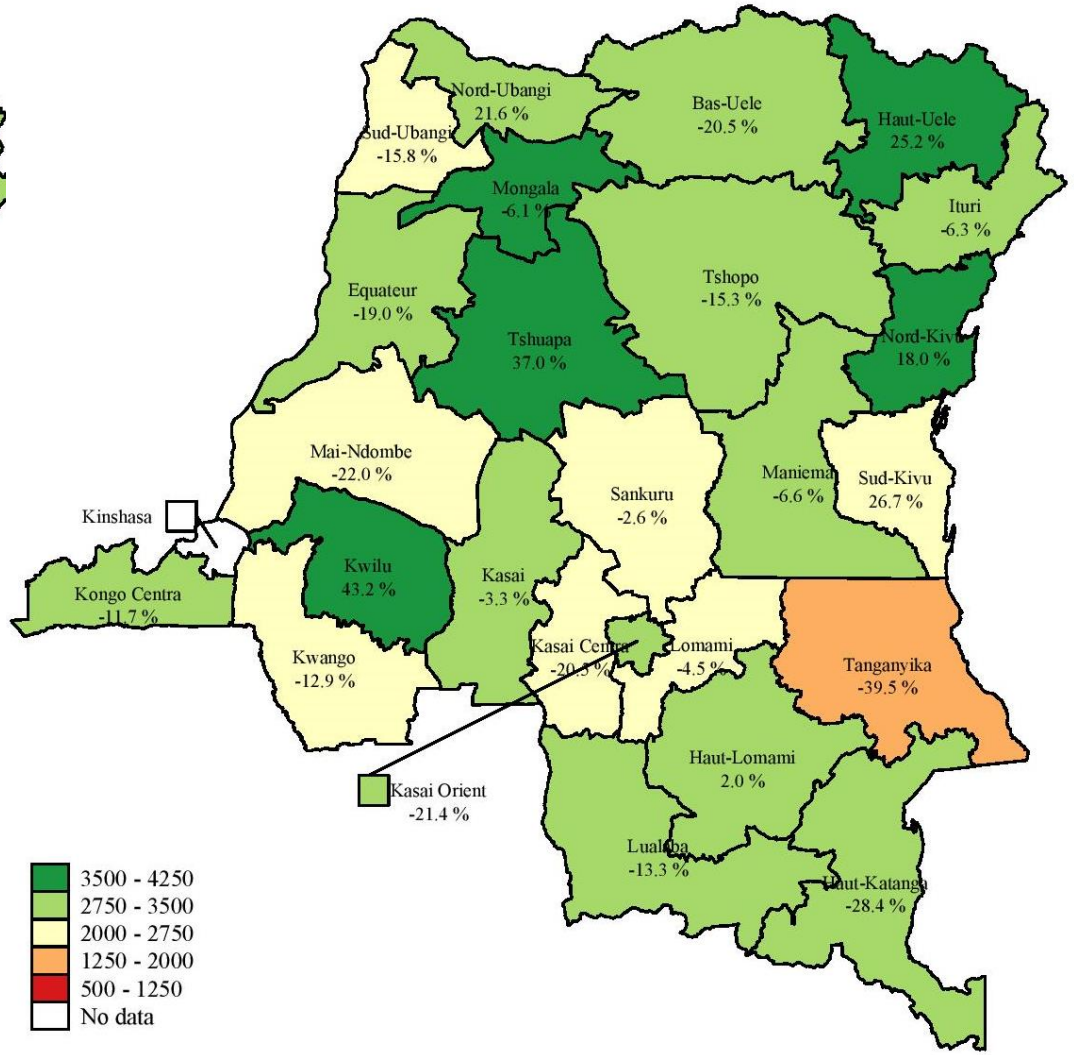

Figure 6: Rural calories daily intake and changes per adult male in 2012

In 2012, in urban areas, nine provinces including Kwilu, Mai-Ndombe, South Ubangi, North Kivu, South Kivu, Tanganyika, Haut Katanga, Lualaba and Kasai Orientale were deficient in calories intake. While in rural areas, South Kivu, Mai-Ndombe, Kwango, Kasai Centrale, Lomami, Sankuru, South Kivu and Tanganyika were deficient in calories intake.

In urban areas from 2005 to 2012, there was an improvement in calorie intake in Kongo Central, Kinshasa, Kwango, South Ubangi, Mongala, Kasai, Kasai Centrale, Tshopo and Ituri by 16.3%, 30.4%, 7.9%, 7.4%, 8.5%, 18.5%, 7.4%, 22.9% and 24.0% respectively. While in rural areas, there was an improvement in calories intake in Kwilu, North Ubangi, Tshuapa, Haut Lomami, South Kivu, North Kivu and Haut-Uele by 43.2%, 21.6%, 37.0%, 2.0%, 26.7%, 18.0% and 25.2% respectively. The other provinces experienced a decrease in calories intake.

The results showed a better intake of calories in rural areas than in urban areas. This could be attributed to the fact that most of the crops such as maize and cassava are produced in rural areas and the supply to urban areas is quite challenging due to poor communication.

Between the rural and urban areas, the calorie intakes by households are heterogeneous in the provinces and quite adequate. From the map, calorie intake reduced in majority of the provinces. This can be explained by the reduction in cassava production and the scarcity of substitute. It is worthy to note that the decrease in the cassava production which represents about fifty-five per cent of the caloric consumption, the high price of maize, and the dependence on Zambian maize can be one of the reasons for the worsened situation in Lualaba, Haut-Katanga and Tanganyika (FEWS NET, 2015; Sob *et al.*, 2017). However, beans and maize are relatively expensive in the Western parts of the country mainly becasue they are supplied from the Eastern part of the country (FEWS NET, 2015). This result is in line with the findings of Van Wesenbeeck *et al.* (2009) who found that the calories in Sub-Saharan Africa were acceptable as opposed to the reports from the FAO and other international organisations who report calories intake to be very low (FAO, 2007; WHO, 2009).

4.3.2 Protein

Daily protein intake for an adult male in 2012, and the changes from 2005 to 2012, are presented in Figure 7 and Figure 8. A low protein intake negatively affects the growth and development of humans; hence, it hinders thier productivity in the long run. As for energy intake, its consumption is highly correlated with age and weight. The recommended intake for an adult male is about 50 g per day.

In 2012, in urban areas, nine provinces including Kwilu, Mai-Ndombe, Bas-Uele, South Ubangi and Haut-Lomami were deficient in protein intake. While in rural areas, Kwango, Mai-Ndombe, Sankuru, Kasai Centrale, Lomami, Tanganyika and South Kivu were deficient in protein intake.

In urban areas from 2005 to 2012, there was an improvement in protein intake in Kongo Central, Kinshasa, Kwango, Mongala, Kasai, Lualaba, Tshopo, Haut Uele, Ituri and North Kivu by 18.6%, 54.1%, 47.4%, 18.6%, 6.0%, 3.5%, 148.4%, 74.0%, 70.8% and 68.7% respectively while in rural areas, there was an improvement in protein intake in Kongo Central, Kwango, Kwilu, Tshuapa, Kasai, South Kivu, North Kivu, Ituri and Haut-Uele by 4.5%, 33.5%, 93.0%, 130.2%, 14.8%, 12.6%, 17.8%, 36.9% and 19.2%, respectively. The other provinces, however, experienced a decrease in protein intake.

Urban areas seemed to have a better intake than the rural areas. This could be because the crops that are rich in proteins are not highly produced as they rely more on the production of maize and cassava (Kabemba *et al.*, 2017). The situation of the protein intake was relatively better for all provinces. This could be due to the high consumption of frozen fish (mpiodi), dried/smoked fish, salted fish (bitoyo) and fried sardine (ndakala) (Marivoet, 2016). These findings contradict the findings of Schonfeldt and Hall (2012) who found that the protein intake in Sub-Sahara Africa is deficient.

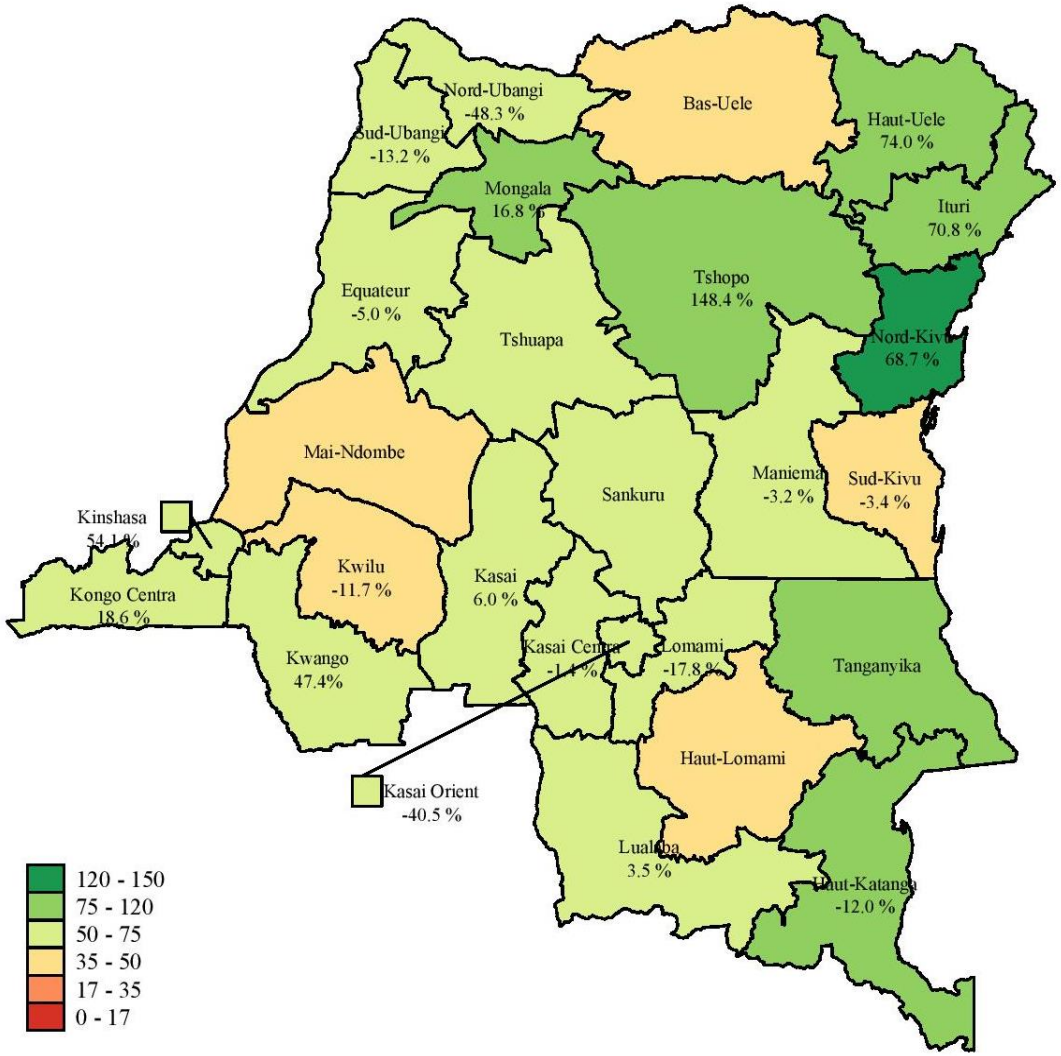

Figure 7: Urban protein daily intake and changes per adult male in 2012

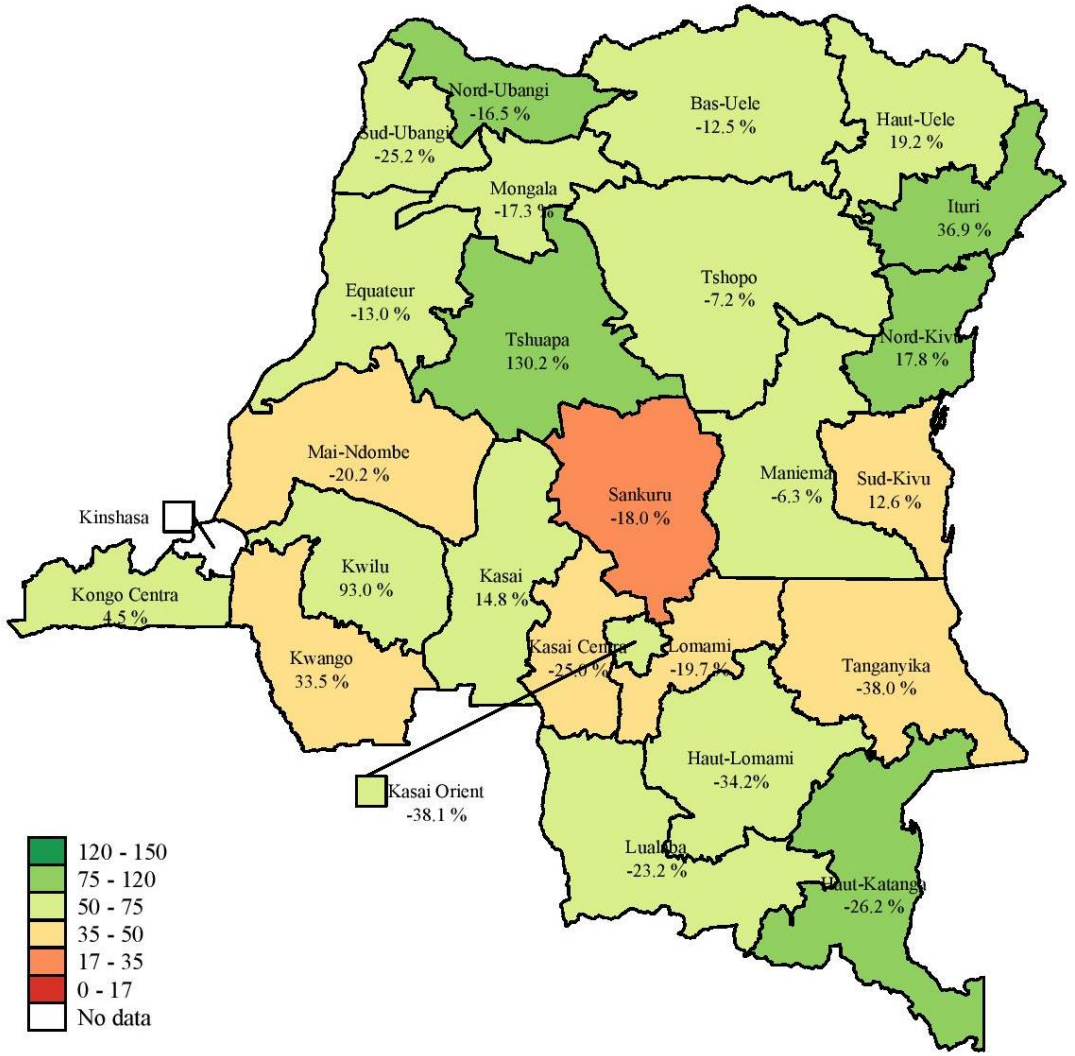

Figure 8: Rural protein daily intake and changes per adult male in 2012

4.3.3 Vitamin A

Daily vitamin A intake for an adult male in 2012, and the changes from 2005 to 2012, are presented in Figure 9 and Figure 10. The human body needs vitamin A in small quantity, however, its deficiency negatively affects human sight, development and growth, immunity, reproductive health and epithelial cellular. Its sources are animal products, green leafy vegetables, yellow vegetables, yellow and orange fruits, and red palm oil. The recommended safe intake for infants and children is between 375 and 500 mcg per day, for adolescents, it is 600 mcg per day and for adults, it is between 500 and 850 mcg per day (WHO, 2004).

The results suggested a very high vitamin A intake accompanied by increased consumption in almost all the provinces. The results are in line with Williams *et al.* (2008) and De Moura *et al.* (2015) who found that the adequacy level of intake of vitamin A is about 97% in Nigeria. However, the findings is in contrast to the works of Amare *et al.* (2012) and Kolahdooz *et al.* (2013) who reported an alarming inadequate intake of vitamin A in Ethiopia and South Africa respectively. The reason behind the high intake of vitamin A could be the high consumption of red palm oil.

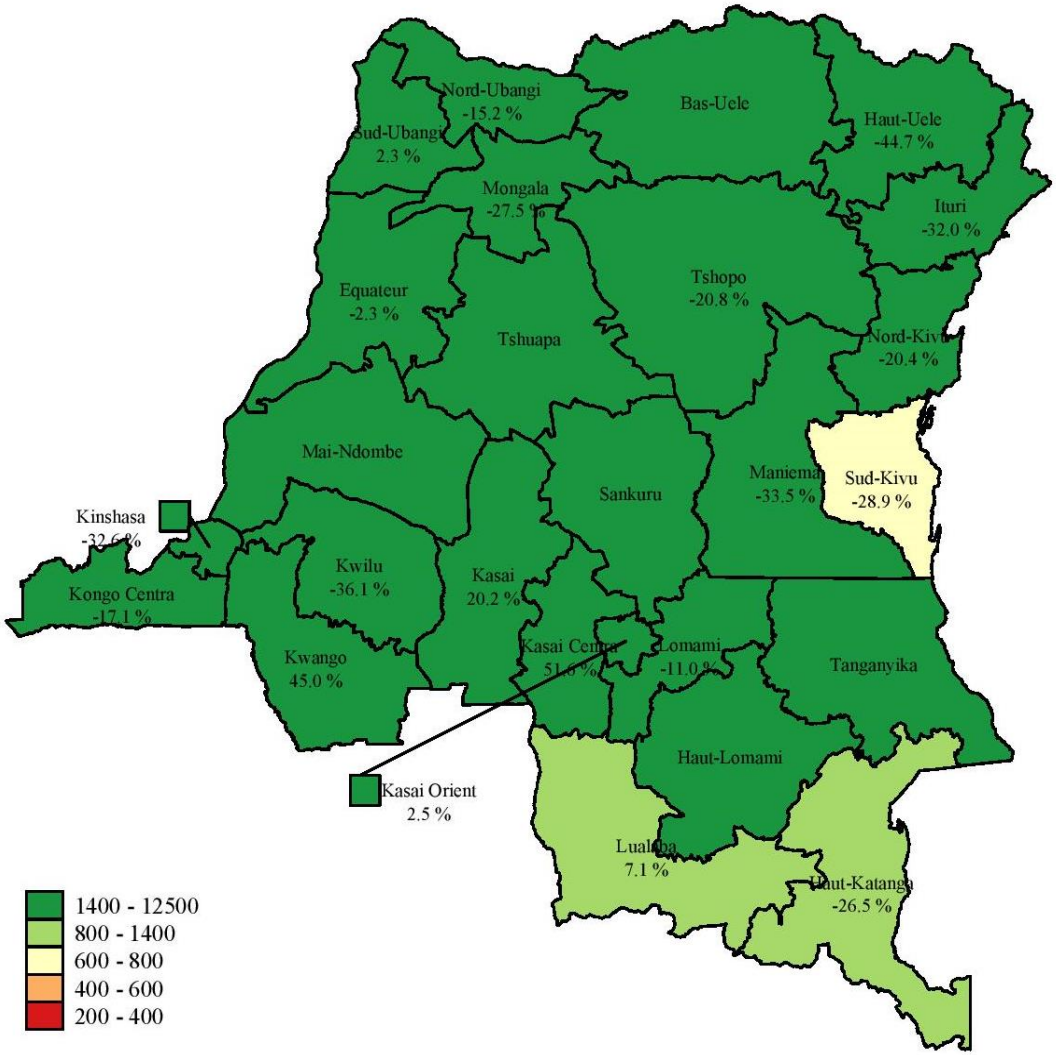

Figure 9: Urban Vitamin A daily intake and changes per adult male per day 2012

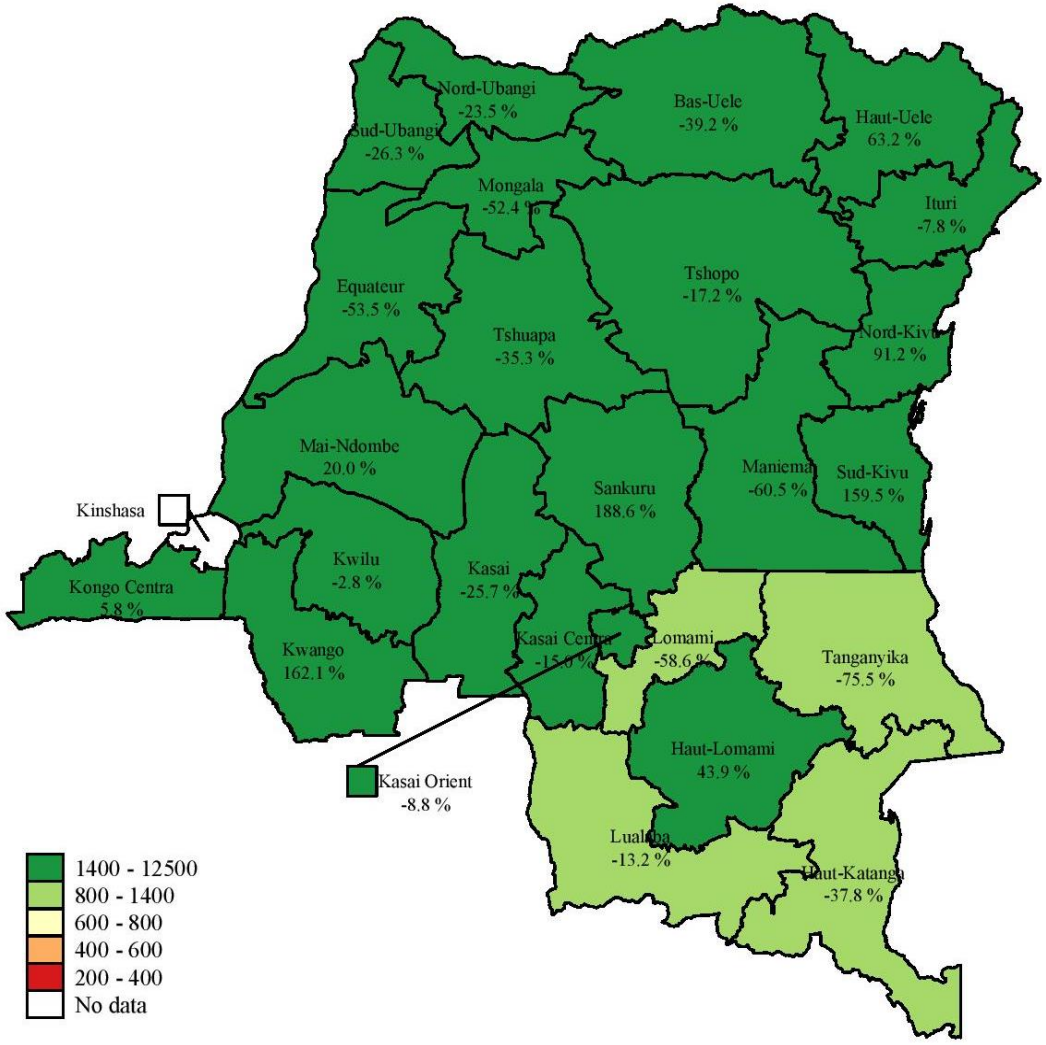

Figure 10: Rural Vitamin A daily intake and changes per adult male per day 2012

4.3.4 Calcium

Daily calcium intake for an adult male in 2012, and the changes from 2005 to 2012, are presented in Figure 11 and Figure 12. The human body needs calcium as it plays an essential role in the rigidity of the skeleton and in many metabolic processes. Its source is mainly animal products, especially in eggs, milk and dairy product. The recommended safe intake for infants and children is between 300 and 700 mcg per day. For adolescents, it is 1300 mcg per day. For adults between 1000 and 1300 mg per day (WHO, 2004).

The results suggest that in 2012, all provinces in the urban areas were deficient in calcium intake except Kwango, Mongala and Tshuapa while in the rural areas, nineteen provinces out of twenty-six provinces were deficient in calcium intake. The calcium intake seems to be better in rural than urban areas.

However, in urban areas from 2005 to 2012, there was an improvement in calcium intake in Kongo Central, Kinshasa, Kwango, Mongala, Kasai, Tshopo, Ituri and North Kivu by 10.0%, 62.6%, 0.5%, 18.4%, 31.6%, 34.8%, 14.2% and 16.1% respectively. While the in rural areas from 2005 to 2012, there was an improvement in calcium intake Kongo Central, Kwango, Kwilu, Tshuapa, Kasai, South Kivu, North Kivu, Ituri and Haut-Uele by 4.5%, 33.5%, 93.0%, 130.2%, 14.8%, 12.6%, 17.8%, 36.9% and 19.2%, respectively. The other provinces showed a decrease in calcium intake.

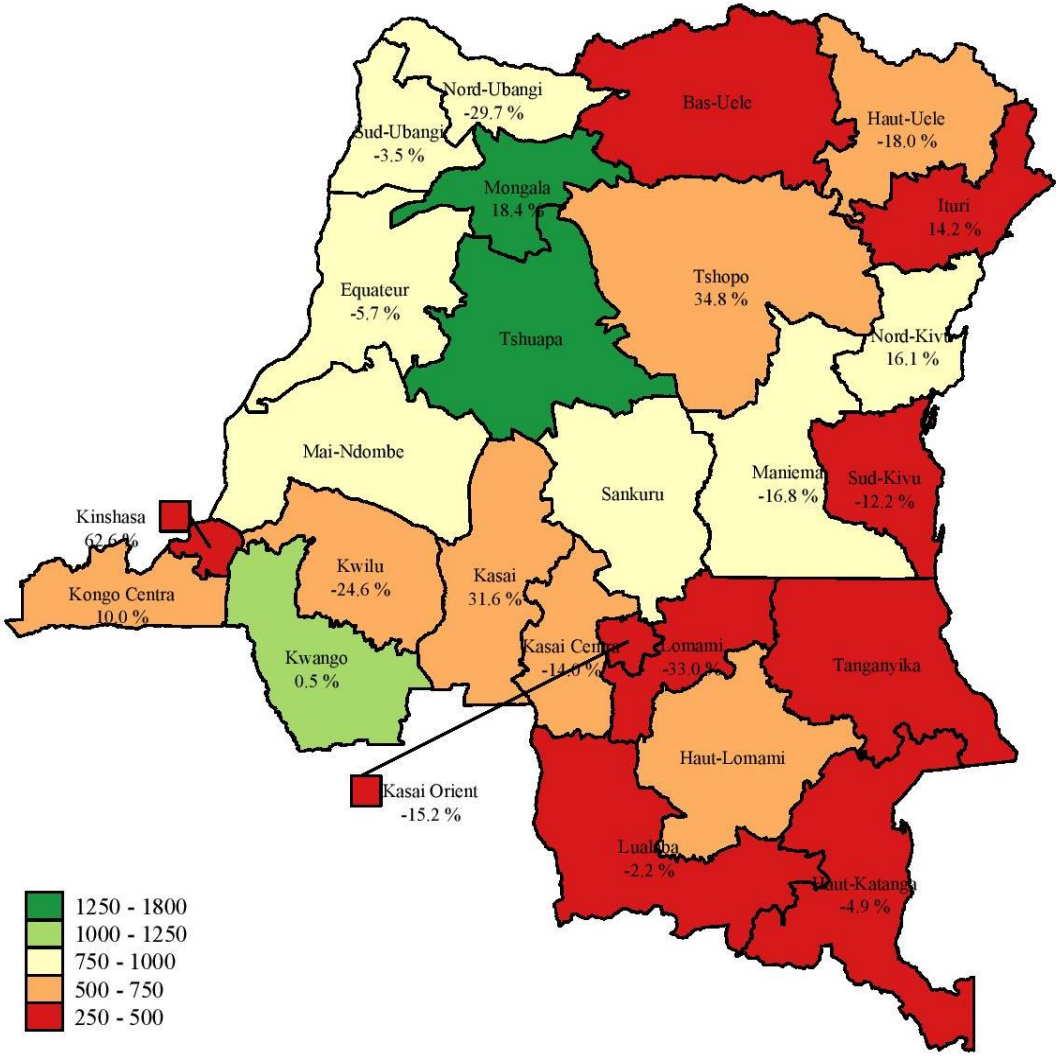

Figure 11: Urban calcium daily intake and changes per adult male in 2012

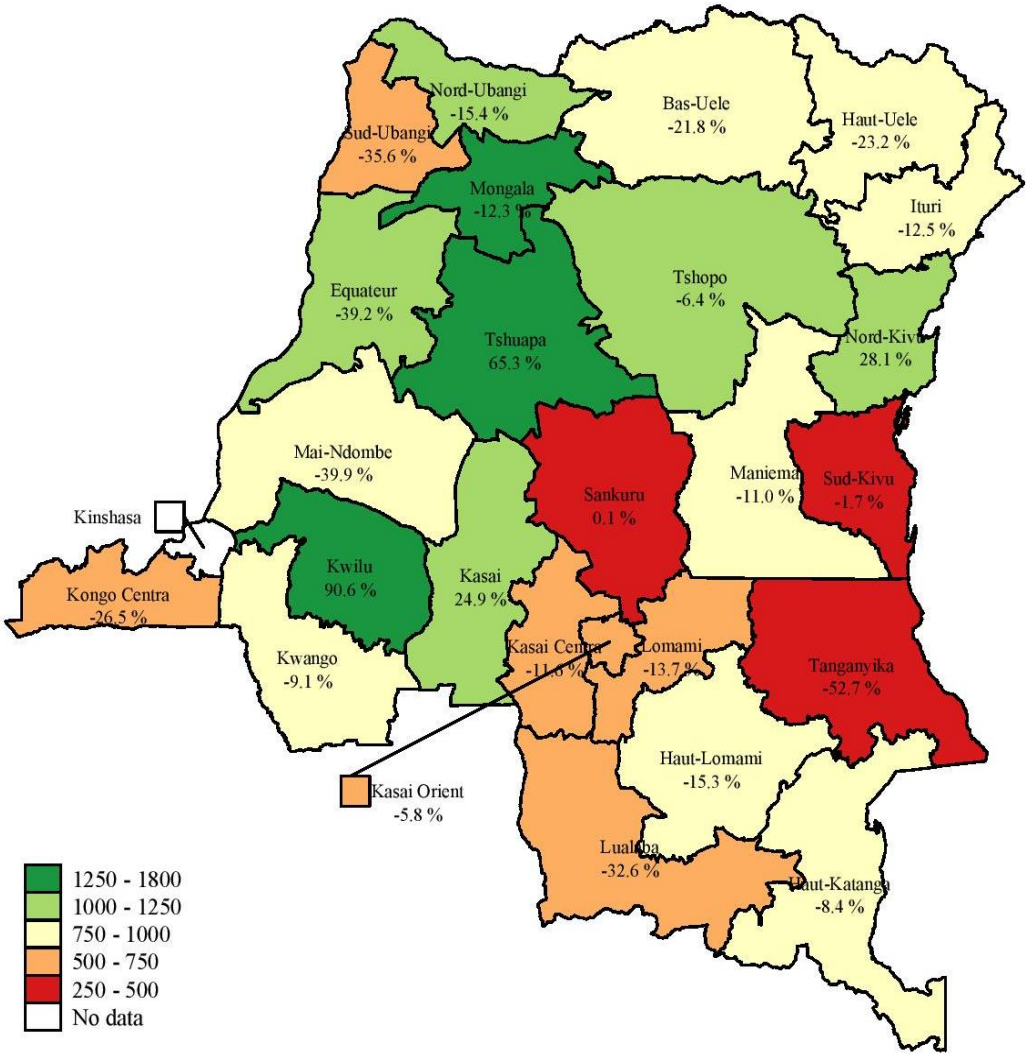

Figure 12: Rural calcium daily intake and changes per adult male in 2012

Almost all the provinces were deficient in calcium intake in the urban areas. This is in line with the findings of Balk *et al.* (2017) who found that countries in Africa and South America are highly deficient in calcium. This could be attributed to low production of animal products which is indicated explicitly in Tables 3 and 4. It was noted that less than 1 per cent of the budget is allocated to milk, dairy product and eggs. However, the increase in consumption can be explained by the development of small livestock breeding in different regions. This could explain the high calcium intake in rural areas compared to urban areas as most of the families that breeds are in the rural areas.

4.3.5 Zinc

Daily zinc intake for an adult male in 2012, as well as the changes from 2005 to 2012, are presented in Figure 13 and Figure 14. Zinc is vital for health and the immune system, and consequently saves the amount of money spent on health care. The main sources of zinc are red meat, pulses, cereals and legumes. The recommended zinc intake for infants and children is between 6.6 and 11.2 mg per day, for adolescents, it is between 14.4 and 17.1 mg per day and for adults between 9.8 and 20 mg per day (WHO, 2004).

The results suggest that apart from North Kivu which showed improvement in meeting the required level of zinc intake, all the provinces in both the rural and urban areas were deficient in zinc intake. The results also suggest an increase in the deficiency level from 2005 to 2012. In DRC, about 60 per cent of the zinc intake come from main staples and the remaining 40 per cent is provided by meat as well as legumes and nuts (Ulimwengu *et al.*, 2012). The low intake of zinc is due to the shallow consumption of meat, legumes, and nuts as shown in Tables 3 and 4. The results were in line with Lee *et al.* (2012) and Oldewage-Theron and Kruger (2011) who also found a deficient zinc intake in Sub-Sahara Africa. Nevertheless, the result contradicts the findings of De Moura *et al.* (2015) who reported an acceptable zinc intake in Nigeria. The low consumption in the DRC could be explained by the low consumption of red meat.

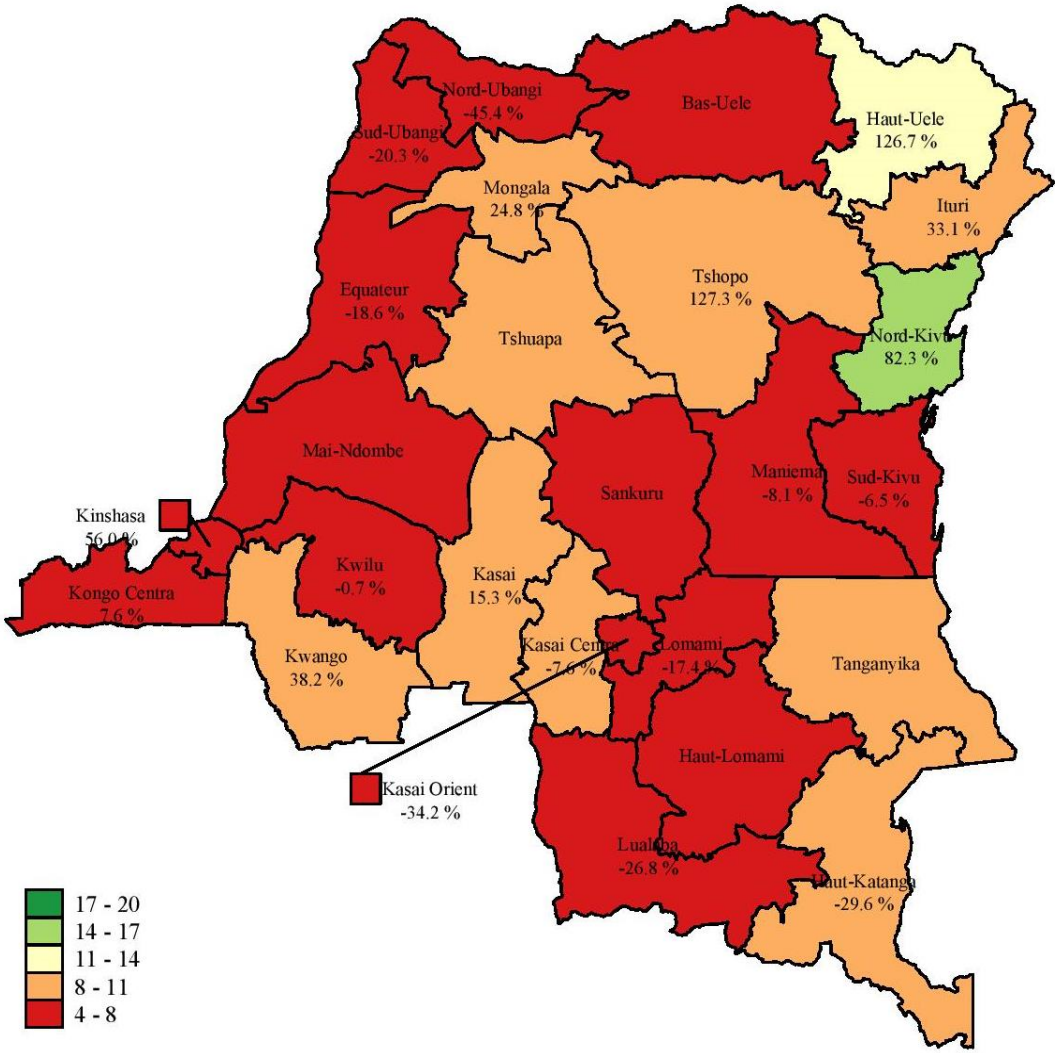

Figure 13: Urban zinc daily intake and changes per adult male in 2012

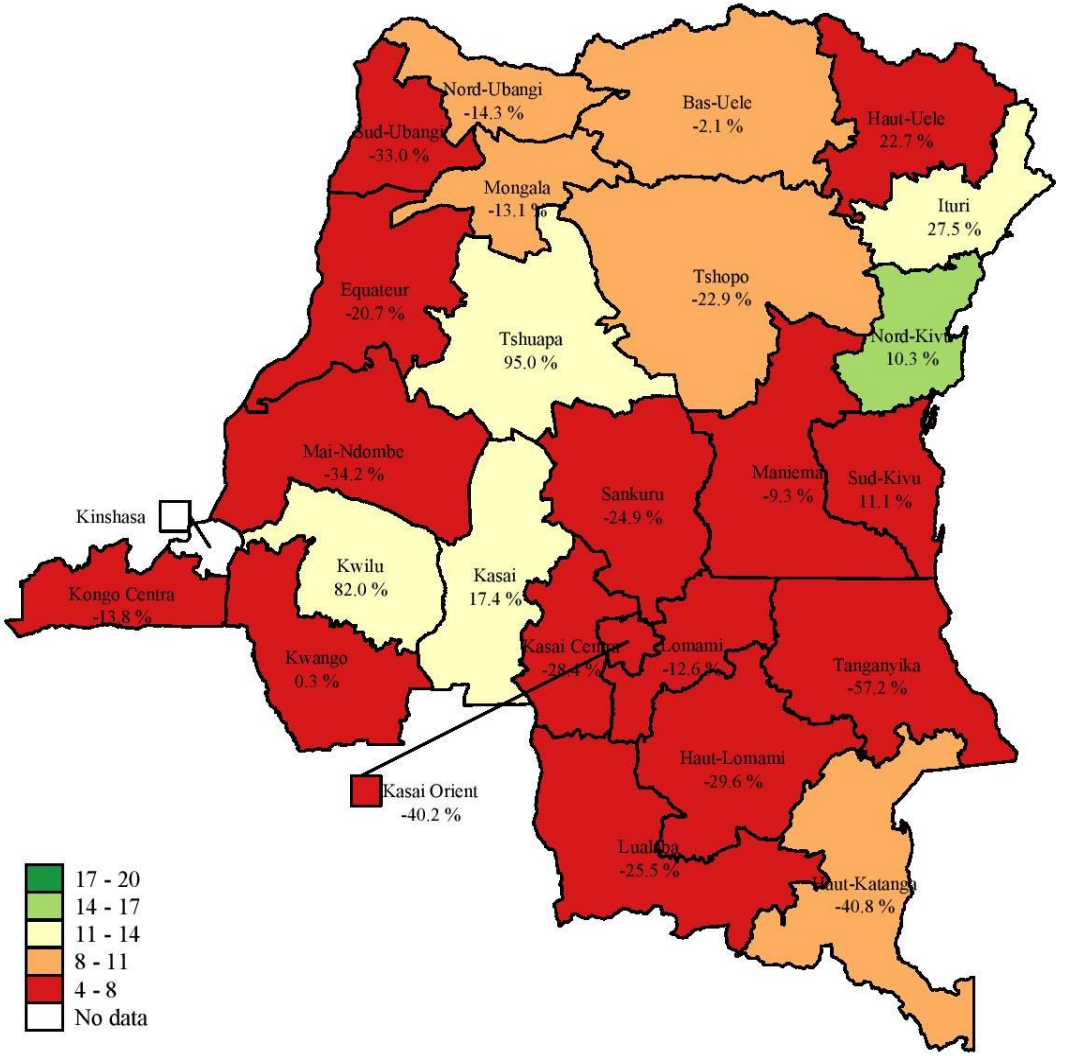

Figure 14: Rural zinc daily intake and changes per adult male in 2012

4.3.6 Iron

Daily iron intake for an adult male in 2012, as well as the changes from 2005 to 2012, are presented in Figure 15 and Figure 16. The main sources of iron are green leaves, root and tubers, pulses, cereals, nuts and legumes. The recommended iron intake for infants and children is between 11.2 and 18.6 mg per day. For adolescents, it is between 29.2 and 37.6 mg per day. For adult males 27.4 (WHO, 2004). It is worth noting that the requirement of iron intake for females (adolescents and adults) is between 58.8 and 65.4 mg per day. This is due to the iron losses during the period of menstruation. Also, there is a considerable reduction during postmenopausal and lactation periods (WHO, 2004).

The results show that there was a deficiency in iron intake in all the provinces. About 90 per cent of the iron intake in DRC is provided by cereals, tubers, and legumes and nuts (Ulimwengu *et al.*, 2012). Although, iron intake is not necessarily an issue in DRC as cereals, and roots and tubers, are highly consumed. However, the low intake could be attributed to inadequate diet (Jonker *et al.*, 2017). This result is in line with the report of the WHO (2004) of an alarming inadequate iron in the tropical region.

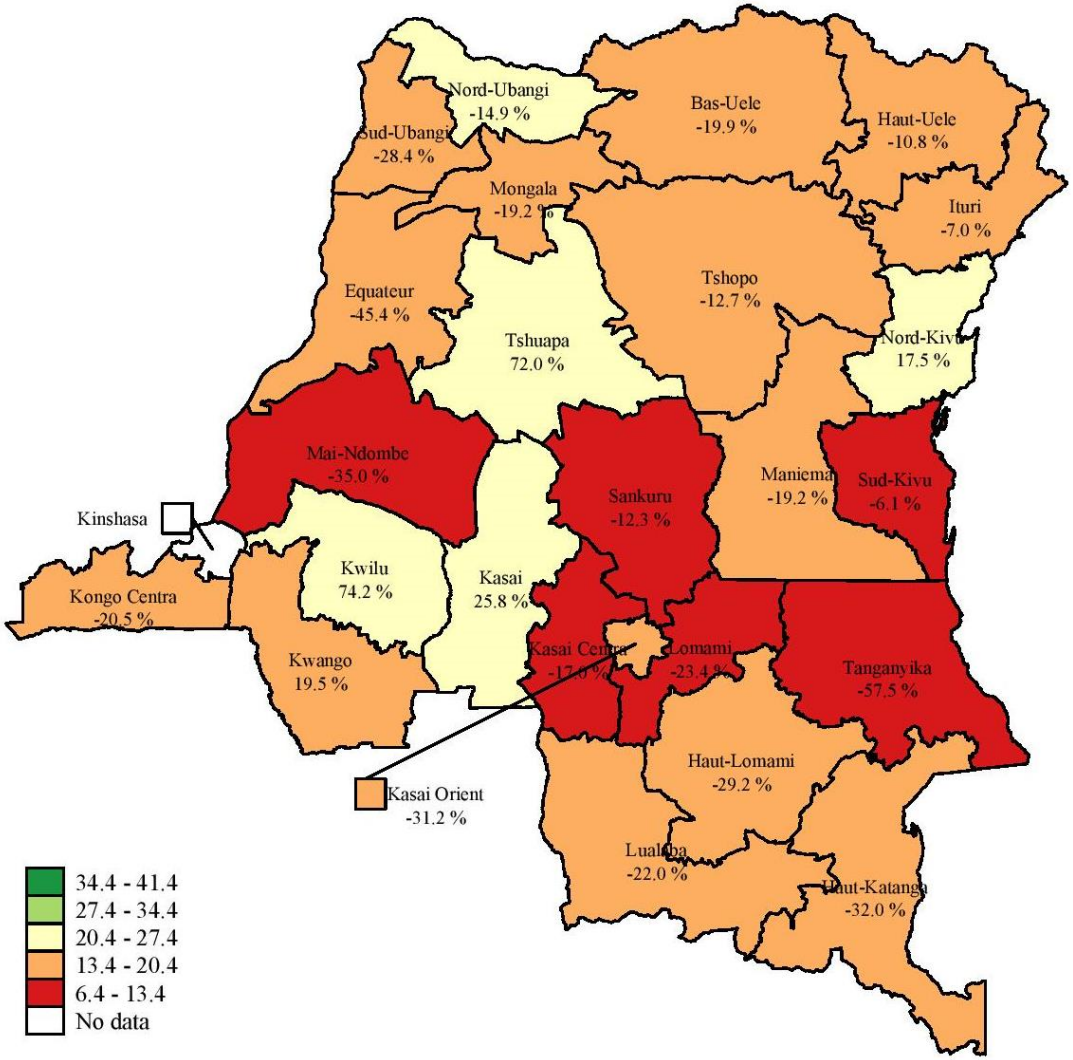

Figure 15: Urban iron daily intake and changes per adult male in 2012

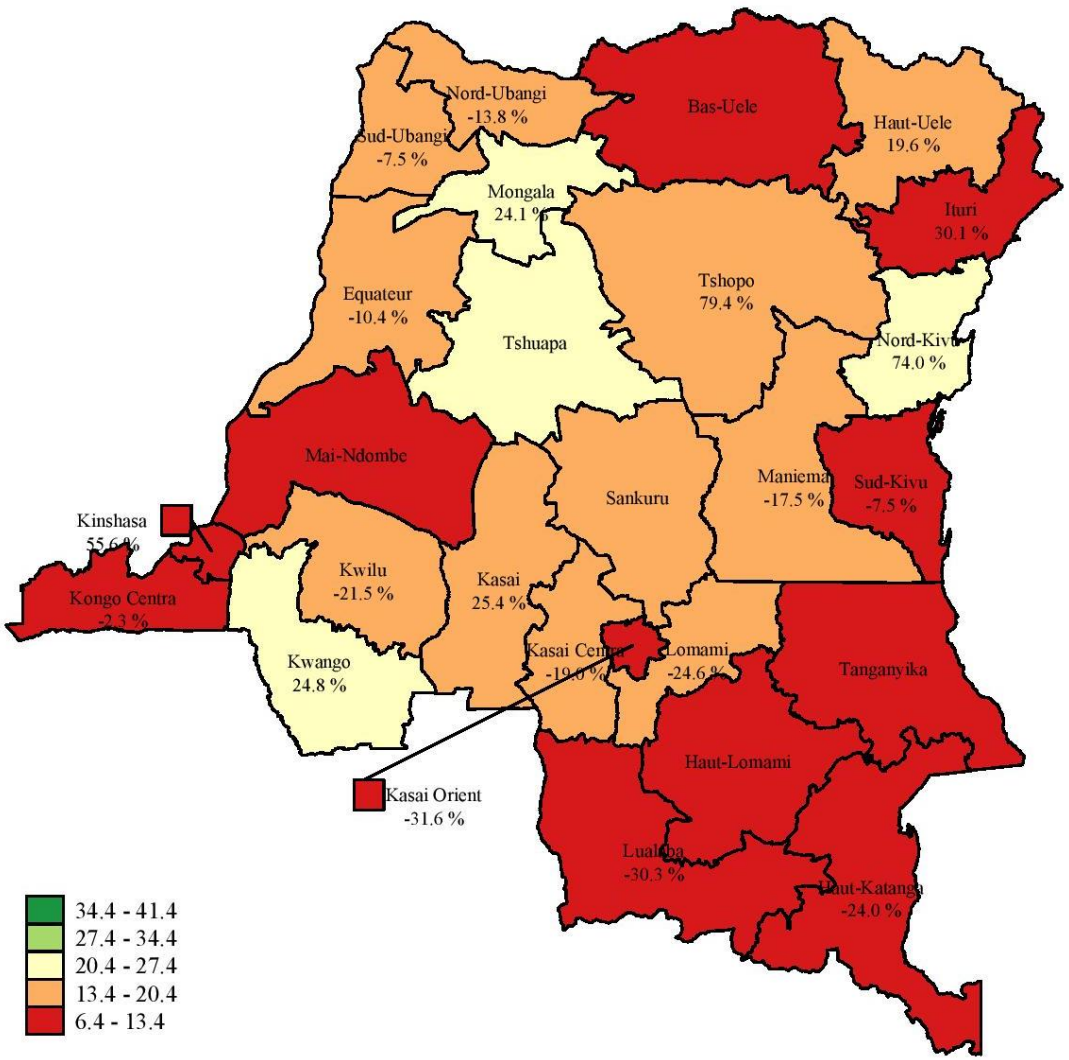

Figure 16: Rural iron daily intake and changes per adult male in 2012

4.3.7 Folate

Daily folate intake for an adult male in 2012, and the changes from 2005 to 2012, are presented in Figure 17 and Figure 18. The recommended folate intake for infants and children is between 80 and 400 mcg per day, for adolescents and adults between 400 and 600 mcg per day (WHO, 2004).

The results suggest that in the urban areas, all the provinces that are in the middle and southern part are deficient in folate. However, the situation in rural areas is quite better. The provinces of Mai-Ndombe, South Ubangi, Kasai Central, Kasai Orientale, Lomami, Lualaba, Sankuru and Tanganyika were deficient in folate intake.

In the urban areas from 2005 to 2012, there was an improvement in folate intake in Kwango, Equateur, Mongala, Kasai, Tshopo, Haut Uele, Ituri and North Kivu by 14.0%, 2.5%, 29.4%, 5.0%, 99.9%, 69.0%, 20.5% and 122.2%, respectively while in rural, there was an improvement in folate intake Kwilu, Tshuapa and Ituri by 78.7%, 45.1% and 7.7% respectively.

According to Ulimwengu *et al.* (2012), the low consumption of products rich in folates such as lentils, peas, spinach, fruits could account for the most moderate folate intake at household level in the central and southern parts. Also, the improved situation in the North can be explained by the high consumption of bananas and plantains in those areas. The banana wilt which leads to low bananas production could be the reason why there is a decreased folate intake in the entire country. Nevertheless, these results opposes the work of (Oldewage-Theron and Kruger, 2011))

The improved situation in the rural areas could be explained by the fact that production of the bananas and plantains take place in rural areas. Due to the poor linkages between the urban and the rural areas, product supply to the urban areas was difficult.

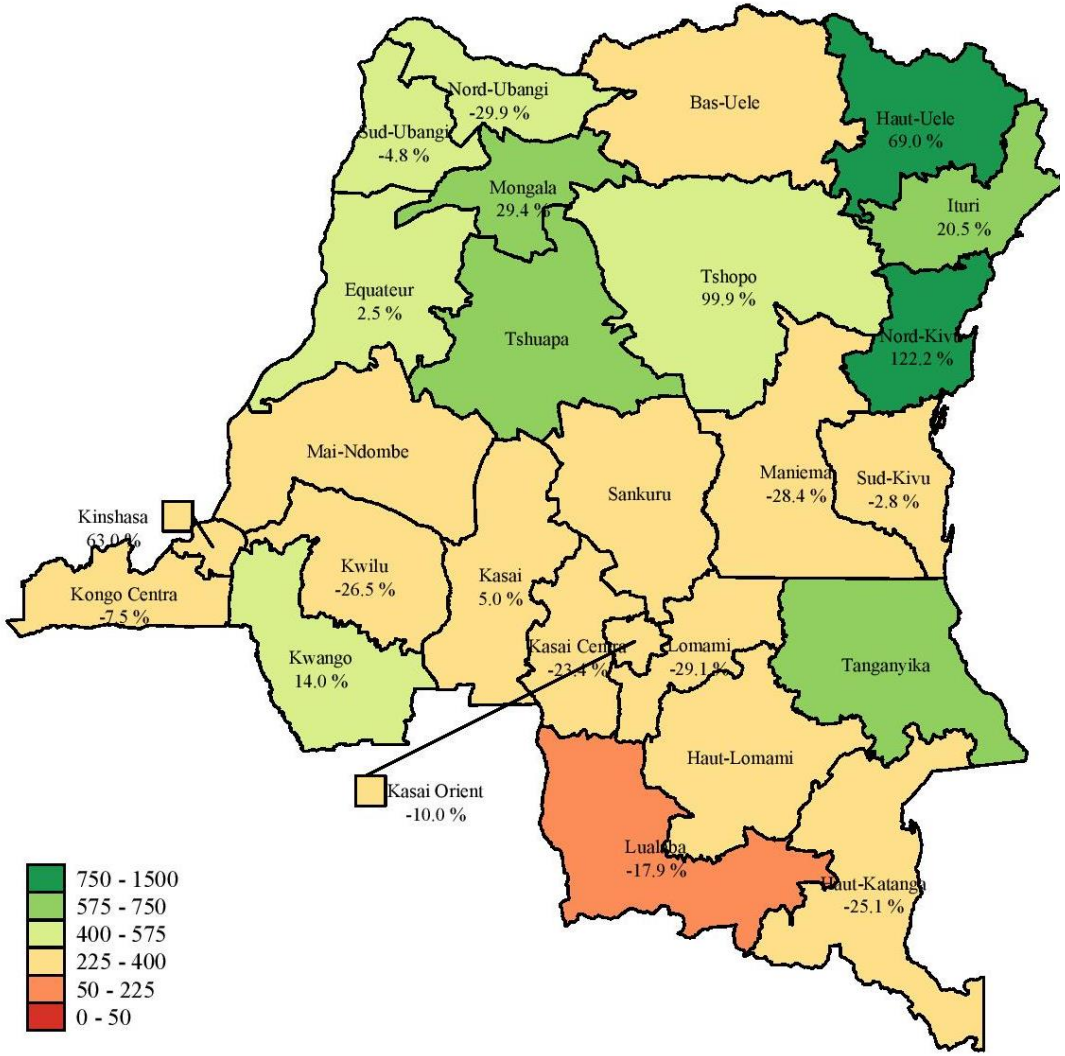

Figure 17: Urban folate daily intake and changes per male adult in 2012

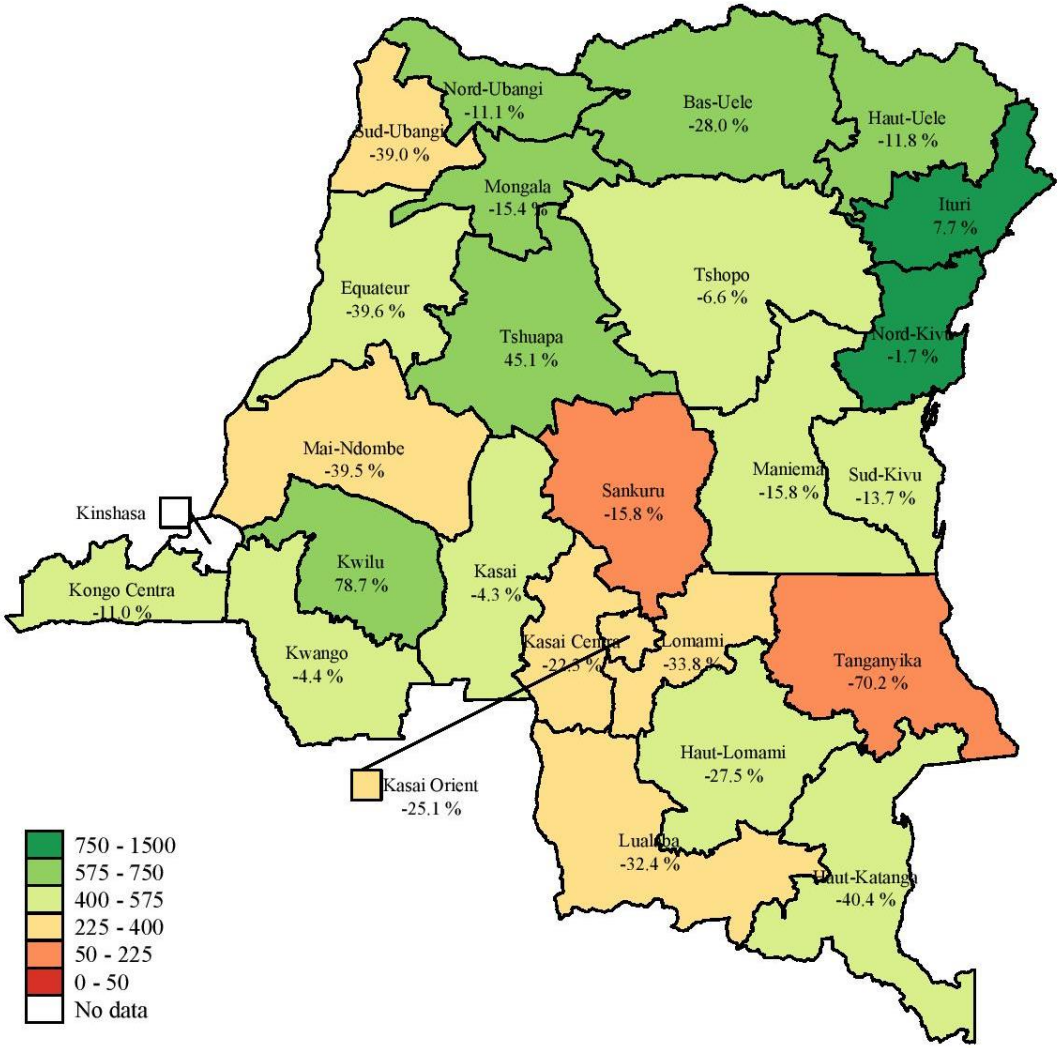

Figure 18: Rural folate daily intake and changes per male adult in 2012

4.3.8 Vitamin B12

Daily vitamin B12 intake for an adult male in 2012, and the changes from 2005 to 2012, are presented in Figure 19 and Figure 20. Vitamin B12 is synthesized only by animals. The recommended vitamin B12 intake for infants and children is between 0.4 and 1.8 mcg per day, for adolescents and adults between 2.4 and 2.8 mcg per day (WHO, 2004).

The results suggest that all the provinces were deficient in vitamin B12 except Tshopo and Maniema in the urban areas. Unlike the urban areas, the intake level was low in the rural areas with an exemption of Equateur, Tshuapa, Tshopo and Ituri in which their Vitamin B12 intake was adequate.

However, some provinces showed some improvement in vitamin B12 intake. In urban areas from 2005 to 2012, there was an improvement of 64.8%, 45.5%, 60.5%, 17.5%, 4.8%, 3.3%, 46.1%, 224.5%, 41.4%, 136.4%, 3.3%, 1121.1%, 57.9% and 78.5% in Kongo Central, Kinshasa, Kwango, Equateur, South Ubangi, Mongala, Kasai Central, Lualaba, Haut-Katanga, Maniema, South Kivu, Tshopo, Haut Uele and Ituri respectively. In rural areas, all the provinces improved their vitamin B12 intake except South Ubangi, Kasai, Kasai Central, Kasai Oriental, Lualaba, Haut Lomami and Maniema.

Although, a significant share of household income is allocated to the animal product except for milk, egg and dairy products, the deficiency in vitamin B12 is an evidence that the consumption level is below the required intake level. The reason, as stated earlier, could be attributed to the underdevelopment of the animal sector and the high prices of meat (with prices reaching up to USD10) in the cities (Marivoet, 2016). However, the improvement in vitamin B12 is attributed to breeding of small livestock. These results were in line with Allen (2008) who found that in developing countries, deficiencies in vitamin B12 is much more common due to the low consumption of animal products.

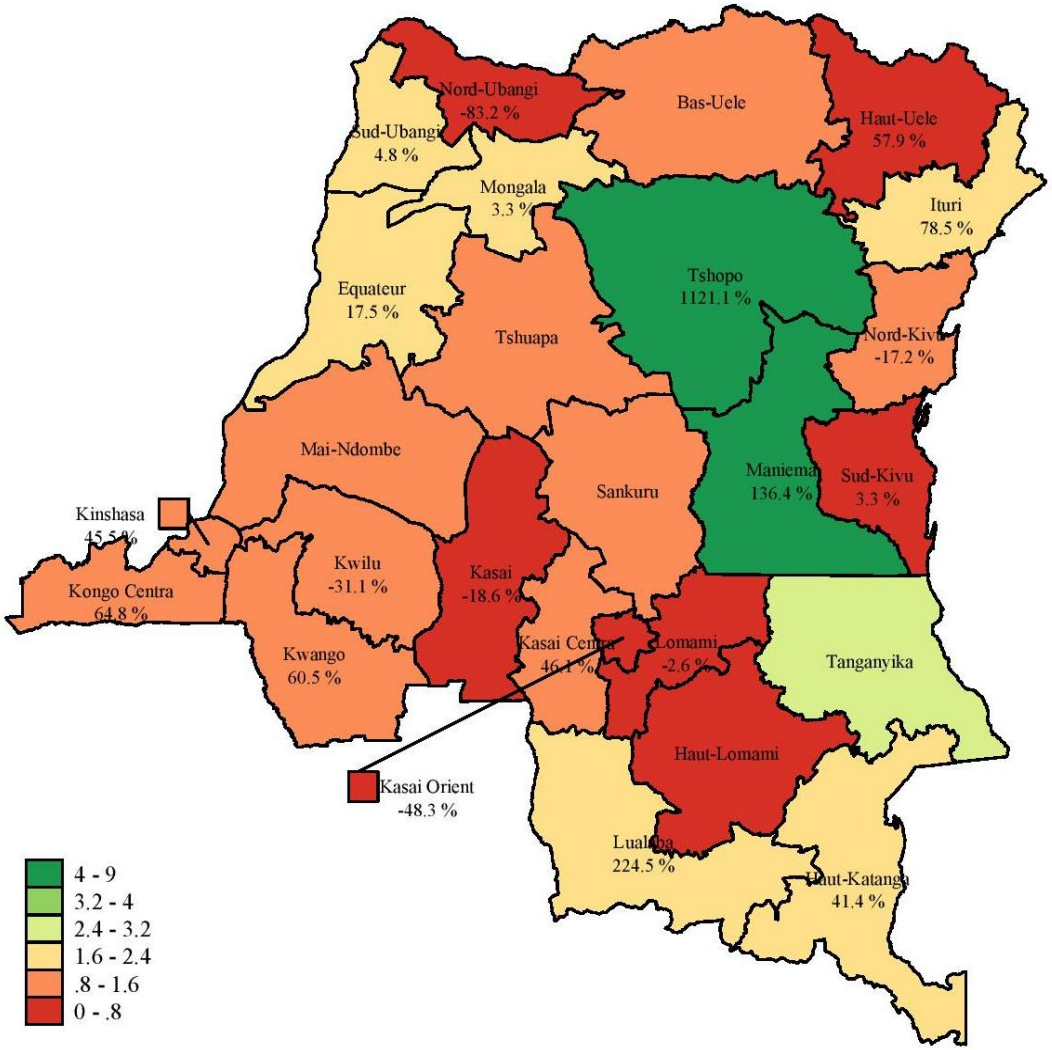

Figure 19: Urban vitamin B12 daily intake and changes per adult male in 2012

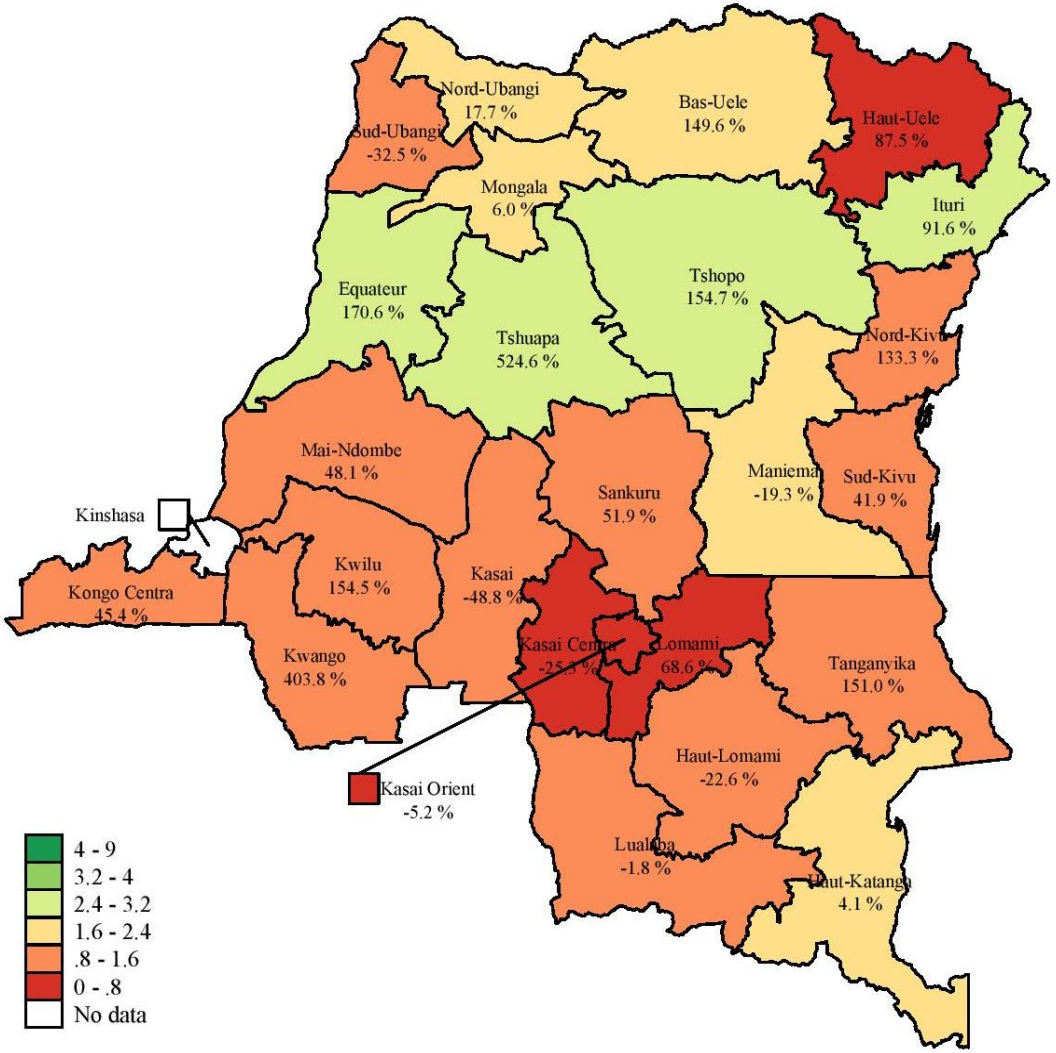

Figure 20: Rural vitamin B12 daily intake per adult male in 2012

Overall, the micronutrients results were similar to the one of Uganda except for vitamin A and Zinc intake that was adequate, as opposed to DRC (Marivoet and Ulimwengu, 2018). The nutrient deficiencies in many provinces can be explained by the very low agricultural production which is a major problem in the country.

Furthermore, the limited linkage between urban and rural areas can account for the difference in nutrient intake (Peemans, 2016). South Kivu and Ituri were deficient in almost all the nutrients intake which could be attributed to the high level of insecurity in both provinces. Even though the North Kivu, South Kivu and Ituri are highly fertile and despite the level of instability in the North Kivu, the province has shown some remarkable commitment to improving their agricultural sector. For example, some commodities like beans and potatoes are produced in large quantities and supplied to different provinces. Potato production is high in the North Kivu compared Ituri and the mountainous areas in the east and northeast of the country. A larger quantity of the potatoes produced is sold to Kinshasa in an effort to earn more income. Moreover, beans are also produced by close to 87 per cent of the crop producers with their output accounting for more than half of the whole production of DRC (FEWS NET, 2015; O'Donnell *et al.*, 2015; FEWS NET, 2017).

4.3 Household demand for food

4.4.1 Income and own-price elasticities

The expenditure elasticity, as well as the own prices elasticities for urban and rural areas, are presented in Table 6.

Table 6: DRC urban and rural areas income and own-price elasticities

	Urban areas			Rural areas		
	expenditure elasticity	U_Own price elasticity	C_Own price elasticity	Expenditure elasticity	U_Own price elasticity	C_Own price elasticity
Main staples	0.836***	-1.188***	-2.671***	0.865***	-0.784***	-0.125
Pulses	0.949***	-0.145	0.188	0.803***	-1.578***	-1.898***
Vegetables	0.849***	-1.426***	-2.589***	0.807***	-1.809***	-2.465***
Fruit	0.879***	-0.783***	-0.210***	0.883***	-0.381***	0.032*
Meat and fish	0.867***	-0.904***	1.091***	1.287	-2.885	-2.772
Milk	0.875***	-1.121***	-0.800***	0.875***	-1.058***	-0.744***
Sugar	0.794***	-0.804***	-0.936***	1.312	0.796	0.827
Oil	0.870***	-1.024***	-0.468***	0.871***	-1.384***	-0.938***

* significant at 10%, ** significant at 5%, *** significant at 1%. Note: U_Own is uncompensated own and C_Own is compensated own

As shown in Table 6, expenditure elasticities of all food groups for both urban and rural areas were positive and less than one with the exception of sugar, meat and fish for the rural areas. This implies that all food groups were found to be necessity goods for urban households while for the rural areas, all were necessity goods except sugar, meat and fish. The coefficients were between 0.794 and 0.949 which implies that in the urban areas, one per cent increase in all expenditure led to a rise in quantity demanded for all food groups by 0.8% except pulses which increased by 0.9%. On the other hand, in the rural areas, the quantity demanded for all food groups increased by 0.8% except sugar, meat and fish which were not statistically significant.

For both urban and rural areas, the uncompensated and compensated own-price elasticities for all food groups had the same sign though different magnitudes, except for meat and fish in urban areas and fruit in rural areas that had opposing signs. Moreover, the uncompensated and

compensated own-price elasticities for both urban and rural areas had the same signs but different magnitudes.

In urban areas, both the uncompensated and compensated own-price elasticities for vegetables, main staples, fruit, milk, meat and fish, sugar and oil show a negative relation between quantity demanded and price. However, meat and fish had a positive relationship under compensated own-price elasticities. This means that if the prices of main staples, vegetables, fruit, meat and fish, milk, sugar and oil reduce by 10% respectively then their demand would rise by 11.9%[12], 14.2%, 7.8%, 9.0%, 11.2%, 8.0% and 10.0%, respectively. Out of this total increase in demand, 26.7%[13], 25.9%, 2.1%, -10.9%, 8.0%, 9.4% and 4.7% were purely due to price effect (i.e., the substitute effect). The income effect of the reduction in prices account for the remaining -14.8%[14], -11.6%, 5.7%, 19.9%, 3.2%, -1.3% and 5.6%, respectively for main staples, vegetables, fruit, meat and fish, milk, sugar and oil increase due to the rise in real income, though the absolute amount of money income remains static. Thus, in the urban areas, the uncompensated and compensated own price elasticities show that oil, milk, meat and fish, vegetable and main staples are price elastic. The percentage change in quantities demanded of items of those food groups was more than the percentage change in their prices. However, pulses, fruits and sugar were price inelastic, implying that the percentage change in quantities demanded were less than the percentage changes in their prices.

Additionally, in rural areas, if the prices of main staples, pulses, vegetables, fruit, milk and oil reduce by 10% respectively, then the demand for those food groups would rise by 7.8%, 15.8%,

[12] The total increase in quantity demanded is the change in price multiplied by the uncompensated price elasticity. $price = -10\%$ *and uncompensated own price elasticity of main staples is* -1.188.
$Total\ increase\ in\ quantity\ demanded\ of main\ staples = (-10\%)(-1.188) = 11.9\%$

[13] The increase in quantity demanded due to price effect is the change in price multiplied by the compensated price elasticity. $price = -10\%$ *and compensated own price elasticity of main staples is* -2.671.
$Increase\ in\ quantity\ demanded\ of main\ staples\ due\ to\ price\ effect = (-10\%)(-2.671) = 26.7\%$

[14] The increase in demand due to the income effect is the total increase in demand minus the increase in quantity demanded due to price effect.
$Increase\ in\ quantity\ demanded\ of main\ staples\ due\ to\ income\ effect = 11.9\% - 26.7\% = -14.8\%$ implying that the income effect reduced the quantity demanded of main staples by 14.8% when the price of main staples falls by 10%

18.1%, 3.9%, 10.6% and 13.8% respectively. Of this total increase in quantity demanded, 0%, 19.0%, 24.7%, -0.3%, 7.4% and 9.4% were purely due to price effect. The income effect of the decrease in prices accounts for the remaining 7.8%, -3.2%, -6.6%, 4.2%, -3.2% and 4.4% respectively for main staples, pulses, vegetables, fruit, milk and oil increase due to the rise in real income, although the absolute amount of money income remains static. This implies that in rural areas, the uncompensated and compensated own price elasticities revealed that pulse and vegetables were price elastic; the percentage change in quantities demanded of items of those food groups were more than the percentage change in their prices. Moreover, the uncompensated own-price elasticity suggests that milk and oil were price elastic as opposed to main staples. Nevertheless, the compensated own-price elasticity suggested that milk and oil were price inelastic. This implies that the percentage changes in quantity demanded was less than the percentage change in prices. Furthermore, the compensated own-price elasticity suggests that the main staples were perfectly inelastic. Both the uncompensated and compensated price elasticities indicate that meat and fish as well sugar were perfectly inelastic.

The overall results on expenditure elasticities were in line with findings of Abdulai (2002), Mittal (2010) and Colen *et al.* (2018) who found that almost all food groups were necessity goods for households in rural and urban areas. However, the current study found expenditure elasticities to be similar between urban and rural areas, which is contrary to the findings of Abdulai (2002), Mittal (2010) and Colen *et al.* (2018), who found that elasticities were lower in urban areas compared to rural areas. The authors further argued that the higher the income of the population, the lower the elasticities. The differences in the results between the current and the past studies could be attributed to the fact that rural households in DRC consume what they produce (Chauvin *et al.*, 2012; Smoes, 2012). Nevertheless, expenditure elasticities in DRC were still high in both urban and rural areas as compared to other African countries implying that DRC households have a lower income compared to other African countries (Colen *et al.*, 2018).

It was worth to note that, in rural areas, the relationship between the change in household expenditure and demand for meat and fish as well as sugar was not significant. This could be attributed to the fact that both products were very scarce and expensive in rural areas. The results were in line with Heinz (1995) who found that in spite of the fact that domesticated animals were reared in rural areas, meat was not often accessible there, as most of the abattoirs where the animals are butchered are in urban areas.

The findings in the current study on main staples in rural areas were in line with the conclusions of the WFP (2007) which stated that for poor developing countries, main staples are usually price inelastic. However, the results in Table 6 showed that in urban areas, staple foods were price elastic opposing the findings of Dorosh and Haggblade (1997) and WFP (2007). The reason could be associated to the fact that in urban areas of DRC, households do not have strong preferences for different items within the main staples. They can therefore easily substitute maize flour for cassava flour, sorghum for rice or even cassava tuber for potatoes.

Moreover, the difference in the own-price elasticities between urban and rural areas could be because households in rural areas do not depend on the market for staple foods. Rural households usually eat what they produce. This is in line with Ulimwengu *et al.* (2012) who found that many households grow their own vegetables, fruits and staples. Only a small quantity of main staples finds its way to the market.

4.4.2 Compensated and uncompensated cross-price elasticities

The compensated and the uncompensated cross-price elasticities for urban and rural areas of DRC are presented in Table 7 and Table 8 respectively. The discussion focused on the compensated cross-price elasticities as it best explains the effects of change in price on the quantity demanded.

Table 7: DRC urban and rural areas compensated cross-price elasticities

	Price							
Urban areas	**Main staples**	**Pulses**	**Vegetables**	**Fruit**	**Meat and fish**	**Milk**	**Sugar**	**Oil**
Main staples	**-2.671*** **	0.380***	-1.172***	0.607***	2.066***	0.336***	-0.131	0.584***
Pulses	-1.923***	**0.188**	-2.115***	0.542***	2.280***	0.399***	-0.074	0.702***
Vegetables	-1.518***	0.542***	**-2.589*** **	0.627***	2.116***	0.337***	-0.129	0.614***
Fruit	-1.652***	0.292***	-1.319***	**-0.210*** **	2.145***	0.363***	-0.166*	0.547***
Meat and fish	-1.593***	0.348***	-1.260***	0.607***	**1.091*** **	0.343***	-0.143	0.606***
Milk	-1.626***	0.381***	-1.256***	0.645***	2.153***	**-0.800*** **	-0.131	0.634***
Sugar	-1.399***	0.156	-1.063***	0.651***	1.975***	0.289***	**-0.936*** **	0.327*
Oil	-1.619***	0.385***	-1.315***	0.557***	2.181***	0.364***	-0.085	**-0.468*** **
Rural areas								
Main staples	**-0.125**	-0.454***	-0.774***	0.405***	0.164	0.335***	-0.037	0.485***
Pulses	0.868***	**-1.898*** **	0.163	0.580***	-0.009	0.295***	-0.096	0.096
Vegetables	0.726***	0.08	**-2.465*** **	0.501***	0.101	0.324***	0.249***	0.486***
Fruit	0.661***	-0.495***	-0.873***	**0.032***	0.076	0.300***	-0.025	0.324***
Meat and fish	1.416	0.039	-0.928*	0.402	**-2.772**	0.436	0.525	0.881
Milk	0.714***	-0.328***	-0.735***	0.391***	0.107	**-0.744*** **	0.05	0.544***
Sugar	-1.16	1.594	-8.4	-0.481	1.926	0.748	**0.827**	4.946
Oil	0.723***	-0.075	-0.772***	0.295***	0.152	0.381***	0.233***	**-0.938*** **

Standard errors in parentheses, * significant at 10%, ** significant at 5%, *** significant at 1%

Table 8: DRC urban and rural areas uncompensated cross-price elasticities

	Price							
Urban areas	**Main staples**	**Pulses**	**Vegetables**	**Fruit**	**Meat and fish**	**Milk**	**Sugar**	**Oil**
Main staples	**-1.188*** **	0.087***	-0.027	0.062*	0.143***	0.030**	0.008	0.049**
Pulses	-0.239***	**-0.145**	-0.814***	-0.076	0.096***	0.050*	0.084**	0.095**
Vegetables	-0.011	0.244***	**-1.426*** **	0.074*	0.162***	0.025	0.012	0.071***
Fruit	-0.093***	-0.016*	-0.115***	**-0.783*** **	0.123***	0.041***	-0.020***	-0.015*
Meat and fish	-0.055***	0.043***	-0.072***	0.042*	**-0.904*** **	0.025**	0.001	0.052***
Milk	-0.075***	0.074***	-0.058***	0.075***	0.141***	**-1.121*** **	0.015**	0.075***
Sugar	0.01	-0.122	0.025	0.133	0.149***	-0.003	**-0.804*** **	-0.181
Oil	-0.075***	0.080***	-0.123***	-0.01	0.178***	0.044***	0.060***	**-1.024*** **
Rural areas								
Main staples	**-0.784*** **	-0.109**	-0.071**	0.001	0.088***	0.026	-0.057*	0.043
Pulses	0.256***	**-1.578*** **	0.816***	0.205***	-0.080**	0.007	-0.116***	-0.315***
Vegetables	0.111***	0.401***	**-1.809*** **	0.124*	0.029*	0.035	0.229***	0.073
Fruit	-0.012	-0.143***	-0.155***	**-0.381*** **	-0.002	-0.016	-0.046***	-0.128***
Meat and fish	0.434	0.552	0.119	-0.198	**-2.885**	-0.025	0.494	0.222
Milk	0.047***	0.020***	-0.023**	-0.017***	0.030***	**-1.058*** **	0.029***	0.097***
Sugar	-2.16	2.116	-7.333	-1.093	1.81	0.278	**0.796**	4.275
Oil	0.058***	0.272***	-0.063***	-0.111***	0.075***	0.069***	0.212***	**-1.384*** **

Standard errors in parentheses, * significant at 10%, ** significant at 5%, *** significant at 1%

The cross-price elasticities (Table 7 and Table 8) indicate that when the price of main staples increased, households reduced the quantities demanded for pulses, fruit, meat and fish, milk as well as oil. This implies that these food groups were complements to the main staples. However, in rural areas, the results in Table 7 and Table 8 show that the situation was completely different. When the price of main staples increased, households increased the quantities demanded for pulses, vegetables, milk and oil; making them substitute goods compared to the main staples.

There is not much difference between the compensated and the uncompensated cross-price elasticities in term of coefficient signs. However, the values of the coefficient of compensated cross-price elasticities are bigger than the uncompensated cross-price elasticities in absolute value. This implies that the income effect significantly affects the choice of food items.

For both uncompensated and compensated, the cross-price elasticities in rural areas were significant. However, their low magnitudes suggested limited complement or substitution possibilities for all food groups. As explained earlier, the reason could be that rural households did not depend highly on the market for food. This is in line with the findings of Abdulai (2002) and Huq and Arshad (2010) who reported that substitution effects is not strong in poor communities.

However, households in urban areas highly depend on the market for main staples. The results for main staple food in urban areas were in line with the findings of Ulimwengu *et al.* (2012) who found that in case of a rise in the price of staple foods, the household would reduce the quantity consumed for other food groups in order to maximize the consumption of main staples.

In the urban areas, when the price of pulses increased, households increased the quantities demanded for all food groups except sugar; making them substitutes goods compared to pulses. While in rural areas, pulses were complement as compared to main staples, fruit and milk.

From Table 7 it can be observed that vegetables were complements as compared to other food groups for both areas. This is in line with Blisard *et al.* (2004) who found that vegetables are

considered as complement food in low-income communities. Furthermore, when the price of meat and fish increased, households significantly increased the quantities demanded for all food groups meaning that all the food groups are substitutes as compared to fish and meat. In contrast, in rural areas, the change in the price of meat and fish did not affect the demand of other food groups.

Fruit, milk and oil had a similar pattern in both urban and rural areas. In case of a price increase, the quantity demand for all food groups increased. This implies that fruit, milk and oil are substitutes to other food groups. The results corroborate that of Green *et al.* (2013) who reported that in low-income areas, if the price of food items such as fruit, milk or vegetables increases, households substitute them with others affordable food items.

4.4 Effects of income on different food groups in DRC

4.5.1 Main staples

The main staples' quadratic and the polynomial Engel's curves for urban and rural areas for the year 2005 and 2012 are represented in Figure 21. They illustrate the links between the levels of consumption of main staples and levels of income across households, providing evidence on how main staples consumption could possibly change when income rises.

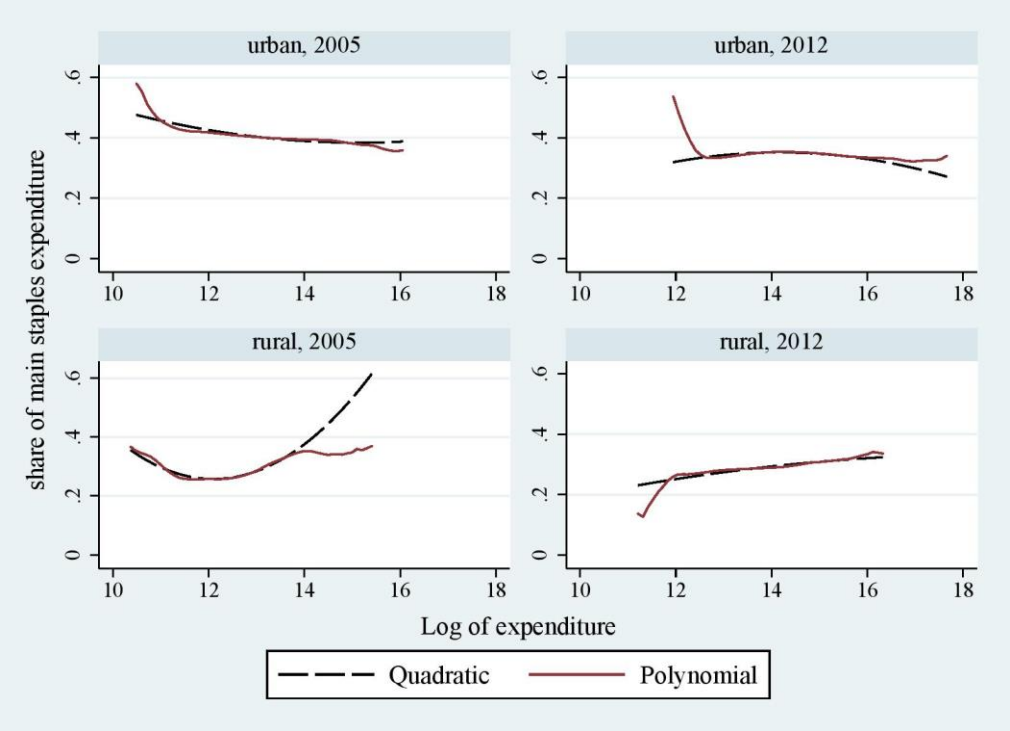

Figure 21: Main staples' Engel's curves

Overall, for the two periods, given the slopes of the Engel's curves, main staples were found to be necessity goods in urban areas and luxury in rural areas. Meaning that the share of household budget allocated to main staples declined as income increased in urban areas while the reverse was observed in the rural areas. This could be because of the inability of rural households' production of staples food to sufficiently cover households' needs. As a result, the rich households get their supply from the local market to fill the gap. This is in line with the findings of Jensen and Miller (2008) who found that in China rural areas, when households income increases, they prefer to

consume rice that is more expensive to improve the quality of their diet which possibly leads to an increase in the budget share of main staples. Moreover, these results corroborate the findings of Moustier and David (1997) that as income increases, households self-production decreases.

4.5.2 Pulses

The pulses' quadratic and the polynomial Engel's curves for urban and rural areas for the year 2005 and 2012 are presented in Figure 22.

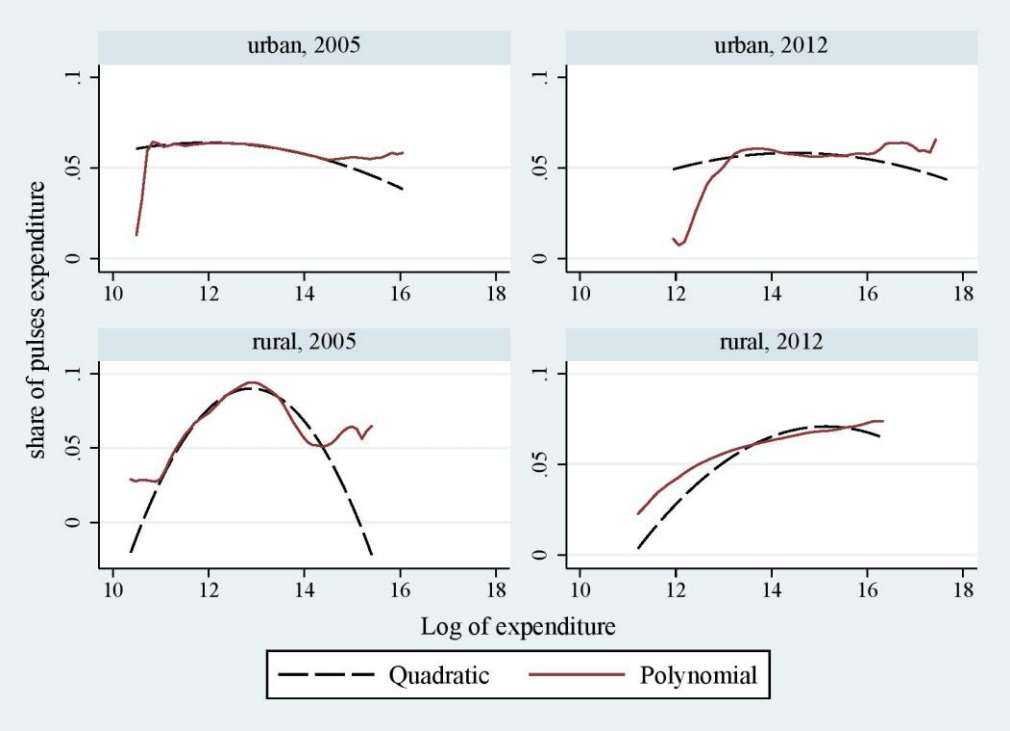

Figure 22: Pulses' Engel's curves

The slopes of the Engels curves suggest that in urban areas for both 2005 and 2012, pulses were consumed as necessity goods while in rural areas they were luxury goods. The polynomial Engels curves illustrate that for the poor and the rich households in the urban areas, pulses were luxury goods. In rural areas, in 2005, pulses were luxury goods. However, beyond a point point, they became necessity goods.

The budget share for pulses did not change significantly with an increase in income except in rural areas where beyond a certain income level, the budget allocated increases. This was in line with the finding of Marivoet *et al.* (2017) who argued that when households become richer in the DRC, pulses were gradually included to their diet. Due to the limited variety of pulses, usually multicoloured beans, there was no significant change that happened in the dietary habit of households. However, for wealthy households, they prefer imported pulses to diversify their intake. Moreover, as the multicoloured beans are usually produced by households in rural areas for their self-consumption, the results was in line with the argument of Moustier and David (1997) that as income increases, households decrease their self-production.

4.5.3 Vegetables

The vegetables' quadratic and the polynomial Engel's curves for urban and rural areas for the year 2005 and 2012 are represented in Figure 23.

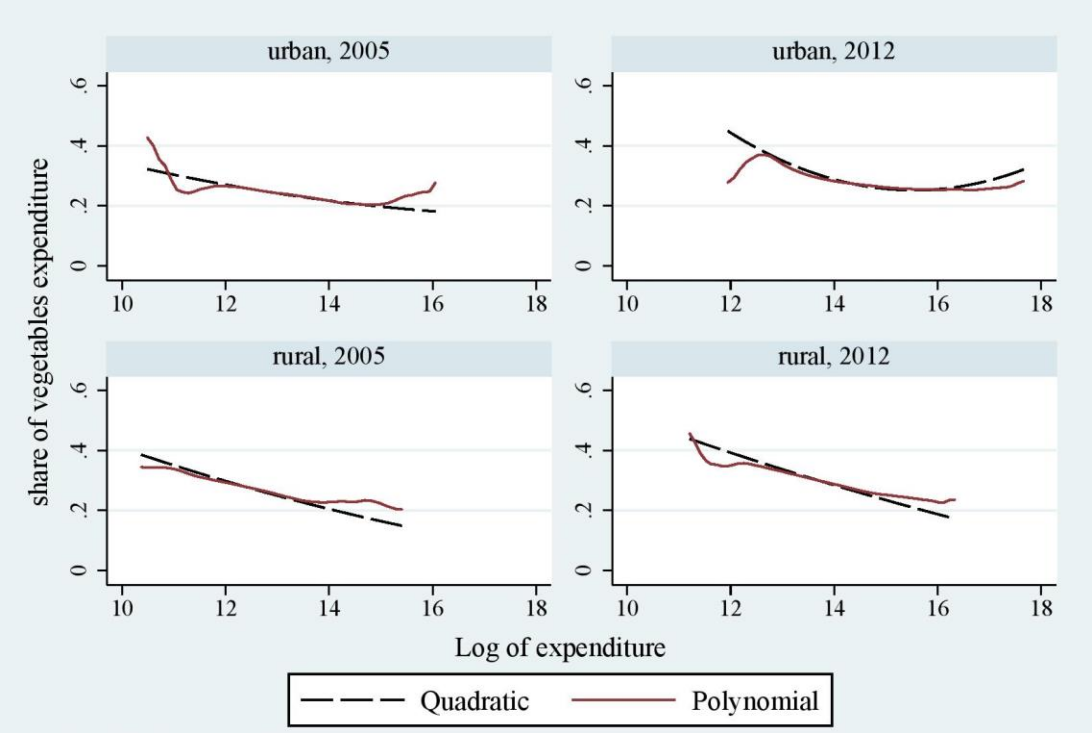

Figure 23: Vegetables' Engel's curves

Regarding vegetables, the results suggested that vegetables were necessity goods for urban and rural areas in both 2005 and 2012. Vegetables are mostly cheap and can be afforded by most households including those with low income. Hence, the rise in income across households does not change the demand for vegetables. This was in line with Ruel *et al.* (2005) who argued that even in case of a decrease in the budget, the quantity demanded of vegetable increased. Nevertheless, this holds only if that decrease is little. This findings are similar to FAO report in 1997 which posits that a higher purchasing power of households in Sub-Saharan Africa leads to reduction their vegetable consumption (Moustier and David, 1997).

4.5.4 Fruits

The fruit quadratic and the polynomial Engel's curves for urban and rural areas for the year 2005 and 2012 are represented in Figure 24.

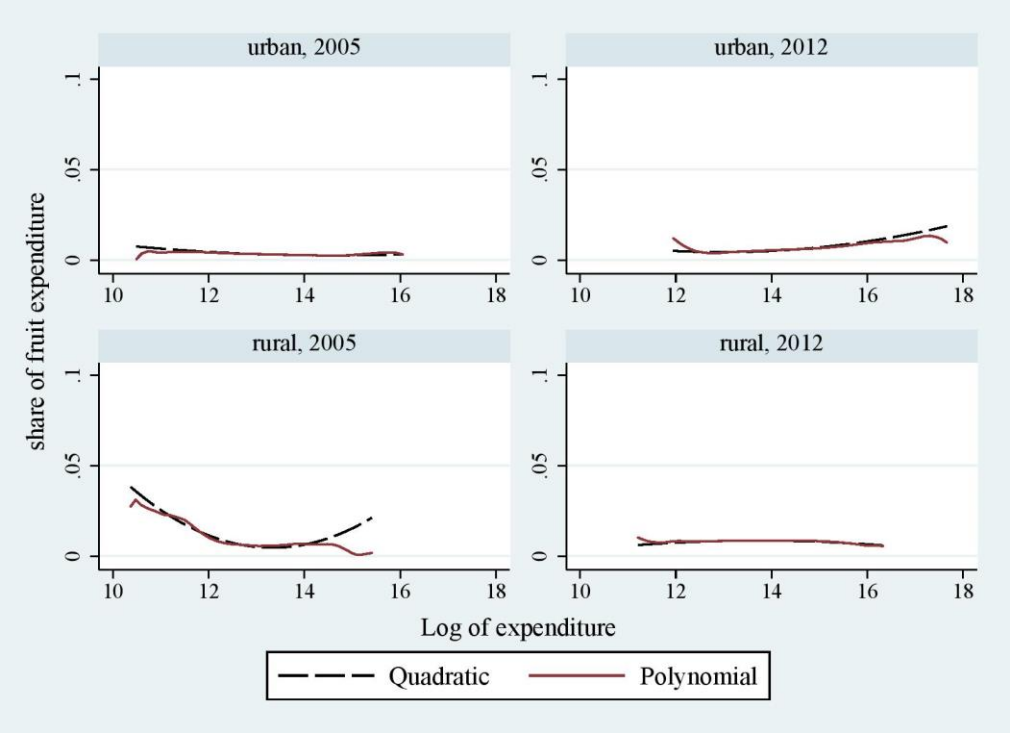

Figure 24: Fruit's Engel's curves

From Figure 24, it was observed that little budget was allocated to fruits by both poor and rich households. The 2015 data showed that fruits were necessity goods for urban households while they were luxury goods for the households in rural areas. As for 2012 in urban areas, fruit were luxury goods as opposed to rural areas.

The results from the Figure 24 suggest households allocate a very low share of their income to food groups including fruit. However, the share increases with the rise in income, especially in urban areas, certainly because households with higher income tend to consume more fruits. This verified the findings of Marivoet *et al.* (2017) who reported that the consumption of fruits was somehow negligible. In the same line, Akakpo *et al.* (2014) found that fruits were scarce and were

limited to households with higher purchasing power in many developing countries. Hence, the fruits were considered to be luxury goods (Blisard *et al.*, 2004). However, the results contradict the findings of Ulimwengu *et al.* (2012) who found that the fruit share decreased with rising food expenditure. This could be because in the author's analysis of the Engel Curves, only the year 2005 was considered and the urban and rural results were aggregated.

4.5.5 Meat and fish

The meat and fish' quadratic and the polynomial Engel's curves for urban and rural areas for the year 2005 and 2012 are represented in Figure 25.

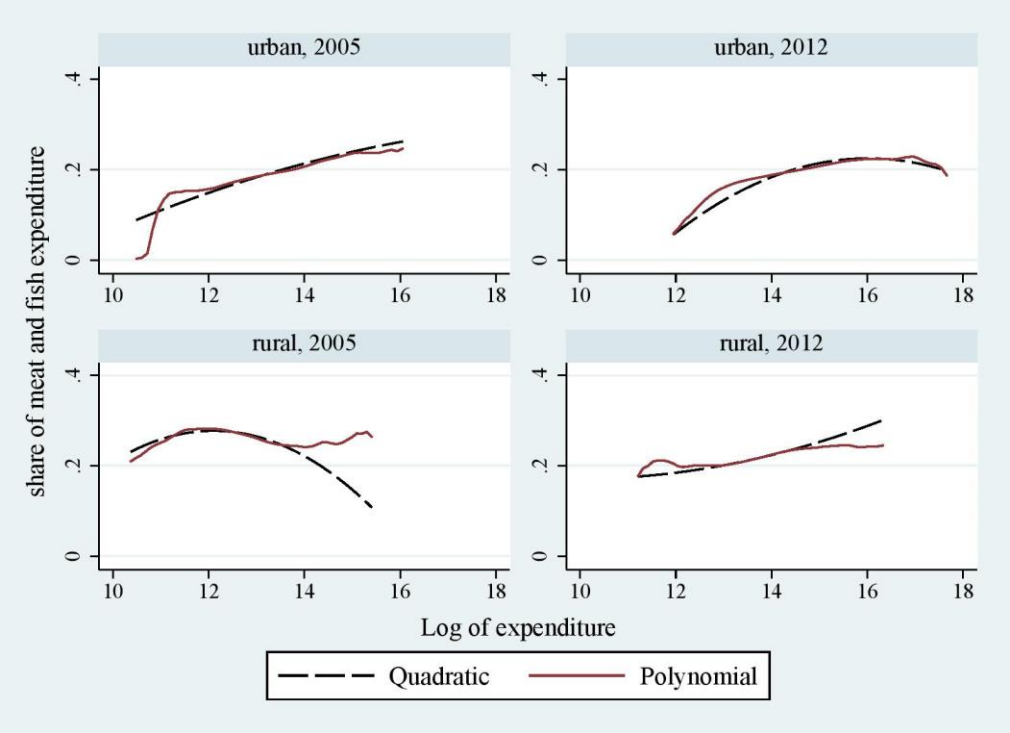

Figure 25: Meat and fish's Engel's curves

Except in the rural areas in 2005, the overall results indicate that the budget share for meat and fish food groups increases with the rise in income across households. This, therefore, implies that meat and fish are luxury goods in DRC.

It is worth noting that the results presented in Figure 25 is inconsistent with that of Akakpo *et al.* (2014) who found that when the budget of the DRC household increases, the budget share allocated to meat and fish decreases. The probable reason for this could be the differences in the analytical method used. Akakpo *et al.* (2014) divided the population of DRC into three groups based on income and did not consider the differences that exist between urban and rural areas. Nevertheless, as explained earlier in many cultures of DRC, meat, as well as fish consumption, is a sign of good

living standard, adding to it the high price of meat and fish. These results were in line with the findings of Moustier and David (1997) who found that in Sub-Sahara Africa, when income increases, the consumption of meat and fish increases as well.

4.5.6 Milk

The milk's quadratic and the polynomial Engel's curves for urban and rural areas for the year 2005 and 2012 are presented in Figure 26.

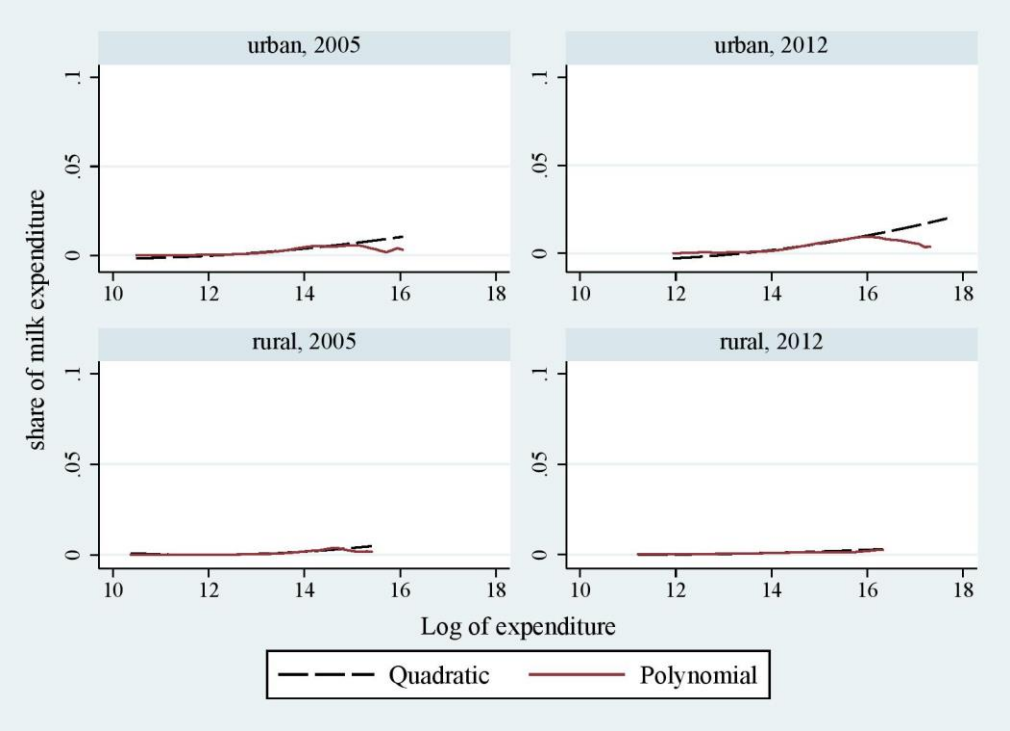

Figure 26: Milk's Engel's curves

It was observed from the results that the budget allocated to milk and dairy products in rural areas is very small, even with a rise in income across households. However, the overall results suggest that milk and dairy products are luxury goods. This further implies that the consumption of milk increases with the rise in the household income. This finding is in line with, Delgado (2003), Kearney (2010) and Kasirye (2015) who found that increase in income leads to an increase in the consumption of milk and dairy products.

4.5.7 Sugar

The sugar's quadratic and the polynomial Engel's curves for urban and rural areas for the year 2005 and 2012 are represented in Figure 27.

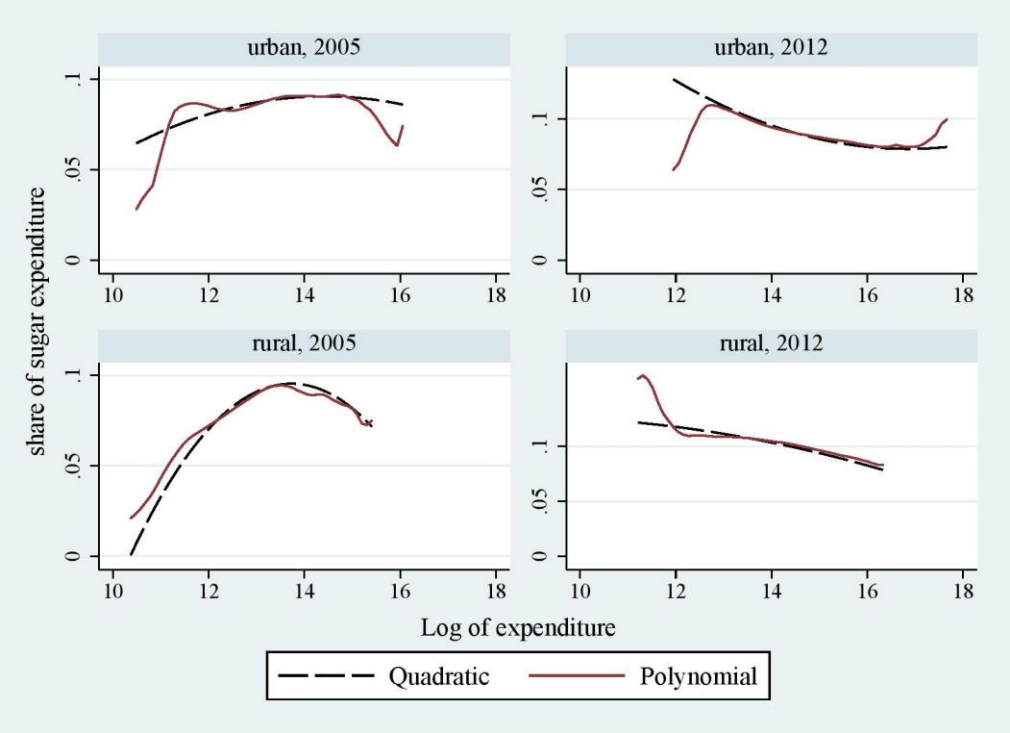

Figure 27: Sugar's Engel's curves

The overall results suggest that in 2005, sugar was a luxury good while in 2012 it became a necessity goods for both rural and urban dwellers. The 2005 result could be attributed to the high price of sugar in the rural areas due to the decrease in the production of sugarcane between 1998 and 2006 (Gathovagheni, 2009). Also, the change observed in 2012 could be as a result of the increase in local production of sugar cane from around 1.5 million in 2006 to approximately 2 million tonnes in 2012[15]. However, it is worth to observe that sugar is was still a luxury good for very poor households in urban areas in 2012. The 2012 results were in line with Temple and Steyn

[15] https://knoema.fr/atlas/R%C3%A9publique-d%C3%A9mocratique-du-Congo/topics/Agriculture/Cultures-agricoles-Quantit%C3%A9-tonnes/Canne-%C3%A0-sucre visited on 02 April 2019

(2013) who found that in South Africa and many countries in Africa, rich people tend to reduce their consumption of sugar to reduce the risks of diseases.

4.5.8 Oil

The oil's quadratic and the polynomial Engel's curves for urban and rural areas for the year 2005 and 2012 are represented in Figure 28.

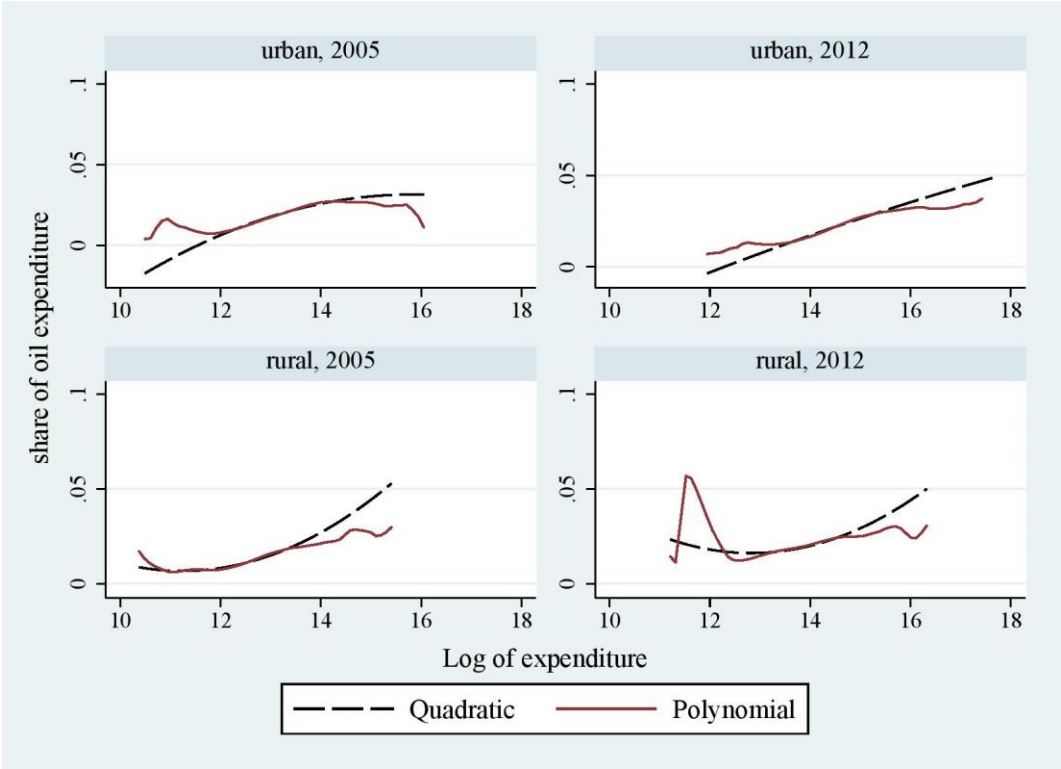

Figure 28: Oil's Engel's curves

Overall, for the two periods, given the slopes of the Engel curves, oil was consumed as a luxury good in urban areas. Oils and fat are luxury goods since their budget share increases with increase in household expenditure. As earlier stated, households with higher income tend to go for food items of better quality, which are usually more expensive. For example, low-income households consume goods that are produced locally (palm oils) while those with higher income prefer imported goods (different brand of vegetable oils) especially since the local production of palm

oil is not adequate, and the output is decreasing over time (Marivoet, 2016). These results are in line with that of Mancini *et al.* (2015) who found that wealthy households assume that imported oils are well refined and healthier than the locally processed ones.

CHAPTER FIVE : CONCLUSIONS AND RECOMMENDATIONS

5.0 Conclusions

Based on the findings of this study, it can be concluded that households in DRC spent about three-quarter of their income on food within the study period. The budget share has been useful to determine the level of vulnerability towards food insecurity and malnutrition. Households in both urban and rural areas were highly vulnerable to food insecurity. In other words, in all the provinces under study, for both urban and rural areas, any shock such as the loss of a parent, war, drought, price chock, etc. can lead to severe food insecurity and nutrition issues.

About 80 per cent of the food budget was spent on cereals, root and tubers as well as meat and fish which was attributed to the availability of other food groups. The nutrient deficiency analysis suggested that there was hidden hunger all over the country, as shown by micronutrient deficiencies. The findings also showed that the difference between the type of foods eaten and the nutritional status between rural and urban areas as well as between provinces were due to poor road networks within and between provinces.

The expenditure elasticities suggested that the quantity demanded for almost all the food groups rose with increases in income. By implication, an increase in income of the population would lead to a potential growth of the food sector. Therefore, the food sector constitutes an excellent opportunity for investment. Furthermore, in urban areas, Engel's curves show that fruits, meat and fish, milk, and oil were luxury goods while in rural areas, main staples, pulses, meat and fish, milk and oil were luxury goods. This suggests that future rise in income are likely to be assigned primarily on those food groups in each region.

The own-price elasticities are higher than the expenditure elasticities. This suggests that households are more sensitive to changes in price than changes in income, which implies that price policies are good agricultural policy instruments. In other words, price policies are essential to

stimulate agricultural diversity and production. Furthermore, there is a need to reduce the gap between the domestic supply of food commodities and demand by considerably increasing local production. This will minimise food price variation.

The cross-price elasticities show that meat and fish can be easily substituted in urban areas. This means that government price subsidies for food items such as fruit, milk, meat and fish, vegetables can lead to significant consequences in the economy and on the nutrition of the population. The same applies to the main staples in rural areas. However, overall, the cross-price elasticities were very low especially in rural areas, suggesting a limited possibility of substitution. Price intervention will not affect the entire rural economy as opposed to living standards intervention.

The overall findings of the food budget share, food consumption, nutrient deficiencies, their changes, the elasticity as well as the Engel's curve provide evidence for policymakers in DRC to plan for food demand and improvement of the nutrition of the population. These results would similarly support living standards interventions and the design of price policies that serve as incentives to the farmers.

5.1 Recommendations

5.2.1 Recommendations for policy intervention

The government should put more effort into policies that aim to improve the population's living standards. Especially, policies that increases wage and job creation. All the ministries should be driven by the main objective of supporting every activity or project that will lead to creation of employment.

There is a need for the government and development partners to invest more on infrastructures, mainly roads that link rural areas to urban areas and remove all trade barrier for agricultural and

food products between provinces. Hence, help to facilitate food trade within the provinces and the country.

Policymakers and other stakeholders need to design and implement policies such as a system of unconditional cash transfer to promote sustainable livelihoods. In the long-run perspective, there is a need for a resilient food system and policies that boost the building up of assets, savings and insurances to rely on during shortage time.

As the choice of food seems not to diversify with rise in income, courses on nutrition should be given a high interest and introduced in the academic curriculum from the primary school to enable households to go for a more balance diet. In addition, as the culture and the region have significant importance on the choice of foods, it is essential that any public campaigns or programs aimed at improving the nutritional status of the population should look at the nutrition composition of indigenous foods.

Moreover, to satisfy nutritional needs, the promotion of multi-stakeholder partnership is required to encourage investment by private sector and foreign companies in the food system. It is essential for stakeholders to understand that the government alone cannot be able to enhance the nutritional status of the population. International organisations, community-based organisations, social movement, non-governmental organisations, donors, researchers and academia, private and public sectors need to be involved in the processes that produce agricultural commodities, transform them into food in the marketing sector and final sales to consumers.

The study further suggests that policymakers should focus on micronutrients to improve the nutrition of the population. Therefore, emphasis should be placed on crops such as legumes, nuts, vegetables, fruits as well as animal products. The study recommends that investors should establish abattoirs and industries for the processing agricultural products in rural areas. This will permit agricultural products to be accessible to rural households.

5.2.2 Recommendation for further studies

This study used a different approach compared to Ulimwengu *et al.* (2012) and Akakpo *et al.* (2014) to explain changes in demand of different food groups and nutrition deficiency among households in DRC comparing urban and rural areas across 2 time periods.

This study has been done at a national level, a study at the provincial level can significantly add value to this study as it will highlight the heterogeneity that exists within provinces. Further research could also disaggregate the food groups and analyse the demand for food items within the food groups. This will help to understand how households behave regarding food items having similar characteristics. Moreover, it will help in understanding the relationships that exist between the quantity and the quality of food items.

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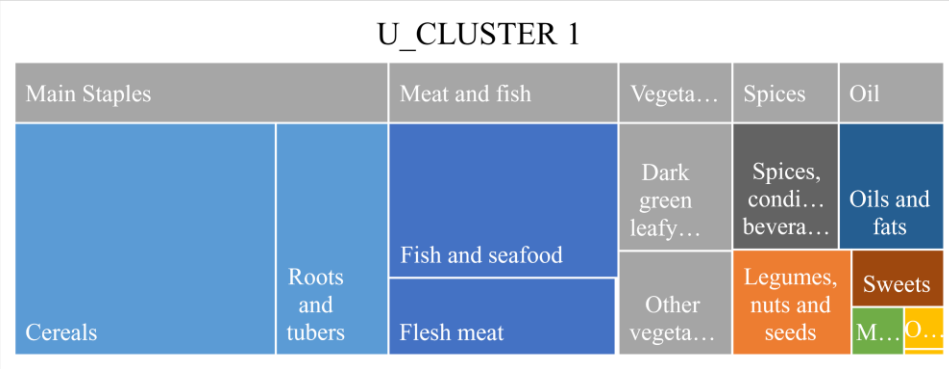
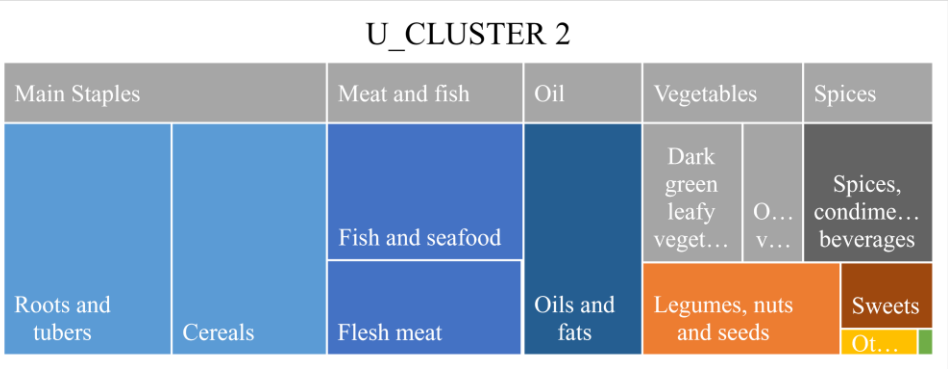
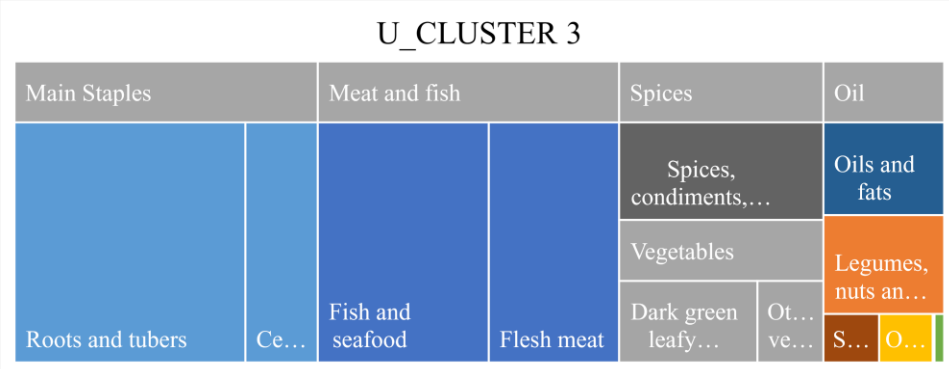
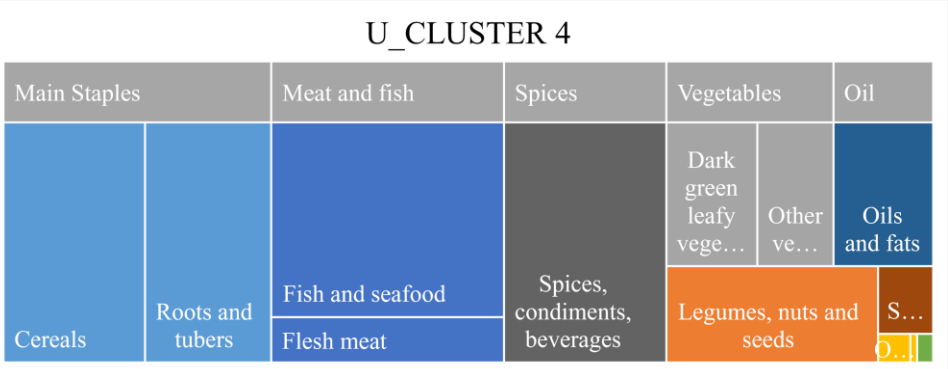
APPENDIX

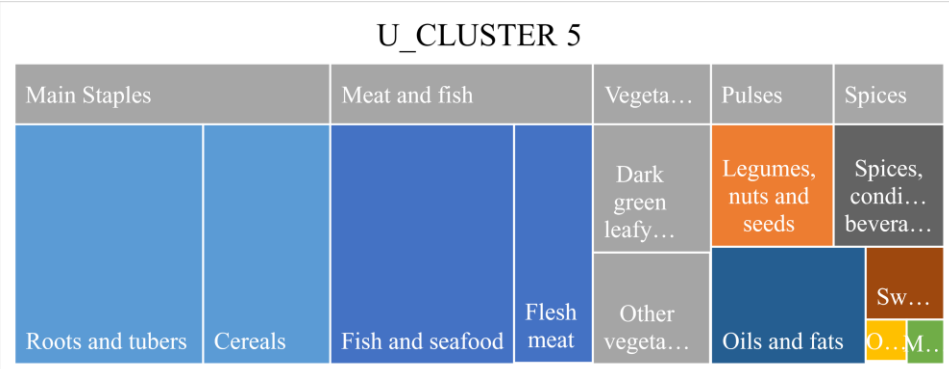
Household food composition











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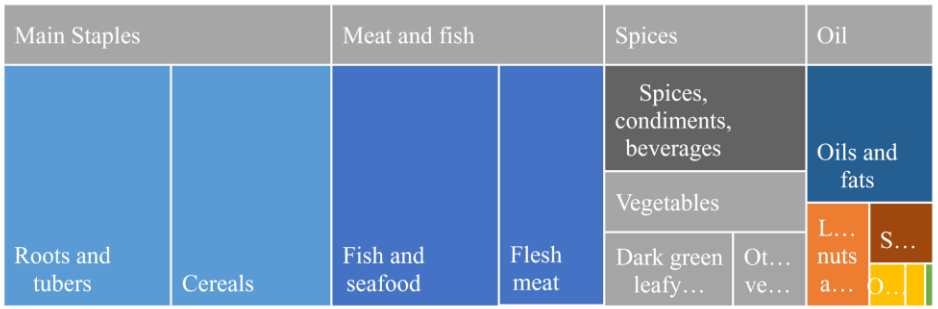

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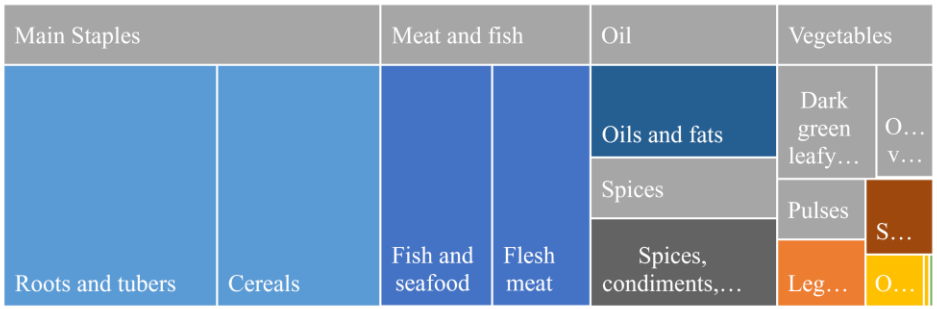

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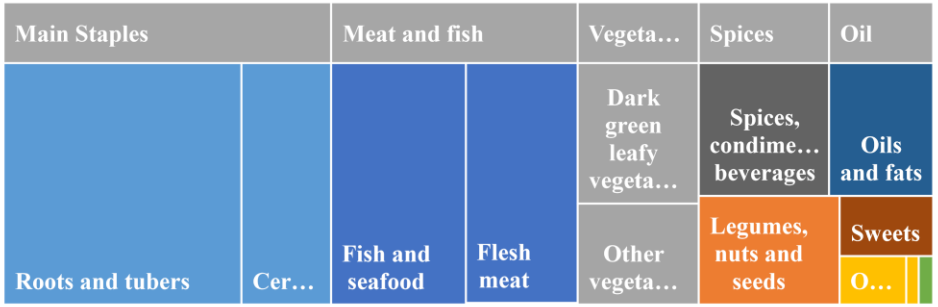

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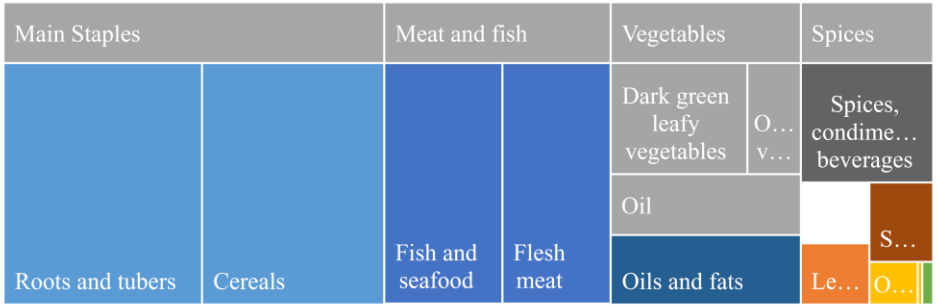

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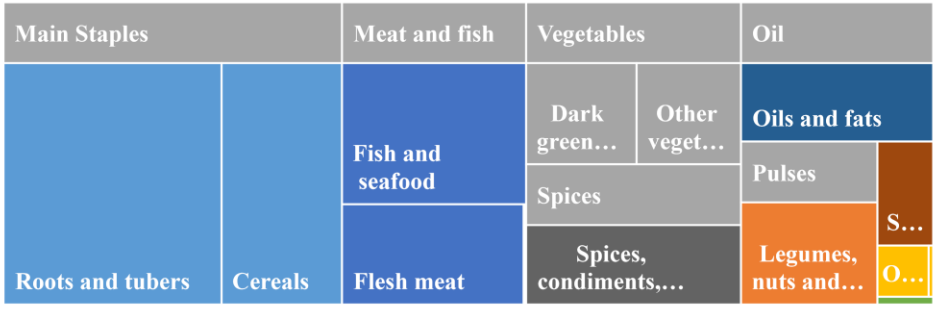

Consumption change by cluster