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

BY

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DECLARATION AND APPROVAL

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

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 of the prevalence of 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 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 the households’ food consumed and nutritional diversity. 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 trends between 2005 and 2012 for urban and rural areas for 26 provinces of DRC. Moreover, 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 trend. 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 a nutrition-sensitive approach, multi-stakeholder partnerships and improvement of the communication within and between provinces. Finally, further study on the households' food consumption and demand should be done on a more disaggregated level.

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CAADP	Comprehensive Africa Agriculture Development Programme
DRC	Democratic Republic of Congo
FAO	Food and Agriculture Organization of the United Nations
FEWS NET	Famine Early Warning Systems Network
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
NEPAD	New Partnership for Africa's Development
PRSs	Poverty Reduction Strategies
SDGs	Sustainable Development Goals
UNDP	United Nation for Development Programme
UNICEF	United Nations International Children's Emergency Fund
USAID	United States Agency for International Development
WFP	World Food Programme
WHO	World Health Organization
PIGLOG	Price-Independent Generalized Logarithmic

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

In recent times, almost all the member countries of the United Nations are committed to achieving the Sustainable Development Goals 2 of zero hunger. However, all over the world, there are many challenges that are making it difficult to achieve this goal. In this process of having a world without hunger in all its forms, food security and nutrition requires special attention owing to the fact that it is fundamental to the development of relevant policies to bring about sustainable growth and development. This is because food and nutrition security is 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 Sustainable Development Goals (SDGs)[1] and the Maputo Declaration (CAADP-NEPAD) to revitalise the agricultural sector of Africa. The Malabo declaration is also meant to enhance and accelerate 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. 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 achieve the three main objectives of food security and nutrition policy: social, economic growth

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

in terms of increased income and promotion of sustainable livelihoods (African Union, 2003, 2014, 2015; Hendriks, 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 meet 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 2nd SDG influences the governments' declaration of nutrition as a central component in policy actions. Moreover, the importance of the agricultural sector changed over this commitment. Currently, agriculture is not only considered as a source of food but also for other assets. Considering that, the commitment is not only to feed the people but also to nourish and improve the livelihood of people (Hendriks, 2018).

Improving nutrition is essential for economic and social development, and this can be 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 right from birth and 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 underweight at the same time called "double burden of malnutrition". Whichever the case, the infant cannot develop appropriate motor skills; moreover, this is not limited to only physical development but also mental development and this will affect all domains of its 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 for 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).

The Democratic Republic of Congo is among the four last countries with the lowest SDG 2 score of 34.8. Between 2009 and 2011, several reports attributed low, if not the worst Global Hunger Index (GHI) scores to the DRC. However, in recent times, there is limited evidence/data to distinctively describe the situation of food security and nutrition in DRC nevertheless the situation remains alarming (Grebmer *et al.*, 2013; Grebmer *et al.*, 2014; Grebmer *et al.*, 2015; Grebmer *et al.*, 2016; Grebmer *et al.*, 2018). OCHA (2017) has reported that over the past years, 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 are facing severe food insecurity and malnutrition, and severe acute malnutrition affects about 2 million children.

USAID in his 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 as well as limited livelihood activities. Due to violence and instability, urgent food and relief need is needed 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]. In the same angle, The Famine Early Warning Systems Network (FEWS NET) projected that crisis levels of acute food insecurity would persist past 2019[3] (USAID, 2018).

1.2 Problem statement

DRC has huge agricultural potential, but it is unable to feed its population. USAID (2019) reported that the total food for peace contribution of 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, out of a population of 81.3 million about 16.8, 27.4, 9.8 and 3.4 million people are facing minimal (IPC1), stressed (IPC2), critical (IPC3) and emergency (IPC4) acute food insecurity respectively.

The government of DRC and its partners usually focus on peace, stability and food aids to resolve the issue of food insecurity and malnutrition. However, very little attention is directed towards improving the quality of the households' food consumed and nutritional diversity, and yet these are very important in stopping hidden hunger. Moreover, DRC has no concrete agenda to improve food security and nutrition (IPC GLOBAL PARTNERS, 2017).

[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

Besides, economic growth is essential for the improvement of the nutritional status of people. However, based on previous studies and reports by international organisations and researchers in DRC, the rate of reduction in malnutrition in DRC is less than the rate of economic growth (DFAE, 2017; UNICEF, 2017). For instance, Marivoet et al. (2018) found that the incidence of underweight declined for both groups in the urban areas. They also found a higher variability in the DRC's economy showing that the change in the economy is not unique to all provinces.

In addition, Marivoet *et al.* (2017) conducted a study on the relationship between diet, the number of calories intake and household food consumption using data from the 123 surveys and found that at a regional level, food consumption score is at an acceptable level. However, they did not provide information on nutrition status.

A number of studies have estimated the nutritional status of household and 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 basket of food in the household can change in case of a change in household income and food price (Marivoet *et al.*, 2018). It is worth to note that Ulimwengu *et al.* (2012) studied the demand for food in DRC. However, the authors did not disaggregate the study area into urban, and the rural areas and the analysis did not capture the temporal aspect. The study used only the 2005 survey. 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 is that there is an issue of malnutrition in the DRC and over time, the situation has not improved. Besides, different regions are characterised based on various aspects when it comes to access to food and nutrient deficiency. Moreover, the level of obesity is also increasing over time[4].

[4] https://www.indexmundi.com/g/g.aspx?c=cg&v=2228&l=fr visited 13 December 2018

Finally, 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.

1.3 Objectives

The purpose of this study was to assess the consumption trends 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:

1) To determine the food budget share and level of food consumption in urban and rural areas
2) To analyse the trends of the food budget share and level of consumption share in urban and rural areas
3) To map the trends of nutrient deficiencies in food consumed in urban and rural areas
4) To analyse the effects of changes in food prices and household's income on food demand

1.4 Research questions

This study sought to answer the following questions:

1) What are the trends of the food share and food consumption?
2) What are the trends of the nutrient deficiencies?

1.5 Research hypotheses

The study tested the following hypotheses:

1) The budget share is low.
2) Households level of food consumption is low.
3) Food prices and household income do not affect the demand for food.

1.6 The Significance of the Study

Analysing the food budget share and the level of food consumption is very useful to identify and classify individuals and communities in DRC according to their vulnerability to shocks such as an outbreak, war, droughts or any other thing that could affect food prices (Lele et al., 2016). The food budget share, the level of food consumption as well as their trends, can similarly be used for support and national monitoring. These indicators can be utilised by the ministry of agriculture, economy and health of DRC, in combination with other indicators, to measure food insecurity and nutrition, and vulnerability to future shocks (Rose, 2012).

Analysing the trends for both the budget share and the level of food consumption is essential as it informs nongovernmental organisations and governments to determine trends in food security and nutrition of a country or a community.

Assessing the nutrient deficiencies and their trends will provide scientific evidence that will be very useful for the design of the guidelines for developing national plans of action for nutrition, and the building 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 area of food policy in DRC as it provides meaningful implication of 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 for the formulation of consumer behaviour models toward food (Babu *et al.*, 2017).

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. In addition, it will be useful to policymakers in DRC in designing policies that will help to achieve all other policies that are related to food security

(Marivoet *et al.*, 2017). Furthermore, the achievement of all SDGs depends directly and indirectly on the nutrition outcome (Babu *et al.*, 2017; Hendriks, 2018).

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 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; it is more of a socio-historical approach in terms of consumption patterns[5].

However, for the purpose and a better understanding of this study, the two approaches are combined. The concepts like household, income and price elasticities of the food demand, the Engel curve as well as the nutrition transition are clearly explained by emphasising their importance in the analysis of the food consumption.

2.2 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 & Subandoro (2007) suggested that households spending more than 75 per cent of their income on food are considered to be "*very highly vulnerable to food insecurity"*. Those that spend between 65 and 75 per cent 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"*.

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

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 respectively spend about 58 per cent and 67 per cent of their income on food. 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 & 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"*.

Regarding diet composition, Chauvin *et al.* (2012) found that cereals represent the highest share of the food budget, followed by fruit and vegetables. These findings are in line with Muhammad *et al.* (2013). Both researchers, 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 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 difference in income between developed and developing countries.

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) 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 the climate change (Anríquez *et al.,* 2013). 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 as well as culture (Ackah *et al.*, 2007; Babu *et al.*, 2017).

In the early ’80s, food insecurity and nutrition were attributed to inadequate supply of food. However, Sen (1982) postulated that famine or food issues was 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 & Ulimwengu (2018) discussed that the issue of obesity in developing countries is due to urbanisation, rise in income levels and sedentary lifestyle. Notwithstanding, the question of triple burden (underweight, overweight and micronutrient deficiencies) requires to take into account the social, cultural, and political contexts of each region. Hendriks (2015) argued that micronutrient deficiencies; wasting, stunting and obesity; negatively affect productivity, well-being, human capacities as well as 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, but 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).

2.3 Review of methods of demand analysis

Since the 60s, consumer food demand has been at the centre of many studies. In the 60s and 80s, the double log and semi-log models were mostly used. However, the main issue with using them is that they 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 was credited with several advantages. However, it has the disadvantage of not permitting goods to be inferior, gross substitutes and demands elastic (De Boer and Paap, 2009; Ullah and Fatima, 2016). Apart from these models, many other models including the Indirect Addilog Model (IAD), the Rotterdam Model, the Generalized Addilog Demand System Model, the Almost Ideal Demand System Model as well as the Quadratic Almost Ideal Demand System (QUAIDS) have been used to tackle the previous issues (Babu *et al.*, 2017).

Houthakker (1960) derived the LES function departing from an implicitly indirectly additive utility; hence, the model became the Indirect Addilog Model also called Implicitly Directly Additive Demand System (AIDADS). The weakness of the 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 always to be positive and summed to unity. Theil (1965) introduced the Rotterdam model, and it has almost similar advantages as AIDS. Nevertheless, Barnett & 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 Muellbar (1980a) 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 most effective of 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; besides, 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. This has been proven to be empirically essential to describe household budget behaviour (Banks *et al.*, 1996, 1997).

2.4 Food consumption demand

Many factors play a role in 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. This is 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. This

study used the QUAIDS as proposed in this current study. It showed how the QUAIDS could be utilised for food price policies.

Moreover, different reports have reported an increase in malnutrition (FAO *et al.*, 2018). Due to food price spike between 2007 and 2008, various studies have attributed the undernourishment to that increase in price. They showed when prices go up, the affordability reduces, 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). In their study to analyse the short-term effects of a staple food price increase on nutritional attainment using cross-country inquiry, Anríquez *et al.* (2013) 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) did a study on demand growth in developing countries, and his results were the same as those of Anríquez *et al.* (2013) 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 they are many drivers for the 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. Those 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 has found that the income elasticity of dairy products was higher than the one of fat. Similarly, the income elasticity of fruit and vegetables was higher than the one of fibre. However, the income elasticities of cereals were lower than the one 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 build 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, in Europe, the situation is different, for example, in the case of Poland, Wyrzykowski (2014) in his study on the income elasticity of demand for food. Moreover, dairy products, cereal as well as bread were perfectly priced inelastic. However, it was very stronger for fruit and fish.

Lechene (2000) did a study on the income and price elasticities of foods consumed in a manage, using the National Food Survey over the period 1988 and 2000 in the United Kingdom. He found that households were sensitive to food price changes. These findings are in line with Colen *et al.* (2018), who found the same in Africa.

2.5 Factors affecting nutrition

Sen (1982) explained that the 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 is also

essential in the sense that rural and urban residents differ in their access to food, nutrition, and health.

Webb & Block (2012) in their study on the impacts of supporting the agriculture during economic transformation on poverty and undernutrition have found that the more the income of the country, the more over-nutrition become a critical nutritional and health problem. This is supported by many other studies. 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 that has been the first country to eradicate extreme poverty in Africa has experienced economic growth since the nineties; however, the nutritional status has not improved in the sense that the number of obese increase (Ecker and Fang, 2016). This has been the case in many other countries in Africa.

Moreover, women and man are not affected the same in case of an increase in income. Conklin *et al.* (2018) in their research on economic policy and nutrition, whereby they have examined the effect of the rise in the minimum wage on women weight. They have found that an increase in income, reduce the number of underweight at the same time increase the number of obese in the country. Moreover, these women still have deficient in some micronutrient such that iron.

Moreover, poor people and the rich are affected differently when there is economic growth in term of nutrition. 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 evaluate protein evaluation of food security and nutrition.

Moreover, high consumption of meat leads to an increase in the prevalence of the disease in the community (Babu *et al.*, 2017). Poor people that are mainly found in the rural area in case of an

increase in income are more likely to trade quality for quantity. This is confirmed by Pérez-Ferrer *et al.* (2018) who studied the nutrition transition in Mexico, whereby, women were likely to be obese than men in case of increase in income. Additionally education was a key component, and the result showed that in association with knowledge, the prevalence of women obese was different in urban and rural area. Parra *et al.* (2015) did a study in Colombia on the nutrition transition over ten years and found that the rate of overweight/obesity is higher than the economic growth in the country.

As a conclusion, for economic growth and an increase in household's income to benefit into better nutritional outcomes require appropriate nutrition policies and intervention strategies at national levels. Coming to economic decline, or decrease in income, Hendriks (2015) argued that it would 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 that is equivalent to inadequate intake leading to nutrient deficiency.

2.6 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 order of pursuing mutual well-being. In other words, the theory assumes that it is a group of people which aim to improve their mutual welfare (Bryant and Zick, 2005). In the same study of the economic organization of the household, Bryant & Zick (2005) stated that human and financial resources, both are 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. Apart from satisfaction to be direct or indirect, the satisfaction can also be immediately

or in the future. Once again, 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 (each day have 24 hours).

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 consumer allocates income on expenditures bundles as if he has an ordered and fixed set of preferences described by an indifference map that he maximises subject to his income and the costs he 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 Muellbar (1980a), 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

3.0 METHODOLOGY

3.1 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, demand for food etc. 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 & 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 & 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.

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. These together (improvement in nutritional dietary intake and health status) brings about improved nutritional status. In fact, Thompson & Amoroso (2014) argued 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, labour 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.

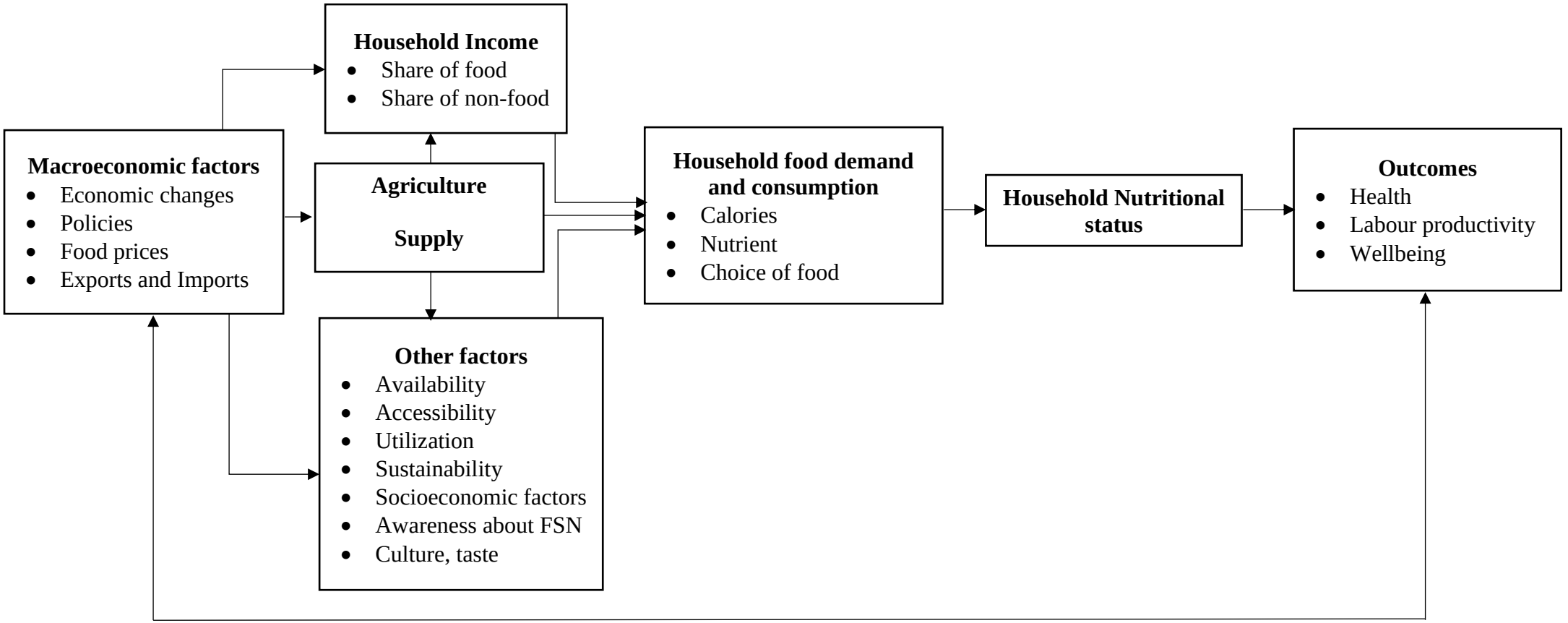

Figure 1: Conceptual framework showing the linkage between factors affecting the nutrient demand of household

3.2 Study area

The study was conducted in the Democratic Republic of Congo, located in Central Africa. It is the second-largest country of Africa by area (2,345,000 km^2) and the eleventh 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%.[6]

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

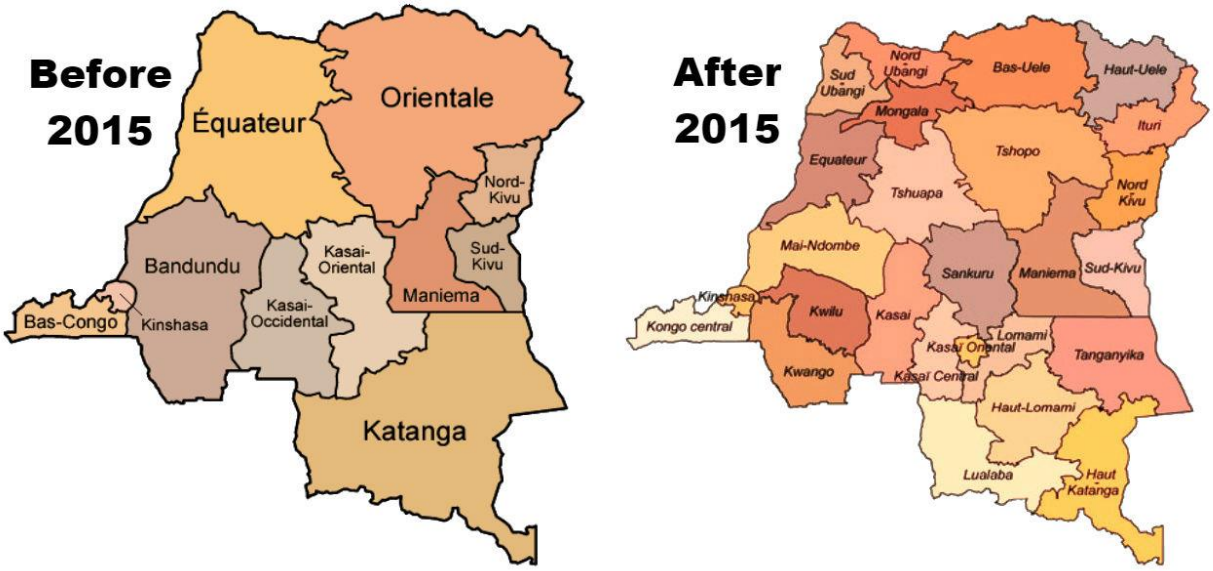

Figure 2: DRC map of old and new provinces[7]

Moreover, 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

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

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 showed a negative balance of 6.9 million tones (a deficit of 22%). Moreover, the deficits in total legumes (beans, peanut, soya, cowpeas) and total cereals (maize, rice, millet, sorghum) after counting 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). Cereals (maize, rice, millet, sorghum), legumes (beans, peanut, soya, cowpeas), tubers (cassava, sweet potatoes, taro, Irish potatoes)

The food habit of RDC's 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, their permanence and their stability. For instance, in western part of DRC, cassava remains the 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 consumption of maize that are consumed as pasta (ugali) (Arsène *et al.*, 2015; Bokombola *et al.*, 2018).

Malnutrition has been reported to have a very negative effect on the GDP of the country. It has been reported by the WFP (2016) that about USD1,771 billion of the GDP (4,56%) was lost in 2014 due to malnutrition. In fact, they reported that from 2010 to 2014, there were 729,160 child deaths due to undernutrition. These deaths account 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 and later on productive abilities when these children reach working age. In fact, in the DRC, 49.8% of working-age adults (15-64 years) suffered from stunted growth in childhood age (WFP, 2016).

3.3 Research design

This study was conducted through a historical research design. The historical research 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 conclude about causes, trends and effects of the 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 trends of households. Moreover, it is useful where primary data cannot be collected.

- Sampling and data collection by the National Household Surveys

The study used two independent rounds of data from the National Household Surveys (Enquête 123) 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). Data on total expenditures have been recorded from a total of 33,490 different households. For the purpose of this study, only total expenditures were utilised. The sample size covers 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. Therefore, their trends were not interpreted and discussed in this study. Moreover, the province of Kinshasa, the capital 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 in order to ensure equitable representation of the population in the sample. The post-stratification ensured that subgroups are proportionately represented in order to ensure the significance of inferences made from the households’ budget data. As the data are not panel, it is tough 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 trends, the intake and expenditures could be

conducted. The data for this study were provided by IFPRI researchers, John Ulimwengu and Wim Marivoet.

3.4 Method of data analysis

Data were analysed using both the descriptive analysis and inferential analysis. The inferential analysis was used to draw conclusions concerning the relation and differences found in research results. To assess if trends 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.

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, the greater share of the total expenditure of poor households is allocated to food (Engel, 1857). However, it is worthy to note 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 exists 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 & 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, or households with same features and same income being in two different societies with different standards of living will 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, demographics, etc are assumed constant.

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

$$Food\ budget\ share\ (\%) = \left(\frac{food\ expenditure}{total\ expenditure}\right) * 100 \qquad \text{(Smith and Subandoro, 2007)} \quad (1)$$

$$trends = Food\ budget\ share_{2012} - Food\ budget\ share_{2005} \qquad (2)$$

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 cluster analysis goal is 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 has the reputation of been 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 us to get clusters characterized by exactly the same diet.

The squared Euclidean distance used the following formula:

$$D_{ES}(x_i, x_j) = \sum_{l=1}^{16} (x_{il} - x_{jl})^2 \qquad \text{(Kumar } \textit{et al.}\text{, 2014)} \qquad (3)$$

$D_{ES}(x_i, x_j)$ 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 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.

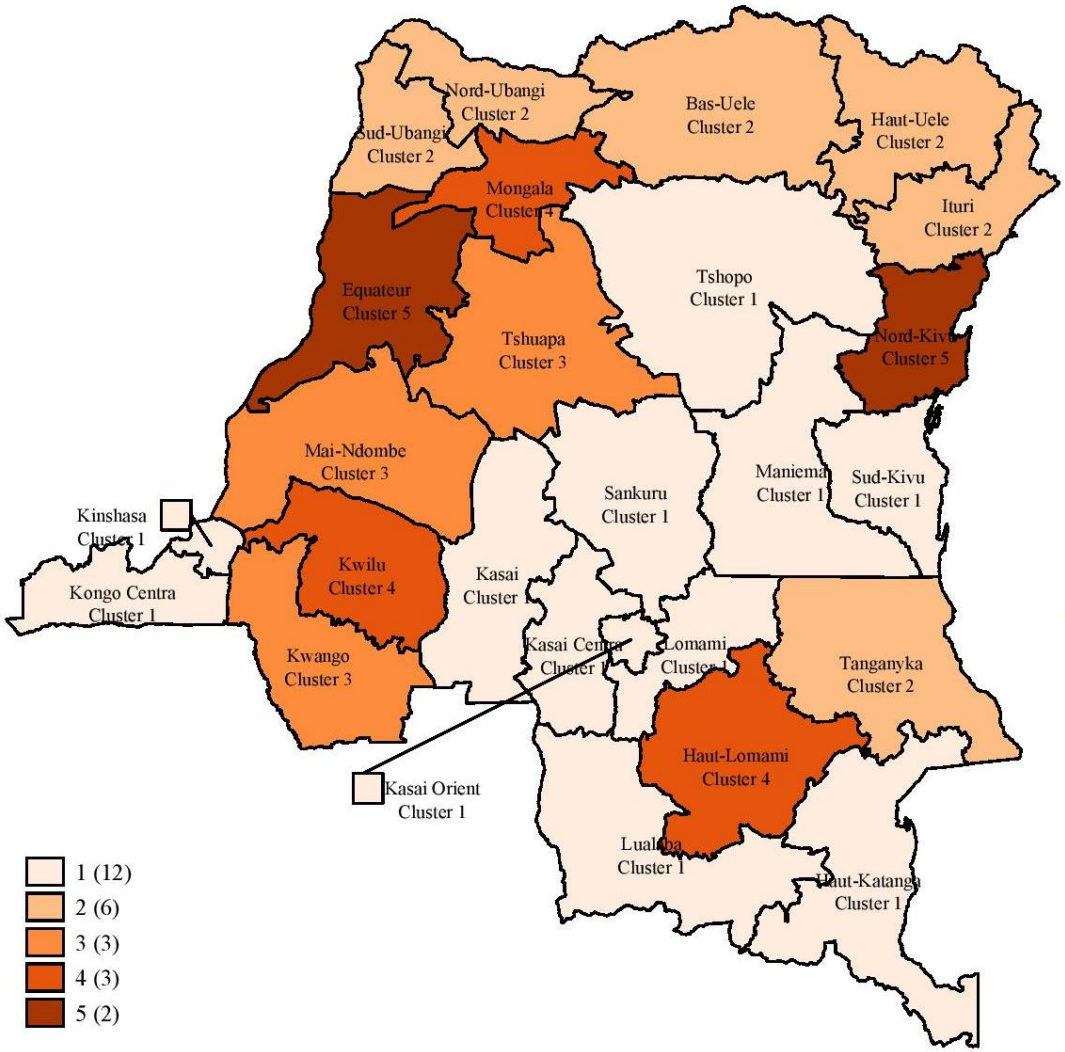

Figure 3: Urban food consumption cluster

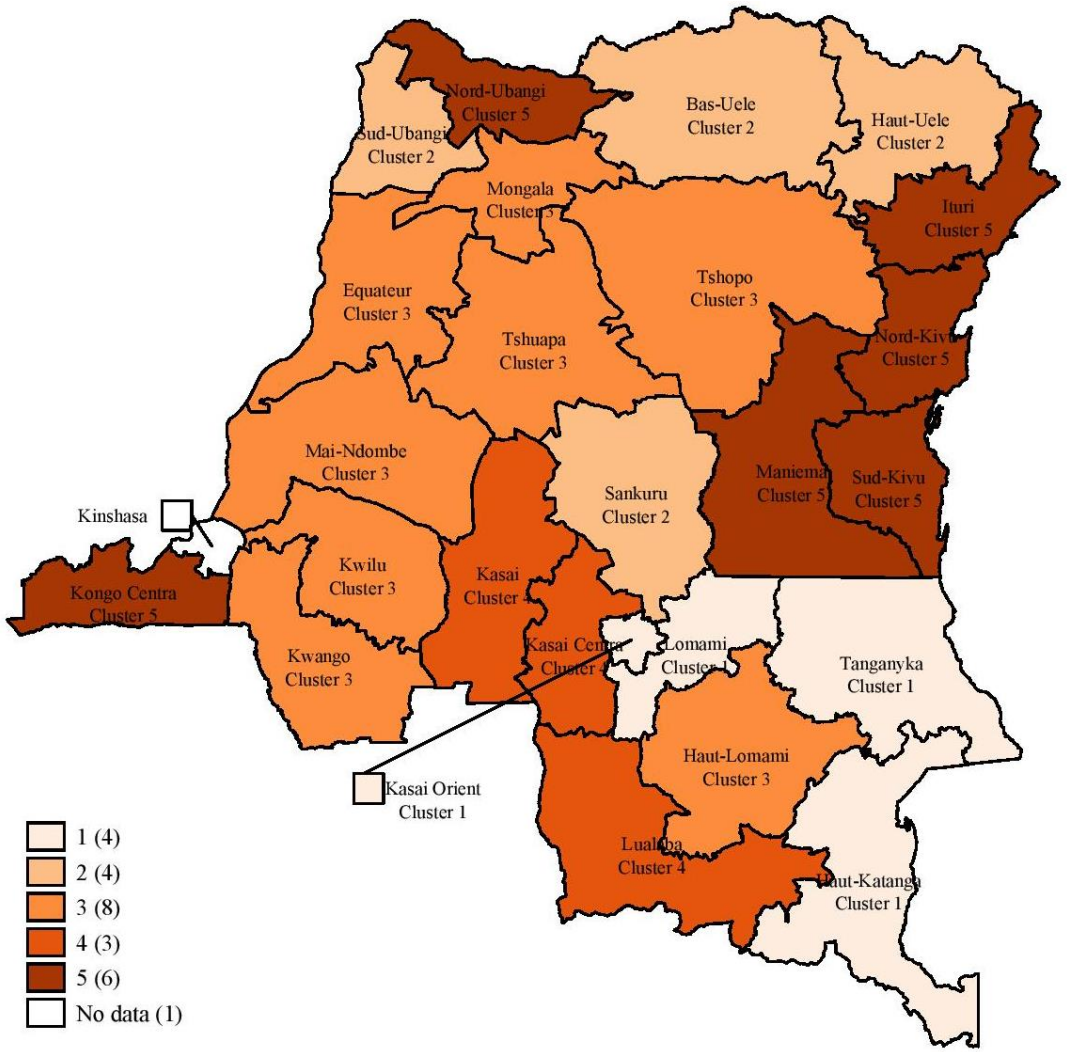

Figure 4: Rural food consumption cluster

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 found should be because 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 as well the culture (Marivoet, 2016).

- *Food consumption and trend*

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

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

- $w_i$is the budget share of food group i
- $Expfg_i$ is the food group i expenditure
- Exp_{food} is the food expenditure.

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

c) Estimation of nutrient Intake

This study estimated the nutrient deficiencies based on the recommended intake levels by sex and age. This was done according to the reports of the FAO/WHO/UNU (2004), WHO (2004) and the World Health Organization & United Nations University (2007). Moreover, as suggested by Marivoet & Ulimwengu (2018), this study considered a 30 year old male as reference for the AME scale. This research assumed his physical activity as a moderate lifestyle.

The daily intake requirements were therefore 2,750 Kcal, 50 g, 600 mcg, 1000 mg, 14 mg, 27.4 mg 400 mcg and 2.4 mcg 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 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:

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

5) m is the household income

6) $a(p), b(p)\ and\ \lambda(p)$ 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.

It has $\ln a(p)$ 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:

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

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, *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,

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

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 oftenly 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[8] (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.

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

- *Income elasticity of the demand for food*

In nutrition policy, policymakers want 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 raise to. The income elasticity can be used for future consumption patterns or trends. The starting point to respond 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 of demand due to a unit percentage change in income is the income elasticities. 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 more than proportionally to 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 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. Moreover, 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).

7) 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 in case of the change 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 most of the time it is taken in absolute value. When the price elasticity of demand is equal to "-1" then the quantity demanded and the price of a given food group change at the same proportion, meaning 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, meaning 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.

8) Engel Curves of food demand

It is important to have a well 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 1 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 & Fang (2016) found that in Ghana the shape of the estimated Engel's curves suggested that the consumption of all food groups increase 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 increase 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. Therefore, due to this limitation, the quadratic representation was preferred. This enables a given good to be a luxury at a certain level of income and a necessity at another (Banks et al., 1997).

The Working-Leser equation form is:

$$w_i = a + blnx_i + \varepsilon_i \quad (18)$$

Whereby 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):

$$w_i = a + blnx_i + c(lnx_i)^2 + \varepsilon_i \quad (19)$$

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 1 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, etc.
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

4.0 RESULTS AND DISCUSSION

4.1 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 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 authors in all the Tables and Figures that follow).

Table 3 showed that the food budget share in urban areas in 2012 were highest in Haut Uele with 84.7% and the lowest in Haut Katanga with 61.1%. The low level of food budget share in Haut Katanga urban areas could be due to the high standard of living and high level of mineral resources in the province (Ngombe *et al.*, 2015). In rural areas, the highest was in Kasai-Oriental at 87.6% and the lowest in Tshuapa with 66.6%. This showed that all most all the provinces were either highly food insecure or very vulnerable to food deprivation in rural areas.

Further, 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 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 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 implies an increase in the prevalence of poverty in the country (Coulombe and Wodon, 2012).

The findings of this research were in line with the research of Dickinson *et al.* (2003), and Smith & 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 one of Chauvin *et al.* (2012) who found that urban households in most African countries spend a lower share of their income of food compared to rural regions. The findings is 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.

Nevertheless, the reason for the high budget share allocated to food in DRC could be attributed to the lower level of income of the households in DRC. The differences found between urban and rural households in DRC 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 lousy infrastructure leading to a poor communication within and between provinces creates a very high diversification in the prices within regions could also be the reason of the differences between and within areas (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 low market commmunication and inter-spatial price differences. The price difference could also explain the diffrences in the food budget allocations between provinces.

The argument on the food price differences is inline 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. they usually earn high-income, however 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 such that transports services, 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 the 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 allocation in these provinces could be due to the fact that these provinces are landlocked reducing their capacity to trade. Another reason for the high allocation of the budget budget allocation 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 own 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. Therefore, families end up spending a considerable amount on food (Marivoet *et al.*, 2018). The low agricultural productivity and production is due to the different wars that the country has experienced 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 trends 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), in fact, all depend on the living location of the household (Ural Marchand, 2017). Notably, the trend in Kinshasa shows that the food budget share had increased, probably due to increase of the standard of living in that region. The increase in the standard of living was due to the over population as a result of a rise in the number of inmigrants (National

Institute of Statistic, 2014; 2015). Also, this trend 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 capital[9].

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

4.2 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.

[9] 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	-0.5	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% from 2005 to 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 from 2005 to 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) suggested 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 to be 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 showed 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 as compared to fruit and milk. This finding corroborates with that of Kyle & Swinnen (1994) who indicated that in many African countries, households spend more of the money only on basic foods. The plausible reason behind the high consumption of oil and fat and spices and beverages apart from the staple foods should be to improve the aroma and the taste of 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[10] (Action Against Hunger, 2007; Nicolaï, 2013). In Kwilu province for example, fishing constitutes 50% of economic activities[11] (Action Against Hunger, 2007). Moreover, the results showed an increasing trend in the budget allocated to fish from 2005 to 2012 in almost all the Clusters. This because before 2004 there was a decrease in the livestock by 30%

[10] http://universitekamina.blogspot.com/2009/11/district-du-haut-lomami.html by Prof. Kabyla Ilunga visited 15 April 2019
[11] 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

and 20% in both number and production respectively. This was due to some socioeconomic crisis, making meat scare 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 provinces in that Cluster. Morover, 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 of a very high dependence of those provinces on the maize coming 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[12] and Marivoet (2016) who found that around seventy per cent of the population consume cassava. However, the consumption of roots and tubers remarkably decreased in almost all the clusters. This can be due to the reduction of cassava production due to the "cassava mosaic virus" that has highly reduced its production. Kabemba *et al.* (2017) emphasised that the cassava mosaic virus has been a key factor in foods issues in DRC by the reduction of the yield that it caused. It is early in the year 2000 that remarkably attention has been made on the Cassava Mosaic Disease (CMD) (FEWS NET, 2017).

In all the Clusters, between 5 to 10 per cent of the budget was allocated to the dark green leafy vegetable, this 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 cassava mosaic disease should be the reason for the reduction of the budget allocated to the dark green leafy vegetables in some Clusters. Households allocated a very tiny budget to fruits, eggs,

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

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 was balanced between the consumption of cereals, roots and tubers while in rural areas there was very high consumption of roots and tubers.

4.3 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 trends from 2005 to 2012, are presented in Figure 5 and Figure 6. A low energy intake hinders human physical activities, therefore, 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.

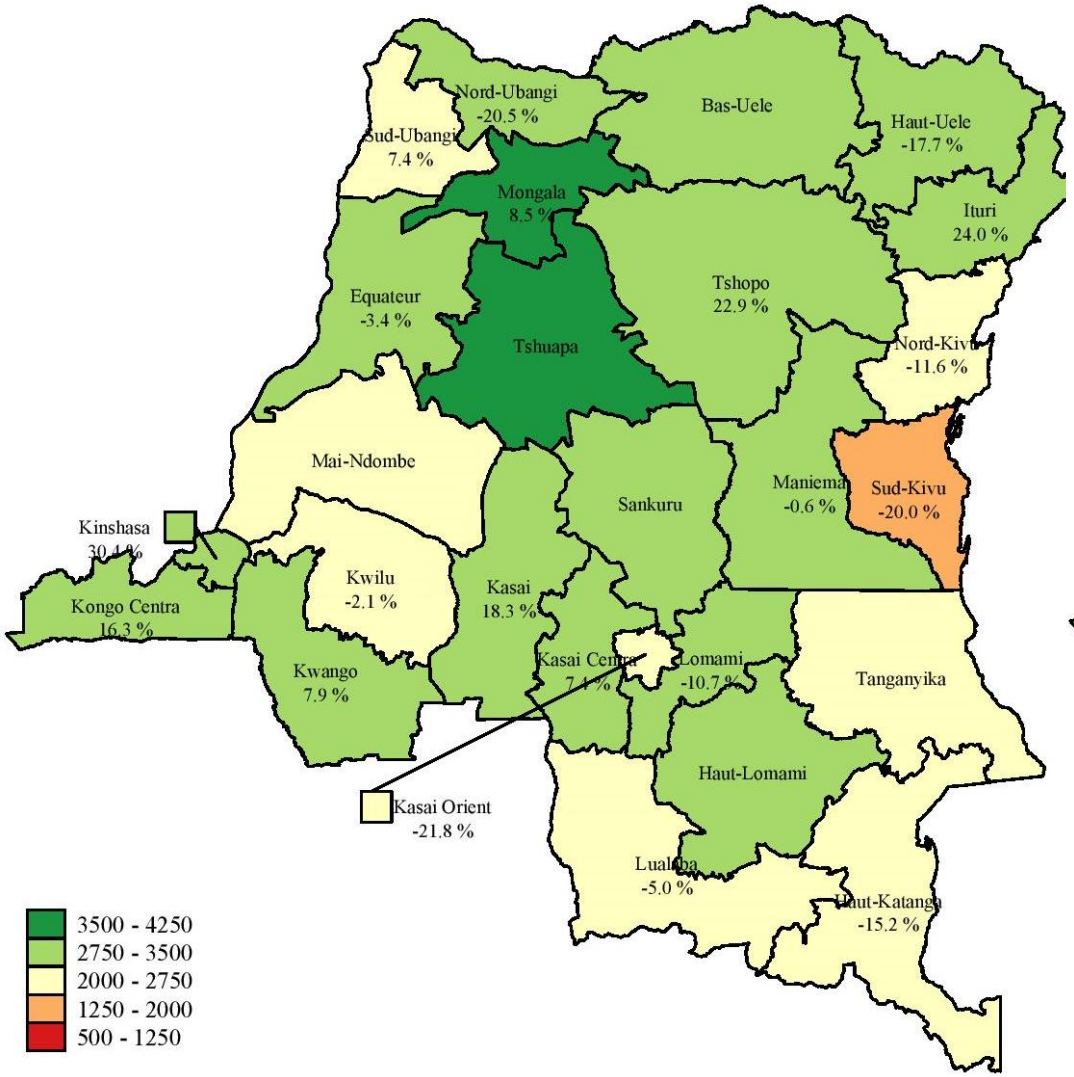

Figure 5: Urban calories daily intake and trends per adult male in 2012

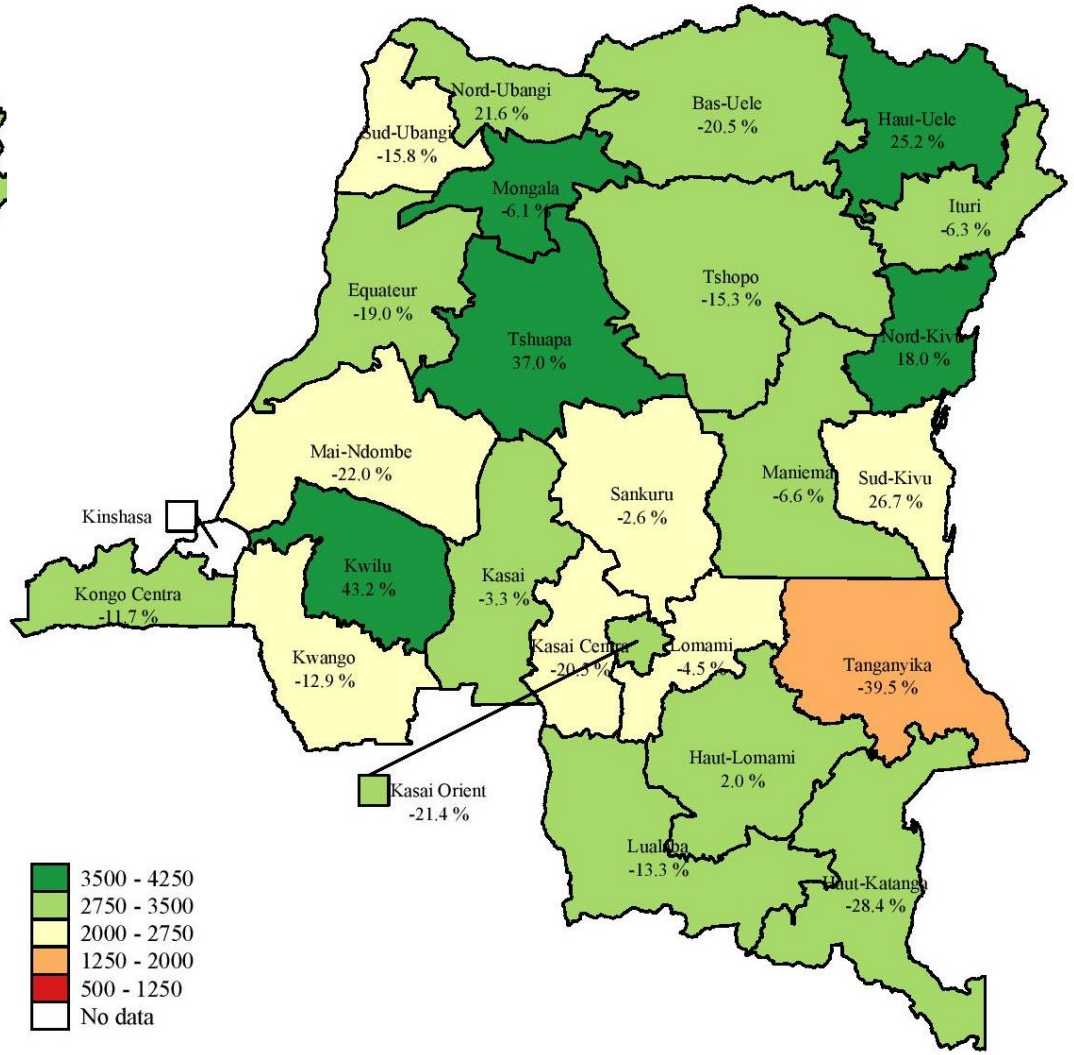

Figure 6: Rural calories daily intake and trends per adult male in 2012

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 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 calories 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 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. In all the remaining provinces, there was a decrease in calories intake.

The results showed a better intake of calories in rural areas than in urban areas. This can be due 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.

The calories intake by households is heterogeneous in the provinces and quite adequate. From the map; calorie intake reduced in the majority of provinces. This can be explained by the reduction of the production of cassava and the scarcity of substitute. It is worthy to note that the decrease in the cassava production that 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 part of the country mainly as 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 find that the calories in Sub-Saharan Africa were acceptable as opposed to 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 trends from 2005 to 2012, are presented in Figure 7 and Figure 8. A low protein intake negatively affects the growth and development of human hence hinder the 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 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. In all the remaining provinces, there was a decrease in protein intake.

Urban areas seemed to have a better intake than the rural areas. This is could be because the crops 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 was valid maybe because of the high consumption of frozen fish (mpiodi), dried/smoked fish, salted fish (bitoyo) and fried sardine (ndakala) (Marivoet, 2016). These findings opposed the findings of Schonfeldt & Hall (2012) who found that the protein intake in Sub-Sahara Africa is deficient.

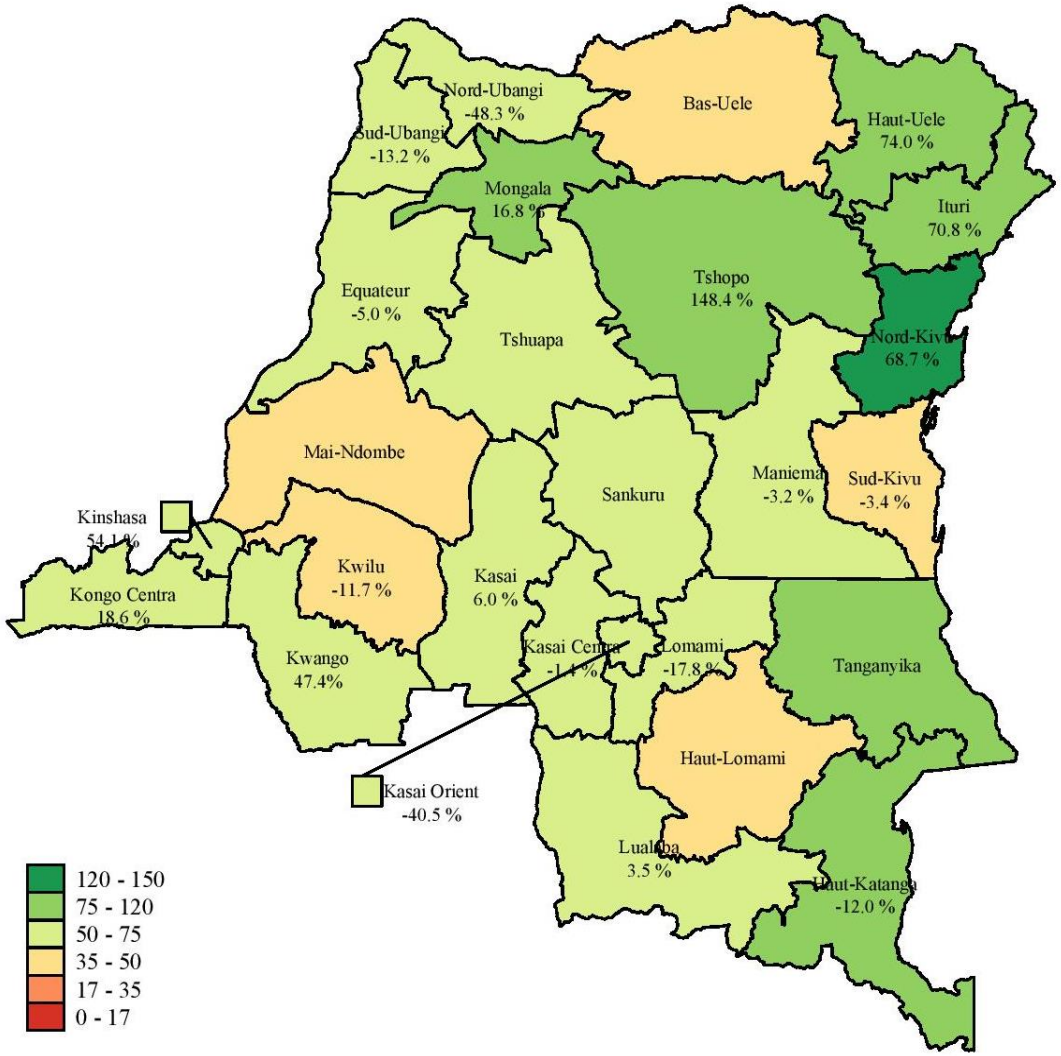

Figure 7: Urban protein daily intake and trends per adult male in 2012

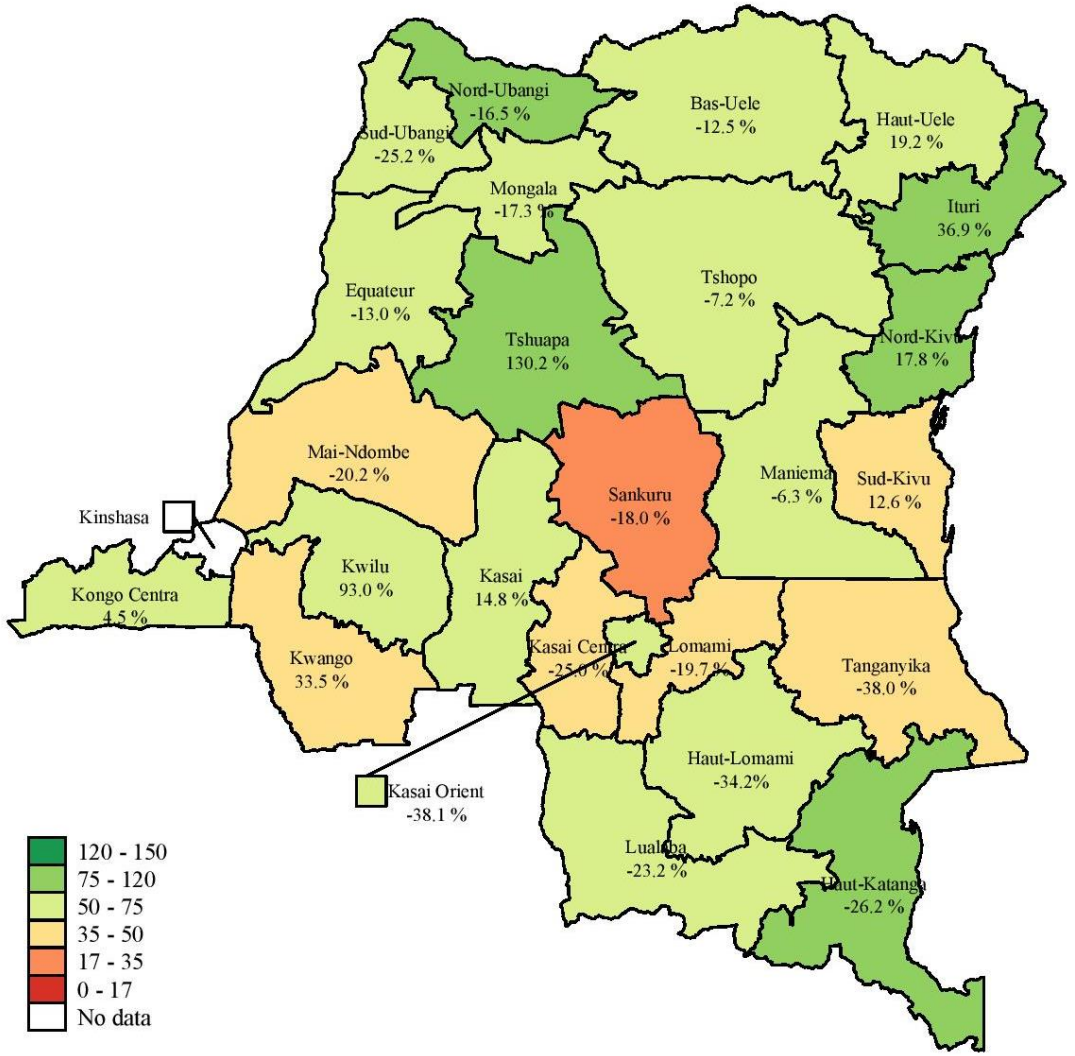

Figure 8: Rural protein daily intake and trends per adult male in 2012

4.3.3 Vitamin A

Daily vitamin A intake for an adult male in 2012, and the trends 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 RE per day, for adolescents, it is 600 mcg per day and for adults, it is between 500 and 850 mcg per day (WHO, 2004).

Our results suggested a very high vitamin A intake accompanied by an increase in the consumption in almost all the provinces.

The results were in line with Williams *et al.* (2008) and De Moura *et al.* (2015) who found that in Nigeria the adequacy level of intake of vitamin A is about 97%. However, the findings opposed the one 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 palm oil could be the high consumption of red palm oil.

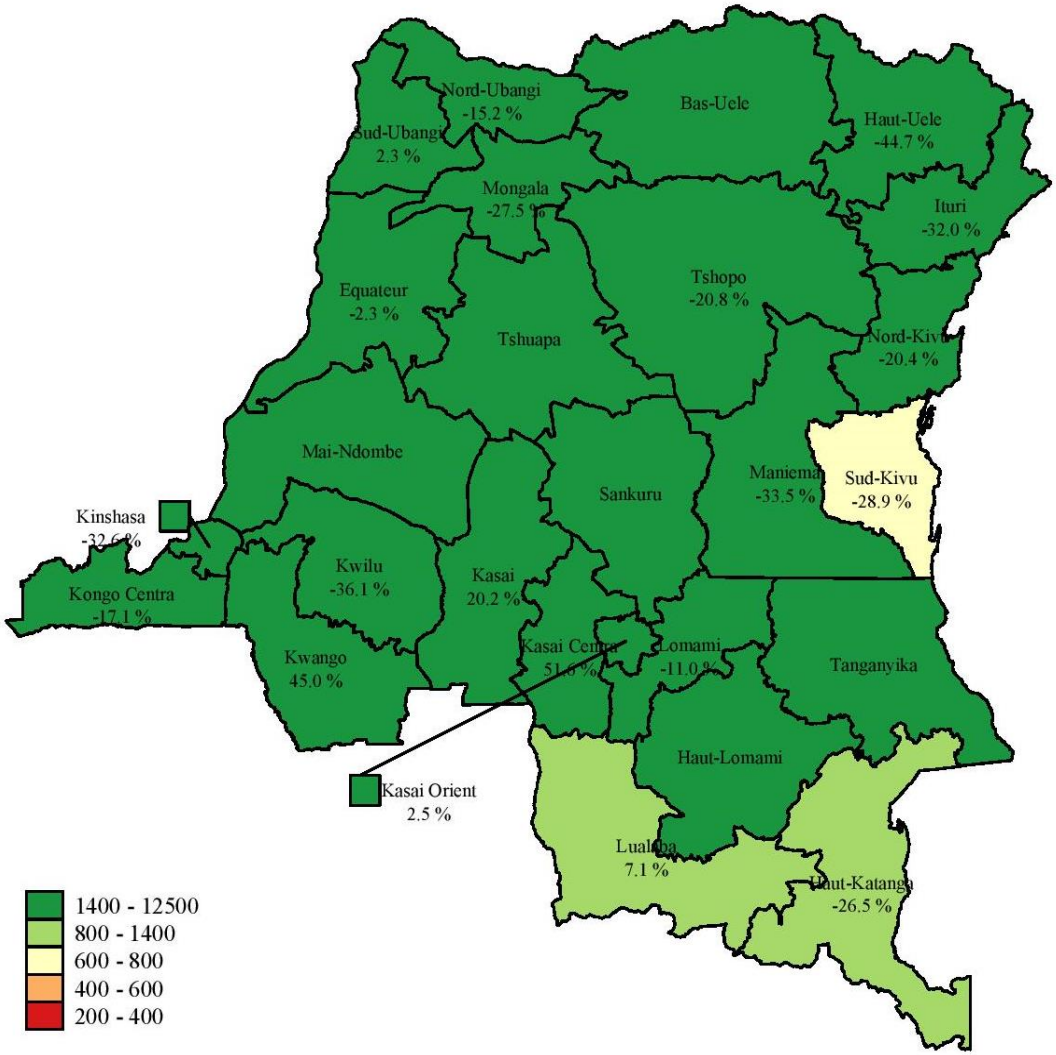

Figure 9: Urban Vitamin A daily intake and trends per adult male per day 2012

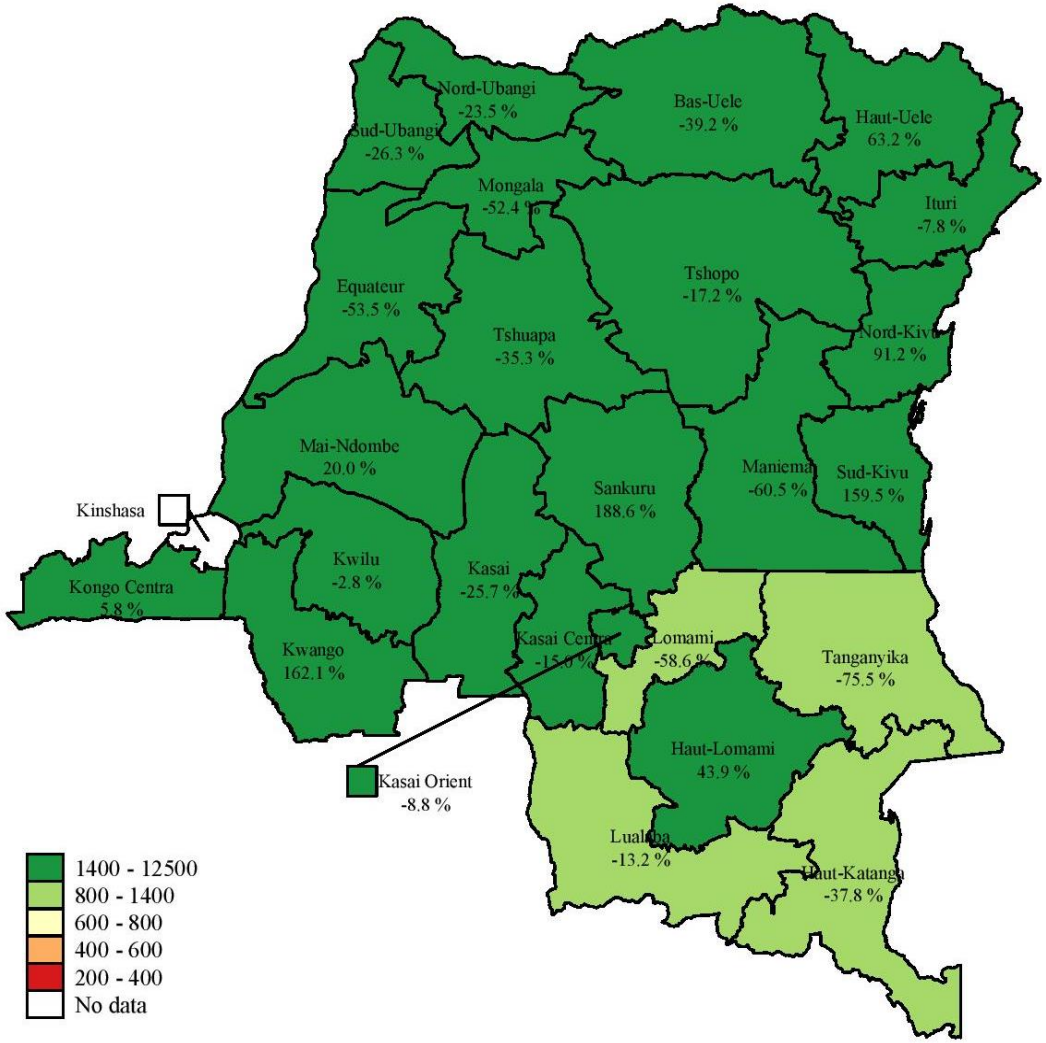

Figure 10: Rural Vitamin A daily intake and trends per adult male per day 2012

4.3.4 Calcium

Daily calcium intake for an adult male in 2012, and the trends 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 RE per day. For adolescents, it is 1300 mcg per day. For adults between 1000 and 1300 mg per day (WHO, 2004).

Our results suggest that in 2012, in urban areas, all provinces 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 seemed 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. In all the remaining provinces, there was a decrease in calcium intake.

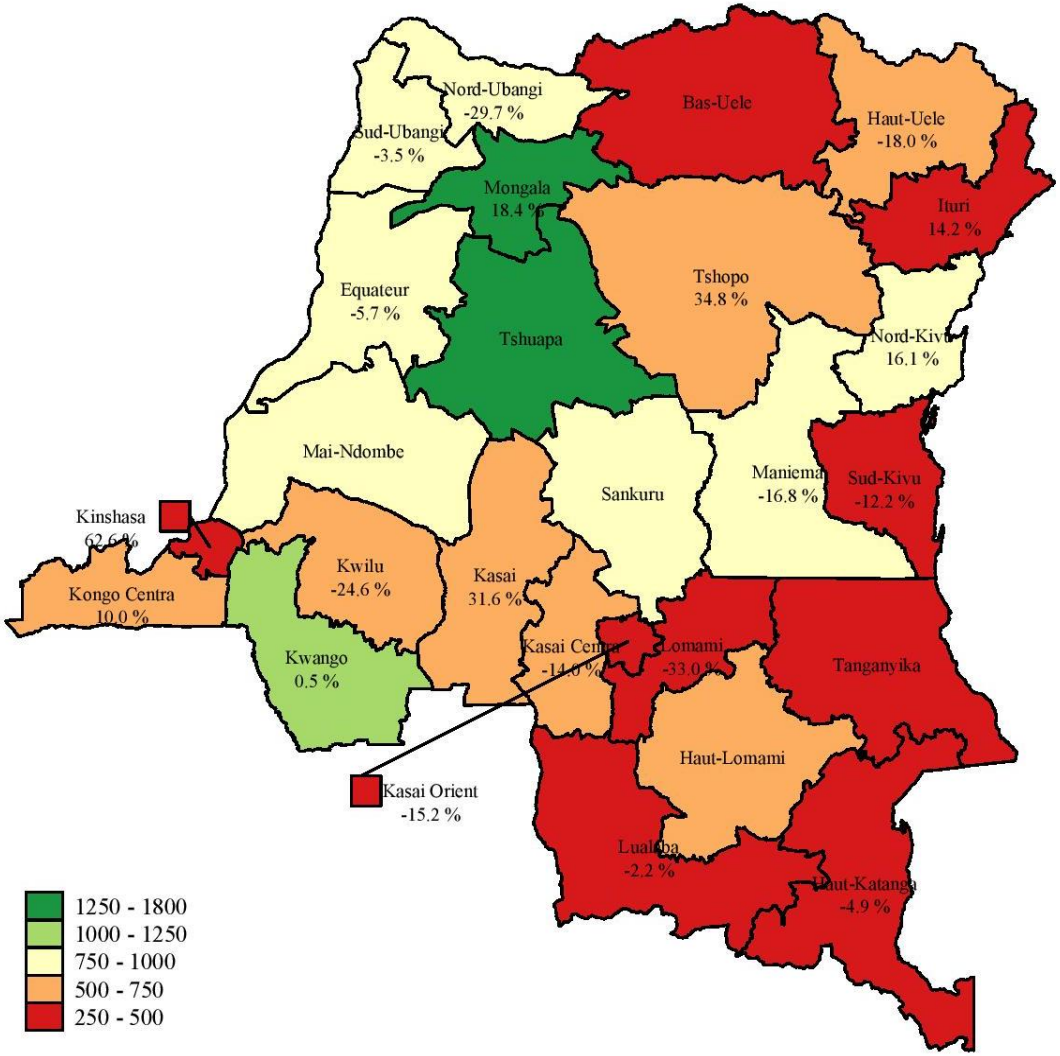

Figure 11: Urban calcium daily intake and trends per adult male in 2012

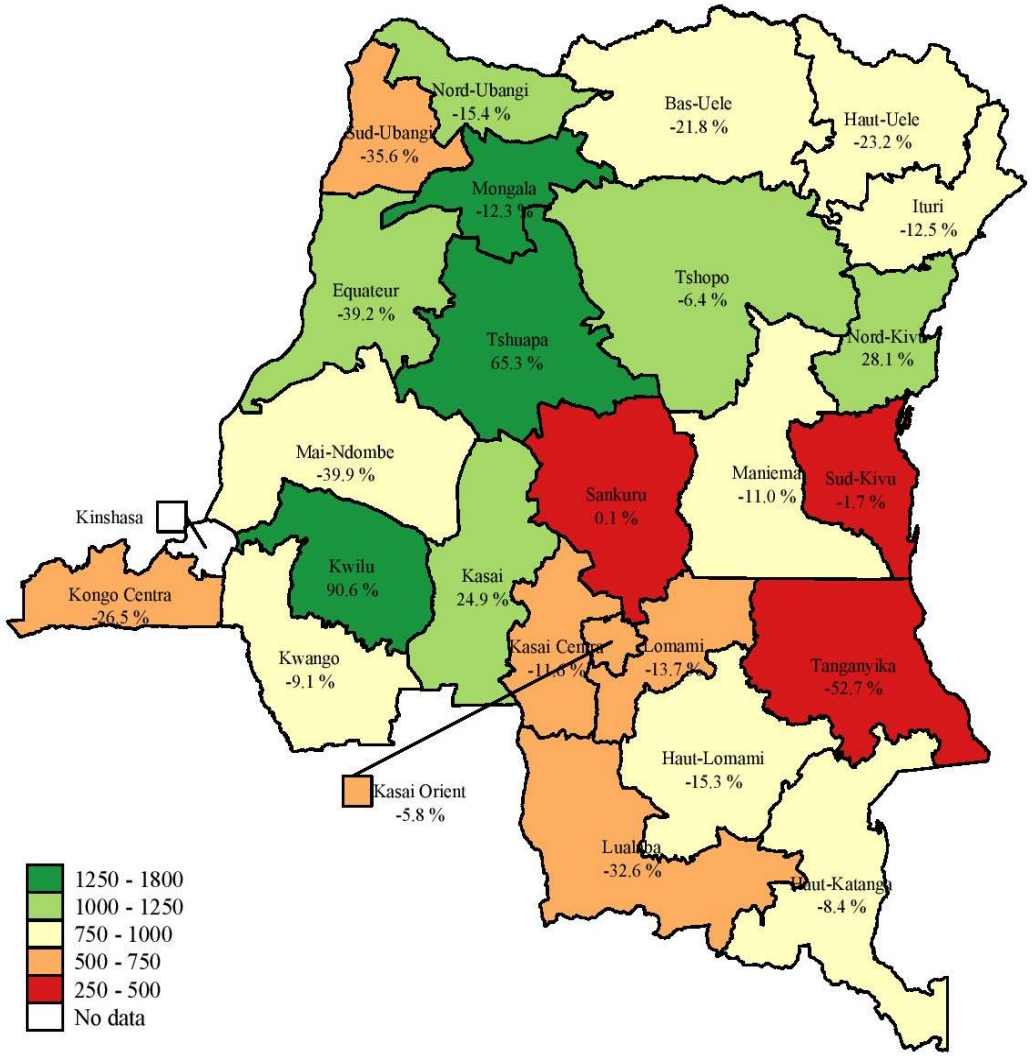

Figure 12: Rural calcium daily intake and trends per adult male in 2012

Almost all the provinces are deficient in the calcium intake in their urban areas. This is in line with the findings of Balk *et al.* (2017) who found that in countries in Africa and South America are highly deficient in calcium. The reason behind that is that the low production of animal product and this is explicit in the Table 3 and Table 4, it is 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 family breeding in different regions. This could explain the better calcium intake in rural areas compared to urban areas as those family breeding is usually done in rural areas.

4.3.5 Zinc

Daily zinc intake for an adult male in 2012, as well as the trends from 2005 to 2012, are presented in Figure 13 and Figure 14. Zinc is vital for health and the immune system consequently 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).

Our results suggest that all the provinces of DRC were deficient in the zinc intake in both their urban and rural areas except the North Kivu that improved to meet the requirement zinc intake. Moreover, the results suggested that there was 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 remain 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 shallow consumption of meat, and legumes and nuts as shown in tables 3 and 4. The results were in line with Lee *et al.* (2012) and Oldewage-Theron & Kruger (2011) who also found a deficient intake in zinc intake in Sub-Sahara Africa and South Africa respectively. Nevertheless, the result opposed the one of De Moura *et al.* (2015) who reported an acceptable zinc intake in Nigeria.

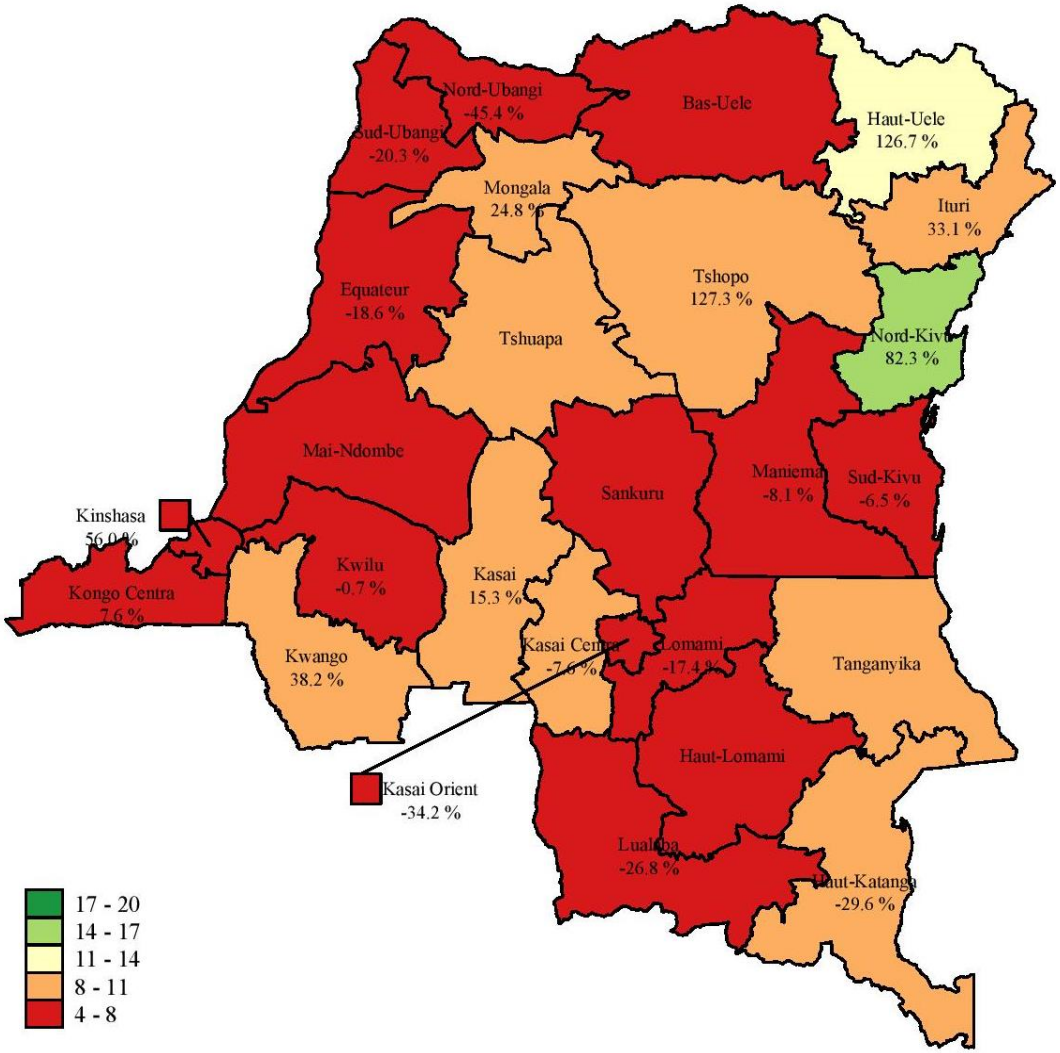

Figure 13: Urban zinc daily intake and trends per adult male in 2012

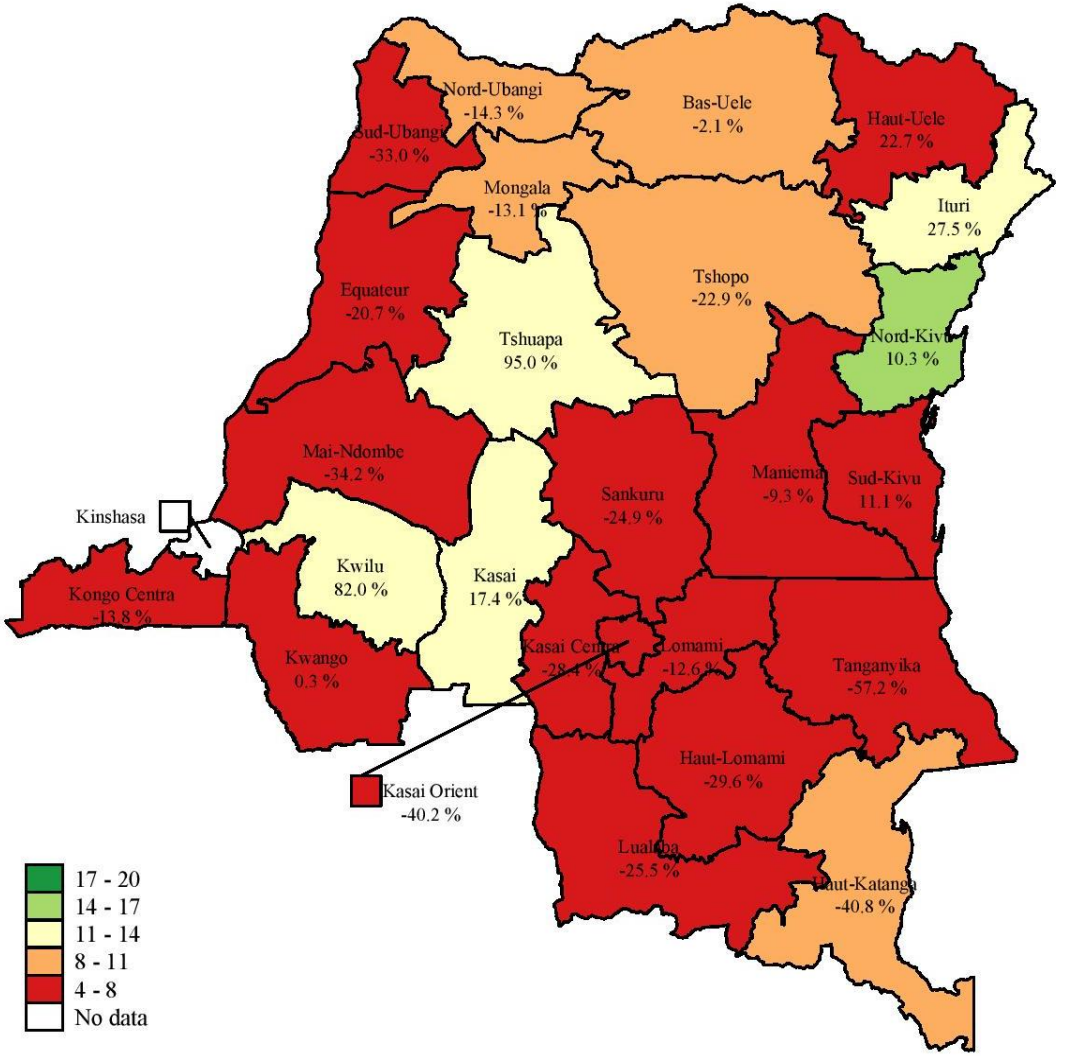

Figure 14: Rural zinc daily intake and trends per adult male in 2012

4.3.6 Iron

Daily zinc intake for an adult male in 2012, as well as the trends from 2005 to 2012, are presented in Figure 15 and Figure 16. The main sources for iron intake 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 adults' males 27.4 (WHO, 2004). It is worth to note 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 iron losses during the menstruation. In postmenopausal and lactation, its considerably reduces (WHO, 2004).

The results showed that there was a deficiency in iron intake in all provinces of DRC. 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 could not be an issue in DRC as cereals, and roots and tubers, are highly consumed the inadequate diet should be the reason for the low iron intake (Jonker *et al.*, 2017). Moreover, this result was in line with the report of the WHO (2004) who reported an alarming inadequate of iron in the tropical region.

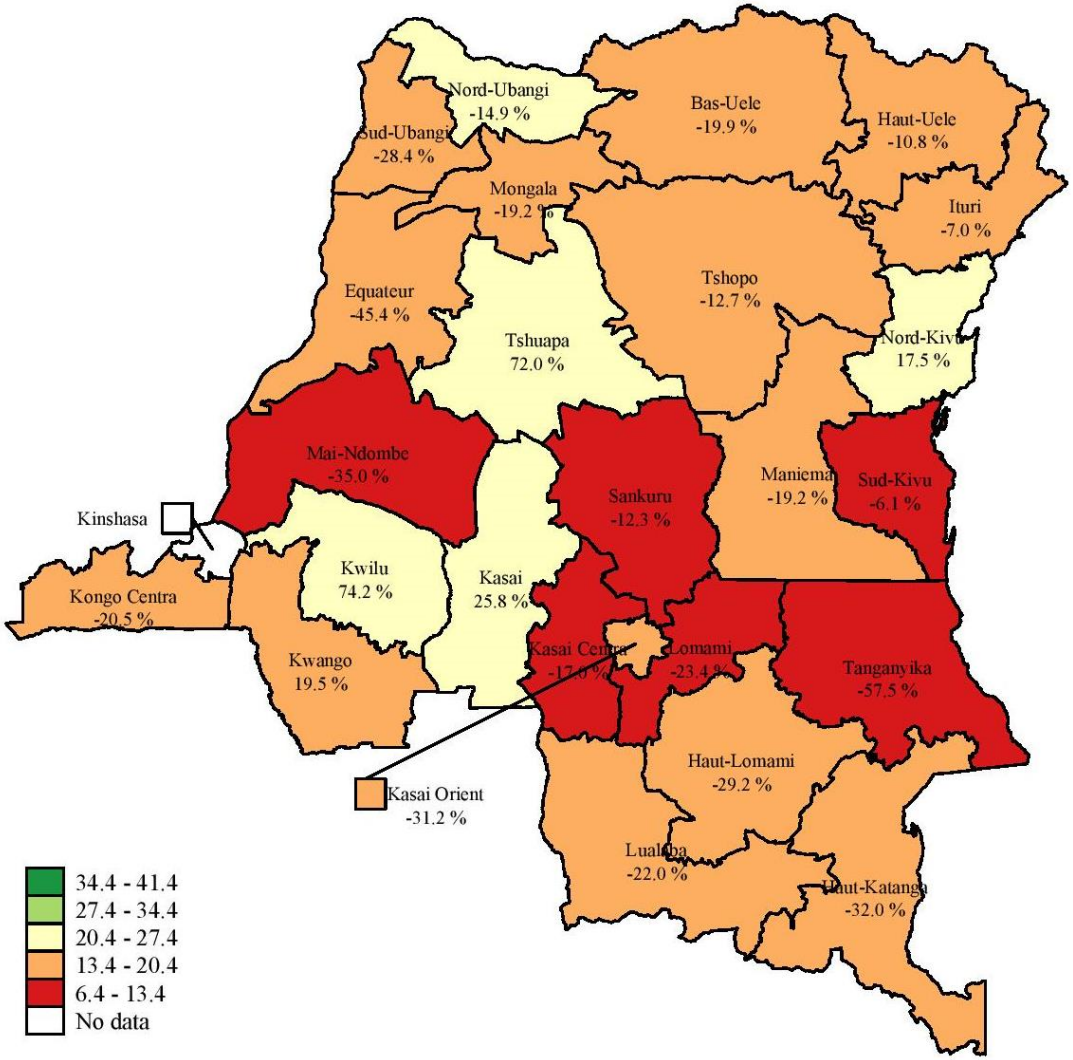

Figure 15: Urban iron daily intake and trends per adult male in 2012

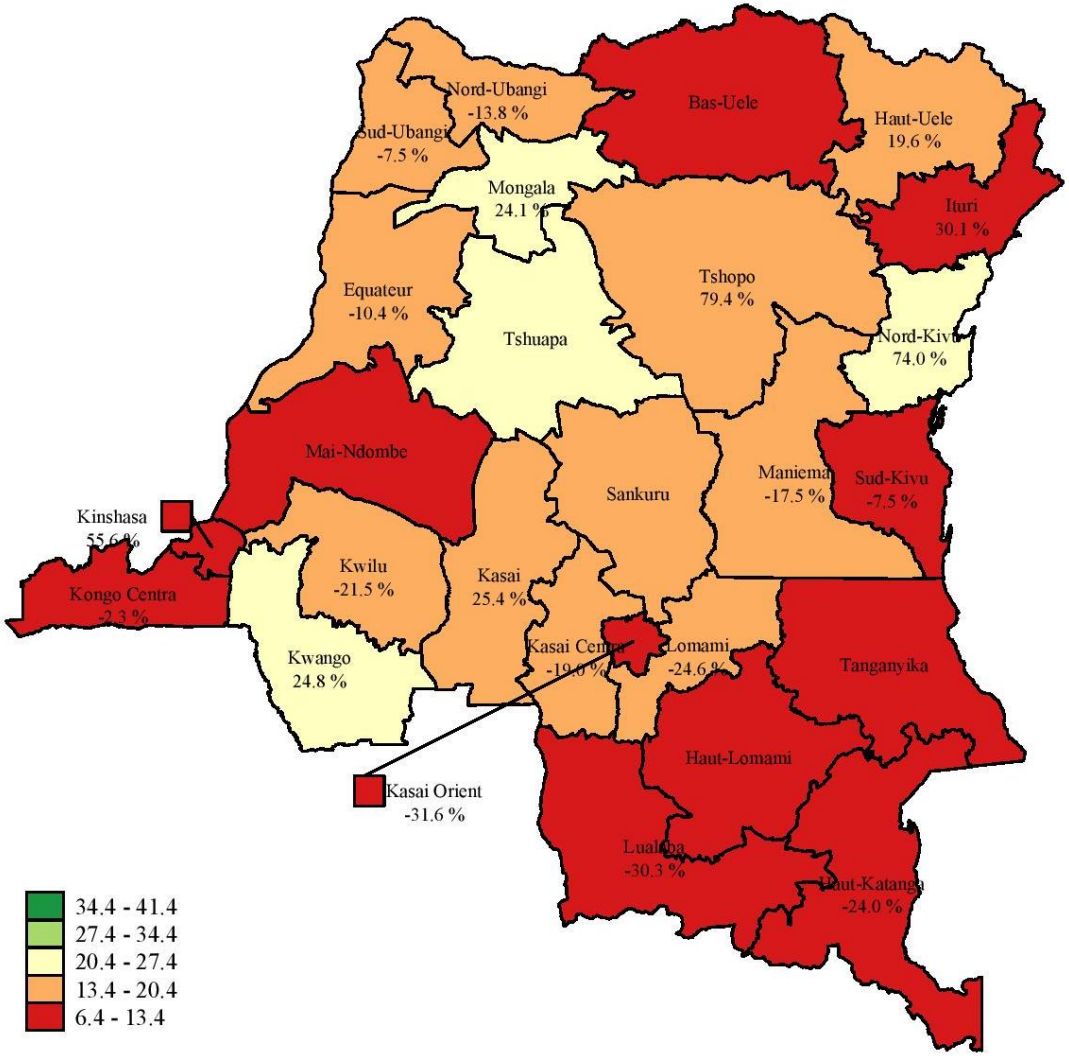

Figure 16: Rural iron daily intake and trends per adult male in 2012

4.3.7 Folate

Daily folate intake for an adult male in 2012, as well as the trends 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 urban areas all the provinces that are in the middle and southern part of DRC 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 the 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 be the cause the most moderate folate intake at the household level in the central and southern parts. However, a better situation in the North can be explained by the high consumption of bananas and plantains in those areas. The banana wilt that causes the loss in bananas production can be the reason why there is a decrease in the folate intake all over the country. Nevertheless, these results opposed the one of (Oldewage-Theron and Kruger, 2011)

The better situation in the rural areas could be explained by the fact that the bananas and plantains were produced in rural areas and due to the lack of communication between the urban and the rural areas, the supply of those products to urban areas was difficult.

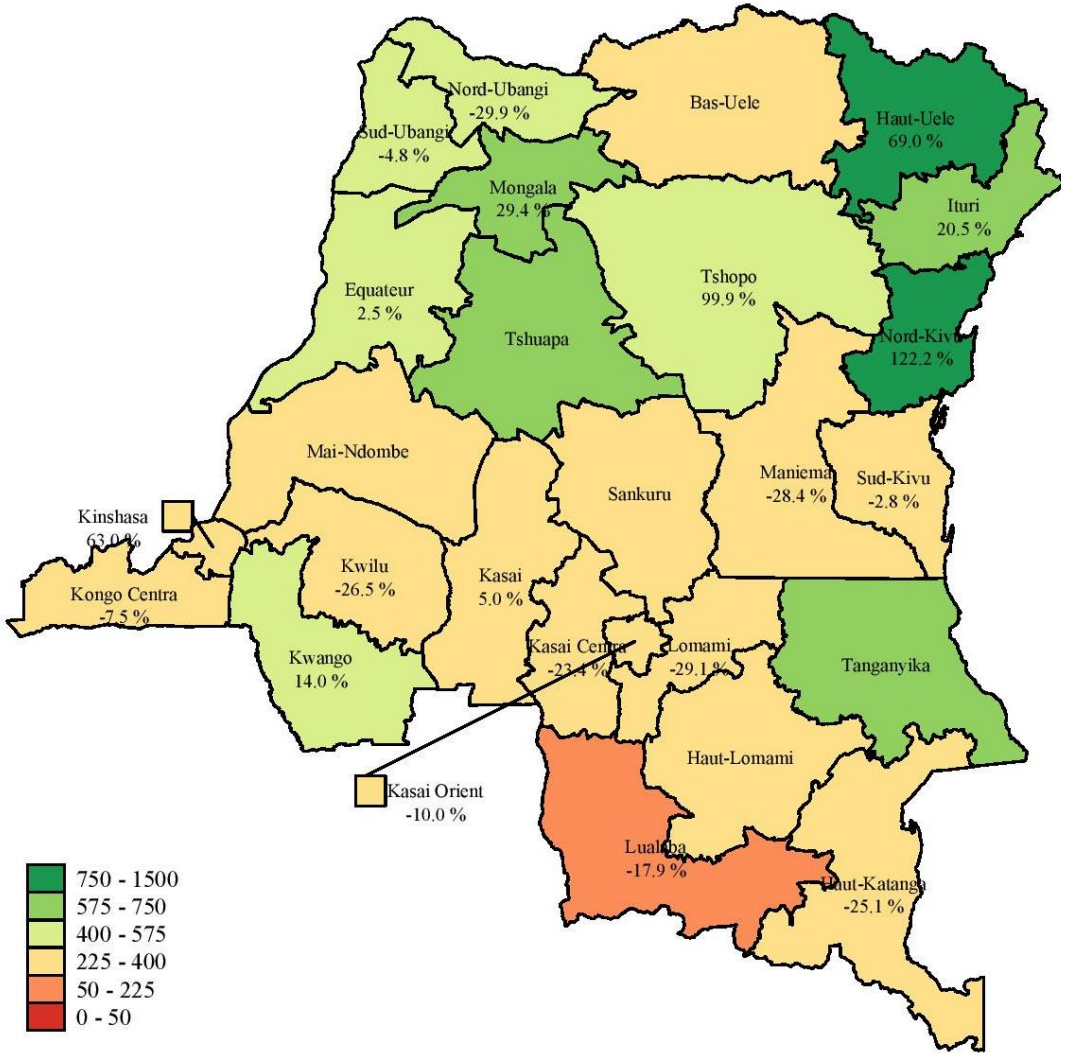

Figure 17: Urban folate daily intake and trends per male adult in 2012

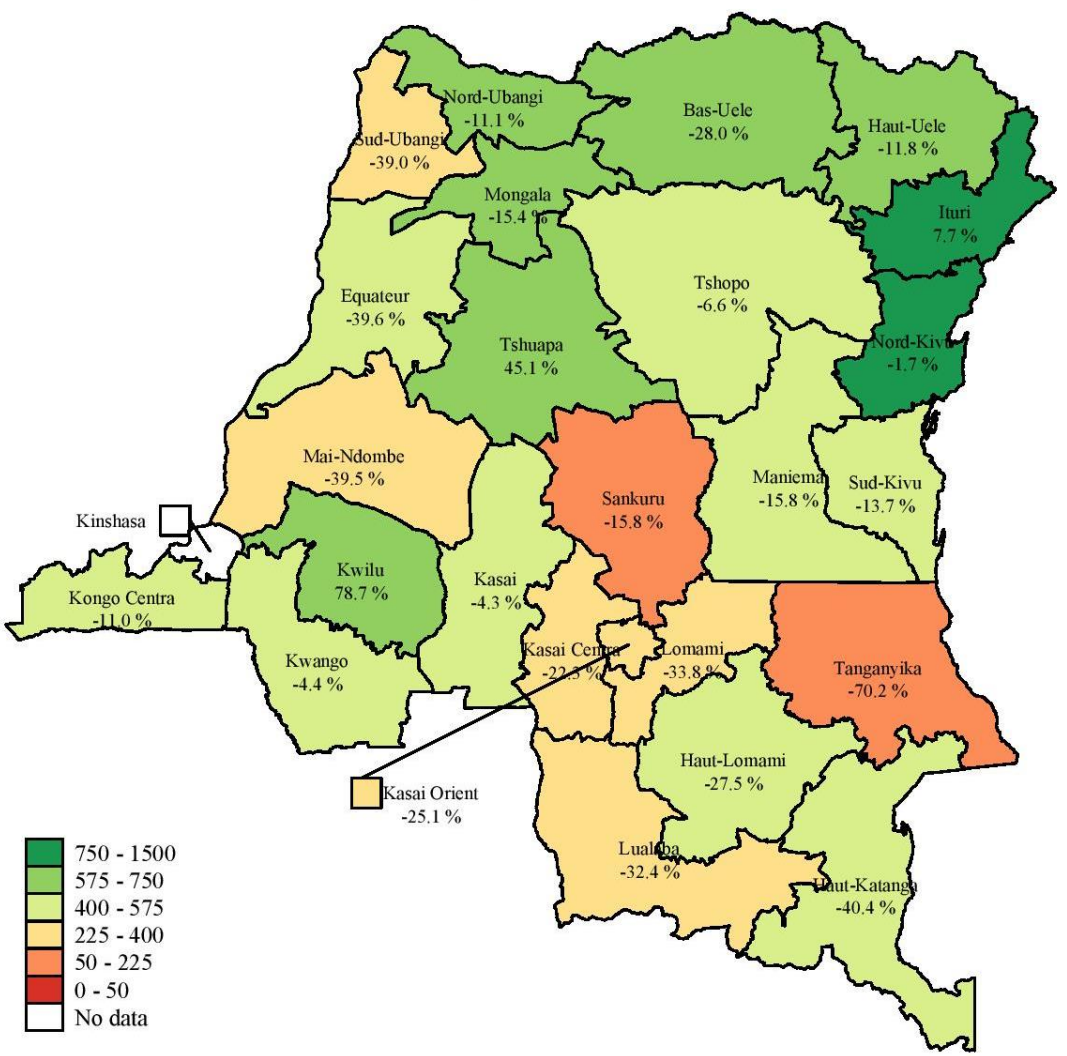

Figure 18: Rural folate daily intake and trends per male adult in 2012

4.3.8 Vitamin B12

Daily vitamin B12 intake for an adult male in 2012, as well as the trends from 2005 to 2012, are presented in Figure 19 and Figure 20. As 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 urban areas. Unlike the urban areas, rural areas had a very low intake, only Equateur, Tshuapa, Tshopo and Ituri had an adequate vitamin B12 intake.

However, some provinces show 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 household is allocated to the animal product except for milk, egg and dairy products. The deficiency in vitamin B12 is evidence that the consumption is not enough to cover the need. The reason had been given earlier, concerning the underdevelopment of the animal sector and the high price of meat with prices reaching the USD10 in the cities (Marivoet, 2016). However, the improvement in vitamin B12 should be due to the presence of small family breading.

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-source foods.

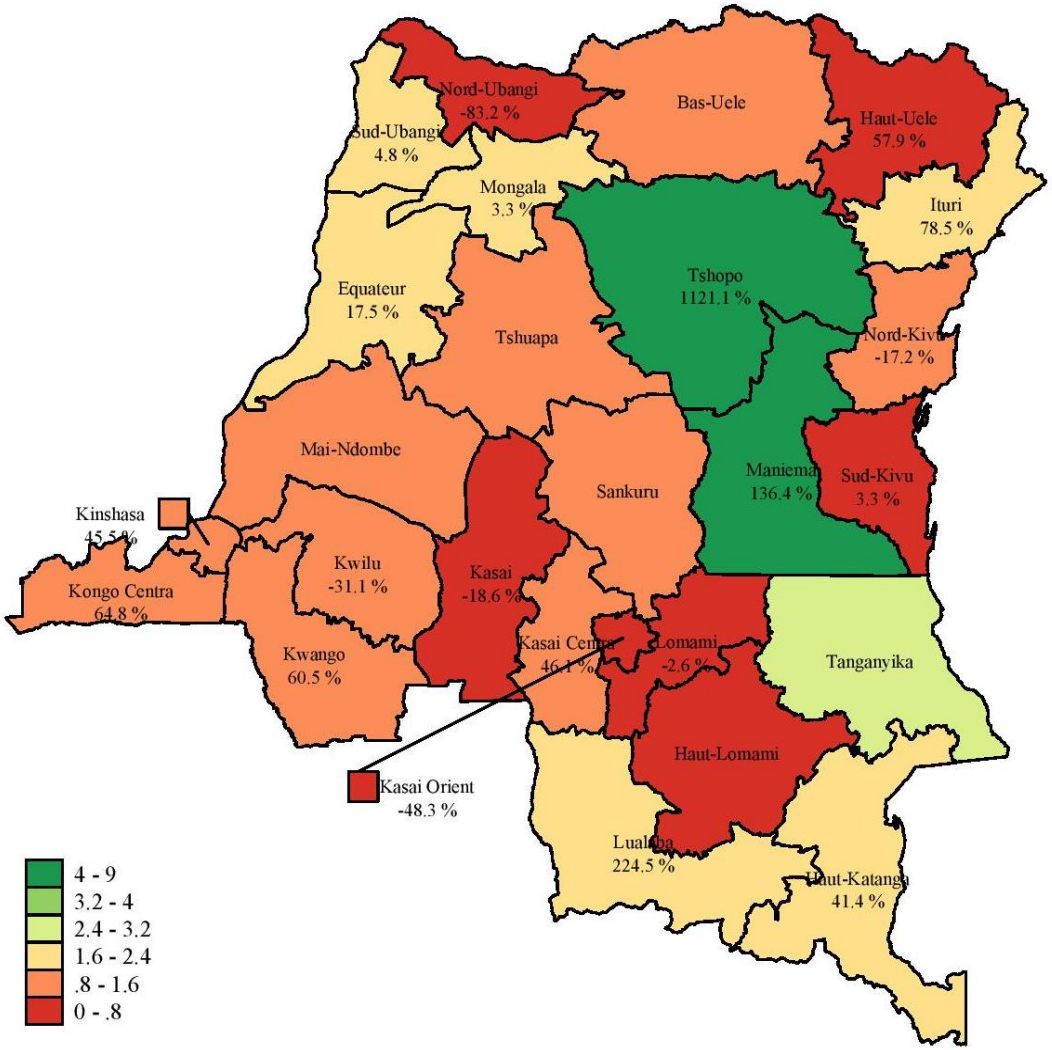

Figure 19: Urban vitamin B12 daily intake and trends per adult male in 2012

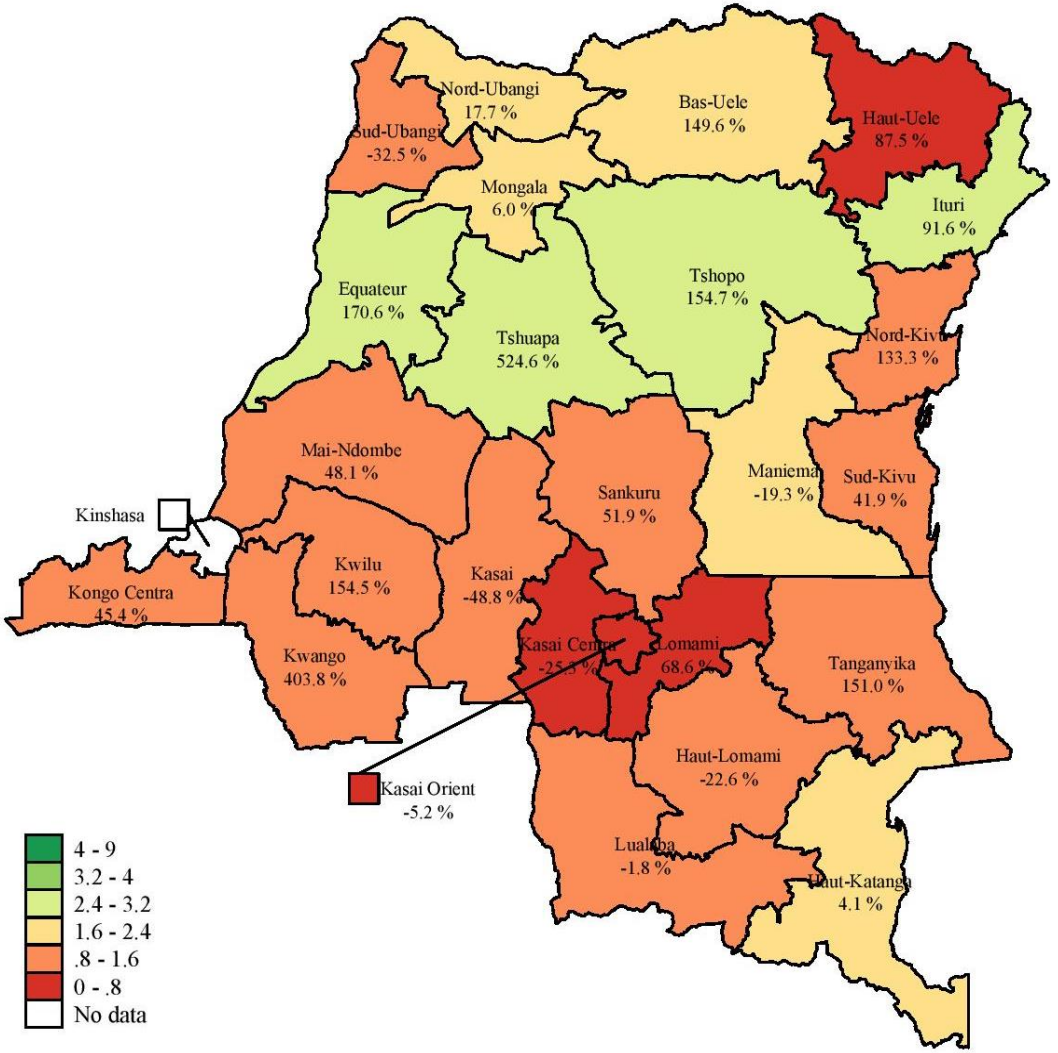

Figure 20: Rural vitamin B12 daily intake per adult male in 2012

Overall, the micronutrients results were similar to the one of Uganda except for vitamin A and Zinc intake that was acceptable, as opposed to DRC (Marivoet and Ulimwengu, 2018). The nutrient deficiencies in many provinces can be explained by the very low production that characterises 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 are deficient in almost all the nutrients intake. This can be explained by the high level of insecurity in those provinces. Even though the North Kivu, South Kivu and Ituri are highly fertile and despite the level of instability in the North Kivu too, the province has shown some remarkable commitment to improving their agricultural sector. For example, some commodities like beans and potatoes, they highly produce and even supply to different provinces. Potatoes are highly produced in the North Kivu compared Ituri and farmers of the mountainous areas in the east and northeast of the country that provide. A higher part of this production is sold to Kinshasa because of their higher income. Moreover, beans are also produced by around 87 per cent of the crop producers and their output over half of the whole production of DRC (FEWS NET, 2015; O'Donnell *et al.*, 2015; FEWS NET, 2017).

4.4 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%.

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 under 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. This means that in 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 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 different 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, except for meat and fish under compensated own-price elasticities which had a positive relationship. 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%[13], 14.2%, 7.8%, 9.0%, 11.2%, 8.0% and 10.0% respectively. Of this total increase in demand, 26.7%[14], 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%[15], -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. This implies that 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 was less than the percentage changes in their prices.

Additionally, in rural areas, if the prices of main staples, pulses, vegetables, fruit, milk and oil

[13] 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.
$Total\ increase\ in\ quantity\ demanded\ of main\ staples = (-10\%)(-1.188) = 11.9\%$

[14] 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.
$Increase\ in\ quantity\ demanded\ of main\ staples\ due\ to\ price\ effect = (-10\%)(-2.671) = 26.7\%$

[15] 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%

reduce by 10% respectively, then the demand for those food groups would rise by 7.8%, 15.8%, 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 prices 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 quantities demanded was less than the percentage change in their prices. It is worth to note that the compensated own-price elasticity suggested that the main staples were perfectly inelastic. Both the uncompensated and compensated price elasticities indicated that meat and fish as well sugar were perfectly inelastic.

The overall results on expenditure elasticities were in line with findings from 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 the butchering happened in abattoirs 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) who 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 & 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 in DRC 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 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*** **

Source: Authors. 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*** **

Source: Authors. Standard errors in parentheses, * significant at 10%, ** significant at 5%, *** significant at 1%

The cross-price elasticities (Table 7 and Table 8) indicated 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 & 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 instead 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 find 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 corroborated with 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.

4.5 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 be likely to change when income rises.

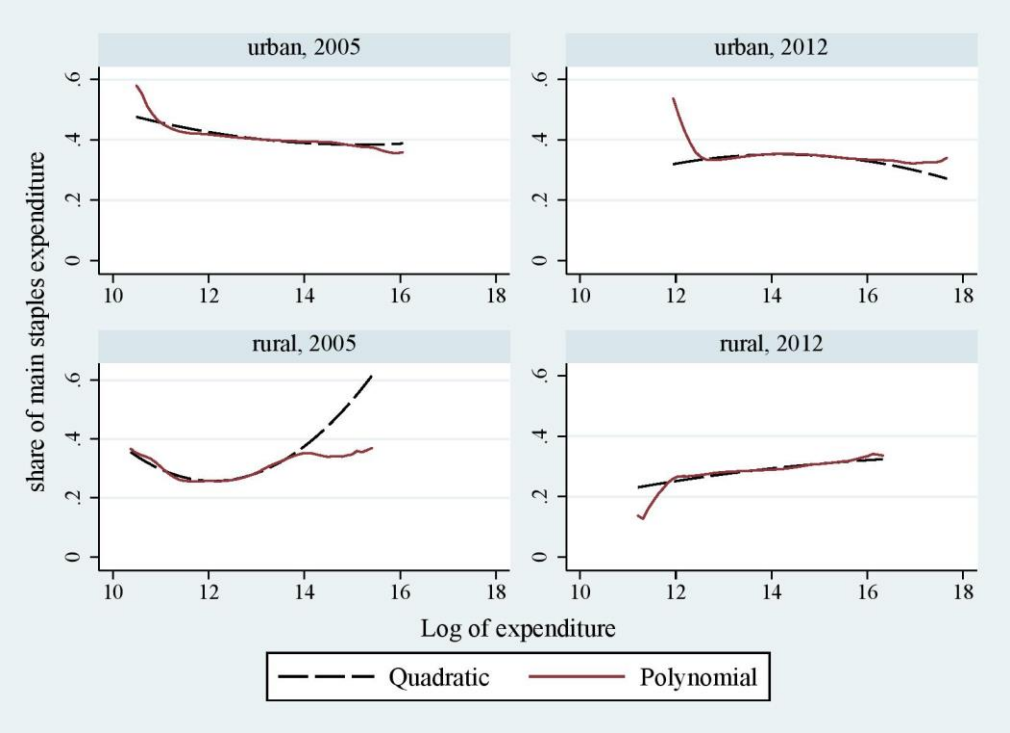

Figure 21: Main staples' Engel's curves

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 rural areas. This could be because rural households' production of staples food was not able to cover the needs of the households. 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 & Miller (2008) 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; hence the budget share of main staples is likely to increase. Moreover, these results supported the findings of Moustier & David (1997) argued that as income increases households decrease in self-production.

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 represented in Figure 22.

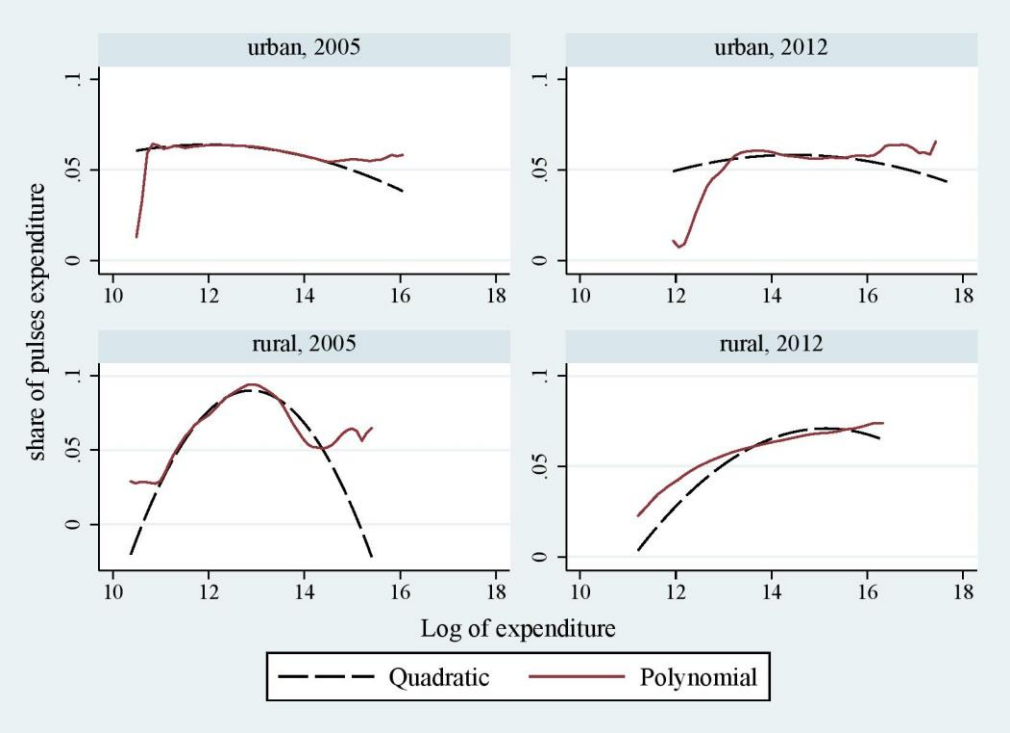

Figure 22: Pulses' Engel's curves

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 are luxury goods however, it reaches a point whereby they became necessity goods.

The budget share for pulses does 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) argued that when households became richer in the DRC, pulses were gradually added 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 were usually produced in by households in rural areas for their self-consumption, the results verified the Moustier & David (1997) argued that as income increases households decrease in 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.

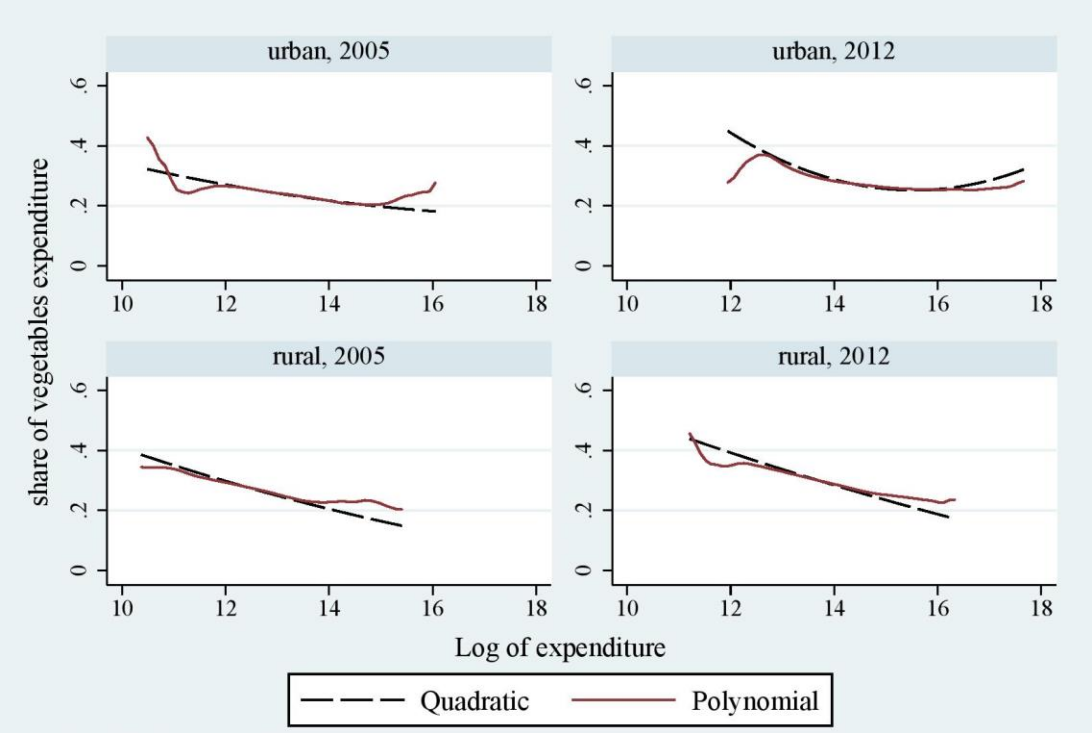

Figure 23: Vegetables' Engel's curves

Regarding vegetables, our 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 include those with low income. Hence, the rise in income across households does not change their 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 tiny. This findings on vegetables are similar to FAO findings suggesting that when the purchasing power of a household in Sub-Saharan Africa increases the household reduced their consumption of vegetables (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.

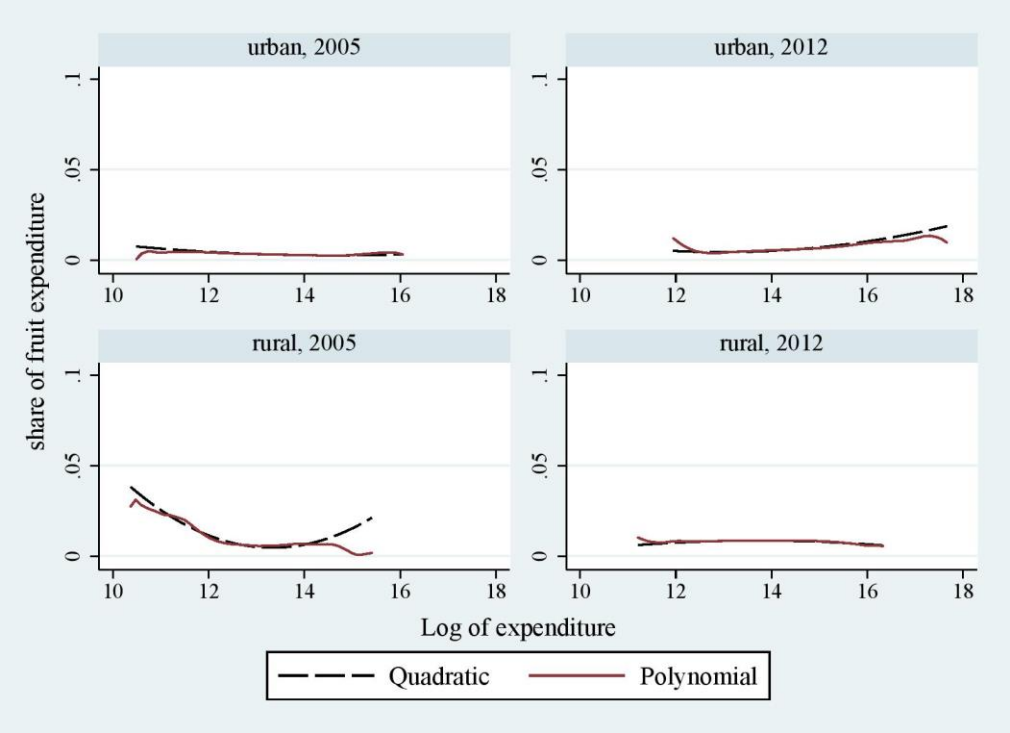

Figure 24: Fruit's Engel's curves

From Figure 24, we observe that the budget allocated to fruit was very small for both poor and rich households. Fruits were necessity goods in 2005 and for wealthy households in rural areas, they were luxury goods. As for 2012 in urban areas fruit is luxury goods as opposed to rural areas.

The results from the Figure 24 suggested 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 mentioned, 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 one of Ulimwengu *et al.* (2012) who found that the fruit share decreased with rising in food expenditure. This could be because in his analysis of the Engel Curves he considered only the year 2005 and did not separate urban and rural areas.

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.

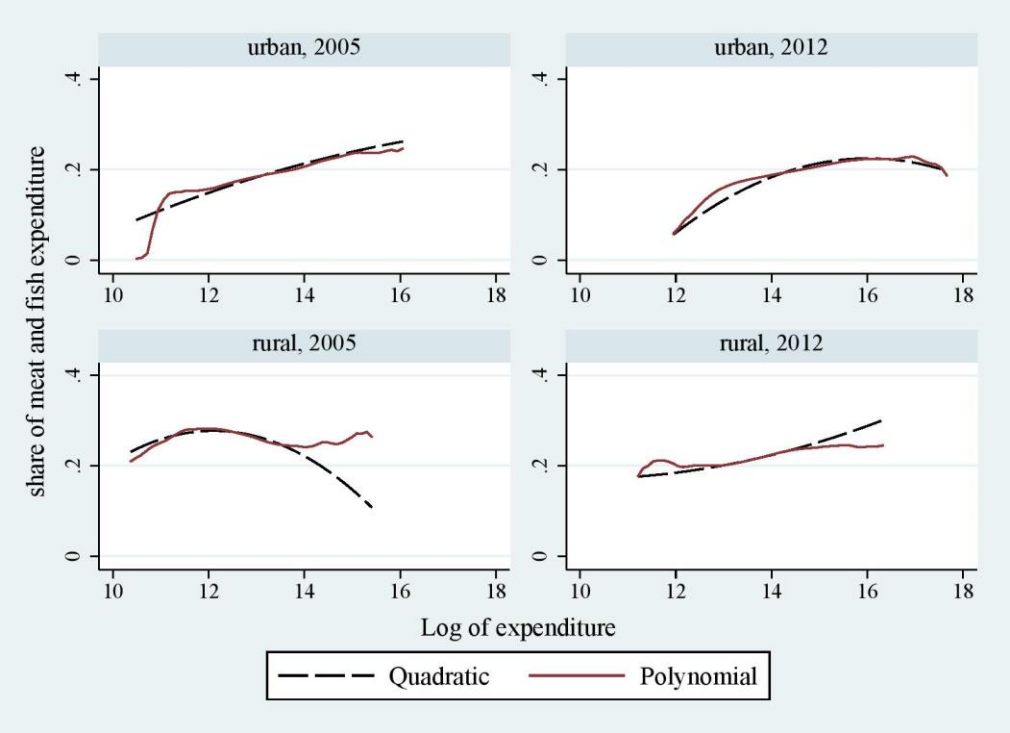

Figure 25: Meat and fish's Engel's curves

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

It was worth to notify that Figure 25 results opposed the one from 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 should be the differences in our methods. 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. Moreover, these results were in line with the findings of Moustier & David (1997) who found that in Sub-Sahara Africa, when the 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 represented in Figure 26.

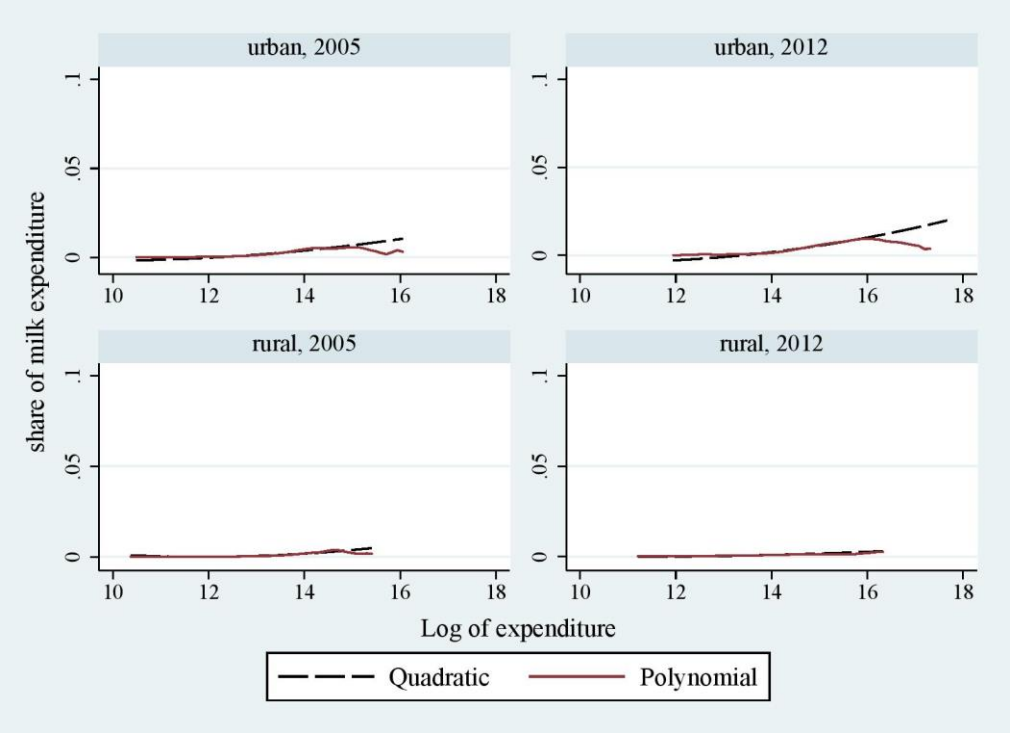

Figure 26: Milk's Engel's curves

We observe 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, our overall results suggest that milk and dairy products are luxury goods. This implies that the consumption of milk increase with the rise in the household's income. The explanation could highly be related to one of the consumptions of meat and fish. In addition, this finding was in line with, Delgado (2003), Kearney

(2010) and Kasirye (2015) who stated that the increase in income leads to an increase in 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.

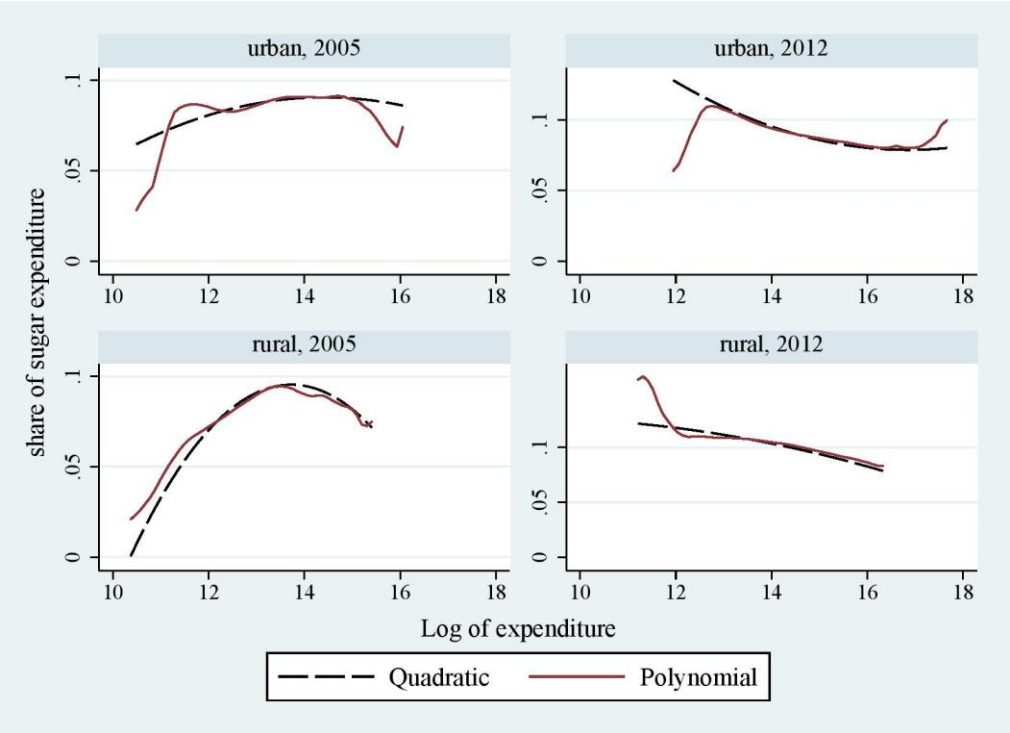

Figure 27: Sugar's Engel's curves

From the result, the overall results suggest that in 2005, sugar was to be a luxury good while in 2012 it was to be necessity goods. However, it is worth to observe that sugar is a luxury good for very poor households in urban areas in 2012.

In 2005, sugar was found to be a luxury good, probably due to the high price of sugar in rural areas associated with the decrease in the local production of sugar cane from 1998 to 2006 (Gathovagheni, 2009). However, in 2012 for both urban and rural areas, we found that sugar became a necessity good. The most probable reason is the increase in the local production in sugar

cane from around 1.5 million in 2006 to approximately 2 million tonnes in 2012[16]. The 2012 results were in line with Temple & Steyn (2013) who found that in South Africa and many countries in Africa, rich people tended 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.

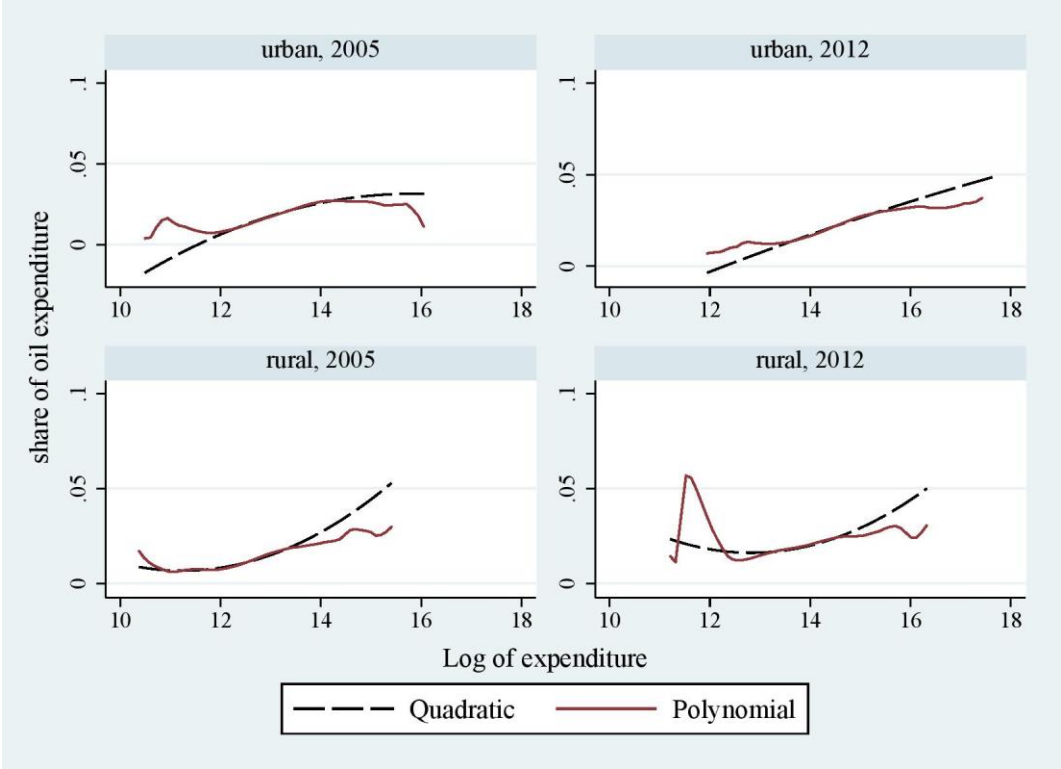

Figure 28: Oil's Engel's curves

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; their budget share increases with rises in household's expenditure; as stated before, households with higher incomes go for food items of

[16] 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

better quality, which also tend to be 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 sufficient, and the output is decreasing over time (Marivoet, 2016). These results were in line with the one of Mancini *et al.* (2015) who found that wealthy households assume that imported oils well refined, and healthier allowing to avoid diseases.

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

Households in DRC spent about three-quarter of their income on food. The budget share has been useful to determine the level of vulnerability towards food insecurity and malnutrition. It was found that households in both urban and rural areas were highly vulnerable towards food security. In all the provinces of DRC, 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 security and nutrition issues.

About 80 per cent of the food budget was spent on cereals, root and tubers as well as meat and fish. This was mainly due to the issues of the availability of other food groups. The nutrient deficiencies analysis suggested 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 is due to poor road networks within and between provinces.

The expenditure elasticities suggested that the quantity demanded for almost all food groups rose with income. This implied that an increase in income of the population would lead to 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 are luxury goods while in rural areas main staples, pulses, meat and fish, milk and oil are luxury goods. This indicates that future rises 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 implies that households are more sensitive to changes in price than changes in income. This shows that price policies are

good agricultural policy instruments. In other words, price policies are essential to stimulate agricultural production. Further, it is a necessity to diminish the gap between the domestic supply of food commodities and demand by considerably increasing local production. This will prevent food price variation.

The cross-price elasticities show that meat and fish can be easily substituted in urban areas. This means that government price interventions for those food items can lead to significant consequences in the economy and the nutrition of the population. Hence, there is a need to ensure a stabilised price for those commodities. 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 and price intervention will not affect the entire rural economy as opposed to living standards intervention.

Overall findings of the food budget share, food consumption, nutrient deficiencies, their trends, the elasticity as well as the Engel's curve provide evidence for policymakers in DRC to plan for demand for food and improvement of 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.

5.2 Recommendations

5.2.1 Recommendations for policy intervention

The government should put a lot of effort into policies such as the creation of stable economy of low inflation and positive economic growth. This will boost the country's economy in order to improve the population's living standards. All the ministries should be driven by the main objective of poverty reduction through the creation of employment.

There is a need for the government to improve infrastructures, mainly roads that link rural areas to urban areas and remove all trade barrier for agricultural and food products between provinces. Hence to facilitate food trade within the provinces and the country.

Policymakers as well as stakeholders, have 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 as well as policies that boost the building up of assets, savings and insurances to rely on during shortage time.

Courses on nutrition should be given a high interest and introduced in the academic curriculum from the primary school. In addition, as the culture and the region have significant importance in 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 nutrition 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 sell the food to consumers.

The study further suggests that to improve nutrition of the population, policymakers should focus on micronutrients. 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 transformation of 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.

Nevertheless, a more disaggregated approach can significantly add value to this study as it will highlight the heterogeneity that exists between and within provinces. Moreover, further research could also disaggregate the food groups and analyse the demand for food items within the food groups. This will allow one to understand how households behave regarding food items having similar characteristics. Moreover, it will help to understand the relationships that exist between the quantity and the quality of food items.

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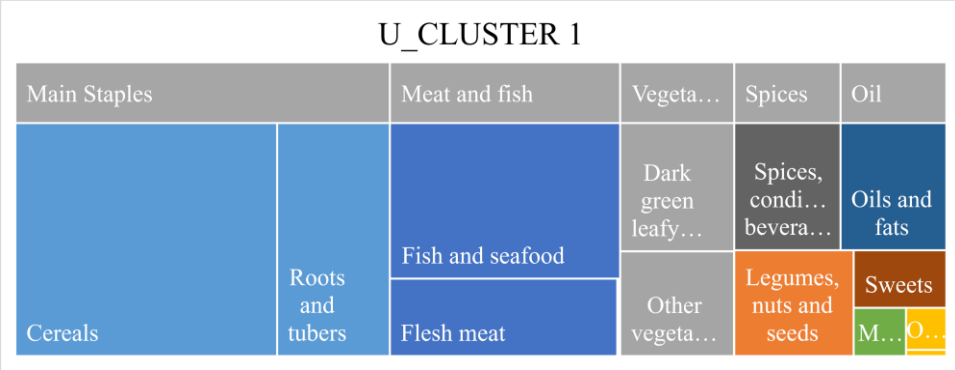
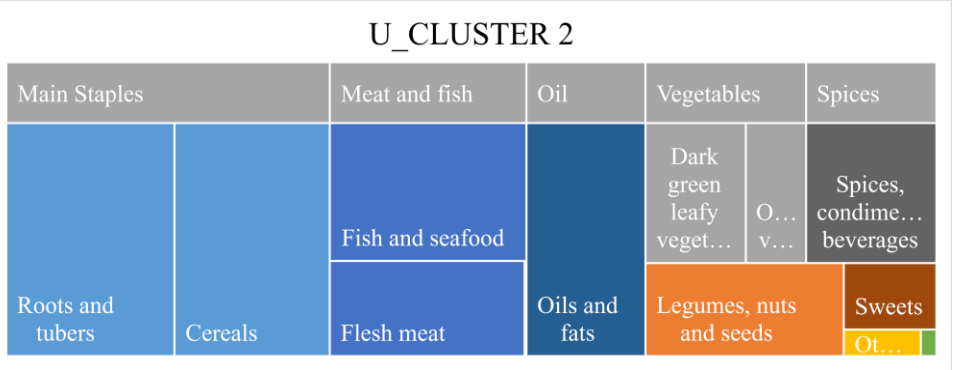
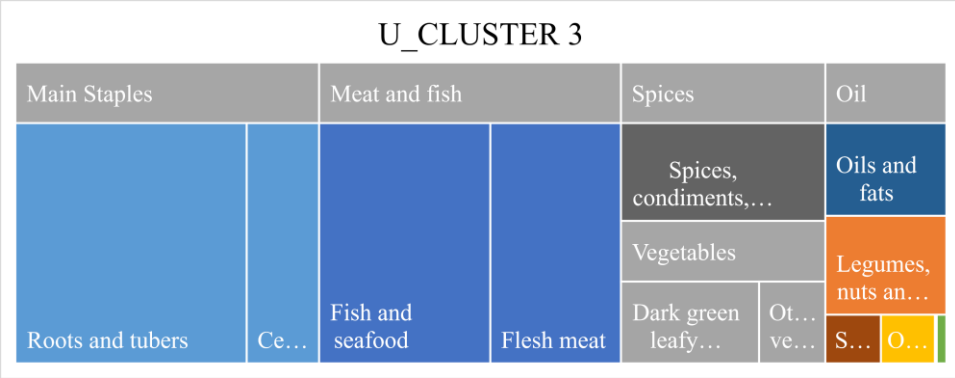
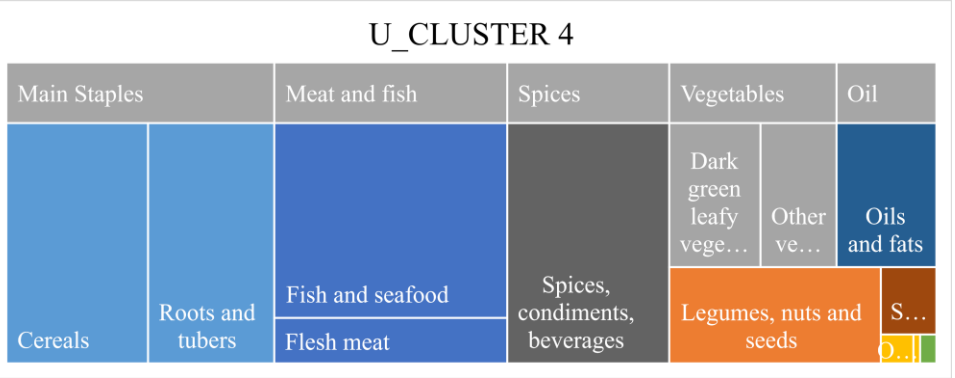
APPENDIX

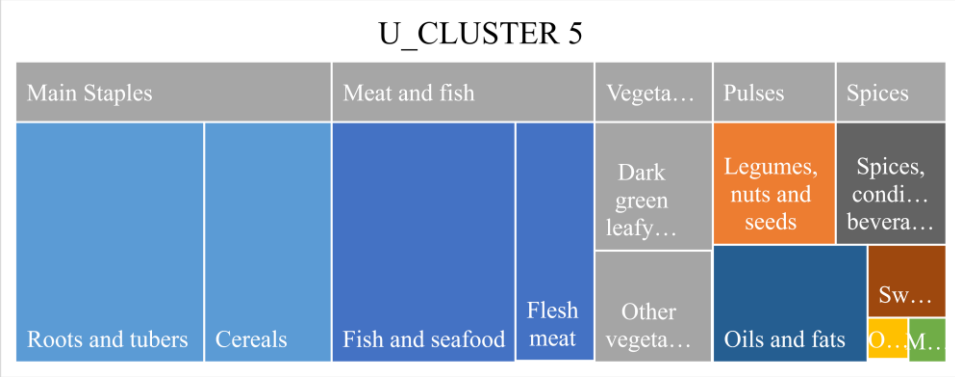
Household food composition











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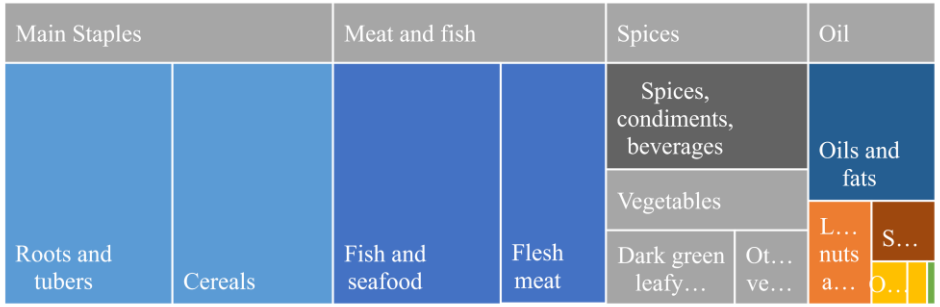

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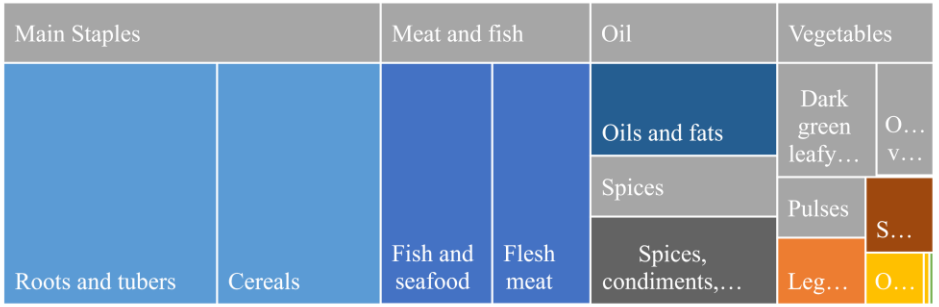

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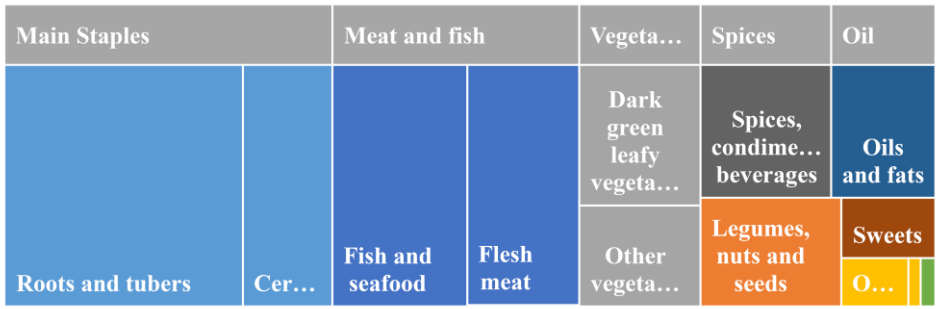

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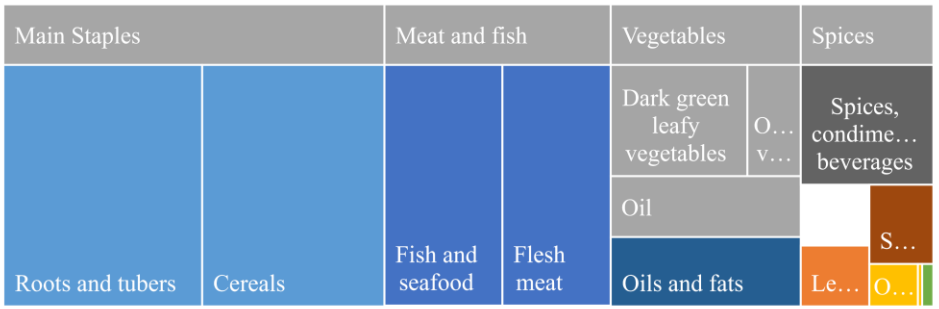

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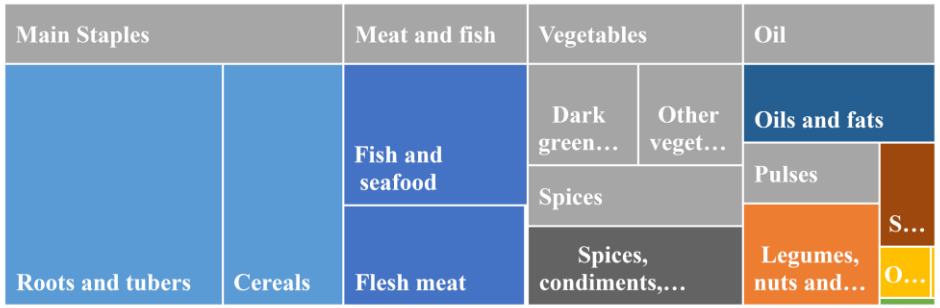

Consumption trend by cluster