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The Contribution of Fruit From Trees to Improve Household Nutritional Security in the Context of Deforestation in Cameroon

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Abstract

Cameroon needs healthy citizens to archive emergence by 2035. Malnutrition and undernourishment is the highest burden in the World in recent times and a silent crisis facing most rural communities in forest areas of Cameroon. Its abstruseness makes extremely fragile political, social and economic planning to foster development in such areas. Therefore, it is time we bring appropriate understanding and new strategies on unpacking the complexities of food and nutritional security and define practical solutions to food insecurity. Working in the context of increasing deforestation, this thesis brings evidence on the situation of household food insecurity (FIS) access experience in forest areas which is not reported in current discussions at the national level. It further investigates the knowledge and awareness of households on the availability, accessibility, utilisation, vulnerability and consumption of nutrient rich food items using the example of fruits from trees. Thus, the aim of this research was to investigate strategies for addressing household FIS through increased domestic supply and consumption of fruits from trees in the context of deforestation in Cameroon. Data were collected through four rounds of structured interviews completed between August 2013 and October 2014. Analysis was done using simple citations and ordering, Principal Component Analysis (PCA), Likert scale, $\chi 2$-test of association and Cramer's V coefficient to test the strength of the association and means and ANOVA. The HFIAS approach used to determine household FIS.

Only 1% of the population were food secure and the moderately deforested zone showed the worst trends in food insecurity. Therefore, the effect of deforestation was nuanced. Diverse fruit trees were registered. Households said they required fruits only 2.4 ± 1.5 times per week. Recently, the intake of 400 g of fruit per person per day for good health was announced as a priority of international recognition. However, households were not aware of the importance and frequency of fruit consumption with less than 50% of households eating fruits daily during the harvesting season. Fruit tree nurseries where scarce and seeds where obtained from local sources. Fruit tree diseases where rampant and up to 50% harvest lost was registered for some fruits species. This study has shown that food availability does not necessarily mean adequate food intake.

Three opinions about fruit trees and the prevalence of food insecurity in Cameroon has been raised in this thesis. First, there is ineffectiveness in the eradication of FIS because even in agricultural conducive environments, hunger and food insecurity are still prevalent at high rates. Therefore, effective and efficient targeting of food insecured groups need to be promoted in all clusters of the population. Secondly, the national nutrition program is neglecting sensitisation on food consumption patterns and therefore people are not making use of nutrient rich foods even when this maybe found around their environments - taking the case of fruits from trees. Thus, very few people ate fruits and at irregular frequencies of consumption. Thus, there is need to design special campaign programs to promote the consumption of fruits from trees. Thirdly, the word-of-mouth or neighbour-to-neighbour dissemination approach on fruit trees planting has not been efficient across communities. As such nurseries where scarce and people obtained fruit trees plants from natural regeneration or found them on the field when establishing the field. Therefore, in this research, it is postulated that no matter the nature of efforts and level of intervention, what is certain is that addressing FIS requires effective targeting of the vulnerable population and the implementation of novel and practical approaches on promoting access to and consumption of fruits in the right frequencies.

This research further revealed that poor eating habits was a problem and lack of knowledge about the frequency and intake of nutrient rich food was serious. For instance, people were not aware on the recommended frequency of fruit consumption and people ate infested fruit while reserving the healthy ones for sale. This is the trap of the food insecurity problem in some regions – knowledge about foods and ways of food utilisation. This is neither a problem of availability nor accessibility, but rather a problem of lack of knowledge and lack of sensitisation. From FAO reports on the state of food insecurity in the world and other studies of food intake in most developing nation, poor food consumption is a global problem in most poor regions and even in rich areas affected by obesity. Thus, there is a need to establish a high level policy framework maybe in the form of a convention or an intergovernmental panel at the level of the United Nations and/or the African Union on ‘reducing malnutrition in all its forms (rates, drivers and consequences on human health and the environment)’. This structure will promote setting priorities, strategies, monitoring on peoples eating habits, setting nutritional standards, and principles and indicators for observing undernutrition, overnutrition and associated problems within all population strata.

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Dedication

To my husband and children for their immeasurable love

AND

To my mom Mama Rose Angwi and brother Ni Thomson Atesang who were called to the Lord in April 2015 and December 2014, respectively.

Mama and Ni Thomson… the tears have never been dry from my eyes

However, I trust that even in purgatory, you have continued to intercede for us and this is why your dreams and aspirations for me are still being realised.

RIP Mama and Ni Thomson

List of Abbreviations

AGRI-STAT	Agricultural Statistics
BUCREP	Bureau camerounais de recensement de la population
CFSVA	Analyse global de la sécurité alimentaire de la vulnérabilité
CIFOR	Centre for International Forestry Research
DSCE	Growth and Employment Strategy Paper in Cameroon (Document de Stratégie pour la Croissance et L'emploi)
ECAM	Conditions de vie des populations et profil de pauvreté au Cameroun
EDS - MICS	Enquête démographique et de santé et a indicateur multiples (Multiple Indicator Demographic and Heath Survey)
EESI	Employment and informal sector survey
FAO	Food and agricultural Organisation of the United Nations
FIS	Food insecurity
GDP	Gross Domestic Products
HDI	Human Development Index
HFIAS	Household Food Insecurity Access Scale
HFZ	Humid Forest Zone
IFPRI	International Food Policy Research Institute
IITA	International Institute of Tropical Agriculture
INS	Institutes national des la statistique (National Institute of Statistics)
IRAD	Institut de recherche agricole pour le developpement (National Institute of Agricultural Research for Development) in Cameroon
IUFRO	International Union of Forest Research Organizations
MDG	Millennium Development Goal
MINADER	Ministère de L'Agriculture et du Développement Rural (Ministry of Agriculture and Rural Development)
MINEPAT	Ministère de l'Economie, de la Planification et de l'Aménagement du Territoire (The Ministry of Economy, Planning and Regional Development)
MINSANTE	Ministry of Public Health
NTFP	Non-timber forest products
(PNSA)	The national food security program (Programme National de Sécurité Alimentaire)
REDD	Reducing Emissions from Deforestation and Degradation
RGPH	General Population and Housing Census
SSA	sub-Saharan Africa
SUN	Scaling Up Nutrition
TBS	Tableau de bord social sur la situation des enfants et des femmes au Cameroun
UN	United Nations
UNDP	United Nations Development Program
WFP	World Food Program
WHO	World Health Organisation

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Key definitions

In this thesis, I define key concepts as follows:

Deforestation: Deforestation is the conversion of forest to another land use or the long-term reduction of tree canopy cover below the 10% threshold (FAO, 2001).

Food insecurity: A situation that exist when people lack secure access to sufficient amounts of safe and nutritious food for normal growth and development and an active and healthy life. It may be caused by the unavailability of food, insufficient purchasing power, inappropriate distribution, or inadequate use of food at the household level. FIS, poor conditions of health and sanitation, and inappropriate care and feeding practices are the major causes of poor nutritional status. FIS may be chronic, seasonal or transitory (FAO et al., 2012).

Food security: A situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life (FAO et al., 2012). The nutritional dimension is integral to the concept of food security. The five pillars of food security are:

- Food availability: production, distribution and exchange;
- Food accessibility: affordability, allocation and food preference;
- Food utilisation: nutritional and social values, and food safety) (Ericksen, 2008) and

- Vulnerability/stability: the physical, environmental, economic, social and health risks that may affect availability, access and use (WFP, 2003).
- Nutritional aspect of food: Suitable quantity and quality intake of food that meets an individuals' body requirements (FAO et al., 2012).

Forest: A forest is an ecosystem dominated by trees and other woody vegetation. FAO defines a forest as a minimum of 1 ha in size, with at least 10 % crown cover and with mature trees at least two meters tall. The definition explicitly includes open woodlands, such as those found in the African Sahel (FAO, 2011; Robiglio et al., 2010).

Fruit: Fruit as used in this thesis include fresh fleshy parts of plants excluding nuts and seeds and preserved fruits like canned fruits, fruit juice and jams.

Hidden hunger: Refers to vitamin and mineral deficiencies, or micronutrient deficiencies. Micronutrient deficiencies can compromise growth, immune function, cognitive development, and reproductive and work capacity. Somebody who suffers from hidden hunger is malnourished, but may not sense hunger. Micronutrient deficiencies can also occur in people who are overweight or obese (FAO et al., 2012).

Malnutrition: The result of poor food consumption patterns, poor absorption and/or poor biological use of nutrients consumed.

Nutrients: These are the nutritious components in foods that the body needs to grow strong and healthy. A diverse and balanced diet contains a range of nutrients, all of which play an important part in keeping bodies healthy. Fruit are important sources of key nutrients (Kehlenbeck and McMullin, 2015).

Nutritional security: A situation that exists when secure access to an appropriately nutritious diet is coupled with a sanitary environment, adequate health services and care, to ensure a healthy and active life for all household members. Nutrition security differs from food security in that it also considers the aspects of adequate caring practices, health and hygiene in addition to dietary adequacy (FAO et al., 2012).

Nutritional status: The physiological state of an individual that results from the relationship between nutrient intake and requirements and from the body's ability to digest, absorb and use these nutrients (FAO et al., 2012).

Undernourishment: Food intake that is insufficient to meet dietary energy requirements continuously (Kehlenbeck et al., 2013). This term is used interchangeably with chronic hunger, or, in this report, hunger. As such, “undernourishment” has been defined as an extreme form of FIS, arising when food energy availability is inadequate to cover even minimum needs for a sedentary lifestyle (FAO et al., 2012).

CHAPTER 1

GENERAL INTRODUCTION

Daily intake of 400 g of diverse fruits is necessary to maintain good health (WHO, 2003).

1.1. Background

During the last few decades, rapidly growing awareness on global issues such as climate change, population increase and the double burden of malnutrition are raising fundamental concerns about the world's food security (FAO et al., 2015; Nasi et al., 2008). Food security is defined as a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life (FAO et al., 2015, Barret, 2010). Food security involves the means by which people have access to food and use it (Barret, 2010). Household food security means that all members of the household are food secure (Pinstrup-Anderson, 2009; Ericksen, 2008). The nutritional dimension is integral to the concept of food security (FAO, 2013). Thus, nutritional security is a situation that exists when secure access to an appropriately nutritious diet is coupled with a sanitary environment, adequate health services and care, to ensure a healthy and active life for all household members. Nutrition security differs from food security in that it also considers the aspects of adequate caring practices, food intake, health and hygiene in addition to dietary adequacy (FAO et al., 2012). In 2009, the World Summit on Food Security stated the "four dimensions of food security as:

- food availability (production, storage, distribution and exchange);
- food accessibility (affordability, allocation and food preference);
- food utilisation (nutritional and social values, dietary practices and food safety) (Ericksen, 2008) and;
- vulnerability/stability - the physical, environmental, economic, social and health risks or unrest that may affect availability, access and use (Smyth et al., 2014; WFP, 2007);

In 2015, FAO et al. (2015) added a fifth dimension i.e. the nutritional aspect also insinuated by Bhaskar et al. (2015).

Household food security means that all members of the household are food secure (Pinstrup-Anderson, 2009). Household food insecurity means that one or more members of the household are food insecure (Maren et al., 2008). This definition implies that food insecurity is not only a problem of having too little food, but also means that i) people do not have access to food (either physical or economic) and/or that ii) due to poor food quality or hygiene in food

preparation/handling, the benefits of food are not received by the body (Maren et al., 2008), and/or iii) people afflicted by various vulnerabilities or with limited knowledge about food uses and a wider variety of food items will be food insecure (Abu-Basutu, 2013). Nearly one billion people go hungry every day and more than two dozen countries have “alarming” or “extremely alarming” hunger levels (Conway and Wilson, 2012; FAO et al., 2012). In 2012, while some 870 million people were food insecure, a further two billion people suffered from nutrient deficiencies (FAO et al., 2012). Further to this, whilst income poverty greatly reduced in Southeast Asia malnutrition remained high (15.5%), like in sub-Saharan Africa, where income poverty did not improve much (FAO et al., 2012). This means that fighting FIS is not just about having food and resources but also combatting the consequences of environmental changes and peoples adaptation to such situations. It is hypothesised that fighting FIS also entails the ways by which foods are acquired and used, as well as households’ knowledge about various food items, their importance to human nutrition and various food acquisition mechanisms (Stadlmayr et al., 2013; Ericksen, 2008; Dindyal and Dindyal, 2003).

Shackleton and Shackleton (2012) suggested that rising levels of human vulnerability are driving increased dependency on biodiversity and ecosystem services. Likewise, Tata et al. (2011) and Tieguhong (2008) showed that sustainable forest management needs to move from a theoretical concept to one that can reduce conflicts, deforestation, poverty and famine. Under climate change, forest based livelihoods are highly affected because forests and woodland cover are diminishing, and forest based livelihoods, particularly food and nutritional security is threatened and poverty is increasing (Tata et al., 2011; Robiglio et al., 2010; Tieguhong et al., 2009; Bellassena and Gitz 2008; Gregory et al., 2005). More to this, the ‘household food consumption value of forest’ has hardly been studied and therefore the food and nutrition security situation of forest people is not well understood or documented (Viviany et al., 2013; Termote et al., 2012; Tee et al., 2009). Whilst it is known that forests provide a range of foods to rural people, it is only recently that quantitative relationships have been explored. Powell et al. (2011) showed that rural households in Tanzania with tree patches or forests close to their homes had a higher dietary diversity and more nutrient dense foods than households at greater distances to areas with trees. This was explained at a larger scale by Ickowitz et al. (2014) for 21 countries in Africa. Using national-scale data on forest cover and dietary indices, they concluded that there was a strong positive relationship between tree cover and dietary diversity,

as well as with fruit and vegetable consumption. They like other authors (Chakravarty et al., 2012; Leakey et al., 2012; Asaah et al., 2011; Nasi et al., 2008), postulated several possible pathways for the relationships between forests and food security. These include; a higher diversity of foods available from natural forests than from other non-forest biomes; the benefits of agroforestry farming practices and in some areas the inherent diversity of cropping systems associated with shifting cultivation in forest. For instance, in the past 30 years, ICRAF has promoted domestication of many indigenous fruit trees in the view of facilitating fruit tree for sustainable livelihoods and fruit supply in Cameroon and most parts of Africa (Leakey, 2012; Tchoundjeu et al., 2012; Asaah et al., 2011).

Increasing scientific evidence suggests that fruits are essential components of a healthy diet and that their consumption could help prevent a wide range of diseases (Agudo, 2004; Ruel et al., 2005; Nesbit et al., 2010; Pene, 2007). Fruits in the daily diet have been associated with reduced risk for some forms of cancer, heart disease, stroke, and other chronic diseases (Agudo, 2004). Food groups like fruits and vegetables are cheap sources of essential micronutrients and are protective against chronic diseases (Ruel et al., 2005; Kengue, 2002; Gockowski et al., 2003; Abu-Basutu, 2013). Fruits are rich in bioactive compounds including vitamins and minerals like Vitamin A and C (Ruel et al., 2005, Flyman and Afolayan, 2006; Termote et al., 2012; Bharucha and Pretty 2010). In poor regions, household food and nutritional security can be enhanced by increase consumption of fruits, which are nutrient rich foods and grow naturally in forest and farmlands. Generally, the consumption of fruits is very low in poor countries (Agudo, 2005; Ruel et al., 2005; Pinstrup-Anderson, 2010) necessitating a need to investigate the factors such as deforestation that affect sustainable access to nutrient rich foods like fruits from trees.

Deforestation is defined as the conversion of forest to another land use or the long-term reduction of the tree canopy cover, below the minimum 10% threshold (FAO, 2001). Short and medium term consequences of deforestation are often perceived as environmental problems, but in the end, they affect food security and humans in many ways (Ickowitz et al., 2014, Leakey et al., 2012). Deforestation affects wind flows, water vapour flows and absorption of solar energy thus causing global heating. It disrupts normal weather patterns, thus increasing drought and desertification, crop failures, melting of the polar ice caps, coastal flooding and

displacement of major vegetation formations (Chakravarty et al., 2012). Slash and burn agriculture in tropical regions exposes the soil to high intensity sunlight causing severe and rapid evaporation as well as severe torrential rains leading to severe soil erosion and leaching (Chakravarty et al., 2012). All these effects of deforestation lead to inadaptations in the existing cropping and farming patterns leading to crop failure and therefore food and nutritional security. Presently, the rate of deforestation is reported to be reducing worldwide (FAO et al., 2014). It has even reversed in some countries like Cameroon through improved tree planting activities (de Wasseige et al., 2014; FAO, 2014). However, its effects on food security are beginning to be most felt. This warrants investigation and continuous action. Due to the disappearance of some naturally existing species, indigenous people have been obliged to change their dietary patterns and adopt news foods (Ickowitz et al., 2014; Powell et al., 2011) which in some cases are less healthy.

1.1.1. The effects of deforestation on food security

It is widely agreed that due to climate change, people and forests will have to adapt to changing environments (Leakey, 2012; Angelsen et al., 2009). Forest degradation is a major factor that underscores the vulnerability of forest adjacent population to adequately sustain and maintain durable livelihoods (Angelsen et al., 2011; Nasi et al., 2008). Just as many authors have stressed, a good analysis of forest resources used by forest dwellers can provide appropriate insights to forest management as well as to developing livelihood strategies for the forest-dependent peoples (Angelsen et al., 2011). In the past, the diets of hunter-gatherer communities were solely composed of wild foods (Bharucha and Pretty 2010). Even today, forests provide food and other livelihoods to people through fruit trees, income and Non-timber forest products (which include fruit) (Angelsen et al., 2014; Arnold et al., 2011; Nasi et al., 2008; Tieguhong, 2008; Shackleton and Shackleton, 2004).

Approximately 75% of Cameroon is covered with forest and/or woodland and constitutes a significant portion of the Congo Basin forest, which is the world's second largest ecosystem after the Amazon Basin. Cameroon's forest area is highly valuable because it supports high level of flora and fauna containing one of the important biodiversity hotspots in Africa (Ndoye and Kaimowitz, 2000). About 50% of Cameroon is covered with dense rainforest (Freudenthal et al., 2011). Cameroon is one of the Sudano-Sahelian countries in

Africa that show signs of some desertification (de Wasseige et al., 2012; Dkamela, 2010). The northern part of the country was previously under forest, and due to the extreme degradation of vegetative cover, it's now under savanna grasslands. It appears, therefore that under climate change, forest degradation and deforestation should be a main issue of concern to policy makers in the Cameroonian context (Dkamela, 2010; Angelsen et al., 2009).

Afforestation is the establishment of forest plantations in areas not previously under forest, and denotes a change from non-forest to forest. It differs from reforestation, which is the establishment of forests (through planting, seeding or other means) after a temporary loss of the forest cover. Areas under reforestation are classified as forest since the forest is actively regenerating (FAO, 2001). Deforestation cannot be avoided but should be managed (Leakey, 2012; Angelsen et al., 2009). When deforestation is accompanied by afforestation and reforestation through agroforestry activities, then biomass cover may increase or remain stable although there will be forest degradation endured through the change from one land use system to another. In the late 1990's, the global estimate for above-ground woody biomass was 422 billion tonnes, with South America having the largest portion of 43% (Chakravarty et al., 2012; FAO, 2001; Kaimowitz and Angelsen, 1998). In order of importance, Brazil encompassed 27% while Africa had the second largest quantity with 17% or 71 billion tonnes and the other regions together accounted for 49% of the global above-ground biomass (Chakravarty et al., 2012; FAO, 2001; Mertens et al., 2000; Kaimowitz and Angelsen, 1998). The rate of deforestation in tropical forests during the 1990's and early 2000's was alarming (Angelsen et al., 2009; Carvalho et al., 2004; Mertens et al., 2000; Kaimowitz and Angelsen, 1998; Myers, 1993).

Deforestation occurred at the rate of 9.2 million hectares per annum from 1980 - 1990 corresponding to -16 billion tonnes of woody biomass, 16 million hectares per annum from 1990-2000 and decreased to 13 million hectares per annum from 2000-2010 (FAO, 2014; Chakravarty et al., 2012; FAO, 2001). The net change in forest area during the last decade was estimated at -5.2 million hectares per year, the loss area equivalent to 140 km^2 of forest per day (de Wasseige et al., 2014; Chakravarty et al., 2012). The losses were mainly in the tropics, whereas the non-tropics had an increase of volume in biomass (Chakravarty et al., 2012; Carvalho et al., 2004; Ndoye and Kaimowitz, 2000). In the Amazon, Carvalho et al. (2004) reported that increased deforestation would lead to an upsurge in CO_2 emissions in the order of

2 - 5 billion tons of C in 25 - 35 year period, or an additional 85-140 million T/C/year. In the Congo Basin, the gross deforestation annual rate was 0.13 % for the period 1990 - 2000, which doubled for the period 2000 - 2005 (de Wasseige et al., 2012). The evolution of gross deforestation between 1990 - 2000 and 2000 - 2005 was significant for DRC, Cameroon and Congo (de Wasseige et al., 2012). For instance, Mertens et al. (2000) established a marked increase in deforestation around the forest area in the East region of Cameroon after the economic crisis of the mid 1980's.

The causes of deforestation are the forces that motivate agents to clear the forests (Brown and Sonwa, 2015; Chakravarty et al., 2012; Leakey, 2012; Sonwa et al., 2012). Most existing literature typically distinguishes between two levels of specific causes of deforestation: direct and indirect factors (Brown and Sonwa, 2015; Chakravarty et al., 2012; Leakey, 2012; Sonwa et al., 2012). First, the direct underlying causes of deforestation lead to the conversion of forestland to other uses such as agriculture, infrastructure, urban development, industry, and other (de Wasseige et al., 2014; Robiglio et al., 2010). Second, plantation agriculture, timber extraction and mining are not direct causes of deforestation although indirectly, they cause deforestation in the opening up of roads and the establishments of residential areas next to the forest for their workers (de Wassigne et al., 2014). Fuel wood extraction does not necessarily cause deforestation as mostly dead wood is extracted. However, together with logging, fuelwood extraction causes forest degradation.

Typically, tropical forests are the last avenues for the search of subsistence for the most vulnerable people worldwide (Leakey, 2012; Arnold et al., 2011; Nasi et al., 2008; Myers, 1993). Millions of people live on the tropical forest with less than a dollar-a-day, where a third of a billion are estimated to be foreign settlers or victims of violence with no other livelihood assets (Chakravarty et al., 2012; de Wasseige et al., 2012; Nasi et al., 2008). Therefore, growing evidence confirms that the most renowned cause of deforestation is slash and burn agricultural activities in which many small farmers cut small portions of forest for crop production and later on shift to a new forest portion when the fertility drops (Brown and Sonwa, 2015; Chakravarty et al., 2012). Artisanal logging is another important cause of deforestation because trees are cut indiscriminately and no maintenance or replacement is done to restore the forest, neither is there any payment for environmental services (Brown and Sonwa, 2015; Sonwa et al., 2012). Other causes include grazing, infrastructural development,

demographic trends, economic decisions, technological change, charcoal burning and cultural factors (de Wasseige et al., 2014; Chakravarty et al., 2012; Nasi et al., 2008).

Further, the cutting down of trees will lead to biodiversity and habitat loss for some wildlife species that may help with seed dispersal and pollination (de Wasseige et al., 2012; Nasi et al., 2008). This comes along with a reduction in wild foods and other naturally existing species (Powell et al., 2011). Annual economic losses due to the destruction of tropical forests amounts to a loss in forest capital valued at US $ 45 billion (Hansen, 1997). This is the value of all potential future revenues from forest products and employment. By this, forest dependent poor lose important sources of revenue that would have been used for the purchase of supplemental foods like meat, poultry and oil (Angelsen et al., 2014; Arnold et al., 2011; Powell et al., 2011). Other social consequences of deforestation are the destruction of the social institutions of indigenous people and modification in their lifestyles (Freudenthal et al., 2011; Nasi et al., 2008). Putting all these factors together, the consequences of deforestation on food security include: crop failure, low yield, inadaptability of existing crops to changing environmental conditions, loss of forest foods, loss of revenue and change of dietary patterns which leads to household hunger (Ickowitz et al., 2014; Leakey et al., 2012; Arnold et al., 2011).

1.1.2. Undernourishment and FIS in Cameroon

The terms “undernourishment” and “hunger” have been interpreted as referring to a continued inability to obtain enough food, that is, a quantity of food energy sufficient to conduct a healthy and active life. Malnutrition is a consequence and cause of hidden hunger which refers to vitamin, mineral or micronutrient deficiencies (Ganry, 2013; FAO et al., 2012). An individual who suffers from hidden hunger is malnourished, but may not sense hunger. Investing in the reduction of micronutrient deficiencies, for example, would result in better health, fewer child deaths and increased future earnings, with a benefit-to-cost ratio of almost 13 to 1 (FAO, 2013). The causes of malnutrition are complex and multidimensional. First, is the inadequate availability of and access to safe, diverse and nutritious food (Scaling Up Nutrition (SUN), 2010; Pinstrup-Anderson , 2009), especially micronutrient rich foods like fruit and vegetables (Agudo, 2005; Ruel et al., 2005). Next, is the gap between food security policies and nutritional programs.

Micronutrient deficiencies as a global health problem, affects about two billion people and occurs in people who are overweight or obese (FAO, 2013; Leão and dos Santos, 2012). The multiple types of malnutrition are becoming a significant global concern wherein underweight and nutrient deficiency co-exist in the same population alongside overweight, obesity and other associated diseases (FAO, 2013; Leão and dos Santos, 2012; SUN, 2010). The costs of under nutrition and micronutrient deficiency are estimated at 2 - 3% of global GDP, equivalent to US$ 1.4 - 2.1 trillion per year (FAO, 2013). Childhood malnutrition is a cause of death for more than 2.5 million children every year (FAO et al., 2012).

Cameroon is among the 36 countries in the world with the largest number of children under five years suffering from stunted growth (SUN, 2014). Nearly 33% of children under five suffer from stunting: equivalent to approximately one million children (INS, 2011, Socpa et al., 2008). Of this, 37 % were observed in the eastern region and 33 % in the southern region (INS, 2011). It was also reported that up to 40 % of children under the age of five years in forest areas suffered from severe malnutrition and 63 % of these children suffer from anaemia (OCHA, 2015; INS, 2011). Generally, six out of ten children are anaemic due to iron deficiency (Sneyd, 2013; Germaine et al., 2011). The prevalence of acute malnutrition is 6% across the country and reaches 10% in the North and Far North regions (SUN, 2014; Tanya et al., 2011). These statistics suggest that micronutrient deficiency is a food security phenomenon that affects most of Cameroon, including forest areas, which are reported to be agriculturally suitable environments (Tata et al., 2014). Tanya et al. (2011) and Georgius et al. (1993) had earlier reported that the diets of the forest people are imbalanced consisting of mainly monotonous carbohydrates based diets. Such contradictions suggest that micronutrient deficiency in forest areas maybe resulting from poor use of existing foods products and lack of knowledge on nutritious foods, which needs investigation. Furthermore, in Cameroon, deforestation affects households' ability to access and use food all year round. This is through direct loss of some food tree species like fruit trees (FT), soil depletion that leads to declining yields and global environmental change that leads to inadaptability of conventional crop varieties to new climatic situations (Edoum et al., 2011; Germaine et al., 2011; Robiglio et al., 2010; Duguma, 2001; Georgius et al., 1993).

The most direct way in which forests and trees contribute to food security is through contributions to diets and nutrition and increasing crop yields in agroforestry systems (Asaah et

al., 2011; Goenster et al., 2011). Plants and animals found in forests provide important nutrient-rich supplements for rural households. They add variety to diets and improve the taste and palatability of staples. Forest foods often form a small but critical part of otherwise bland and nutritionally poor diets (FAO, 2013; van-Wyk, 2005). Deforestation is not a direct cause of FIS. However, the effects of forest disappearance can be severe on FIS. Many studies have demonstrated the importance of fruit for improved diets and nutrition in human populations (Tatry et al., 2011; Braun and Venter 2008; Lock et al., 2005). WHO (2003) recommended that individuals need a daily intake of 400 g of fruit and vegetables to maintain a healthy life. It has been estimated that increased availability, accessibility and adequate fruit consumption would decrease the worldwide non-communicable disease burden by almost 2%, while 2.7 million lives could be saved each year (Lock et al., 2005). Drewnowski (2005), in analysing the concept of a nutritious food, describes energy-rich or nutrient-poor foods as food that did not contain a fruit food item. Further to this, nutrient-dense food is that which encompasses grains, vegetables, fruit, meats and dairy products. Other studies have gone beyond the simple recommendation of fruit as part of a nutritious diet and evaluated peoples' knowledge of daily serving requirements and consumption (Grutzmacher and Gross, 2011; Tatry et al., 2011; Braun and Venter, 2008). A diverse and balanced diet contains a range of nutrients. Kehlenbeck and McMullin (2015) note that "fruit deliver important nutrients for healthy and strong bodies such as Vitamins A, C and B6. Vitamin A is for healthy eyes and good vision, vitamin C provides general good health and reduces illness such as colds and vitamin B6 is good for pregnant women and young children for healthy development". According to the World Health Organisation (WHO), mortality and morbidity are among the top 10 global risk factors from inappropriate fruit consumption (WHO 2003).

The importance of fruits tree including indegeneous fruits trees has been articulated in many studies of Africa and in other forest communities in the World (Beydoun and Wang, 2008; Lock et al., 2005; WHO, 2003). Beydoun and Wang (2008) recommended that increasing consumer awareness of the recommended daily intake of fruit for good health is a priority, because knowledge of fruit availability, accessibility as well the recommended intake would, in part, determine an individual's ability to assess the adequacy of his or her current consumption and need for change. However, the novelty in this research is that it has investigated people's knowledge and the link between deforestation gradient and the nutritional

values/importance of fruits to the wellbeing of people beyond issues of safety nets. It capitalises on fruit from trees because, once planted, they can serve many generations and can be easily gathered and consumed by children (Agea, 2011; Angelsen et al., 2011; FAO, 2011; Ganry, 2009; Ambe, 2001). Furthermore, in Cameroon, forested areas have been reported to harbour numerous fruit from indigenous trees (Ingram and Schure, 2010; Degrande et al., 2006; Matig et al., 2006). All these studies have assumed that these FTs contribute to the livelihoods of households through home consumption and income generation. However, none of these studies have researched the FIS access experience of households in forest areas, linking it up with FT diversity, fruit availability and consumption frequencies, and increasing rate of deforestation. Furthermore, households' awareness on the importance of fruit consumption and knowledge on the actual and recommended intake of fruit for better nutrition has never been studied. This is the focus of this thesis.

1.2. Aim and objectives

The aim of this research was to investigate strategies for addressing household FIS through the supply and consumption of fruit from trees in the context of deforestation in Cameroon. The objective was to analyse daily practices that enable or constrain the contribution of fruit from trees to assist households to deal with FIS in the context of deforestation in Cameroon.

To achieve this objective, the research was structured around four components:

1. Household FIS access in the context of deforestation in Cameroon

The aim was to quantify the extent and intensity of household FIS access experiences (Coates et al., 2007) along a deforestation gradient and demonstrates the degree to which households may be vulnerable to the effects of FIS. The objectives were to:

- Explore household parameters and experience of FIS;
- Measure the prevalence of FIS using the household food insecurity access scale (HFIAS) approach; and
- Determine the severity of FIS access.

2. A survey on fruit and fruit tree diversity and management along a deforestation gradient in Cameroon

This chapter sought to analyse FT planting (nurturing) and management activities to assess the main problems faced by farmers at the local level.

The objectives of this chapter were therefore to:

- Examine FT ownership and diversity in the face of increasing deforestation;
- Explore the level of awareness of local communities on FT planting (nurturing) and management activities;
- Investigate the factors that influence farmers' capacity to plant and maintain more FTs in their fields and home garden.

3. Households' awareness of the importance of fruit consumption in the context of deforestation in Cameroon

In this chapter, I seek to investigate local factors that determine access to and consumption of fruits from planted and wild sources relative to different levels of deforestation. The objective of this study was to investigate households' access mechanisms to a variety of fruits and their awareness on the importance of fruit consumption. Specific aims were to:

- Survey households' access mechanisms to a variety of fruits along a deforestation gradient;
- Analyse fruit consumption patterns and local perceptions of wild and planted fruits;
- Investigate the awareness on the expected frequency and importance of fruit consumption.

4. The availability, accessibility, utilisation and stability factors affecting the intake of fruit from trees in forest areas in Cameroon

The aim of this chapter was to examine food security through an analysis of the factors that affect the sources, acquisition and intake of fruit from trees as deforestation increases. The objectives were to:

- Survey the factors that affect fruit availability;
- Analyse fruit acquisition mechanisms along a deforestation gradient;
- Investigate the present frequency of fruit consumption as deforestation increases; and
- Research the impact of fruit accessibility, availability, utilisation and stability on fruit intake with increasing deforestation.

1.3. Conceptual framework

As reported earlier, Cameroon is among the 36 countries in the world with the largest number of children under five suffering from stunted growth (SUN, 2014). Scenarios on food deprivation and dietary adequacy suggest that malnutrition and food insecurity is more than just having food and thus requires more in-depth investigation into the diversity and use of food items, knowledge about foods and dietary practices and habits (Germaine et al., 2011; Tanya et al., 2011; Dindyal and Dindyal, 2003; Georgius et al., 1993). Fruit are of particular importance in this context because fruit are naturally occurring foods and therefore could contribute in enhancing the food security situation in Cameroon in a nutritionally safe way (Stadlmayr et al., 2013; Tchoundjeu et al., 2012; van Dijk, 1999). They are derived from various spaces ranging from natural forests to home gardens (Tchoundjeu et al., 2012; Asaah et al., 2011; Degrande et al., 2006). The linkages from food system (agriculture and food security) activities to nutritional outcomes are often indirect (Figure 1.1.). Food system policies and interventions are rarely designed with nutrition as their primary objective, so impacts can be difficult to trace and thus, food system interventions are frequently ineffective in reducing malnutrition (FAO, 2013).

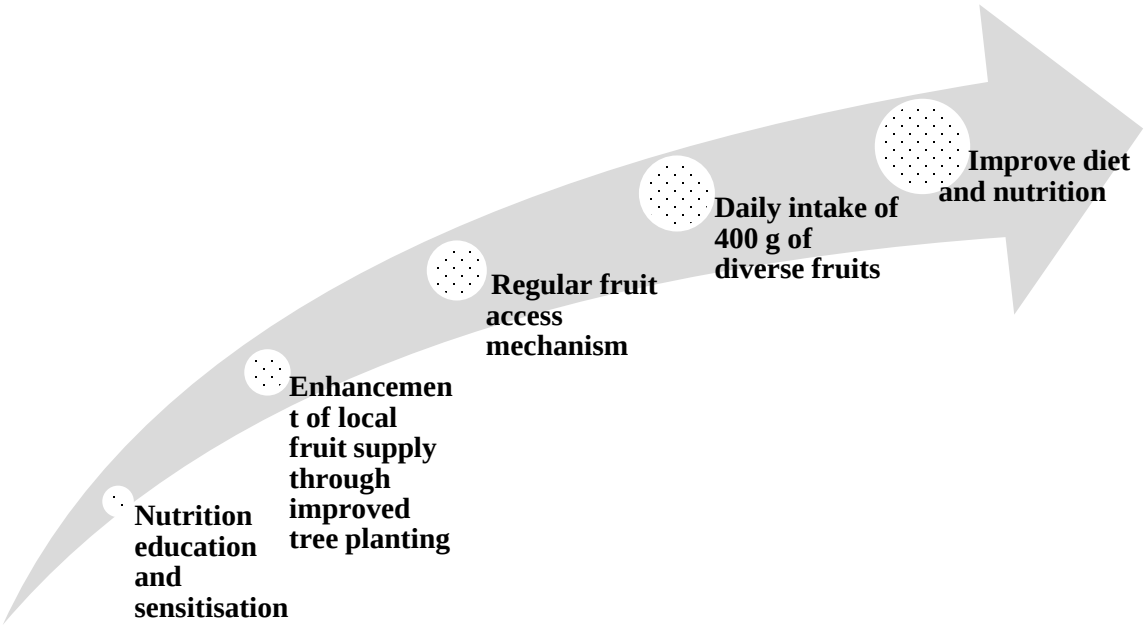

Figure 1.1: Conceptual framework for enhancing nutritional security throughfruits from trees

Figure 1.1. proposes a pathway to offset the situation by the use of wild and planted fruit species. This starts with the need for increase sensitisation on the importance of daily consumption of fruit. Obviously increased consumption require increased supply which can be guaranteed through improved fruit tree planting of diverse species adaptable to new climatic conditions and management of existing ones in farmers' fields as already practiced (Leakey, 2012; Asaah et al., 2011). Bharucha and Pretty (2010) note that during the process of slash and burn agriculture, cultivators have often nurtured trees of value, including fruit trees. Increased local availability will enable improved accessibility since in local areas, people acquire fruit through gathering and harvesting from the wild (Termote et al., 2012; Flyman and Afolayan, 2006; Shackleton and Shackleton, 2004). As well, fruit trees are often found in many landscapes and farming systems from home gardens (Jamnadass et al., 2011; Goenster et al., 2011; Shackleton et al., 2008) to distant fields (Tchoundjeu et al., 2010) and intact or semi intact forests (Viviany et al., 2013; Akais et al., 2011; Degrande et al., 2006). Generally, many poor farmers lack effective methods to achieve and maintain stable fruit production from year to year (Smith and Samach, 2013). There is further need to accompany fruit tree planting with studies on harvesting and intake of fruit from trees to ensure that daily consumption quantities and frequencies are attained. Therefore, farmers should be monitored to make sure that they respect the expected daily intake of 400 g of fruit per person per day which will lead to better nutritional outcome for the population (Ganry, 2013; WCRF, 2007; WHO, 2003).

Overall, this schematisation from nutrition education to fruit intake does not exclude the contribution of other food products. It rather supposes that people in forest areas are already used to and are consuming carbohydrates, which need to be supplemented by a wide range of fruit to ensure improved diet and nutrition. This study justifies the weaknesses in fruit consumption. It develops clarity on the interaction between nutritional outcome and deforestation and shows the gaps in knowledge on fruit consumption within local communities.

1.4. Contribution of this research to existing knowledge and policies

This study is complementary to existing results on fruit food chemistry, domestication, inventory etc. done by IRAD/ICRAF (IRAD, 2013; Tchoundjeu et al., 2012; Asaah et al., 2011) and many other institutions. Nevertheless, what was lacking is the verification as to

whether effectively the long term objectives of this fundamental research are being attained in providing sustainable nutrient rich foods to rural communities and improving on local livelihoods. The results of this study will compliment on-going government initiatives on the fight against malnutrition and FIS in Cameroon. Now, Cameroon has engaged in serious food security and nutrition campaigns: For example, in 2007, the national food security program (Programme National de Sécurité Alimentaire (PNSA) was created although it only went operational in 2012. It includes a support component for production and nutrition education to raise awareness of the consumption of food with a high nutritional value, education and scientific research, rural development, social protection, and poverty reduction/growth stimulation. Additionally, Cameroon established a national nutrition task force in 2008 and has a food security and nutrition department in the Ministry of Health. Further, an inter-departmental committee for food security was created in 2009, comprising 19 ministries and chaired by the Secretary General of the Prime Minister's Office. Its mission is to develop policy and strategy for food security actions and the implementation of the PNSA. More recently, on 18 February 2013, the Republic of Cameroon joined the Scaling Up Nutrition (SUN) Movement with a letter of commitment from The Minister of Public Health in Cameroon. In 2014, a national program for the fight against malnutrition in Cameroon was created which emphasises schoolchildren feeding programs, specifically for girl children in the three northern provinces.

All these processes are barely in the initiation phase and focus more on the three northern provinces. Meanwhile the population of the forest area will continue to replicate the food insecurity experience existing at the moment. Data from this study will first inform policy-makers' regarding the situation of food security in forest areas with increasing deforestation and provide practical pathways to address the problems. Most often, the approach used in these situations is food aid (SUN, 2014; Tanya et al., 2011). However, food aid has its limitations because once it stops households will fall back into a more complex situation of FIS (Leão and dos Santos, 2012; Loek and Maxwell, 2011). This research proposes practical steps that can be used to help people to be self-reliant towards ensuring their food security. The experience from this research could be replicated in the three northern provinces and results used to build a more sustainable approach to addressing problems of food security.

The WHO recommendation on daily intake of fruit and the required quantity is not yet being applied in Cameroon. Results from this study will bring evidence to the fact that people are not aware of this and are thus, not respecting it. Therefore, it will stimulate government to engage new policies to promote this recommendation and design sensitisation and advocacy programs towards this. Leakey (2014) has developed a tool that could be used for the achievement of food security through a three-step generic model comprising of twelve principles which could serve a valuable tool for valorisation of fruit trees.

1.5. Presentation of this thesis

The structure of this thesis follows the structure proposed by Bryman (2012). The thesis is structured into three parts and seven chapters. The first part, which comprises Chapters 1 and 2 is the introductory part. The second part presents with four results chapters, while the last part presents a general conclusion and recommendations. While the list of references goes along with each chapter, a general abstract, acknowledgements, list of abbreviations, table of contents, list of figures and list of tables were presented at the beginning of this thesis. The rest of the thesis is arranged as below.

The first part begins with an introductory chapter that presents the background of the study together with the aims and objectives. Next, the contribution of this research to existing knowledge and policies was presented bringing out major advances in addressing food insecurity in Cameroon and existing gaps. It then moved over to defining key concepts. This emphasised food security and its five pillars (food availability, food accessibility, food utilisation, vulnerability/stability, nutritional aspect of food), food insecurity, hidden hunger, nutrition security, nutritional status, undernourishment, malnutrition, forest, deforestation and nutrients. This chapter culminates with a presentation of the ethics respected during the execution of this research. Chapter 2 presents the study area and major changes and trends within the study area. It examines national indicators that affect food security, including demographic parameters, health, education, agriculture, dietary practices and institutions. The next part of Chapter 2 examines site selection and sampling approaches used for the research. This is followed by a presentation of the overall research methods used for data collection and analysis. Detailed research methods are presented within each chapter.

The second section of this thesis is the results section. The third chapter and first results chapter presents a baseline situation of food insecurity access experience in the study area. It was captioned household FIS access in the context of deforestation in Cameroon. The main aim was to quantify the extent and intensity of household FIS access experiences along a deforestation continuum and demonstrate the degree to which households may be vulnerable to the effects of FIS. The fourth chapter dwells on a survey on fruit tree diversity for improved fruit supply in forest areas of Cameroon along a deforestation gradient. The aim of this chapter was to inventory fruit trees available on the local landscape and develop strategies to stimulate local fruit supply for increase home consumption in the context of deforestation in Cameroon. The fifth chapter is on households' awareness on the importance of fruit consumption in the context of deforestation in Cameroon. It investigated local scenarios that determine access to and consumption of fruit from planted and wild sources while testing the impact of the different levels of deforestation. The sixth chapter examined the availability, accessibility, utilisation and stability factors affecting the intake of fruit from trees in forest areas in Cameroon: The aim of this chapter was to analyse how fruit can durably contribute to improved diet and nutrition by examining the four pillars of food security as deforestation increases.

Finally, the third and last part of this thesis and the seventh chapter is a section on general conclusion and recommendations. It presents advances in the use of fruit for security as the results of this research and way forward.

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CHAPTER 2

STUDY AREA AND RESEARCH METHODOLOGY

Doing interviews in Akomnyada village

2.1. Geographic and physical characteristics of Cameroon

2.1.1. Physical characteristics

Cameroon is a Central African country situated in the Gulf of Guinea with a surface area of approximately 475 650 km² of which 9 600 km² is water (de Wasseige et al., 2009). It lies on the west-central coast of Africa between latitudes 2° and 13° N (about 1 200 km) and longitudes 8° 30´and 16° 10´ E and for the most part between 200 and 800 m above sea-level. Often described as 'Africa in miniature', it is culturally highly heterogeneous with approximately 250 ethnic groups. With French and English as official languages, Cameroon is bordered to the west by Nigeria, to the north by Chad, to the east by Central African Republic and to the south by Equatorial Guinea, Gabon and the Republic of Congo. It is divided into 10 administrative regions, 58 divisions and 349 sub-divisions (councils) (MINEPAT and INC, 2011).

According to Dkamela (2010), forest occupies between 33% and 54% of the national territory depending on the definition of forest. An alternative estimate shows that Cameroon contains 60% of forest of which 80% is exploitable forest (de Wasseige et al., 2009). It contains about 70 species of timber, 764 plant and 45 mammal species, excluding rodents (MINEF, 2003). It also has huge mining potential and vast water resources. Protected areas, which constitute part of the permanent forest domain, are grouped into several categories as 17 national parks; six wildlife reserves; one sanctuary of wildlife and two others in the making; three zoological gardens; 46 hunting grounds to lease out; and 22 hunting grounds under community management (MINEF, 2003). At local level, many council and community forests are being created to give the local population a possibility to legally access forest resources (MINFOF, 2009; MINEF, 2003). This gazetting raises a lot of debate following the expansion of mining activities, agricultural and other natural resource use industries, which increase the rate of deforestation especially in the Humid Forest Zone (HFZ) (Figure 2.1). Although buffer zones exist within most forest management units for agriculture and the harvesting and use of wild plants, local people still go into protected areas in search of required resources (MINFOF, 2005).

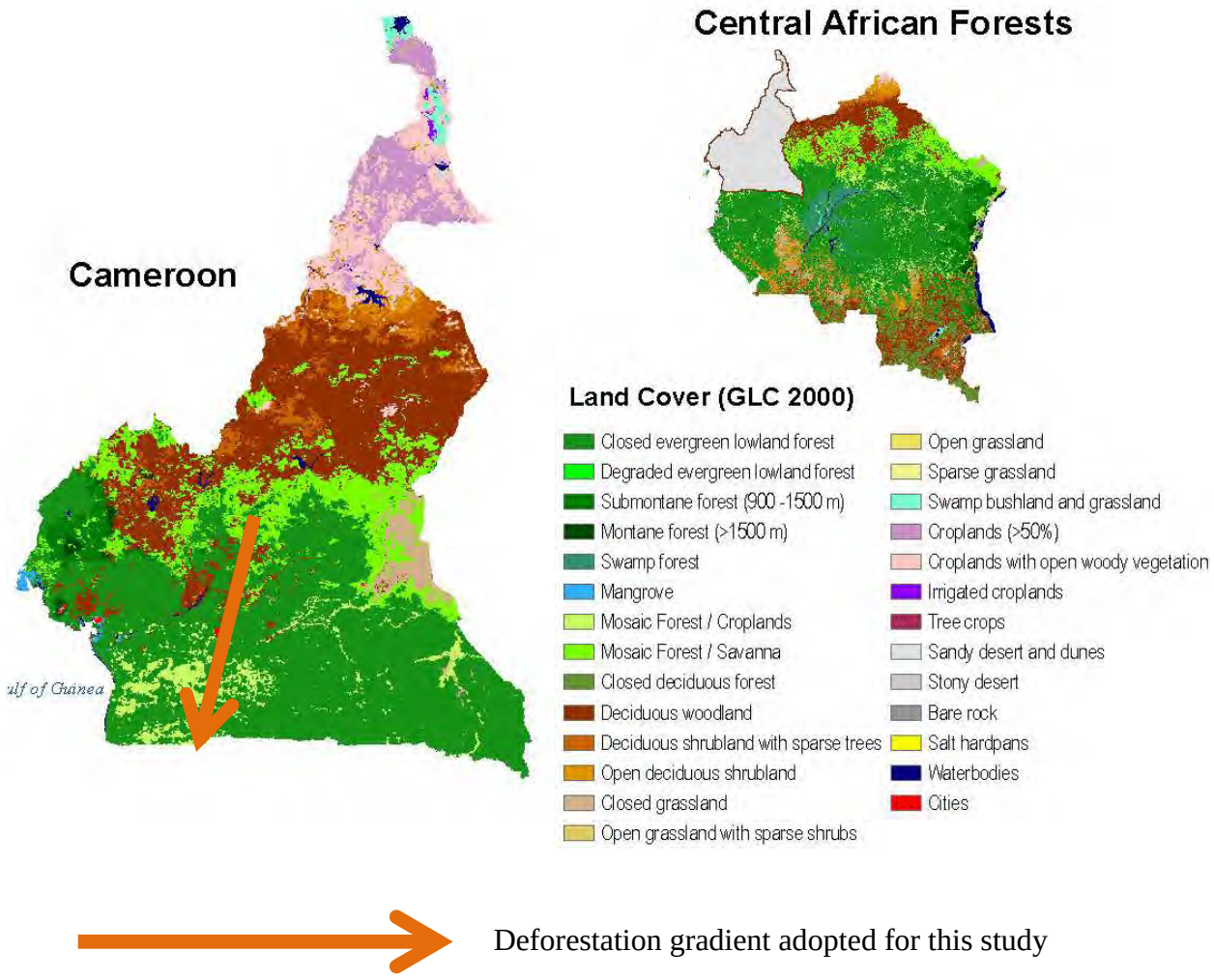

Figure 2.1: Cameroon in the Congo basin forest - Land cover map

(Source: Robiglio et al., 2010)

2.1.2. Agricultural landscape

Cameroon encompasses three main eco-regions of the sahel, the savanna and the forest regions. Considering at its agricultural potentials, Cameroon is a highly diverse country and has been divided into five agro-ecological zones (IRAD, 2013). Zone one is the Sahel zone and stretches across the Extreme North and North regions of the country. Zone two is the savanna zone, which covers the entire Adamawa region of Cameroon. The third and fourth zones are known for the high potential in agricultural production and have a unimodal rainfall pattern. Zone three, which is in the north-western part of the country, is mainly grassland and dominant

in food crop production, especially cereals, fruit and grains. The fourth zone is the Coastal and South-west region. It is a forest area and contains most of the agro-industries in the country. It is known for its production of roots and tubers, fruit, banana and plantains. Zone five is the biggest agro-ecological zone and has a bimodal rainfall pattern (two growing seasons, each one fitting in one rainy season (Bellassena and Gitz, 2008), with a large humid forest area and some mining areas. It covers the centre, south and eastern parts of the country. This makes zone five to serve as a hub to many forest exploitation and mining companies (MINEF, 2003).

This study area is located in the fifth agro-ecological zone, which also corresponds to the continental plateau that extends from Central Africa Republic to southern Cameroon. The climate is subequatorial with two rainy seasons (March - June and September - November) and two dry seasons. The average annual rainfall is between 1 600 to 2 000 mm, with annual mean temperature between 24°C and 25°C (IRAD, 2013; MINADER, 2010). The agro-ecological zone has huge potential for crop production, particularly cocoa, coffee, rubber, banana, plantain, yams cocoyam, millet, rice, maize, beans, and a host of non-timber forest products. (MINADER, 2010; FAO, 2009). Forest activities are also very intense in this zone. This study site follows a north-south deforestation gradient (Robiglio et al., 2010), and runs from Mbalmayo area in the Centre region to Ambam area in the South region (Figure 2.1).

Looking at the food basket of the study area, the rural communities depend mostly on starchy foods (MINADER, 2014; Georgius et al., 1993) for home consumption. The main staple food crops include: groundnuts, cassava, corn, cocoyam, beans, plantains, irish potatoes, bananas and yams. Vegetables grown include tomatoes, nightshade, anchia (*Solanum aethiopicum*), pepper (*Capsicum frutescens*), african eggplant (Garden egg (*Solanum macrocarpon*), okomobong (*Telfairia occidentalis*), okra (*Abelmoschus esculentus*), clove basil (messep (*Ocimum gratissimum*)), waterleaf (*Talinum fruticosum*), sweet potatoes leaves (*Ipomea batatas*), coco leaf (*Colocasia esculenta*), and nkenekene (*Jute mallow*). The main cash crops include coffee, cocoa, oilpalms, rubber and bananas (MINADER, 2014; Tata et al., 2014; Georgius et al., 1993). Fruit are also grown for consumption and as a source of income and include avocado pears, oranges, mangoes, pawpaw, pineapples, grapefruit and plums. Andobeti (*Irvingia gabonensis*), angokong/Engakom (*Marianthus arboreus*), akomNgoe (*Terminalia superba*), Bikwam (*Vitex doniana*) and Bison (*Aframomum spp.*) are some of the wild fruit harvested from the forest (see Chapters 4 and 5).

2.1.3. Demographic parameters

Since independence in 1960, Cameroon has had three general population censuses in April 1976, April 1987 and November 2005. The results of the 2005 census showed that expected population growth rate for 2015 would be 2.5% and the population was estimated to reach 21.9 million inhabitants (BUCREP, 2010). Men constitute 49.6% while women constitute 50.4%. Following the age structure, 43.7% of people were between the ages 0 - 14 years, 53.1% from 15 - 64 years and 3.3% were 65 years and above (INS, 2010a). According to MINPROFF (2013), the population density in 2010 was 37.5 inhabitants per km^2. The population will increase for all regions but will stabilise for the South West (SW) region around 2012-2015 and will decrease for West and North West regions during this same period. This shows that population disparities will continue to exist in Cameroon although these estimates did not take into consideration key policies like the decentralisation policy that when effectively applied, the trend of population growth in some regions may seriously slow down and even be reversed.

In 2005, the urbanisation rate was 48.8% (BUCREP, 2010). This high urbanisation rate in Cameroon is as a result of the notion of town. In November 2005, 312 towns were numbered of which only two were not administrative head-quarters - Mutengene town in the SW region and Lara in the Extreme North (EN) region. The notion of town led to the mode of life, a particular architecture and the presence of economic production units which give the active population opportunities to exercise professional activities in the tertiary and/or secondary sectors. Although the growth rate is declining, it is around 2.1% which is still high and the population will reach 34 million inhabitants by 2035. The most populated region with more than two million inhabitants each in order of importance is the EN region (three million inhabitants), Centre region (three million inhabitants) and Littoral region (three million inhabitants) while the south region records less than one million inhabitants.

2.1.4. Employment opportunities

Labour and employment statistics in Cameroon are complex and vary depending on the source and purpose for which the data were generated. First, the informal sector is big and in some cases it is difficult to draw a line between the formal and the informal sector (ESS 1& 2). According to the international labour Organisation (ILO), the unemployment rate in Cameroon

was 4% in 2010. There is a slight drop as compared 4% observed in 2005. Women (5%) are more affected than men (3%). However, the underemployment rate is very high and stands around 71% (MINPROFF, 2013). According to ECAM 3 (INS, 2008), 43% of employed people are poor. Although poorly defined, the agricultural sector and the informal sector employ 92% of the active population compared to 8% in the public sector.

It is difficult to compute data on employment in Cameroon especially on farming and petty trading which is practiced by many households on equal terms as their full time jobs and therefore difficult to classify. Looking at the various categories of the population, farmers constitute 94% of households. About 22% of households living in urban areas were farmers (MINEPAT and UNDP, 2013). Theese urban farmers buy 34% of the food they consume in their households and, 57% is from their own production and the rest from gifts. Gift was in the form of food items, money to buy food or prepared food offered to individuals or households periodically through social relationships (families, friends..) and organisations (network of relationships). This means that the amount of food recived through gifts depends on the connectedness of a household. Their household expenditure level is low at < 12 000 FCFA (20USD) per month. Private sector employers constitute 13% of households with 86% in urban areas and high dependence on markets 93%. Average expenditure stands at 30 000 FCFA per person per month (INS, 2010b). On their part, traders make up 7% of households with 73% in urban areas. About 89% of food is bought with an average expenditure per household member per month of 24 000 FCFA. Public sector employers constitute 10% and 77% being urban (MINEPAT and UNDP, 2013; INS, 2008). They depend on markets for food products as they buy 92% of their food and spend > 30 000 FCFA per person per month. Petty jobs like drivers constitute 10% of households with 73% in urban areas and spend about 18 700 FCFA per person per month. Small traders make up 7% of households and 73% in urban areas. These traders depend on the market at 88%. These figures appear to overlap showing the crossing that proliferates in the employment sector in Cameroon.

Livestock breeders, natural resources exploiters and civil servants populations are more likely to eat acceptable diets (87%, 81% and 80%, respectively) than farmers, daily wage earners and small trader's population (72%, 70% and 76%, respectively). These later groups have small revenue earnings that are unstable and this puts them in very vulnerable and food insecure positions. Well-being index also affect the level of balanced food consumption. The

higher the income levels of households, the higher their level of acceptable food consumption (MINEPAT and UNDP, 2013; INS, 2011). Cameroon households use about 34% on average of total revenue to purchase food while 66% is used for non-food expenditure. Cereals, legumes, vegetables, fruit, meat/fish, sugar, milk, oil are the diverse dietary varieties purchased on field sites. Food processing is still very limited with a major processing industry being the beer industry. This is a major weakness in the food security policy in Cameroon (Edoum et al., 2011).

Markets for food crop and horticultural products are informal and operate at various scales. Much effort has been made by MINADER to promote group sales and organisation of agricultural markets, but these markets remain largely small scale, disorganised and self-motivated (MINADER, 2014). Urban areas, public spaces and roadsides are the main markets for agricultural products (Tata et al., 2014). Most marketing transactions of agricultural products are hampered by the lack of appropriate transportation equipment, unclear policy and legal framework, which leads to some extortion of product dealers, transporters and subsequently farmers by administrative authorities.

2.1.5. Wealth, incomes, poverty and food security

Locally, the average monthly income of the main job of the various members of the household is 83 700 FCFA at national level, 124 800 FCFA in urban areas and 55 600 FCFA in rural areas (INS, 2011b (ESS 1 data). The average monthly income ranges from 13 800 FCFA in the family agricultural sector to 145 400 FCFA in civil service with households heads working in the subsistence agriculture having the lowest income (39 900 FCFA) (INS 2011b (ESS 1 data). The average monthly income from the main job at the country level was 39 400 FCFA in 2010. This represents an increase in nominal value of 12 600 FCFA compared to 2005 reflecting some improvement in the income of the main job during this period. The informal sector (subsistence agriculture and informal private sector), which employs 92% of workers, has the lowest levels of pay. Most of the workers of family agriculture (84%) earn less than 28 500 FCFA monthly (Common wealth report 2013; INS 2011b).

According to ECAM 3 (INS, 2008) a household is poor when the adult income equivalent of the household is less than 738 FCFA per day or 22 454 FCFA per month (a threshold based on prices in the capital, Yaoundé). The severity of poverty and poverty line are

measured in Cameroon at the national and regional level disaggregating between gender, sector of activity, educational level, household size, location etc. On the socio-economic plan, the incidence of poverty decreases with increasing educational level of the family. The annual consumption expenditure per household measured in adult equivalent stands at 144 000 000 FCFA; meaning 439 787 FCFA per adult equivalent per year (Commonwealth report, 2013; INS, 2011b; INS, 2010b). There are high disparities in adult equivalent in budget consumption between regions, urban and rural areas and between gender. Other aspects of poverty are illustrated using data on education, health, gender, nutrition and employment.

2.1.6. Health and nutrition

Predominant diseases are malaria, diarrhoea, HIV, tuberculosis, and occasional cholera outbreaks (INS, 2011a). Tuberculosis incidence per 100 000 population was 190 in 2008 (INS, 2011a). Data on HIV/AIDS is not publicly reported probably because the disease is still attached to taboos and associated stigma. HIV/AIDS mortality rate per 100 000 people is 240 (WHO, 2010). Its prevalence is higher among women (7%) than men (4%) in all regions of the nation and more among the 15 - 49 age groups (INS and UNDP, 2008; MINSANTE, 2008). Cameroon's HIV/AIDS prevalence is 5.1% (Worldbank, 2013; INS, 2011a (EDS-MICS)). Data indicate that the less educated and poorest quota of the population are less infected than the more educated and economically stable population. Malaria is prevalent in about 50% of the national population on average with higher prevalence values of 61% observed in the South region (INS, 2011a (EDS-MICS)). Malaria incidence was most prevalent in the 0-14 age group (77%) compared to the 15-59 and 60+ age groups prevalence of 58% and 15%, respectively (INS, 2011a).

The percentage of women who receive prenatal care from skilled health personnel at the national level ranged from 63% - 85%, being higher in the regional capitals than in the divisional capitals. The Centre region had the highest percentage of women who had access to skilled health personnel. Both male and female life expectancy at birth is 53 years. Maternal mortality ratio per 100 000 live births ranges from 600-690 (WHO, 2010; INS and UNDP, 2008). National annual morbidity rate is 25%. The national under-five mortality per 1 000 ranges from 127-154 while the infant mortality rate per 1 000 is about 95. The main causes of

under-five mortality include malaria (19%), pneumonia (18%), diarrhoea (16%), and HIV/AIDS (5%) (INS, 2011a).

2.1.7. Food insecurity and malnutrition

Despite all political efforts put in place by the government to alleviate food insecurity and malnutrition, the country is still confronted by problems of nutritional security even in areas with good agricultural potentials. Malnutrition resulting from unbalanced and insufficient diets in proteins, carbohydrates and vitamins often translates to retarded growth and infectious diseases. Records show that 30% of under-five children are affected by chronic or moderate malnutrition, while 13% of these children are severely affected (WFP et al., 2011; INS and UNDP, 2008). Malnutrition rates of under-five children are higher in the rural areas (38%) than in the urban areas (21%) (WFP et al., 2011; Socpa et al., 2008). The number of children affected by retarded growth varies from 7% in urban areas to 17% in rural areas. Generally, the South and the Centre regions are amongst the most affected by malnutrition/retarded growth with levels of 36% and 15%, and 33% and 15% for moderate and severe malnutrition. Several major national programs to combat malnutrition exist including the Scaling Up Nutrition movement; the department of food and nutrition of the ministry of health; the national malnutrition program started in 2014; and the national food security program.

On major advances, Cameroon established a national nutrition task force in 2008 and has a food nutrition department in the ministry of health since 2011. An interdepartmental committee for food security was created in 2009, comprising 19 ministries and chaired by the Secretary General of the Prime Minister's office. Its mission is to develop policy and strategy for food security actions and the implementation of the National Food Security Program. Cameroon joined the Scaling Up Nutrition (SUN) Movement in March 2013. SUN consists of 55 countries that have committed to scaling up nutrition and working collectively as a movement. The movement unites people from governments, civil society, international NGOs, donors, businesses and researchers in a collective effort to improve nutrition. Within the SUN Movement, governments are prioritising efforts to address malnutrition (SUN, 2014). Since 2014, a national program for the fight against malnutrition is being set up with a special program for the distribution of food items to school children. The way forward now is to see how to make operational all these national initiatives.

2.1.8. Education and literacy

The percentage of school enrolment is higher in the urban areas than in the rural areas, and a pupil-teacher ratio higher in the rural communities than in the urban areas. Higher pupil teacher ratio in the rural communities translates in poorer quality of education. The pupil teacher ratio for the study sites ranges from 32 - 50 pupils per teacher. Primary enrolment rates for Cameroon range from 52% in the Extreme North region to 96% in the South region. The national average primary enrolment is 79.8%. On average national expenditure on education per household is 4.7%. An equivalent average of 47 490 FCFA is spent annually per child on education. The average distance to the nearest primary school is between 1.2 km and 1.7 km in the study area. Gender disparities in basic education have not improved since the 1990s. The disparity gap is wider moving up the educational ladder. This further translates to gender disparities in professional careers and the political arena. Secondary school enrolment rates are lower than for the primary level and follow the same trend of more boys enrolled than the girls. Lower completion rates occurred in the rural areas than the urban areas. The literacy rate of the younger generation, especially for children between 6 - 14 years, is higher than that of adults. The literacy rate of children 6 - 14 years ranges from 84% - 98%, while that of adult ranges from 73% - 89%. Adult literacy rates for urban areas (89%) were higher than that of its rural counterparts (59%).

2.2. Indicators on food and nutrition in the study area

The study area is located in the rural part of the forest area typified with monotonous carbohydrate based diets, poor housing infrastructure, lack of portable water, no local markets and bad roads (MINADER, 2014). Agricultural activities are oriented towards subsistence agriculture, characterised by a slash-and-burn system of cultivation and poor yields of staple crops (corn less than one t/ha, cassava less than 12 t/ha, plantain less than three to seven t/ha, peanuts 0.8 t/ha) (MINADER, 2014; Robiglio et al., 2010). The proportion of the population living below the poverty line is 29.3%. Most households have 1 - 2 carbohydrate-based meals per day with some vegetables at times but limited fruit consumption. Up to 45% of children (12 - 23 months) are malnourished and women account for up to 95% of local people involved in farming and sales of food crops. The small and scattered nature of the villages, long distances

to schools and lack of teachers account for very low rates of primary school attendance in villages - girls/boys parity index is 52 girls and 48 boys. This explains why most households prefer their children to school in urban centres while staying with relatives or by themselves in private accommodation. Therefore, children separate from their parents at very young ages and start living in cities thus promoting rural exodus. Additionally, children lack parental care, the family agricultural labour force is reduced, which leads to reduction in food production.

The average weaning age for babies is estimated at six months with extreme cases being two months and 16 months (INS, 2011a). The mortality rate of children under the age of five years is 15 per 1 000 and immunisation coverage rate is 85%. The proportion of births attended by skilled medical personnel is low at 43%, while HIV prevalence rate among the sexually active population (15 - 49 years) is 12%. Prevalence of malaria among women and children of 0 to 5 years is 76% and the percentage pregnant women that attend antenatal care are 26% (INS and UNDP, 2008; MINSANTE, 2008). Less than 30% of the population has access to drinking water and lighting.

2.3. Research Methodology

2.3.1. The study sites

This study was located in a forested area of the Humid Forest Zone (HFZ) of Cameroon. Although the southern part of Cameroon was once all forest, due to urbanisation, agricultural extension and logging (Robiglio et al., 2010; Ndoye and Kaimowitz, 2000), some parts of this area now contain less forest than others. This supposes that the use of foods and fruit from trees may differ from one area to another depending on the level of change in the forest area and/or the level of agricultural development and prevailing agroforestry system. Thus, the axis of vulnerability/stability was the deforestation gradient, which indicated the location of a household per level of forest cover. Robiglio et al. (2010) note that “deforestation is not a uniform process and depending on the way in which the direct and underlying factors that control land use change dynamics combine in a specific locality or region, dramatically different trends can be observed”. Accordingly, in this study, deforestation gradients were examined at two levels-between villages and at the level of the humid forest area following the north south direction as in Figure 2.2.

A two-stage stratified random sampling procedure was used for selecting deforestation zones and villages. At the first stage of the sampling, three levels of deforestation were established using results from Robiglio et al. (2010) on deforestation and forest degradation in the humid tropics forest areas in Cameroon (Figure 2.2).

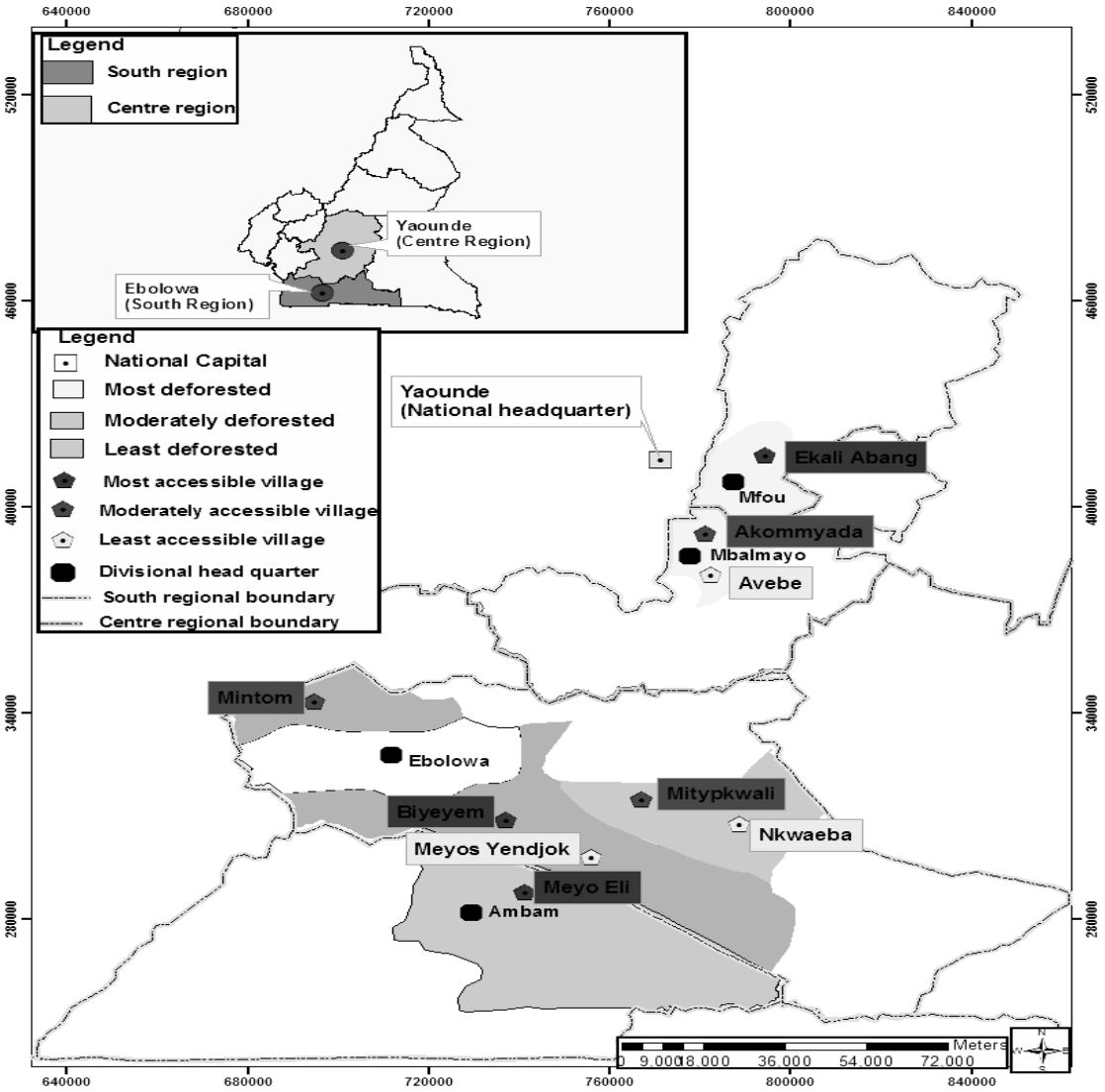

Figure 2.2: Location of study villages

The first stratum was the most deforested zone, which due to infrastructural development, population growth and urbanisation, has lost most of its forest. Here the canopy cover was less than 30% and old growth forest cover was less than 10%. The second stratum was the moderately deforested zone in which the forest is fast disappearing, although it still contains some patches of forest with average canopy cover of ± 50% and old growth forest

cover around 30%. Finally, was the least deforested zone with canopy cover of ±70% and old growth forest cover of more than 50%. Because this site still contains much forest, there are active forestry activities like logging companies and forest management operations going on there (Levang et al., 2015). The study area starts from around the capital city of Cameroon in Yaounde in the Centre region. This is the most deforested area. It passes through Ebolowa, the capital city of the South region which is moderately deforested zone and runs down to the Biwong-Bulu sub-division that is still forested with the presence of timber exploitation companies like "Fabrique camerounaise de parquets (FIPCAM), located also in the South region (Levang et al., 2015). This is the least deforested area.

2.3.2. Village selection and households sampling

Within each deforestation zone, a second stage of sampling was done to choose the villages. Sampling of villages used parameters such as level of road development including the state of roads, transportation possibilities, number of vehicles that ply the road, presence of a car loading point (Motor Park) and proximity to an urban area with easy transportation options like bikes. These criteria are important in determining the possibility of having a market for farm produce, either locally or in a neighbouring locality. These nine villages, classified into most accessible, moderately accessible and least accessible were located in two regions, five divisions and seven councils (Table 2.1). These administrative units also confirm the trend in the deforestation gradient induced by higher population and accessibility, with the most deforested areas having many more administrative units than the least deforested areas.

Three main ethnic groups were involved in the interviews including the Ewondo in the Centre region and in the most deforested site, the Bulu in the moderately deforested site around the Ebolowa area and the Ntumu in the forest site around the Ambam area. So far and from field interviews, nothing suggests that ethnic group would affect perception, attitudes or behaviour towards food insecurity and the contribution of fruit to food consumption patterns. Balloting following the purposive sampling approach (Bryman, 2012) was conducted to choose ±30 and ±15 households in each village for the first survey. This represented ±15% of households for the baseline survey and for the remaining three surveys, a subsample of ±7.5% of households was drawn. With nine villages, the total sample size generated was valid to run

statistical test. During village meetings and discussion with the village facilitator, efforts were made to select households from all parts of the village.

Table 2.1: Administrative units of the study villages

Region	Division	Deforestation level	Council	Village	Degree of village accessibility
Centre	Nyong et So	Most	Mbalmayo	Ekali-Abang	Most
				Akomnyada	Moderate
	Mefou et Afamba		Mfou	Avebe	Least
South	Mvila	Moderate	Efoulan	Biyeyem	Most
			Ebolowa II	Mintom	Moderate
				MeyosYedjok	Least
	Vallée du Ntem	Least	Ambam	Meyo-Elie	Most
	Mvila		Biwong-Bulu	Mitypkwali	Moderate
				Nkpwaeba	Least

The most vulnerable groups (female-headed households, households with women of child bearing age, large families (households with many people especially children), and households without a source of stable income (no cocoa farm, no pension or salaried job) were given priority while selecting households. This is because most households' heads from such categories hardly took part in village meetings or were neglected in listing of households. In all the villages after setting these criteria, it was observed that at least 50% of households fell within these categories therefore, after such categories of households were selected to make half of the sample size, the choice of the remaining households was randomised. Households were chosen just by a simple draw from a basket of names proposed by the village community leaders. When a community was found to have about 50 households, just half the sample size of 30 households was drawn from there i.e. 15 households and the rest of the sample was collected from the next closest community.

2.3.3. Research approach

This research was an applied and basic research design using triangulation of both qualitative and quantitative methods. The research was carried out through a multidisciplinary approach combining ethnobotanical methods, biodiversity and nutrition and food sciences. It was executed through nine village meetings, field discussions, participant observations and four surveys representing three research phases. This gave four rounds of field data collection

through interviews with 273, 141, 147 and 133 households, respectively, in nine villages (Figure 2.3).

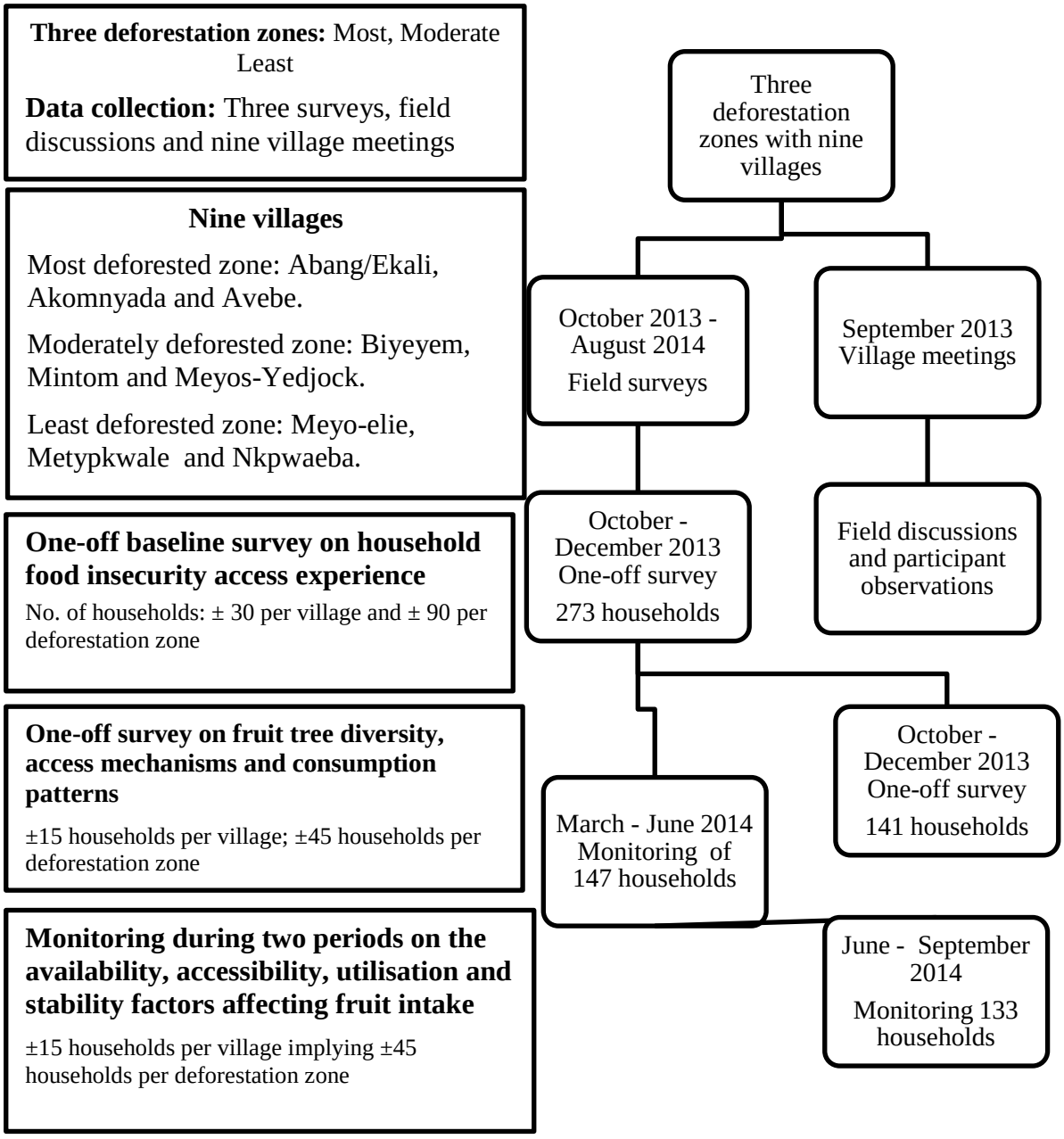

Figure 2.3: Research approach and sample sizes

During village meetings combined with field discussions and participant observation, the research team established a relationship with the field partners, identified and sampled households for field interviews, did a listing of local fruit types and discussed food consumption patterns. After this meeting, a baseline survey was executed on food insecurity

access experience using the household food insecurity access experience nine-item questions (see Chapter 3). This survey provided a state of the art on the situation of food insecurity and vulnerability of the population being studied.

This was immediately followed by another baseline survey on fruit tree diversity and fruit consumption patterns. Here, the aim was to appreciate daily practices and households' impressions and knowledge about the consumption of fruit. This is further elicited in Chapters 4 and 5. Last, were two rounds of monitoring on the processes that influenced the supply, acquisition and use of fruit during their various ripening season. This monitoring was done during two successive periods of March to May and June to September so that data on fruit ripening and consumption could be obtained for most fruits found and on a period of six months. The results of these two monitoring surveys are reported in Chapter 6. These data were collected in nine villages and three levels of deforestation as outlined on Figure 2.3, with a focus on fruit from trees.

2.3.4. Questionnaire preparation and data collection process

Three sets of questionnaires were developed. All the questionnaires had both open and close-ended questions as presented in the annexes and individual chapters. First was the questionnaire used for the baseline survey on food insecurity access experience, which was adapted from the FAO handbook by Coates et al. (2007). Second was the questionnaire used to evaluate fruit tree diversity and fruit consumption adapted from a questionnaire developed by the 'Fruiting Africa' project of ICRAF in Kenya. Last was a questionnaire to monitor for the availability, accessibility, utilisation and stability factors affecting the intake of fruit from trees in forest areas in Cameroon. This emerged from the field trends during the implementation of the first two questionnaires. These are schematised on Figure 2.2. All these data collection tools were prepared in English and translated into French, which was the main official language in the study area. All field activities were executed in the French language with field translation in the native language by the local facilitators hired during field work. Once the questionnaire was prepared, it was translated into French which was the language spoken the study areas. Three enumerators were recruited and trained at the Institute of Agricultural Research for Development (Institut de Recherche Agricole pour le Développement-IRAD). One enumerator had an advance level certificate and two a Bachelor's degree in sociology and two of the

enumerators were from the study area and thus understood the local language. After training of the enumerators, the questionnaire was tested in the Ngout community near Yaoundé. Comments were made and suggestions were proposed for the restructuring of some of the sections to ease the interview process.

The village meetings were organised before the start of questionnaire administration. They lasted between one and two hours. A guide was prepared for the meeting that carried basic information concerning the survey and the village. More importantly were general discussions regarding food consumption patterns, names of food items especially fruit using free listing and prompting by the research team. It ended with balloting to identify households to take part in the interviews. Immediately after, a group of interested persons were put together to clean and fine-tuned the names of fruit mentioned (see Chapters 4, 5 and 6). All field activities were complemented with transect walks, participant observations and field discussions.

During the months of October to December 2013, interviews were conducted following a stepwise approach. After the baseline survey on FIS in which ±30 households were selected, another sub-sample of ±15 households was drawn randomly and used for the survey on fruit tree diversity and consumption. This survey was done immediately after the baseline survey on the same population. Although it was intended to do the two surveys at the same time, it would have been too long and boring to the respondents. Thus, the interviews were done in two rounds. The same sample on the fruit tree diversity and consumption survey was retained for the two rounds of monitoring which were done in May and August 2014, respectively. In the case where the retained households were disinterested in the survey, they were either dropped out or replaced when it was possible.

For the FIS survey, data were collected using a recall period of one month. For the fruit tree diversity and consumption survey, the recall period was variable depending on the question, from one week, one month, last three months, last two to three years, etc. For the monitoring survey, the recall period was “during the last ripening season of the individual fruit type - referring to the last three months prior to the date of the interview”.

The questionnaires were administered to households with more than one household member present although one person had to respond to the questionnaire on behalf of the

household. This person was the one who decided on what to cook or the household head. Although a local interpreter was hired during the field exercise, questionnaires were administered in French. In cases were the respondent did not understand, they were assisted by their children who helped to interpret some of the questions and responses in the local language. However, this situation was not frequent. The approach of administering questionnaires with household members helped counteract problems of long recall periods and improve on data quality. Thus, during interviews, most responses provided by the main respondent were corroborated (contradicted) by other members of the household present. The interviewer was vigilant to some non-verbal signs like facial expressions by the other household members or statements made in the local dialect especially by children. These elements helped verify or check on the responses. In as much as this method was deemed more efficient, it was more time consuming than ordinary interviews.

2.3.5. Data entry and analysis

The questionnaires were examined and based on responses codes were created for all open questions and questions that contained ‘others’. These codes were entered into SPSS 17.0 in which the spreadsheet for data entry was prepared. Data analysis was done using statistical software of Excel 2013 for data cleaning and drawing of graphs. SPSS 20.0 was used for descriptive statistics, Chi-square test, multivariate test using the general linear model, means and simple ANOVA while XLSTAT was used for running principal component analysis (PCA). Graphpadprism 5 for one-way ANOVA, Kruskall-Wallis test, Friedman test, Two-way ANOVA and correlation tests. Data analysis started with an exploratory data analysis to check basic statistics using univariate and bivariate methods as well as measures of spread (Angelsen et al., 2011). All tests were carried out at the 95% confidence level.

In all, normality tests (D’agostino-Pearson and Shapiro-wilk) were used to see if the different data were spread along the Gaussian distribution to determine if parametric or non-parametric tests should be executed. Then, simple one-way ANOVA or ANOVA with matched observations were used for parametric data and Kruskall-Wallis or Friedman test were used for non-parametric data to show the variations of different variables in relation to the deforestation gradients and evaluate if some parameters could influence the occurrence or magnitude of different variables. Two-way ANOVA was used to evaluate simultaneously, the difference

between factor parameters (e.g. between deforestation gradient, fruit harvesting season and frequency of fruit consumption). Statistical analyses focused on the discriminating parameters across the three deforestation zones. Principal Component Analyses (PCA) was performed to epitomise respectively the villages, the deforestation gradients, the fruit location, the fruit seed source and all the type of fruit on a multifactorial plot. The multiple choice scale, the Likert scale of 1 to 5 representing 'agree to strongly disagree' was used to analyse opinion as regards specific topics. Citations were used to indicate the frequency of responses and measure the magnitude of importance attributed to each response (Ambe, 2001). This is the case for mentioned fruit per households. Descriptive statistics were used to illustrate graphically the information recorded on the field (histograms, circular diagram, cumulative histograms, pie chart, etc.). Correlation test using the Pearson coefficient were used to show the relation between two-by-two quantitative variables while Chi-square test was used to evaluate the link or relationship between two-by-two qualitative variables for instance deforestation gradient and months of food scarcity.

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CHAPTER 3

HOUSEHOLD FOOD INSECURITY ACCESS EXPERIENCE IN THE CONTEXT OF DEFORESTATION IN CAMEROON

Food stock in a household of seven people during the food abundant period. Photo by Tata P. September 2014

3.1. Introduction

In developing countries, food insecurity (FIS) coupled with the increasing rate of forest degradation and deforestation is one of the most burning challenges of the 21st century (Barrett, 2010; Webb et al., 2006). The 1948 Universal Declaration of Human Rights, the 1992 International Conference on Nutrition, the 1996 World Food Summit, the 2009 World Summit on Food Security and the 2012 report on the State of Undernourishment in the World all emphasised the critical need to decrease FIS and hunger globally and especially in sub-Saharan Africa. However, in developing countries, measuring FIS has remained a major problem, not just because of lack of human and financial resources, but also because of the need for suitable methodological approaches (Ballard et al., 2013; da Costa et al., 2013). Consequently, many definitions have been advocated to capture FIS more precisely. FIS exists whenever the availability of nutritionally adequate and safe foods or the ability to acquire such foods in socially acceptable ways is limited or uncertain (FAO et al., 2012; Sharafkhani et al., 2011). FIS may be chronic, seasonal or transitory (FAO et al., 2012). FIS applies to food-insecure households which include those with low food security and very low food security; the former being without hunger and the latter being with hunger (FAO et al., 2012; Sharafkhani et al., 2011).

FIS and malnutrition have often been viewed by policymakers as a problem of food availability (da Costa et al., 2013; Barrett, 2010). Gebbers and Adamchuk (2010) observed that policies to address issues of FIS and malnutrition should focus on modernising food production and agricultural technologies. Yet, as Barrett (2010) argues, agricultural intensification strategies are not necessarily the best means for providing greater food availability and therefore food access to households. This concurs with evidence from Eastern Asia, where, despite reductions in income poverty and increased food production, there are no signs of decreases in undernourishment rates since 2000 (FAO et al., 2012). It is also the situation in the forest area of Cameroon where environmental conditions are suitable for intensive and extensive agricultural production (Robiglio et al., 2010; Bellassena and Gitz, 2008), but it is notorious for inconsistent food supply and sporadic food shortages at the household level (Bellassena and Gitz, 2008; Socpa et al., 2008). Thus, having enough food available at national and local levels is necessary but not sufficient for ensuring that households have adequate

access to food (Barrett, 2010; da Costa et al., 2013). Reducing undernourishment is a key goal for most development agencies in recent times. Broad policy statements acknowledging reduction in FIS and hunger to attain the Millennium Development Goals (MDGs) by 2015 and the new Sustainable Development Goals (SDG) by 2030 are being made. However, evidence shows that FIS will continue to rise in Africa over the next several years (FAO, 2013) if actions are not taken to effectively target the most vulnerable populations. Thus, Barret (2010) notes that "effective direct food security interventions depend on effective targeting of the vulnerable sub populations and of the causes of FIS". This is the rationale of this chapter.

Forests constitute an important source of food for many forest dependent, poor households (Boedecker et al., 2014; de Wasseige et al., 2012; Bellassena and Gitz, 2008). Deforestation that accelerates climate change and failure in agricultural production (Robiglio et al., 2010; Bellassena and Gitz, 2008), coupled with nation-wide poverty, can lead to FIS (Sneyd, 2013). Serious consequences of FIS are undernourishment and malnutrition. Malnutrition in all its forms (undernutrition, micronutrient deficiencies, and overweight and obesity) imposes unacceptably high economic and social costs on countries at all income levels (FAO, 2013). FAO et al. (2012) estimates that 868 million people in the world are food insecure, representing around one-sixth of the world's population. Childhood malnutrition is a cause of death for more than 2.5 million children every year (FAO et al., 2012). Micronutrient deficiencies as a global health problem affect about two billion people and also occur in people who are overweight or obese (FAO, 2013; Leão and dos Santos, 2012).

Food security and nutrition analyses have been dominated by the study of specific nutrients, nutrient deficiencies, and sometimes specific foods or food groups and their impact on health and nutrition (Johnston et al., 2014); which are expensive and complicated to interpret. Coates et al. (2006) hypothesised that there are three levels of the household FIS experience. First are core domains that are the deepest structure of the universal FIS experience, which appear pertinent across all cultures and include issues like inadequate quality. Second, are the subdomains that may be of common concern across most, but possibly not all cultures, for example lack of dietary diversity. Last is the superficial level of expression of FIS specific questions and statements that form items in a questionnaire. This is the expression of subdomains using culturally relevant examples and language and will likely differ according to cultural and environmental specific characteristics such as preferences and

dietary practices (Johnson et al., 2014; McGarry and Shackleton, 2009). FIS assessment in developing countries is often ad hoc and limited in scale, resulting in misleading efforts in targeting and assessing FIS, especially in rural communities (Johnston et al., 2014; Deitchler et al., 2011; Sharafkhani et al., 2011; McGarry and Shackleton, 2009; Webb et al., 2006). This is even more pronounced in remote communities with poor infrastructural development and social services (Cordeiro et al., 2012; Kamgaing and Fotio, 2011; Loek and Maxwell, 2011).

With growing interest in FIS and malnutrition, policy-makers in developing countries need measurement methods that are cheap, simple to use and easy to analyse and interpret. To that end, FANTA and its partners (Coates et al., 2007) identified a set of Household Food Insecurity Access Scale (HFIAS) generic questions that have been used in several countries and appear to distinguish the food secure from the insecure households within different cultural contexts (Ballard et al., 2013; Swindale and Bilinsky, 2006). These previous studies have formulated and verified the applicability of the nine items in the form of questions to evaluate households' perceptions on food access over a recall period of one month (30 days). Each question had two parts; the first part verified whether or not the phenomena occurred, the second part investigated the frequency-of-occurrence in the month, which ranged from never (0 times), rarely (1 - 2 times), sometimes (3 - 10 times), and often (more than 10 times). Adapting and integrating these questions in a food security survey, four main measures are established to qualify the existence and severity of household FIS access. First, the measure of whether or not the phenomenon occurred and the frequency-of-occurrence define the condition of household FIS which simply indicates the percentage of households experiencing specific items during the month. The second part of each of the nine questions, verifies specific domains of households which range from mild FIS (meaning people simply worried about how to procure food) to severe FIS during which people start experiencing hunger. These are tagged as the domains of household FIS. Thirdly, the frequencies of occurrence are summed together to define the FIS access scale which is a continuous score that indicates the severity of FIS in a household or a population. This scale ranges between 0 and 27, and the higher the score the more food insecure the household or the population being assessed. The average of these points for all households put together is the HFIAS score. Finally, using cut-off points, households or populations are further assigned along a continuum of severity, the prevalence of FIS access,

which classifies households into food secure, mildly food insecure, moderately food insecure and severely food insecure.

The HFIAS questionnaire is designed to capture information on the prevalence of household FIS access (Coates et al., 2007). This can be used for geographic targeting (Ballard et al., 2013, Coates et al., 2006), including the location of households and to detect changes in the household FIS access situation over time (Johnston et al., 2014; Deitchler et al., 2011; Sharafkhani et al., 2011), e.g. for monitoring and evaluation (Cordeiro et al., 2012; Kamgaing and Fotio, 2011; Loek and Maxwell, 2011). The HFIAS approach (Coates et al., 2006; Swindale and Bilinsky, 2006) also depicts the underlying conditions or behaviours of households facing FIS and classifies households into domains of inadequate household food access (Coates et al., 2007). These range from being food secure through to worrying about how to procure sufficient quantities and varieties of food, compromising on quality and variety, reducing quantities and skipping meals and experiencing hunger at the household level and at the community level.

Most food security intervention programs in developing countries do not take into account social factors like peoples' tastes, preferences and styles of food utilisation (McGarry and Shackleton, 2009; Socpa et al., 2008). Operational agencies therefore lack a basis for differentiating households of varying degrees of FIS to target and evaluate their interventions (Webb et al., 2006). FIS is a multifaceted concept with varying dimensions. FIS assessment using the HFIAS measurement approach has been criticised for being subjective (Johnston et al., 2014; Deitchler et al., 2011). However, it is important because it gives respondents the chance to express the way they perceive certain aspects of their welfare, especially in developing countries where record keeping and data are scarce and social facilities are limited (Coates et al., 2007). Thus, in this way, development will not only be based on measures like income or consumption but also on social indicators (Ballard et al., 2013). The southern part of Cameroon is assumed to be a food self-sufficient area because of the suitability of the bio-climatic environment for agricultural production (Robiglio et al., 2010) and other food products from the wild (Ingram and Schure, 2010). Yet, I hypothesise that even after harvest and with additional income from cocoa activities, as deforestation increases, rural households become more vulnerable to FIS and subsequent land degradation.

The main purpose of this chapter was to appraise the extent to which with increasing deforestation, households were able to maintain food access throughout the year by assessing their food security status shortly after the main harvesting season and at the peak of the cocoa harvesting period. The objective was to understand the characteristics, prevalence and severity of household FIS access as deforestation increases. This chapter (i) explored household parameters and experience of FIS, (ii) measured the prevalence of FIS using the HFIAS approach and (iii) determined the severity of FIS. The chapter aimed to quantify the extent and intensity of household FIS experience along a deforestation continuum and demonstrate the degree to which households could be vulnerable to the effects of FIS.

3.2. Study area and research methodology

3.2.1. Preamble

Two assumptions were made in this study. First, was that the timing of the survey, which was (i) at a period immediately after the main harvest, when the majority of households were likely to have a reasonable access to stored food (da Costa et al., 2013) and (ii) during the peak of the cocoa season, when people usually had money from cocoa sales or as payment from hired labour for harvesting cocoa or post-harvest operations. Many studies have suggested that after the main harvest, households should have available stock of stored food like groundnuts and maize in their barns and roots and tubers on their farms to enable them have adequate access to sufficient food (da Costa et al., 2013; Sneyd, 2013; Sharafkhani et al., 2011; Robiglio et al., 2010). The second assumption is that, accessibility to food from other sources does not compensate the potential food access lost through the effects of deforestation and therefore I expected households become more food insecure with increasing deforestation.

The study area has been described in Chapter 2. This section dwells on the method of data collection and analysis.

3.2.2. The HFIAS methodology on household FIS measurement

The HFIAS 9-item questionnaire for measuring experience based FIS access was used. It has been tested to be effective; internationally (Ballard et al., 2013; Coates et al., 2006; Swindale and Bilinsky, 2006); between rural and urban women in Kenya (Keino et al., 2014);

between rural and urban households in Ethiopia (Gebreyesus et al., 2014) and in Iran with urban households (Nahid et al., 2014). For this study, the 9-item questions were adapted to the local context and Table 3.1 provides the modifications made to these questions and the intended meaning of the questions.

Table 3.1: Adaptation made on the HFIAS 9-item questionnaire for measuring experience-based FIS access in the forest areas of Cameroon.

Scale item	Adapted questions	Intended meaning with respect to adequacy to food access domains in the context of the study area
Q1: Worry about food	Did you worry that your household would lack food?	Worrying about how to procure food and variety
Q2: Unable to eat preferred foods	Did anyone eat what he did not prefer?	Food preference (Compromising quality)
Q3: Eat just a few kinds of foods	Did anyone eat limited kinds of food because of lack of food?	Food variety (Compromising quality)
Q4: Eat foods they really do not want to eat (Unable to cook a standard meal)	Were you unable to cook food that was considered a standard meal in the village?	Healthy and nutritious food (Food quality and preference) (Compromising quality)
Q5: Eat a smaller meal (Unable to cook food appreciated by children)	Were you unable to cook food that was appreciated by children?	Children food preference (Compromising quality)
Q6: Eat fewer meals in a day	Did anyone eat fewer meals because of less food?	Skipping meals (Reducing quantities)
Q7: No food of any kind in the house (No food of any kind to cook)	Were you unable to cook because there was no food of any kind to cook?	Running out of food from the house, neighbours or farms (Hunger)
Q8: Go to sleep hungry	Did anyone go to sleep hungry because there was not enough food?	Experiencing hunger at household level
Q9: Go a whole day and night without eating (Day's food gotten through neighbours, a feast or the forest)	Did you or anybody in your house go to neighbours houses, a feast or the wild forest just to get food for the day?	Experiencing hunger at household and local level (socially unacceptable means of getting food (Scavenging)

Source: Adapted from Ballard et al. (2013), Coates et al. (2007), Swindale and Bilinsky (2006) and Coates et al. (2006).

Each question had part A and part B for recording firstly, whether or not the phenomena occurred, and secondly, the frequency-of-occurrence (1 = rarely, 2 = sometimes, 3 = often), respectively. In adapting the standard questionnaire for measuring experience-based household FIS access, five conceptual adjustments were made. To begin with, instead of conducting interviews with the person who prepared food in the household, interviews were conducted with all household members who were available to participate. Thus, it was a mixed group discussion and interview approach corroborating Agrawal and Chhatre's (2011) idea of integrating quantitative and qualitative research as an important strategy for research on human-environment interactions. In this way most responses were substantiated or contradicted

by the other members of the household. The interviewer was vigilant to non-verbal signs like facial expressions by the other household members or statements made in the local dialect, especially by children. These elements helped bring clarifications on the responses. In as much as this method appeared more efficient, it was more time-consuming than interviews with a single individual.

In the context of poverty, as the case in this area, it was normal for people to eat food that they did not want to eat. Thus, this question shifts from the idea of household members eating some foods that they did not really want to eat (Coates et al., 2006; Swindale and Bilinsky, 2006) and replaces it with whether household members eat food that they considered nutritious, in which case I referred to it as 'a standard meal' (nutritious food according to Ballard et al. (2013) and Johnston et al. (2014)). During village meetings, people described a balanced or nutritious meal as one that is comprised of much meat/fish, enough peanut/egusi, some starchy foods like cassava/grains/plantain and vegetables. This meal was supposed to be accompanied by a beer, preferably, or some local alcoholic drinks to make it complete. Fruits were not considered as part of such a meal and were eaten as available. Devereux's (2001) idea of Sen's entitlement approach best explains these food consumption patterns: people are entitled to something because they deserve it and thus own it, was not applicable. Here, although people deserve food, the available types of food, their culture, environment and income does not permit them to eat what they like. Rather, they are forced to adapt to what is available.

Historically, there has been little global effort directly addressing household FIS access taking into consideration experiences of food that is appreciated by children, especially children aged between 5 and 18 years and adolescents as a whole. Malnutrition and nutrient deficiency studies have often focused on anthropometric measures of children 0 - 5 years, which provides limited information for the food intake of adolescent children. As a consequence, there has been low focus on what children actually eat, especially children from 5 to 18 years old (Cordeiro et al., 2012; McGarry and Shackleton, 2009) who in effect run the risk of undernutrition and malnourishment. Evidence from Cameroon revealed that childhood obesity among school children aged 3 to 14 years was 16%, 14% and 6% using weight for height, weight for age and body mass index, respectively. Similarly, diabetes was 1% in 1994 and 6% in 2003 while hypertension, which was 13% in 1994 rose to 27% in 2003 (Tanya et al.,

2011). Furthermore, the age of 5 - 18 is the age when children learn fast, are active and can easily be derailed due to hunger, poverty and hardship (Cordeiro et al., 2012; McGarry and Shackleton, 2009). Besides, poor nutrition can lead to reduced immunity, impaired physical and mental development and reduced productivity (Johnson et al., 2014; Johnston et al., 2014; Sharafkhani et al., 2011). Therefore, in this study, I sought to capture FIS as experienced by children by examining the number of times food appreciated by children was prepared within households. Since most household members took part in the interviews, such questions were often directed to the children themselves. Eating fewer meals was framed to mean if they ate less than usual as people in the study area typically ate one full meal a day, habitually in the evening. In the morning, they ate left over food, which was small. During the day, they ate mostly fruits, nuts or some form of local snacks, several times a day as opportune. It came out that there was hardly any special food for children, although there were some foods preferred by children. To formulate the question on child food preference, in each village, five to eight children between 5 and 15 years old were identified randomly by the research team and asked individually 'if they were often consulted before deciding on what to cook'? In each case the children laughed and found this question extremely strange because the decision on what to cook was mainly from their parents.

Subsequently, referring to 'no food of any kind in the house' is limiting in rural areas and could be misleading. This is because people typically had their food barns on their farms or in the forest and any time they wanted to cook, they could quickly go into the farm or the forest and harvest and come home and cook. Thus, this question was rephrased to 'no food of any kind to cook' meaning they could not get food from their farms/forest, borrow from a neighbour or local shop keeper or food from the house.

Finally, in most villages in the study area, it was unusual for someone to go a whole day and night without eating, but, the fact that people don't go to bed hungry does not mean that they had food in their homes. People traditionally eat together and so households may not in effect have food, but will not go to bed hungry because of social relationships and organisations at the local level. Thus, the question on 'go a whole day and night without eating' was reformulated to 'did you or anybody in your house go to neighbours houses, a feast or the wild forest just to get food for the day (day's food gotten through neighbours, a feast or the forest

(scavenging))'. This is the case where forest foods were used as safety nets, i.e. as a source of last resort food.

3.2.3. Data collection and sampling procedure

Field work ran from August 2013 to October 2014. Three main methods were used for data collection. First, were village meetings (one per village) during which the study was explained to the inhabitants and the nine questions regarding food FIS were verified and modified to suit the local context. Second, were three key informant interviews per village to assess the understanding of the questionnaire and the perception of some key people concerning the study.

The questionnaire had three sections. First, were household socioeconomic variables, which focus on parameters such as sex, number of persons interviewed, age of household head, marital status, level of education and ability of read and write etc. It further examined the total number of people in household, total number of children below five years and the presence of a sick family member over a month and if yes, who? Next, income parameters were such salary and the presence of a salaries household member were captured. The second part of this questionnaire dwelled on wellbeing parameters such as; type of house, source of energy for cooking, proportion of food and non-food household expenditure and the location of the household determined by the deforestation zone and the village. The last part of the questionnaire captured the experience of FIS investigating if households witness FISH, if there were times they lacked food to cook, cooked less desired food or did not cook at all. Furthermore this section verified the food insecure months of the year and coping strategies to FIS. This section was crowned with the nine questions to explore the experience of FIS access (Table 3.1).

Between 26 and 33 households were interviewed in each village making a total of 90 to 92 households per deforestation zone and 273 households overall in the three zones. The choice of households was randomised. Vulnerable groups (female-headed households, households with women of child-bearing age, large families (households with many people, especially children), and households without a source of stable income (no cocoa farm, no pension or salaried job) were given priority while selecting households. After such categories of households were selected to make half of the sample, the others were chosen just by a simple

draw from a basket of names proposed by the village community leader. Because most villages had just about 50 households, this study considered a group of communities located along the same stretch to constitute a village and a sample was drawn from this group of communities. Thus, communities in which data was collected had ± 200 households each.

3.2.4. Data analysis

All raw data were captured in Excel. After preliminary cleaning through the cross tabulation function of Excel, values were created and the data were transferred into SPSS version 20.0 for analysis. Further verification on the consistency of data was done using descriptive statistics (frequencies and cross tabulations). Statistical significance was considered at $p < 0.05$. Household parameters together with FIS responses were analysed to situate the social context of the study and the observations made at the different levels of deforestation using descriptive statistics. Pearson Chi-Square and ANOVA were used to establish relationships and test differences in mean respectively (Bryman, 2012). Further to this, data on specific FIS parameters were treated and analysed as explained in the next sections.

3.2.4.1. Household FIS access related conditions, domains, scale score and prevalence

The nine FIS questions were grouped together to provide some general indication on FIS access. In reporting household FIS access experience, a number of different measures were analysed. The next section explains the calculation of several measures including conditions, domains, scale score and prevalence of household FIS access.

Food insecurity access related conditions refer to the percentage of households that responded, "yes" to a specific item on the HFIAS questionnaire and the percentage of households that responded to a specific frequency-of-occurrence per item. For example: often (>10 times) 40% of households ate fewer meals because of lack of food and resources. The frequency-of-occurrence questions was coded between 0 and 3.

$$\text{Percentage of households with 'yes' response} = \frac{\text{Yes to Q1 or Yes to Q7}}{\text{Total number of households responding to Q1 or Q7}} \times 100$$

Core domains and subdomains of FIS have been proposed by Coates et al. (2006) in their analysis of household FIS experience across cultures. The second, FIS access related domain considers certain combinations among the HFIAS questions to provide a progressive

picture of inadequate food access domains and show how people actually perceived FIS in daily life. During mild FIS, households simply worry if they will have food and sometimes could compromise quality. Later when FIS persists, they start reducing quantities and end up going hungry because of a lack of resources. As the intensity of FIS deepens, the consequences also change to reach a stage of experiencing hunger at household and, worst still, at the community level. Household FIS access domains were calculated by the percentage of households that were affected by any of the nine items or questions. That is, households experiencing any of the conditions at any level of severity in each item or question. For example, the percentage of households that was worrying about how to procure food and uncertainty about household food supply. Adapting from Ballard et al. (2013) and Coates et al. (2006), the nine questions of FIS are grouped into practical domains of inadequate household food access as observed in daily life:

1. Worrying about how to procure food and uncertainty about household food supply
- Q1: Worry about food
- Q7: No food of any kind in the house (No food of any kind to cook)
2. Compromising on quality and variety
- Q2: Unable to eat preferred foods
- Q3: Eat just a few kinds of foods
- Q4: Eat foods they really do not want eat (Unable to cook a standard meal)
- Q5: Eat a smaller meal (Unable to cook food appreciated by children)
- Q6: Eat fewer meals in a day
3. Compromising on quantity, reducing quantities, skipping meals
- Q6: Eat fewer meals in a day
- Q7: No food of any kind in the house (No food of any kind to cook)
- Q8: Go to sleep hungry
4. Experiencing hunger household level
- Q7: No food of any kind in the house (No food of any kind to cook)
- Q8: Go to sleep hungry
- Q9: Go a whole day and night without eating (Day's food from neighbours, a feast or the forest)
5. Experiencing hunger at the community level
- Q9: Go a whole day and night without eating (Day's food gotten through neighbours, a feast or the forest - in cases where forest foods are used as safety nets).

The third, HFIAS score, is a continuous measure of the degree of FIS access in the households in the past four weeks (30 days). The maximum possible score is 27. This is the case in which the household response to all nine frequency-of-occurrence questions was "often", coded with response code of three. The minimum score is zero (the household responded "no" to all occurrence questions). The higher the score, the more severe the FIS

access of the household. The average HFIAS score for a given population is the scale score. It is the total of the HFIAS score for the entire population divided by the sample size of the survey or sub-group being considered.

Finally, Household FIS Access Prevalence (HFIAP) indicates the level to which households are affected by FIS. The prevalence of FIS access was the percentage representation of the various categories of food secured, mild, moderate and severe food insecure households. Stipulations for establishing households' HFIAP in forest areas were adapted from Ballard et al. (2013), Coates et al. (2006) and Swindale and Bilinsky (2006). Two provisions were established, one based on the nature of response to the frequency-of-occurrence questions and the other based on cut-off points on the FIS access score. When these two provisions are met, then the household is classified into a specific FIS access prevalence category (Table 3.2).

Table 3.2: Conditions for establishing the prevalence of FIS access

FIS access prevalence category	Provision 1: Nature of response to some frequency-of-occurrence questions	Provision 2: Cut-off point based on FIS access score
Food secure	Response to all frequency-of-occurrence questions = 00	NA
Mild	Response to Q8 or Q9 = 0 or 1	1 - 10
Moderate	Response to Q8 & Q9 = 2 or within cut-off point 1 - 10, there is a response on an occurrence question = 3	11 - 17
Severe	Response to Q8 & Q9 = 2 or within cut-off point 11 - 17, there is a response on an occurrence question = 3	18 - 27

3.2.4.2. Severity of household food insecurity

The terms "undernourishment" and "hunger" have been interpreted as referring to a continued inability to obtain enough food, that is, a quantity of food energy sufficient to conduct a healthy and active life. Malnutrition is a consequence and cause of hidden hunger which refers to vitamin and mineral deficiencies, or micronutrient deficiencies (FAO et al., 2012). Somebody who suffers from hidden hunger is malnourished, but may not sense hunger. The severity of household FIS was measured using the estimation of hunger scores and the risk of hunger at the community level. Hunger scores were calculated using questions 7, 8 and 9 in which the frequency-of-occurrence items 1, 2 and 3 (refer to Table 3.1) were recoded as; never = 0, rarely or sometimes = 1 and often = 2. This implies that if a household has a response of zero for all three questions its score will be zero and if a household had a score of two for all three questions, its maximum score will be six. Thus, all the computed scores ranged between

zero and six. After computing these scores and putting together the sum of questions 7, 8 and 9 for every household, hunger categories were established as “little to no household hunger” (scores 0 - 1), “moderate household hunger” (scores 2 - 3), and “severe household hunger” (scores 4 - 6) (Deitchler et al., 2011).

Risk of hunger at the community level considered that many community outlets used for securing daily meals include feasts, neighbours/friends, forest/wild and gifts (da Costa et al., 2013) were useful in guaranteeing meals for several people daily. When people go round scavenging and come back without eating, this means the level of FIS is affecting the community. Q9 was designed to capture this point and the scale for calculating the risk level was adapted from the calculation of hunger scores and the consequences of FIS as reported in Ballard et al. (2013), Deitchler et al. (2011) and Swindale and Bilinsky (2006). Thus, the risk level of hunger at the community level was graded as low, moderate or severe risk based on cut-off points of 0, 1 and 2, and 3 for each level, respectively (Deitchler et al., 2011; Sharafkhani Rahim et al., 2011).

3.3. Results

3.3.1. Household characteristics

In the deforestation zones, I recorded 23%, 21% and 16% female respondents as against 10%, 13% and 17% male respondents for the most deforested, moderately deforested and least deforested zones, respectively. The majority of household heads were between the ages of 26 and 60 years old (79%) with a few being 25 years or younger (3%) and the remainder being 60 years and above (18%). Age did not correlate strongly with any of the other household parameters. Generally, younger household heads were reluctant to take part in the interview for fear that they will be seen as poor and not eating well, especially as people traditionally will not want others to know they don’t often eat standard food (containing much meat, fish, etc.). Thus, many younger people declared their unwillingness to continue taking part in the interview.

The average household size was 7.7 ± 4.6 persons, with approximately 2.8 ± 1.4 children under the age of two years. Only 12% of households did not have children under the age of two, with 10% of households having up to four children less than two years of age. The number of persons interviewed in each household was 1.8 ± 0.8. Most respondents were female

(60%). About one-third of households (31%) reported to have had a sick person in the household within the last month with proportions of 41%, 37% and 14% for the most, moderately and least deforested zones, respectively. There was a significant difference between the presence of a sick person in the household and deforestation zone, ($F = 9.30$ $p < 0.001$). Although this study did not analyse the degree of seriousness of the illness, overall trends showed that more women were reported to be sick than men. The percentage of sick persons were husband (6%), wife (46%), mother/step mother (15%), father/step father (6%), brother/sister, (11%) and children under the age of five years (15%). χ^2-tests showed a significant relationship between deforestation zone and the person that was sick ($\chi^2 = 26.81$ $p = 0.003$; Cramer's $V = 0.409$ $p = 0.003$). The most deforested zone registered the highest proportion of sick persons and the highest number of women that were sick followed by the moderately and the least deforested zones.

More than 51% of households consisted of married people living together with their spouses and 2% were divorced. The rest of the households (47%) were either just living together, single, widows or in a polygamous marriage. The main ethnic groups studied were the Betti in the Centre region and the Bulus in the South region. The population was fairly homogenous with people intermarrying between villages of the same ethnic group. Regarding the educational level, although 5% of people never went to school 48%, 44% and 4% had attended primary, secondary and university education, respectively. The level of reading did not reflect the educational level declared. People declared that they could read and understand a few lines (26%), one paragraph (12%), perfectly (58%) and 4% said they were unable to read or understand. This weak educational level is confirmed by only 12% of households that had any salaried household members. Household annual incomes averaged around 971 664 ± 1 214 835 FCFA, with the minimum income being 20 000 FCFA and the maximum was 10 080 000 FCFA (I USD = 500 FCFA).

There were great disparities in income, although all income classes were represented in the study area. Around 11% households had very high incomes per year > 2 000 000 FCFA while a majority of households had less than 2 000 000 FCFA (4 000 USD) per year. The main income source was from cocoa and food crop sales, although from informal discussions with household members and field observations, remittances (not officially declared by most household members) appeared to be an important source of income in the area. Food

expenditure averaged 44.1 ± 17.7% and correlated positively with household income (Pearson Correlation = 0.161 p = 0.019). This suggests that with higher household income, food expenditures would likely increase.

The ability of household heads to read, understand and write showed a non-significant relationship with household income (F = 0.037 p = 0.990) with mean incomes of 1 010 604 ± 764 522 FCFA (yes, few lines), 1 026 146 ± 946 996 FCFA (yes, one paragraph), 957 276 ± 1 426 953 FCFA (yes, perfectly), 1 002 000 ± 1 305 303 FCFA (no). This means that household income did not depend on reading level, whereas the ability of household heads to read had a relationship with food expenditure (F = 8.124 p < 0.001) with means of food expenditure percentage per response category being; yes, a few lines (52.1 ± 16.6%), yes, one paragraph (47.0 ± 16.1%), yes, perfectly (40.5 ± 17.1%) and no (37.5 ± 18.1%). Consequently, as the reading level increased, the food expenditure percentage reduced. Four income quintiles were established and the mean annual per income quintile was first quintile-poorest 25% (171 483 ± 70 817 FCFA), the second quintile (409 188 ± 77 844 FCFA), the third quintile (810 049 ± 158 644 FCFA) and the fourth quintile (2 405 818 ± 1 696 010 FCFA). There was a significant difference between the mean of household income and income quintiles (F = 73.8 p < 0.001).

Housing structures were mostly traditional (64%), which were characterised by mud and stick walls, and earthen floors; intermediate traditional houses (21%) that had plastered mud and stick walls and cement floors; modern houses (12%) with brick walls and cement floors and wooden houses popularly called ‘caraboat’ houses (4%). Regardless of the housing type, all households used fuelwood as the main source of cooking energy. Meanwhile, approximately 3% and 2% of households used gas and kerosene, respectively, for cooking.

3.3.2. Household characteristics and experience of FIS

Nearly all households (94%) admitted that they sometimes experienced food scarcity due to lack of resources. The proportion of households that experienced food scarcity due to lack of resources per income quintile were 89% for the poorest quintile, 100% second quintile, 96% for third quintile and 98% for the fourth quintile. There was no significant difference between income quintile and experience of food security due to lack of resources (F = 2.22 p = 0.088).

Peak periods of food scarcity within a year were listed as January - March (38%); April - June (4%); July - September (3%); October - December (31%) and all year round (24%). This shows that immediately after harvesting in October - December, 30.9% of households already faced food shortages and an additional 23.5% faced food shortages all year round. This indicates that people were unable to store sufficient food to guarantee adequate food access all year round. Food scarcity months per deforestation zone were January - March, 9%, 13% and 16%; April - June, 3%, 2% and 0%; July - September, 0%, 3% and 0% and October - December, 6%, 18% and 7%; for the most, moderately and least deforested zones, respectively. No relationship was observed between food insecure months and deforestation zone ($\chi^2 = 13.82$ $p = 0.086$; Cramer's $V = 0.319$ $p = 0.086$), thus, the food secure months were likely to be similar at all levels of deforestation. Many more households declared the presence of a sick person during January - March (55%), which is the period most reported as a food insecure period. Otherwise, 22% of households declared to have a sick person during the period of October - December, and all year round, respectively.

Households were asked to list the three most important reasons for experiencing food scarcity during the year. It was recorded that the most important reason (cited 112 times) was that crops were not ready for harvest. This was the case for the most and moderately deforested zones. Seasonal variability appeared to be the most important reason for food scarcity in the least deforested zone and was the second most important reason for experiencing FIS. There was a significant relationship between deforestation zone and reasons for experiencing food insecurity ($\chi^2 = 40.8$ $p = 0.009$; Cramer's $V = 0.285$ $p = 0.009$). Similarly, most reasons presented for FIS were related to food availability and specifically, productivity (from their farms or natural environment) and markets. No household mentioned a reason of lack of nutritious food or quality food, meaning that FIS in this region is seen at the household level as a problem of food availability and not taking into consideration food quality. However, the statistically significant relationship between months of FIS and having a sick person in the household suggests that quality is important. Households adopted different coping strategies to deal with FIS which involved eating culturally unacceptable meals like fried rice (painted rice), staples with no soup or merely drinking water.

3.3.3. Household FIS access related conditions

FIS access related conditions were verified first by the yes and no responses to the 9-item FIS questions on limited food access due to lack of resources over the last month. More than 75% of households' responded 'yes' to all nine questions with 100% of households stating that they often did not cook food appreciated by children due to lack of resources (Figure 3.1). There was a significant difference between all levels of deforestation and the responses on eight items on FIS access questions. The question on 'go to bed hungry' had only 62% affirmative responses. There was no significant difference in the responses per deforestation zone ($F = 1.21$ $p = 0.301$). There was a statistically significant difference in the response of the other seven questions and deforestation zone. In the most and moderately deforested zones many more households worried about lacking food 87% and 82%, respectively; compared to only 55% of households in the least deforested zone ($F = 14.8$ $p < 0.001$). Similar trends were observed with Q2 and Q3.

On being unable to eat preferred foods the percentage of households with yes responses were 87%, 85% and 64% for the most, moderately and least deforested zones ($F = 8.33$ $p < 0.001$). But, on eating just a few kinds of food, the percentage of households with affirmative responses were 84%, 86% and 62% for the most, moderately and least deforested zones ($F = 8.63$ $p < 0.001$). The trends changed on Q4, which examined the ability to cook a standard meal. The affirmative responses were 97%, 100% and 87% for the most, moderately and least deforested zones ($F = 7.04$ $p = 0.001$) while on unable to cook food appreciated by children, all households responded "yes", and no statistical test was computed for this. On Q6 (Eat fewer meals in a day), Q7 (No food of any kind to cook) and Q9 (Day's food gotten through neighbours, a feast or the forest), 100% of households within the moderately deforested zone responded affirmatively meaning households in the moderately deforested zone were the most affected by these parameters ($F = 6.37$ $p = 0.002$; $F = 16.99$ $p < 0.001$; $F = 9.84$ $p < 0.001$), respectively (Figure 3.1).

Household FIS access related conditions were the percentage of households that responded, "yes" to a specific occurrence questions and the frequency-of-occurrence (Figure 3.1). For example: often (> 10 times) 40% of households ate fewer meals because of lack of food and resources. As per Figure 3.1, more than 50% of households recounted that sometimes (3 - 10 times) they were unable to cook a standard meal and food that was appreciated by

children and a further 30% noted that often more than 10 times per month they were unable to cook a standard meal. This means that food that was cooked was eaten just to "fill the stomach" not because household members really liked the food. This was confirmed by 79% of households who reported to be unable to eat preferred food and 77% who reported to eat just a few kinds of food.

Two extreme cases were further analysed per deforestation zone. The inability to cook food appreciated by children was quite severe with 62% responding that sometimes (3 - 10 times) and a further 14% said often (more than 10 times) in a month they were unable to meet this demand. Examining the affirmative responses on sometimes (3 - 10 times) and the frequency-of-occurrence per deforestation zone, 81%, 66% and 40% of households in the most, moderately and least deforested zones respectively reported that in a month they were unable to cook food appreciated by children.

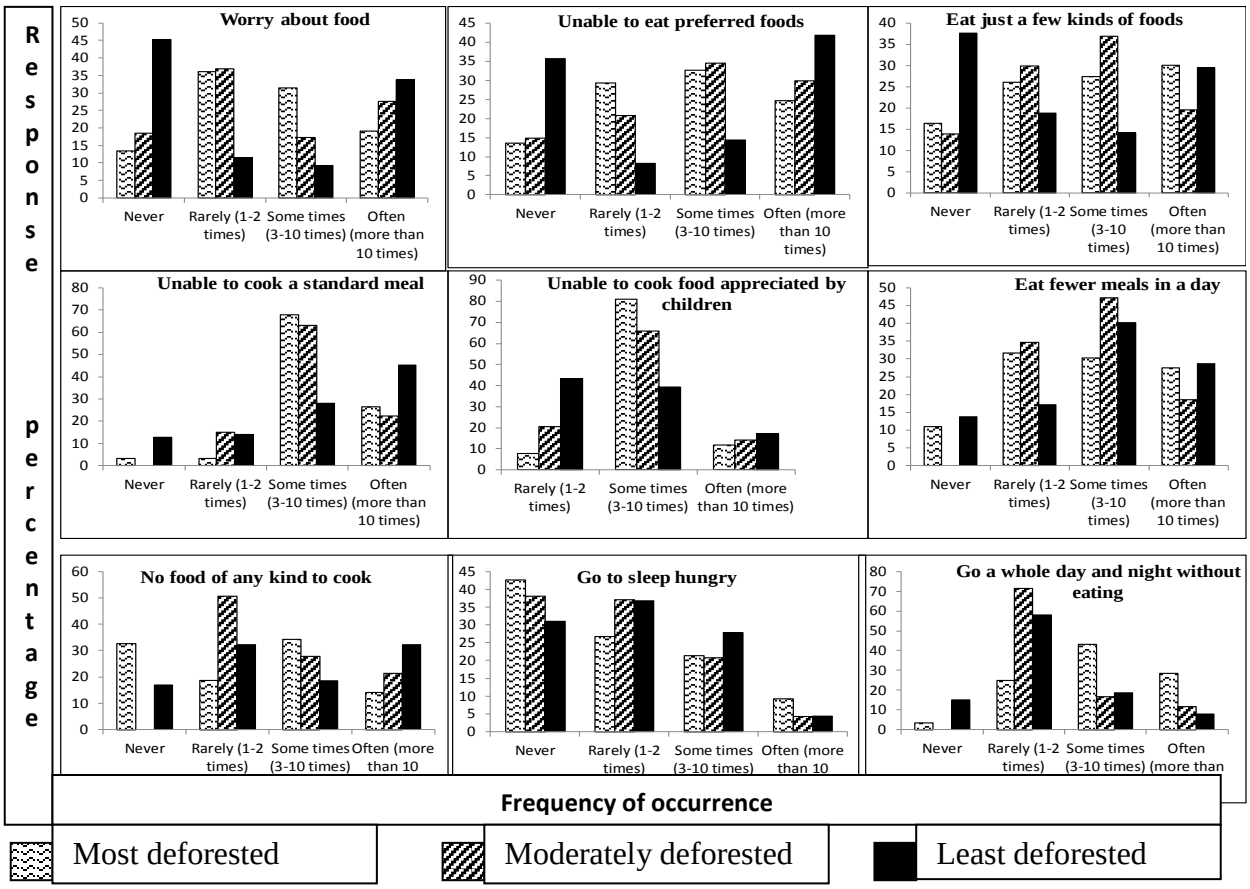

Figure 3.1: 9-item FISH occurrence questions and frequency of occurrence

A significant relationship was observed between deforestation zone and the inability to cook food appreciated by children (χ^2 = 33.03 p < 0.001; Cramer's V = 0.266 p < 0.001) with a decreasing trend of sometimes (3 - 10 times) considering children's tastes and preference in food preparation with increasing deforestation. Even when food appreciated by children was not prepared, in 37% of households, nobody always went to bed hungry. Thus, sometimes (3 - 10 times per month), only 37%, 33% and 40% and often 16%, 7% and 6% experienced going to bed hungry in the most, moderately and least deforested zones, respectively. Since there was no significant relationship between going to bed hungry and deforestation zone (χ^2 = 4.31 p = 0.366; Cramer's V = 0.115 p = 0.366), it can be concluded that the phenomenon of going to bed hungry was not influenced by the level of deforestation.

3.3.4. Household FIS access related domains

The FIS access related domains showed that 80% of households were worrying about how to procure food and uncertainty about household food supply while 89% were compromising on quality and variety (Figure 3.2).

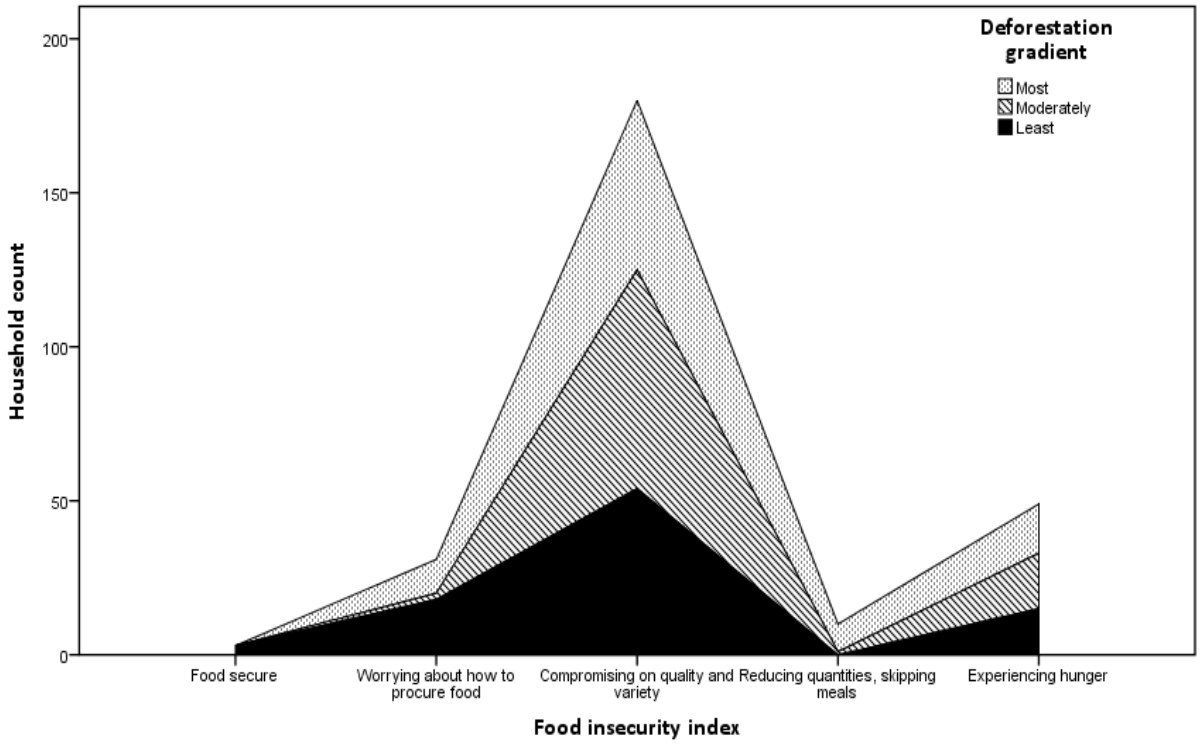

Figure 3.2: Food insecurity (FIS) access related domains

A further 80% of households were compromising on quantity, reducing quantities and skipping meals, making it that 87% of households indicated that they were experiencing hunger at the household level (81%) and at the community level (94%). In splitting the households by all the occurrence questions, and running frequencies, no household responded 'often' to all questions on occurrence of FIS meaning that within a month no single household faced all the occurrence questions more than 10 times.

Only 1% of households were food secure and all of these were located within the least deforested zone. There was a significant relationship in the domains of FIS and deforestation zone ($\chi^2 = 36.38$ $p < 0.001$; Cramer's $V = 0.258$ $p < 0.001$). A majority of households (66%) were compromising on quality and variety. In the moderately deforested area; this was the case of 77% of households as against 60% and 60% of households for the most and least deforested zones respectively.

This means that FIS as experienced by this population was about compromising on quality and variety with a minority worrying about how to procure food (11%) and others reducing quantities, skipping meals (4%) and going hungry (18%). It should be noted that the idea of skipping meals in the study area was not in the usual sense because in most households people could eat prepared food or what is considered a meal, once or twice a day and then eat roughage like steamed cassava paste (baton de manioc), boiled starchy roots, dried banana/plantain or wild fruits and nuts. In this way, they may not be skipping meals, but in the real sense they have not eaten three full meals during that day. Overall, compromising on quality and variety was more intense in the moderately deforested zone than in the most and least deforested zones.

3.3.5. Household FIS access related scale score and prevalence

HFIAS is distributed on a scale of 0 - 27 with zero representing food secure households and 27 severely food insecure households. The mean household HFIAS score for the whole study area was 12.9 ± 5.57, ranging from 0 to 24 points. Within the most deforested zone, the HFIAS score was 12.9 ± 5.79 and ranked between 1 and 24, while for the moderately deforested zone, it was 14.1 ± 4.41 ranging between 2 and 22 and for the least deforested zone the HFIAS score was 11.7 ± 6.18 ranging between 0 and 24 (Figure 3.3). One way ANOVA showed a significant difference between the mean HFIAS score and deforestation zone ($p <$

0.05). The Turkey multiple comparison test was used to compare all pairs of HFIAS means per deforestation zone. The results show that there is a significant difference between the means of HFIAS within the least and the moderately deforested zones (q-value = 4.17 $p < 0.05$). The HFIAS statistics for the study households and the three levels of deforestation indicated a clear prevalence towards moderate to severe FIS.

Examining the prevalence of household FIS access, zero represented the food secure households and these households were located in the least deforested area and constituted 3% of households in this zone. Mild FIS access was reported for 21% of households of which 30% were from the moderately deforested zone and 18% and 16% were households located in the most and least deforested zones, respectively.

Generally, households were affected by moderate FIS (49%) and this was typically predominant in the least deforested zone (57% of households interviewed) as against 45% and 46% for the other zones. Severe FIS affected 28.6% of households with the majority being located in the most deforested zone (37%) as against 24% and 24% for the other two zones. Looking at the overall prevalence on severe FIS, 44% of the interviewed households within the most deforested area were severely food insecure while this was the case for 28% for the moderate and least deforested zones.

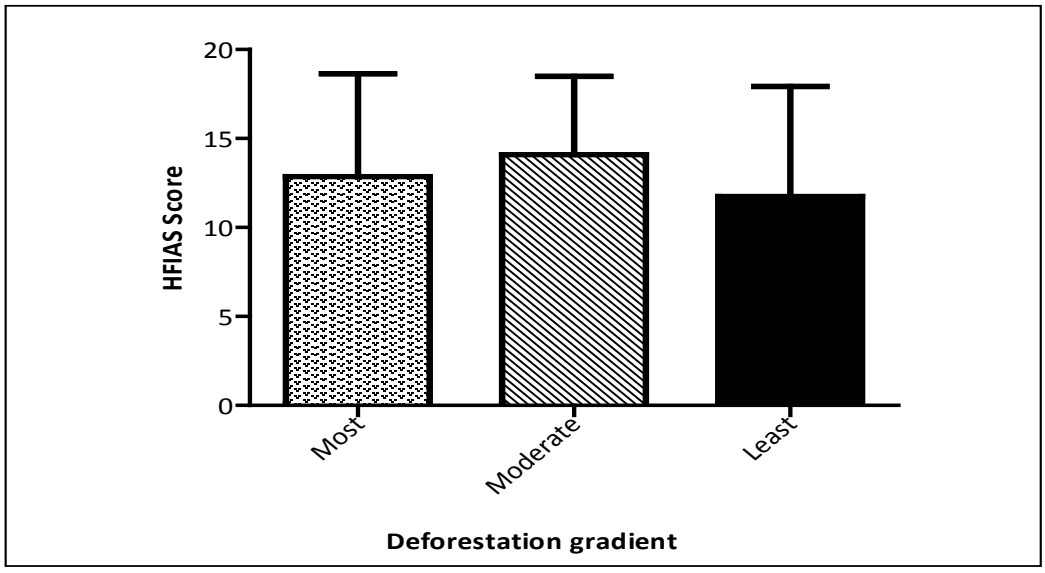

Figure 3.3: Household Food Insecurity Access Scale (HFIAS) values per deforestation zone

3.3.6. Assessing hunger at household and community level

Analysis of hunger scale (Figure 3.4) suggested that only 17% of the population was affected by little to no hunger while 65% suffered from moderate hunger and 18% from severe hunger. The trends in the hunger scale were similar at all three levels of deforestation. Severe hunger affected up to 43% of households in the least deforested zone and 31% and 27% for the moderately and most deforested zones, respectively. However, the hunger scale did not show a significant relation with deforestation gradient (χ^2 = 5.34 p = 0.254; Cramer's V = 0.099 p = 0.254) meaning that hunger affected all deforestation zones to a similar extent. The hunger scale correlated significantly and negatively with two households parameters, i.e. level of education of family head (Spearman's Rho = -0.15 p = 0.016) and whether the household head can read, understand and write (Spearman's rho = -0.17 p = 0.004). This means that educational level was important in determining households' experiences of hunger.

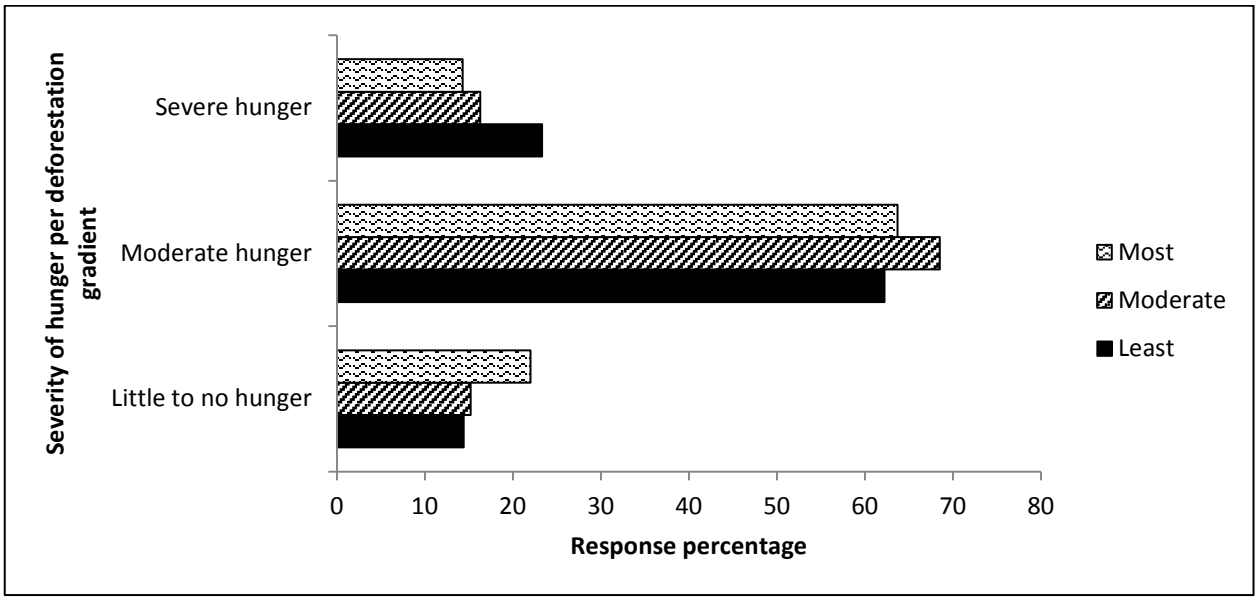

Figure 3.4: Household hunger scale per deforestation zone

The majority of households (77%) ran a moderate risk of hunger at the community level (Figure 3.5) while serious and low risk was the case of 16% and 7% of households, respectively. The most, moderately and least deforested zones accounted for 24%, 24%, and 29%, respectively, for the moderate risk of hunger at the community level. The results indicate

that ‘free’ food obtained through gathering and scavenging is scarce in the study area, meaning that conventional food access mechanisms need to be improved to ensure adequate food supply in this area. Looking at households within each deforestation zone, in the most deforested zone, only 3% of households showed a low risk of hunger at the community level, whereas 71% and 26% showed moderate and serious risk, respectively. Low risk, moderate risk and serious risk of hunger sequentially, for the moderately deforested zone, was 6%, 75% and 19% and for the least deforested zone it was 12%, 84% and 3%, respectively. Whereas the least deforested area recorded the lowest risk of hunger at the community level, the moderately deforested zone was the area most prone to serious risk of hunger. There was a significant relationship between deforestation zone and risk of hunger at community level ($\chi^2 = 21.24$ $p < 0.001$; Cramer’s $V = 0.202$ $p < 0.001$).

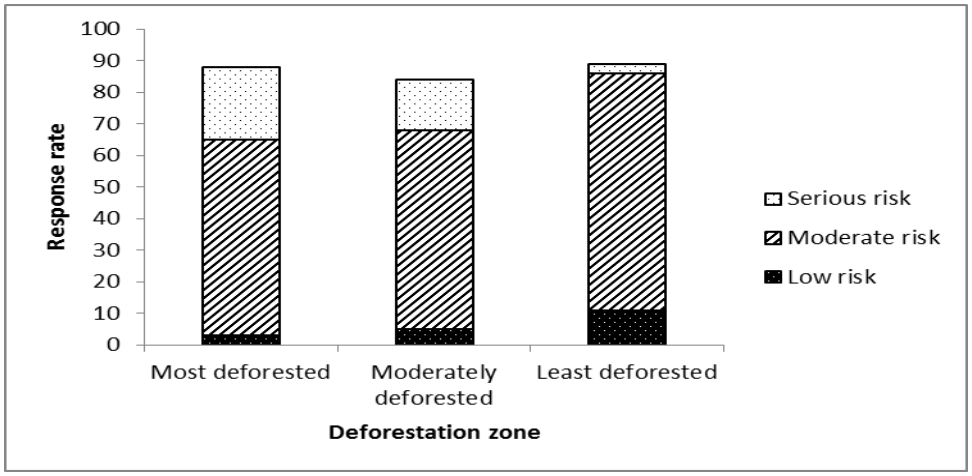

Figure 3.5: Hunger at the community level

3.3.7. Severity of food insecurity access

The main objective of this study was to understand the characteristics, prevalence and severity of household FIS access as deforestation increases. Most commonly, sick persons in households were the wife (46%), mother/step mother (15%), and children under the age of five years (15%). This means that the illness of women significantly affected household FIS. Core socioeconomic household parameters like food and non-food expenditure, income, sex, age, marital status did not show a significant relationship with experiences of FIS. The percentage per prevalence of FIS of the households that reported to have a sick person in the house were,

food secure (1%), mild food insecurity (23%), moderate food insecurity (33%), severe food insecurity (44%) (Table 3.3).

Households in which wives were sick were affected by moderate and severe FIS representing 16% and 29% of households, respectively (χ^2 = 40.67 p < 0.001; Cramer's V = 0.412 p < 0.001). This implies that when a wife is sick FIS is aggravated. A significant relationship was observed between deforestation zone and risk of hunger at community level. Looking at serious risk of hunger, the most deforested zone accounted for 55% of households, while the moderately and the least deforested zones represented 38% and 7% of households, respectively. Hunger scale did not show a significant relationship with deforestation zone.

The HFIAS statistics for the studied households and the three levels of deforestation indicated a clear prevalence towards moderate to severe FIS. ANOVA showed a significant difference in the means between deforestation zone and the distribution of HFIAS score. This may suggest that the moderately deforested zone, which had the highest mean HFIAS score, was most likely to be the area with a more severe prevalence of FIS. As per Table 4, the HFIAS score for households that were experiencing hunger was quite high, around 20 for all levels of deforestation. This means that the level of hunger in these communities is severe and that skipping meals was pronounced for the moderately deforested zone.

Table 3.3: Persons that were sick in the household versus prevalence of FIS

Person that was sick in the household	Prevalence of food insecurity in households				Total (%)
	Food secure (%)	Mild food insecurity (%)	Moderate food insecurity (%)	Severe food insecurity (%)	
Husband		1.2		5.0	6.2
Wife		1.2	16.2	28.8	46.2
Mother/ Step Mother		10.0	3.8	1.2	15.0
Father/ Step Father		2.5	2.5	1.2	6.2
Brother / Sister	1.2	5.0	2.5	2.5	11.2
Children < 5 years		2.5	7.5	5.0	15.0
Total	1.2	22.5	32.5	43.8	100.0

Using GraphPad prism, two linear regression analyses were run to identify best household and environmental variables that can be used to explain FIS in the study area (Table 3.4). The first was with HFIAS as the dependent variable and deforestation zone, sex of household head, age of household head, marital status of household head, educational level of household head, household size, percentage of food expenditure and income as independent ones. The differences between the slopes were not significant (F = 0.29 p = 0.970). The

differences between the elevations were extremely significant (F = 167.87 p < 0.001). No household parameter was significant with HFIAS meaning that FIS in the study area could not be explained by household parameters nor environmental factors like deforestation. Second, examining deforestation gradient as the dependent variable and sex of household head, age of household head, marital status of household head, educational level of household head, household size, percentage of food expenditure, income and HFIAS score. On all these parameters, only food expenditure showed a significant deviation from zero (F = 27.13 p < 0.001). The differences between the slopes were not significant (F = 0.29 p = 0.97). The differences between the elevations were extremely significant (F = 167.87 p < 0.001). Regarding food expenditure, neither household parameters nor experience of FIS significantly vary with deforestation zone. This means that overall FIS was likely to be felt in a similar way by all households at all levels of deforestation. Thus, it is likely that FIS are more linked to other social phenomena like feeding habits and lifestyles which were not considered in this study.

Table 3.4: Means of HFIAS score within each level of deforestation and per level of FIS access related domain

FIS access related domains	Deforestation gradient	Mean	Std. Deviation	F	Sig.
Food secure	Least	0.0	0.00		
	Total	0.0	0.00		
Worrying about how to procure food	Most	4.5	3.36	1.12	0.341
	Moderate	2.0	0.00		
	Least	5.2	2.86		
	Total	4.7	3.01		
Compromising on quality and variety	Most	12.6	4.41	1.09	0.340
	Moderate	12.9	3.19		
	Least	11.9	3.82		
	Total	12.5	3.79		
Reducing quantities, skipping meals	Most	10.7	2.06	6.02	0.040
	Moderate	16.0	.		
	Total	11.2	2.57		
Experiencing hunger	Most	20.7	1.14	2.10	0.134
	Moderate	20.0	1.33		
	Least	20.9	1.62		
	Total	20.5	1.40		

3.4. Discussion

Two assumptions were made in this study. First is that in the period immediately after the main harvesting season the majority of households should have a reasonable access to

stored food and/or during the peak of cocoa harvesting activities people usually have sufficient money from cocoa sales or as casual workers in cocoa harvest and postharvest activities. Secondly, that households become more food secure as deforestation increases (meaning they have more access to food from farming and improved production techniques (Gebbers and Adamchuk, 2010; Robiglio et al., 2010)). These assumptions suppose that many households would be food secure at the time of this study and that FIS would be most severe for the least deforested area. The results have revealed several patterns in this regards.

3.4.1. Food availability does not necessarily guarantee food security

The results on the prevalence of FIS access suggest that at least one-third of households at all levels of deforestation were severely food insecure and more than half of the population suffered from moderate to severe FIS. This corroborates the results that food security indicators reflect general patterns of poverty and poor distribution and use of food (Cordeiro et al., 2012). It also supports the findings by Johnston et al. (2014) on understanding sustainable diets and suggests the importance of measuring food accessibility to better address problems of FIS in rural communities. By examining the situation of FIS in agricultural communities and shortly after the harvesting season, this study has confirmed that FIS is more than just about having food. This contends with the results of Sneyd (2013), who reported that Cameroon could achieve a more sustainable and equitable food system if greater policy attention is directed towards understanding the range of perspectives that influence food security policy. The results have provided insights that can spur governments and development partners to set concrete actions to address FIS and undernourishment at all levels of deforestation. The study confirmed the assertion that ample food availability is necessary but does not guarantee accessibility and utilisation (Barrett, 2010) and thus food security. A recent review on the state of undernourishment in the world reveals that FIS will remain a major challenge in sub-Saharan Africa during the next decade (FAO et al., 2012). A further review on food systems for better nutrition suggests that FIS policies need to go beyond food production and examine other aspects of food access and utilisation (FAO, 2013; Barret, 2010).

Information on the prevalence of household FIS access (Coates et al., 2007) can be used for geographic targeting (Ballard et al., 2013; Coates et al., 2006), including the location of households and to detect changes in the household FIS access situation over time (Johnston et

al., 2014; Deitchler et al., 2011; Sharafkhani et al., 2011). Barret (2010) notes that poor access to food manifests in uneven inter- and intra-household food distribution and in the sociocultural limits and prevailing tastes and values within communities that govern food utilisation.

3.4.2. The moderately deforested zone was more prone to experiencing food insecurity

Relative frequency to which households responded to the FIS questions was similar across all levels of deforestation echoing the study on commonalities in the experience of household FIS across cultures by Coates et al. (2006). The analysis of the affirmative responses on the occurrence questions of FIS suggest that the moderately deforested zone had more affirmative responses and was more prone to FIS although the frequency-of-occurrence was less severe. This is confirmed by 79% of households who reported to be unable to eat preferred food and 77% who reported to eat just a few kinds of food. For these same questions in Ethiopia, Gebreyesus et al. (2015) found affirmative responses for the sampled population to be 79% and 71%, respectively. The results regarding FIS access related conditions show the magnitude of efforts needed to uplift FIS in most developing countries (Gebreyesus et al., 2014; Keino et al., 2014; Nahid et al., 2014) including Cameroon, which is considered a food self-sufficient nation (Robiglio et al., 2010).

The results also confirm why it is thought that FIS and undernourishment will continue to rise in Africa even by 2020 (FAO et al., 2012) since 97% of households acknowledged to experience food scarcity due to lack of resources. The responses on why households experienced food scarcity were still directed on basic food availability and not on the quality of the food. This demonstrates that people in this community often ate just to fill their stomachs and not for the nutritional requirements of their body. This may be probably a reason for the slow pace of fighting undernourishment in the world (FAO et al., 2012) since minute concerns, notably regarding perceptions on food access and use, are not taken into account in designing food security programs. Consequently, efforts in addressing FIS questions need to go beyond just increasing production and money supply (Sneyd, 2013; Kamgaing and Fotio, 2011; Loek and Maxwell, 2011) but should sensitise people apropos the type of nutrition they need and how to manage their food basket. Thus, it is important to combine micro (site and problem specific approaches) and macro (globalising approaches) strategies in addressing undernourishment. Therefore, if region specific details are not targeted in designing food

security programs, most efforts will continue to fail to reduce undernourishment, and may create new forms of malnutrition. This supports the view of Sneyd (2013) who reported that different aspects of FIS are affected by different policies. Consequently, specific policies on food quality and food diversity need to be promoted as a way to address FIS in this area. It is thus primordial for serious actions to be put in place to disseminate, valorise and capitalise the results of IRAD/ICRAF's research on fruit tree domestication in order to provide nutrient rich foods to these communities.

3.4.3. Deforestation alone was not enough to explain the hunger trends observed in the forest area

FAO et al. (2015) has noted that overall hunger remains an everyday challenge for almost 795 million people worldwide, including 780 million in the developing regions. Hence, hunger eradication should remain a key commitment of decision-makers at all levels. The southern part of Cameroon is assumed to be a food self-sufficient area because of the suitability of its natural environment for agricultural production (Robiglio et al., 2010) and other food products from the wild (Ingram and Schure, 2010). The results of this study suggest that hunger trends were similar at all levels of deforestation.

Although many results on FIS parameters like hunger at community level have shown a significant relationship with deforestation zone, the results on hunger trends did not. This means that deforestation alone was not enough to explain the hunger trends being experienced in the study area and supporting the assertions of Johnston et al. (2014) about sustainability of diets and quantities of food produced and used, including cultural and personal aspects of diets (Dindyal and Dindyal, 2003). This contradicts the many studies suggesting that after the main harvesting season, households should have available stock of stored food like groundnuts and maize in their barns and roots and tubers on their farms and therefore should have adequate access to sufficient food (Sneyd, 2013; Cordeiro et al., 2012; Sharafkhani et al., 2011; Robiglio et al., 2010). It however suggests that, when deforestation ocurs, the livelihoods of forest people deteriorate in a similar way at all levels of deforestation. This is because these people are neither benefitting from urban development because their villages are still enclaved nor are they benefitting from forest resources because the forest resources are declining through deforestation (Levang et al., 2015).

It further proposes that food stored by households is not usually sufficient to sustain their food needs and/or that households may not have proper knowledge on how to manage their food basket to maintain an equitable food access throughout the year (Cordeiro et al., 2012; Loek and Maxwell, 2011). Therefore, although forest people get basic food and livelihoods from the forest, for FIS and hunger to be eradicated, forest dependent people need improved access to other food sources as well as some sensitisation on the management of their food basket.

3.4.4. Hunger was a reality and illness of women significantly affected household FIS access

FIS targeting based on the improvement of women's health and under-five nutrition status could create a reasonable impact on addressing FIS. This is similar to findings of Loek and Maxwell (2011) in Guinea. They found that targeting of response interventions and mitigation/adaptation measures to FIS access would not benefit from a focus on household parameters, but rather interventions based on reducing market dependency was more necessary.

Constraints that affect women's roles in ensuring household food access (Sharafkhani et al., 2011) have been discussed in literature looking at limitations in relation to ownership of land (de Wasseige et al., 2012; Leão and dos Santos, 2012; Robiglio et al., 2010), tree and agroforestry systems (de Wasseige et al., 2012; Agrawal and Chhatre, 2011; Shackleton et al., 2008) and cattle for milk production and other natural resources (Loek and Maxwell, 2011; Devereux, 2001). This study has widened these limitations by demonstrating that households with ill people, idiosyncratically when it was a female, had a higher likelihood of being affected by FIS. This buttresses the importance of women's health in ensuring proper food security access. Consequently, efforts in addressing FIS questions need to go beyond just increasing production and income, but should take into consideration aspects related to women and their welfare like improved maternal health for improved family food security.

Hunger at the community level correlated negatively with having an ill person over the last one month in the house and the family member that was ill. It could be that with an ill member in the house, households receive more food from friends and relatives and therefore do not feel the lack of food to the extent of looking for food and not finding. This shows that the social system of food sharing is still very strong in this community. A similar trend was

reported in Timor-Leste wherein da Costa et al. (2013) described 'delayed reciprocity' as a coping strategy to food shortages. This is the sharing of food between neighbours and members of extended families whereby the gift is returned at a later date when the household that has received the gift has a surplus and/or its members are aware that the other household has a shortage.

3.4.5. The HFIAS approach has been adapted in the context of deforestation and tested but more studies are needed

This study has demonstrated that using the HFIAS approach (Ballard et al., 2013; Coates et al., 2007; Coates et al., 2006; Swindale and Bilinsky, 2006), household food security is still limited in the rural areas of Cameroon with only 1% of households food secure. Using this same approach and putting together rural and urban women, 4% of the population was observed to be food secure in Kenya (Keino et al., 2014) and the HFIAS score was 12.6 ± 6.8 for rural households and 11.2 ± 6.0 for urban households similar to 12.9 ± 5.57 obtained for this study. In a similar study in urban areas in Iran, 21% of households were found to be food secure (Nahid et al., 2014). Gebreyesus et al. (2015) demonstrated that there is an important gap between food secure households in urban areas and therefore suggest the likelihood of a very low food secure percentage in rural areas. This means that to properly address problems of undernourishment in Cameroon, emphasis has to be paid to the rural population who constitute the majority of the population (de Wasseige et al., 2012; Robiglio et al., 2010). Geographic targeting should consider households in the moderately deforested zone, which were those most affected by the severe forms of FIS parameters, while for severe hunger, the least deforestation zone should be considered most.

Forest governance and measuring the impact of forestry operations has been a major challenge to most decision makers (Levang et al., 2015; de Wasseige et al., 2012; Agrawal and Chhatre, 2011; Robiglio et al., 2010; Devereux, 2001). The extreme consequences of severe FIS was most prevalent in the moderately deforested zone. These results are novel in that I do not only analyse FIS access in rural areas (Gebreyesus et al., 2014; Keino et al., 2014; Nahid et al., 2014) but also contrasted them at different levels of deforestation. Thus, governments could apply these results to monitor for the impact of forest operation agencies on household FIS

access within the demarcation of forest management units. This can also be a useful tool in appreciating the evolution of forest governance and local peoples' livelihoods.

The HFIAS approach has been shown to be a simple and valid tool to measure the access component of household FIS in urban and rural settings around the world (Gebreyesus et al., 2014; Ballard et al., 2013; Coates et al., 2007; Webb et al., 2006). However, discrepancies in understanding of some of the nine HFIAS questions, especially with respondents on which the tool is being used for the first time, have been observed as a major constraint in rural and urban Ethiopia (Gebreyesus et al., 2014). Therefore, more studies are warranted in other parts of Cameroon to better apprehend the use of the tool.

3.5. Conclusion and recommendations

The aim of this research was to quantify the extent and intensity of household Food Insecurity (FIS) access experience along a deforestation continuum and demonstrate the degree to which households may be vulnerable to the consequences of FIS. FIS, as experienced by this population, was about compromising on quality and variety. But since this is an agricultural environment, this evokes low food access, including poor knowledge about the wide range of foods that may be found locally and food utilisation patterns. Overall, the least deforested zone presented the best HFIAS score and showed the least risk of hunger at community level, the moderately deforested zone showed the highest risk of FIS as a whole. It has suggested that communities in transition are the most vulnerable to FIS with increasing deforestation. This could be that in the most deforested area, other forms of food access have been improved while in the least deforested area forest foods are still more available, whereas in the moderately deforested area improved farming and forest foods are limited, demonstrating that communities in transition are the most vulnerable to FIS. Generally, the results have shown that different measures/parameters of FIS access present different trends with increasing deforestation meaning that each measure could be used for a specific targeting of that aspect of FIS. Hunger at the household and community level correlated negatively with the educational level of household head, meaning the more educated a household head is the less likely the household will go hungry. This means targeting for FIS needs to improve educational infrastructure and ensure the ability of the household head to read, write and understand.

This study has confirmed the assertions that ample food availability is necessary but does not guarantee accessibility and utilisation and thus food security. From this study, it could be concluded that using the HFIAS approach, adequate food access is still rare in the rural areas of Cameroon irrespective of the level of deforestation. It also suggests that women's health is an important factor that affects food access and needs to be improved to increase food access in rural areas. Finally, the risk of hunger at the community level was the most important risk factor, meaning that 'free' food obtained through gathering and scavenging is scarce in the study area. Thus, conventional food access mechanisms need to be improved to ensure adequate food supply in rural and forest areas. Furthermore, improved access to other food sources as well as some sensitisations on the management of food from farmers' fields needs to be buttressed.

These results bring a novel contribution to the analysis of FIS access in rural areas, since it contrasts FISH parameters with different levels of deforestation. With this, governments could use the developed approach to design programs for monitoring for the impact of forest operation agencies on household FIS access in order to promote forest governance programs and livelihoods sustenance of forest dependent people. It will be important to carry out more FIS analysis studies using the HFIAS tools for comparative purposes. As well, the government of Cameroon will require to put in place a monitoring program of the situation of FIS access in order to adequately address problems of undernourishment in the country.

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CHAPTER 4

FRUIT AND FRUIT TREE DIVERSITY AND MANAGEMENT ALONG A DEFORESTATION GRADIENT IN CAMEROON

Fruits from trees are diverse, nurseries are few, pest and diseases are prevalent

4.1. Introduction

The consumption of fruits and vegetables is generally low in developing countries (Ruel et al., 2005) including sub-Saharan Africa, making food insecurity (FIS) and undernourishment a daily reality for most households. Ensuring that all people have access to adequate and nutritious food produced in an environmentally and socio-culturally sustainable manner is presently one of the greatest challenges worldwide (Vicenti et al., 2013). Undernourishment is defined as an extreme form of food insecurity, arising when food energy availability is inadequate to cover even minimum needs for a sedentary lifestyle (FAO et al., 2012). Food security involves the means by which people have access to food and use it. Inadequate use of food at the household level leads to inappropriate care and poor feeding practices, which are the major causes of undernourishment, poor nutritional status and micronutrient deficiencies (Johnston et al., 2014; Lock et al., 2005). Undernourishment, which is used interchangeably with chronic hunger or hunger, is the outcome of poor nutritional status and micronutrient deficiency (FAO et al., 2012). It is food intake that is insufficient to meet dietary energy requirements. Nutritional status is defined as the physiological state of an individual that results from the relationship between nutrient intake and requirements and from the body's ability to digest, absorb and use ingested nutrients (FAO et al., 2012).

Increasing scientific evidence suggests that the consumption of sufficient fruits can help prevent a wide range of diseases (Kehlenbeck et al., 2013; Malézieux, 2013; Banwat et al., 2012; Nesbitt et al., 2010; Agudo, 2005; Ruel et al., 2005). Many fruits have high energy content that can help in facilitating the ability of the body to digest, absorb and use food nutrients because of their high concentrations of minerals and vitamins (Banwat et al., 2012). Despite these nutritional benefits, the consumption of fruits is very low due largely, but not exclusively, to inadequate supply (Pinstrup-Anderson, 2010; Agudo, 2005; Ruel et al., 2005). Therefore, a core strategy in addressing undernourishment in poor regions is to promote adequate availability of, and accessibility to, fruits (Kehlenbeck et al., 2013; Tchoundjeu et al., 2012), which in this paper is analysed using the case of fruits from locally available trees.

Securing food supply for the future requires adequate quantities and quality of agricultural production (Leakey, 2012; Gebbers et al., 2010; Robiglio et al., 2010). With increasing deforestation and high levels of poverty, people rely on energy dense diets just to

"fill the stomach" with little consideration of the quality of food being eaten (Loek et al., 2013). Physical access to food varies from one community to another. In poor and rural areas, food is acquired largely from own production mainly through subsistence agriculture supplemented with wild food sources through gathering (Asaah et al., 2011; Gebbers et al., 2010; Robiglio et al., 2010). Subsistence agriculture typically provides staple foods like grains, roots, tubers, bananas, plantains, cultivated fruits and vegetables (Loek et al., 2013; Tchoundjeu et al., 2012; Gebbers et al., 2010; Robiglio et al., 2010), while wild gathering provides for vegetables, fruits, nuts, etc. (Termote et al., 2012; Flyman and Afolayan, 2006; Shackleton and Shackleton, 2004).

Deforestation is a phenomenon that influences food supply especially wild fruit tree (FT) diversity and fruit supply (Powell et al., 2011; Robiglio et al., 2010). Despite many reforms in the forestry sector in Cameroon, the rate of deforestation appears to be one of the highest in the Congo Basin. According to de Wasseige et al. (2014), between 2000 and 2010, the annual rate of deforestation in Cameroon was approximately 1.04%. Additionally, it was reported that about 75% of the forest in Cameroon has been subjected to exploitation and is degraded (Robiglio et al., 2010). Thus, there has been a great modification in the naturally occurring tree species that potentially supply fruits to local communities. The contribution that domesticated indigenous FTs make to livelihoods and nutrition is often not acknowledged in both national or international policies and statistics (Leakey, 2014a; Akinnifesi et al., 2008; Schreckenberg et al., 2006).

Fruit availability and accessibility have been identified as important factors that influence fruit consumption (Kehlenbeck et al., 2013; Gregory et al., 2005). However, studies on fruit availability, accessibility and utilisation, with the intention to increase local consumption and ensure healthy nutrition for poor communities, are scarce worldwide. For instance, in an analysis of the publications of the French National Institute for Agricultural Research (INRA) by Tatry et al. (2011), almost half of the articles on fruits and vegetables focused on "control of bio-aggressors". Research on "plant material and variety innovation" accounted for 38% of the 136 publications, while graphic visualisation and publications on "socio-economic approaches" were limited. Food and nutrition related articles were blended into socio-economic publications although this did not come out clearly in the analysis. Therefore, practical approaches used by peasant farmers to increase fruit availability and

accessibility have not been sufficiently documented (Leakey, 2012; Asaah et al., 2011). Yet, such knowledge could help development agencies to design on the ground strategies to improve local availability of fruits. Since in rural settings, the majority of fruits are derived from trees, (Matig et al., 2006; van-Wyk, 2005) and trees are perennial, an in-depth study on the constraints and enablements of trees to supply edible fruits locally could help boost supply for increased food security. Improved technologies such as agroforestry systems and tree domestication have contributed largely in the availability and accessibility of fruits through improved tree planting and dissemination strategies (Leakey, 2012; Jamnadass et al, 2011).

Fruit trees are often found in many farming systems from home gardens (Goenster et al., 2011; Shackleton et al., 2008) to distant fields (Tchoundjeu et al., 2010; Degrande et al., 2006) and forests (Viviany et al., 2013; Akais et al., 2011). Generally, many farmers lack effective methods to achieve and maintain stable fruit production from year to year (Smith and Samach, 2013). They often harvest wild fruits from the forest to supplement regular supply from home gardens and farms (Kehlenbeck et al., 2013; Tchoundjeu et al., 2010; Kehlenbeck and Maass, 2004). There is huge potential for the diversification of fruit consumption from the wide range of FTs found in forests and other wooded lands (Banwat, et al., 2012). Traditionally, fruits have been harvested in forests and woodlands, but the availability, accessibility and utilisation of these resources is declining due to deforestation and forest degradation (de Wasseige et al., 2014; Asaah et al., 2011). Fruit trees are also important for environmental conservation and in agroforestry systems (Jamnadass et al., 2013; Quinion et al., 2010; Degrande et al., 2006). To improve the potential of FTs in the livelihoods of farmers in the humid lowlands of West and Central Africa, Degrande et al. (2006) examined farmers' tree planting decisions. They documented 11 exotic tree species and 35 indigenous FT species in Cameroon and Nigeria. These trees provided fruits, shade and fodder to the households as well as contributed to reduce biodiversity loss and land degradation (Kehlenbeck et al., 2013; Malézieux, 2013).

Many studies have evaluated FT ownership and FT diversity in farmers' fields (Kehlenbeck et al., 2013; Tchoundjeu et al., 2012; Degrande 2006) and home gardens (Larinde and Oladele, 2014; Shackleton et al., 2008). Kehlenbeck et al. (2013) working in Cameroon and Kenya recorded 57 indigenous FT species being consumed by the respondents with 36 being found on 104 surveyed farms and 21 species that were exclusively collected from the

wild. Thirty-three of the species found on farms were maintained from natural regeneration (e.g. trees protected during field clearing, new seedlings spared during weeding), of which 17 were never planted and 16 were both protected from natural regeneration and actively planted by respondents. Overall 149 crop species were identified, mainly fruit, vegetable, spice, or medicinal plants by Kehlenbeck and Maass (2004) in analysing crop diversity and classification of home gardens in Central Sulawesi, Indonesia. Despite the high number of FTs per home garden and the rich species diversity reported, it was unclear whether or not the fruits from these trees were solely harvested only by the households members. This means that conclusions could not be drawn on whether or not households had direct access to these FTs for increased home consumption.

Typically, farmers usually plant or retain a range of FTs and apply different management options. This is similar for wild species although this may not be as intensive as in cultivated fields. Bharucha and Pretty (2010) report that "what has also become clear is that farmers, hunters, gatherers, fishers and foragers do not simply take resources from a compliant environment. They manage and amend resources in much the same way as is standard practice on farms". This means a wide range of practices are used by farmers to maintain FTs on farms plus in the surrounding wild lands. Fruit tree planting is an old practice that has existed since the creation of humankind (Viviany et al., 2013; Akais et al., 2011). It has evolved and has been improved through new techniques in domestication (Leakey et al., 2012; Tchoundjeu et al., 2012) and the blending between wild and exotic genes. A major constraint in the supply of fruits in rural areas is the lack of dissemination of improved planting materials. A new way of domesticating trees, referred to as 'the participatory approach', has been developed in Cameroon in the last decade in a close collaboration between scientists and farmers (Leakey et al., 2012; Quinion et al., 2010; Tchoundjeu et al., 2010). This approach involves combining scientific advances in knowledge with local communities' experiences to bring a range of valuable indigenous FT species into cultivation. When applied in Cameroon, significant impacts on livelihoods were achieved. More fruits were observed in the diets of approximately 50% of adopters, and farm cropping systems became more diverse (Tchoundjeu et al., 2010). Although these kinds of technologies have provided encouraging results at the local level, it is not sure how far the technology has been disseminated and if other farmers out of the trial sites were able to grasp and use the technology. Additionally, these results were not contextualised

against a deforestation status or pressures meaning that it is hard to say whether or not the FTs are increasing or reducing with increasing deforestation and if yes which species and at what level of deforestation. Therefore, this study sought to analyse FT planting (nurturing) and management activities to assess the main problems faced by farmers at the local level.

Fruit found in sufficient quantities and of appropriate quality at the local level is useful in contributing to enrich household diets of household and thus promote food security. But this is often not achievable by regular supply chains (Jaenicke, 2008; Gregory et al., 2005). Fruit tree ownership, planting and management strategies are key to increasing fruit availability for enhancing the contribution of fruit intake to better nutrition (Kehlenbeck et al., 2013; Goenster et al., 2011; Lock et al., 2005). Increased FT ownership and better management options can contribute to local fruit supply in a more regular way. Although a wide range of FTs exist in forest areas of Cameroon (Degrade et al., 2006), the numbers, types and species of trees owned by individual households, as well as the problems, on-going FT planting (nurturing) and management strategies, are less known, neither are the effects of increasing deforestation. Consequently, it is hard to develop strategies to stimulate local fruit supply amongst households in forest areas. The objectives of this chapter were therefore to:

- Examine FT ownership and diversity in the face of increasing deforestation;
- Explore the level of awareness of local communities on FT planting (nurturing) and management activities;
- Investigate the factors that influence farmers' capacity to plant and maintain more FTs in their fields and home garden.

4.2. Methods

4.2.1. Data collection

In this study, village meetings and individual household interviews were used for data collection in the sites previously described in Chapter 2. Village meetings were organised at the beginning of data collection. During these meetings, the purpose of the study was explained to the participants and a list of the different FTs present in the village both planted and wild (unplanted) FTs was compiled using the free listing approach (Ambe, 2001). After the free listing exercise, a group of knowledgeable people were put together to write the names

correctly and find the equivalences in English/French. The final list of FTs were used as a guide to identify the FTs during household surveys.

A questionnaire was designed and tested in the Ngout community. The first section of the questionnaire sought basic information on household parameters. The second section considered three aspects of FTs: (i) ownership and diversity (investigated by the kinds, number and variety of trees owned by households), (ii) planting (nurturing) and management activities (that was verified through the locations of where FTs were found, sources of planting material, planting of a FT in the last three years by a household member, reasons for or not planting FTs and the main problems faced with FTs) and (iii) farmers' ability to plant more FTs (access to nurseries, land acquisition and ownership, fields and sizes, their willingness to plant more FTs, sources of information on FTs and their participation in past and future training activities on FTs).

A household was considered to be an arrangement of one or more people who occupy a housing unit (McFalls Jr., 2003) or those who dwell under the same roof and compose a family or those living and eating from the same pot daily. A total of 141 households were drawn randomly from the nine study villages for the interviews (Chapter 2). The questionnaire was coded and data entered into Excel and transferred into SPSS for analysis. Free listed FT species corroborated against key informant interviews enabled the research team to constitute the local names of fruit species. The scientific and common names of FT species were identified from Degrande et al. (2006), Matig et al. (2006) and van Dijk (1999). The questionnaires were administered to households with the main respondent being anyone who could answer the questions with some level of understanding on FTs. In most cases, we had a parent or the family breadwinner in the household as the main respondent and the other family members, including children, were free to take part in the interview especially on questions regarding family assets and FT activities. Where possible, the interviewer often asked other household members present to confirm the answers from the respondent or simply observed the countenance of the other family members to deduce if the response was candid. This approach was good as responses could be doubled-checked progressively as the interview proceeded. In addition, it was easier to attract the respondents' attention and gain their confidence without creating any suspicion, as explanations were provided to questions in the presences of all the

family members. Finally, the approach enabled solicitation of further explanation as required to address any uncertainties.

4.2.2. Data Analysis

Data analysis was done using Excel 2013 for data cleaning and drawing of graphs and descriptive statistics, whilst SPSS 20.0 was used for descriptive statistics, χ^2-tests, a multivariate test using the general linear model and simple ANOVA, and XLSTAT was used for running a Principal Component Analysis (PCA). Some responses were grouped together and citations used to demonstrate the most popular opinion on FT species used. Citation is a qualitative method used to show the magnitude of importance attributed to a particular response by various respondents (Betti and Mebere, 2011). Data analysis was done using descriptive statistics and cross-tabulations to observe differences between deforestation zone and other parameters on FT species, nature, location and management options. Knowledge indicators were constructed from the data to appreciate the level of understanding of the respondents on various parameters like management options and willingness to plant more FTs. PCA was run between villages (representing deforestation gradient) and FT types and between location of fruit trees and FT types.

4.3. Results

4.3.1. Fruit tree ownership, abundance, diversity and location

Fruit tree ownership, diversity and abundance

Fruit ownership was investigated by analysing the most abundant (numerous - meaning number of trees per species) and most cited (widespread within households) FTs for the entire study and each zone. Counting FTs commonly found in their fields, a total of 6 167 trees were recorded across all households with an average of 4.7 ± 6.9 trees per household. Of these, 1 981 trees were wild tree species (32%) with an average of 3.0 ± 2.7 trees per household and 4 186 planted tree species (68%) with an average of 6.3 ± 9.0 per households (Figure 4.1). Pear (*Persea americana*) in the least deforested zone and andobeti (*Irvingia gabonensis*) in the most deforested zone were identified as both wild and planted species. However, there was a strong association between fruit tree type (wild or planted) and fruit tree species (χ^2 = 1520.18 p <

0.001; Cramer's V = 0.996 p < 0.001) meaning that not many species existed as both wild and planted species. Therefore, of the 25 FT species that were distinguished, there were 11 planted and 16 wild FT species.

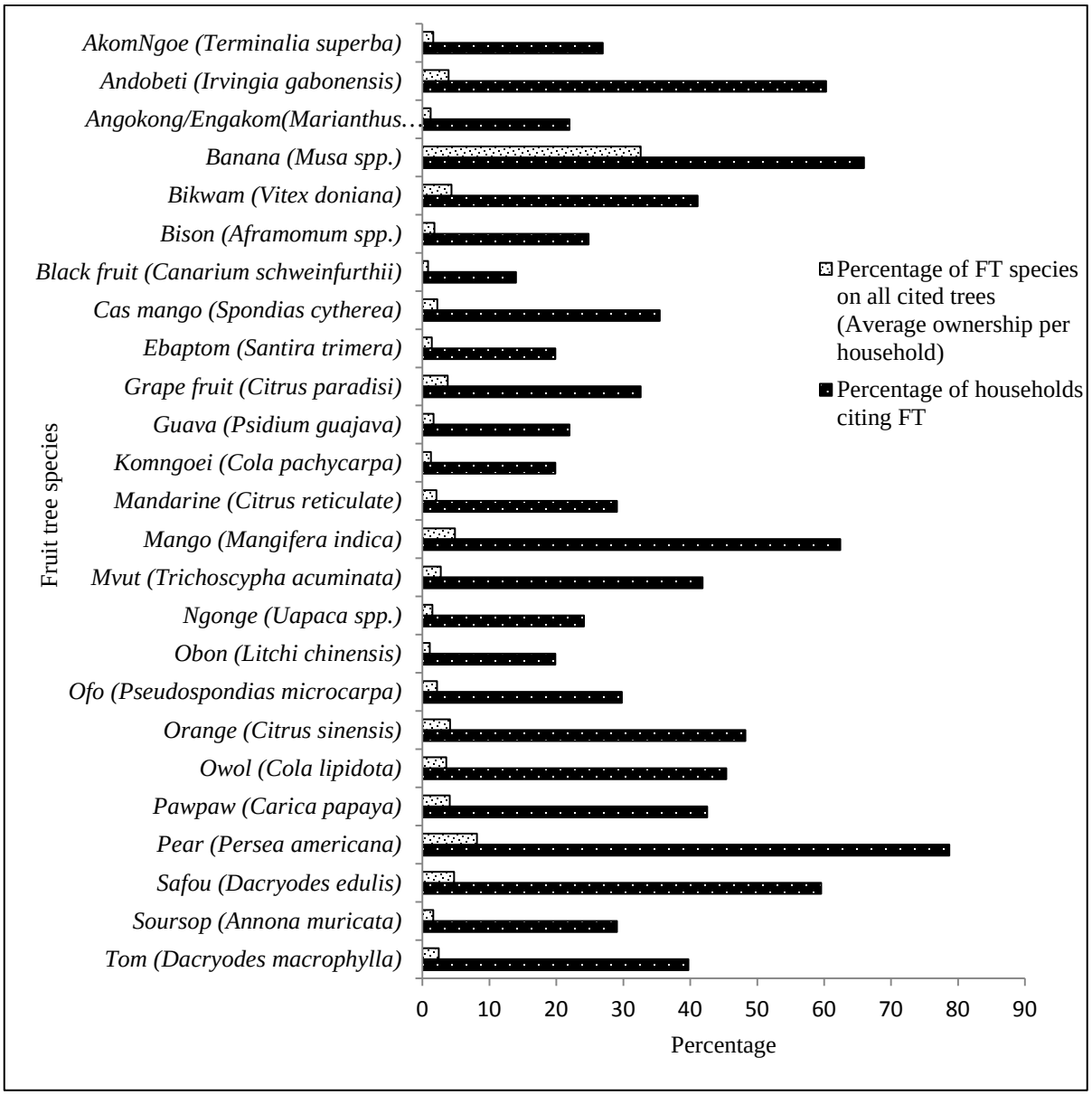

Figure 4.1: Percentage of occurrence and ownership of FTs

Fruits trees with the highest prevalence in peoples' fields were avocado pear (*Persea americana*), banana (*Musa* spp.), mango (*Mangifera indica*), andobeti (*Irvingia gabonensis*), safou (*Dacryodes edulis*), and orange (*Citrus sinensis*) reported by 79%, 66%, 62%, 60%, 60%

and 48% of households (Figure 4.1). The five most common fruits species were banana (*Musa* spp.) 21.6 ± 15.3% and a total of 2 012 trees, pear (*Persea americana*) 4.5% ± 4.1% and a total of 503 trees, mango (*Mangifera indica*) 3.4 ± 2.7% and a total of 301 trees; safou (*Dacryodes edulis*) 3.5 ± 2.6% and a total of 293 trees and bikwam (*Vitex doniana*) 4.6 ± 3.8% and a total of 267 trees. One-way ANOVA showed a significant difference in the mean of the number of FTs per variety and nature of FT ($F = 81.13$ $p < 0.001$). This implies that the mean number of planted and wild FTs per household significantly differed from each other with the occurrence of more planted than wild FTs (Table 4.1).

Per deforestation zone, the most abundant FTs species (species richness) for the most and moderately deforested zones were all planted species. In the least deforested zone, the third, fourth and fifth most abundant FTs species were wild species (Table 4.2). At all zones, the most abundant FTs were banana and pear. Looking at wild FTs, whereas owol (*Cola lipidota*) was the fifth most cited fruit in the most deforested zone, *Irvingia spp*. was the third for the least and the moderately deforested zones. The most, moderate and least deforested zones had 48%, 53% and 51% of planted FTs species and 52%, 47% and 49% wild species, respectively. Despite these observed differences, no association was observed between deforestation zone and neither planted ($\chi^2 = 13.22$ $p = 0.868$; Cramer's $V = 0.094$ $p = 0.868$) nor wild FT types ($\chi^2 = 37.13$ $p = 0.173$; Cramer's $V = 0.128$ $p = 0.397$). This means that the prevalence of planted and wild FTs species did not depend on the level of deforestation. And thus, it also implies that there was no relationship between the various FT species cited and deforestation zone ($\chi^2 = 49.93$ $p = 0.397$; Cramer's $V = 0.128$ $p = 0.397$). The spatial display of FTs on villages (deforestation gradient) is projected in Figure 4.2 which explains 53% of the results.

Figure 4.2 shows that species richness was higher in the most deforested zone and the Beyeyem and Npkwaeba villages of the moderately and least deforested zones, respectively. Fruit trees were least abundant in the Meyo Eli village of the least deforested zone. These results bring out four main findings. First, that the wild and planted FTs were distinct from each other. Second, that the most deforested zone (Ekali, Avebe and Akonmyada) had many more FTs individuals than the moderate (Biyeyem, Meyos and Minton) and the least deforested zones.

Table 4.1: Number of trees per type found in farmers' field

FT Species	Mean ± SD	N*	Range	Sum**	% of Total Sum	% of Total N
Planted						
Andobeti (*Irvingia gabonensis*)	5.0	1	5 – 5	5	0.1	0.1
Banana (*Musa spp.*)	21.6 ± 15.31	93	5 – 90	2 012	32.6	7.1
Grape fruit (*Citrus paradisi*)	5.1 ± 3.84	46	1 – 15	234	3.8	3.5
Guava (*Psidium guajava*)	3.3 ± 1.96	31	1 – 10	103	1.7	2.4
Mandarine (*Citrus reticulate*)	3.2 ± 3.14	41	1 – 20	130	2.1	3.1
Mango (*Mangifera indica*)	3.4 ± 2.65	88	1 – 15	301	4.9	6.7
Orange (*Citrus sinensis*)	3.7 ± 2.61	68	1 – 12	254	4.1	5.2
Pawpaw (*Carica papaya*)	4.2 ± 5.41	60	1 – 40	252	4.1	4.5
Pear (*Persea americana*)	4.6 ± 4.13	110	1 – 30	501	8.1	8.3
Safou (*Dacryodes edulis*)	3.5 ± 2.58	84	1 – 15	293	4.8	6.4
Soursop (*Annona muricata*)	2.5 ± 2.16	41	1 – 14	101	1.6	3.1
Total	6.3 ± 9.01	663	1 – 90	4 186	67.9	50.3
Wild						
Andobeti (*Irvingia gabonensis*)	2.8 ± 1.72	84	1 – 10	235	1.6	2.9
Angokong/Engakom (*Marianthus arboreus*)	2.5 ± 1.96	31	1 – 10	76	3.8	6.4
AkomNgoe (*Terminalia superba*)	2.6 ± 2.30	38	1 – 10	100	1.2	2.4
Bikwam (*Vitex doniana*)	4.6 ± 3.80	58	1 – 15	267	4.3	4.4
Bison (*Aframomum spp.*)	3.2 ± 2.80	35	1 – 12	111	1.8	2.7
Black fruit (*Canarium schweinfurthii*)	2.6 ± 2.19	20	1 – 10	52	0.8	1.5
Cas mango (*Spondias cytherea*)	2.8 ± 2.32	50	1 – 10	138	2.2	3.8
Ebaptom (*Santira trimera*)	3.1 ± 2.36	28	1 – 10	86	1.4	2.1
Komngoei (*Cola pachycarpa*)	2.8 ± 2.53	28	1 – 10	79	1.3	2.1
Mvut (*Trichoscypha acuminata*)	2.9 ± 2.70	59	1 – 17	169	2.7	4.5
Ngonge (*Uapaca spp.*)	2.7 ± 2.29	34	1 – 12	92	1.5	2.6
Obon (*Litchi chinensis*)	2.5 ± 2.13	28	1 – 10	69	1.1	2.1
Ofo (*Pseudospondias microcarpa*)	3.2 ± 2.39	42	1 – 10	135	2.2	3.2
Owol (*Cola Lipidota*)	3.4 ± 2.88	64	1 – 10	219	3.6	4.9
Pear (*Persea americana*)	2	1	2 – 2	2	0.0	0.1
Tom (*Dacryodes macrophylla*)	2.7 ± 2.25	56	1 – 13	151	2.4	4.2
Total	3.0 ± 2.56	656	1 – 17	1 981	32.1	49.7
Total wild + planted						
Andobeti (*Irvingia gabonensis*)	2.8 ± 1.73	85	1 – 10	240	3.9	6.4
Pear (*Persea americana*)	4.5 ± 4.12	111	1 – 30	503	8.2	8.4
Total	4.7 ± 6.84	1 319	1 – 90	6 167	100.0	100.0

** Number of households that mentioned having this fruit tree in their fields*
*** Total number of fruit trees per species*

Third, that, pear and andobeti were the only two fruits that were both wild and planted varieties. Finally, Ekali and Beyeyem villages although found in the most and the moderately deforested zones, respectively, have similar occurrence of FTs while Meyo-eli in the least deforested zone was different from all other villages in the existence of FT species.

Table 4.2: Most abundant and most frequently cited FTs per deforestation zone

Deforestation zone	Five most abundant FTs	Means ± SD of FT per household	Total number of trees
Most	Banana (*Musa spp*.)	4.6 ± 3.2	676
	Pear (*Persea americana*)	3.5 ± 3.0	201
	Mango (*Mangifera indica*)	3.7 ± 2.8	141
	Safou (*Dacryodes edulis*)	21.1 ± 13.5	128
	Pamplemousse (*Citrus paradisi*)	3.7 ± 3.1	118
Moderate	Banana (*Musa spp*.)	5.1 ± 5.1	616
	Pear (*Persea americana*)	20.5 ± 16.8	169
	Pawpaw (*Carica papaya*)	2.6 ± 1.6	114
	Mango (*Mangifera indica*)	3.8 ± 2.5	98
	Orange (*Citrus sinensis*)	3.4 ± 2.3	95
Least	Banana (*Musa spp*.)	3.9 ± 4.1	720
	Pear (*Persea americana*)	23.2 ± 15.9	133
	Andobeti (*Irvingia gabonensis*)	2.8 ± 2.0	88
	Owol (*Cola lipidota*)	3.3 ± 2.7	84
	Bikwam (*Vitex doniana*)	2.8 ± 2.0	79
Most frequently cited FT species by households			
Deforestation zone	Five most cited FTs species by households	Means ± SD (number of FTs per household)	Number of households citing species
Most	Pear (*Persea americana*)	4.6 ± 3.2	44
	Mango (*Mangifera indica*)	3.5 ± 3.0	40
	Safou (*Dacryodes edulis*)	3.7 ± 2.8	35
	Banana (*Musa* spp.)	21.1 ± 13.5	32
	Owol (*Cola lipidota*)	3.7 ± 3.1	27
Moderate	Pear (*Persea americana*)	5.1 ± 5.1	33
	Banana (*Musa spp*.)	20.5 ± 16.8	30
	Andobeti (*Irvingia gabonensis*)	2.6 ± 1.6	28
	Mango (*Mangifera indica*)	3.8 ± 2.5	26
	Safou (*Dacryodes edulis*)	3.4 ± 2.3	26
Least	Pear (*Persea americana*)	3.9 ± 4.1	34
	Banana (*Musa spp*.)	23.2 ± 15.9	31
	Andobeti (*Irvingia gabonensis*)	2.8 ± 2.0	31
	Safou (*Dacryodes edulis*)	3.3 ± 2.7	23
	Mango (*Mangifera indica*)	2.8 ± 2.0	22

Fruit tree location per deforestation zone

Fruit trees were found in all types of land-uses from home gardens to far-off farms and the forests (Figure 4.3). The most important location of FTs was food and cash crop fields in all deforestation zones. A significant relationship was observed between the location of FTs and deforestation zone ($\chi^2 = 41.96$ $p < 0.001$; Cramer's V = 0.121 $p < 0.001$).

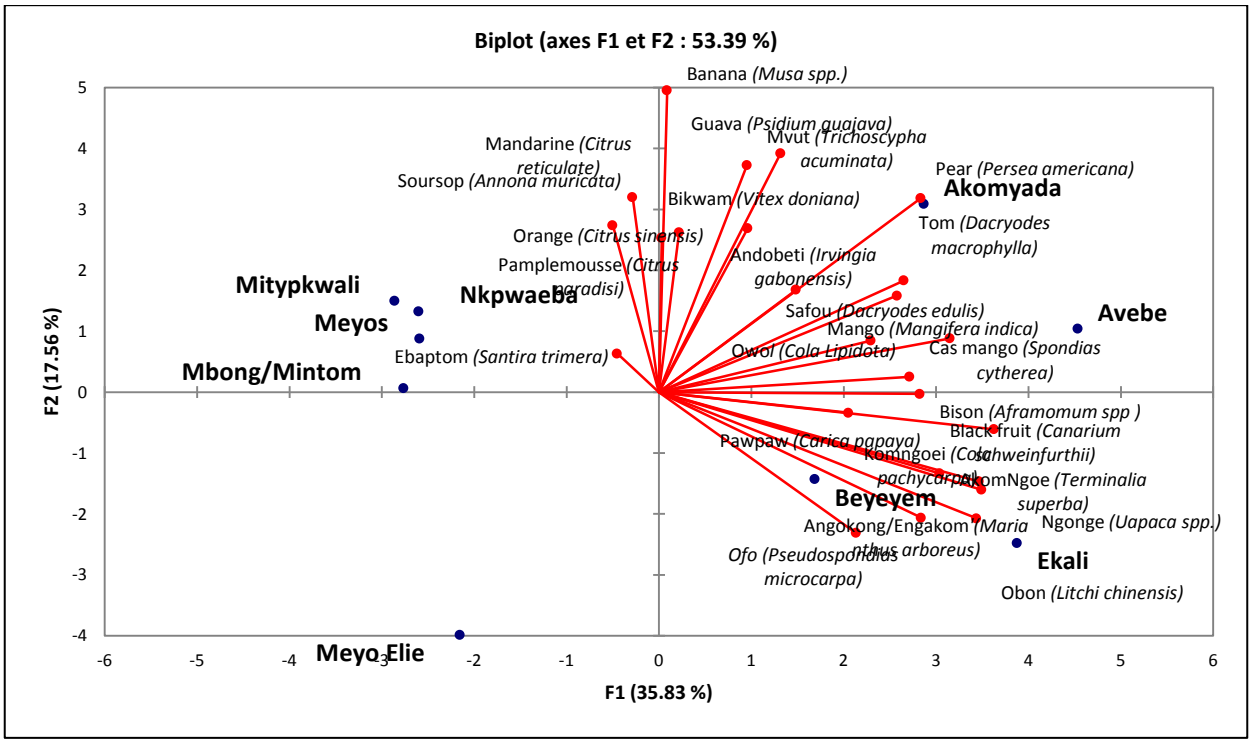

Figure 4.2: PCA vector plot of fruit tree diversity within villages

Food and cash crop fields were more cited in the most followed by the least and last by the moderately deforested zones. Home gardens were more common in the moderately deforested zone and similar in the most and least deforested zones. Of a total of 5 765 trees whose location was specified by farmers, food and cash crop fields harboured 2 870 trees (50%), home gardens 1 874 trees (33%), forest/fallow land 599 tree (10%), bush farms 282 trees (5%) and orchard/FT plantation 152 trees (3%). Home gardens had the highest FT density with 6.2 ± 9.8 trees per household while bush farm had the least 3.7 ± 3.48 trees per household. On an average, 4.6 ± 6.70 trees were found on each land use type. Figure 4.4 shows a PCA representing FTs species along the deforestation gradient.

Figure 4.4a, shows the most deforested zone in which most FTs species were found in the food and cash crop fields with the other land use systems having an almost equal distribution of FTs species. Black fruit was more concentrated around forest and fallowed land. This PCA explains 90.4% of the variance. For the moderately deforested zone (Figure 4.4b), FT species were fairly distributed over all land uses with the exception of orchard and bush farms. Black fruits and komngoei were more located in bush farms.

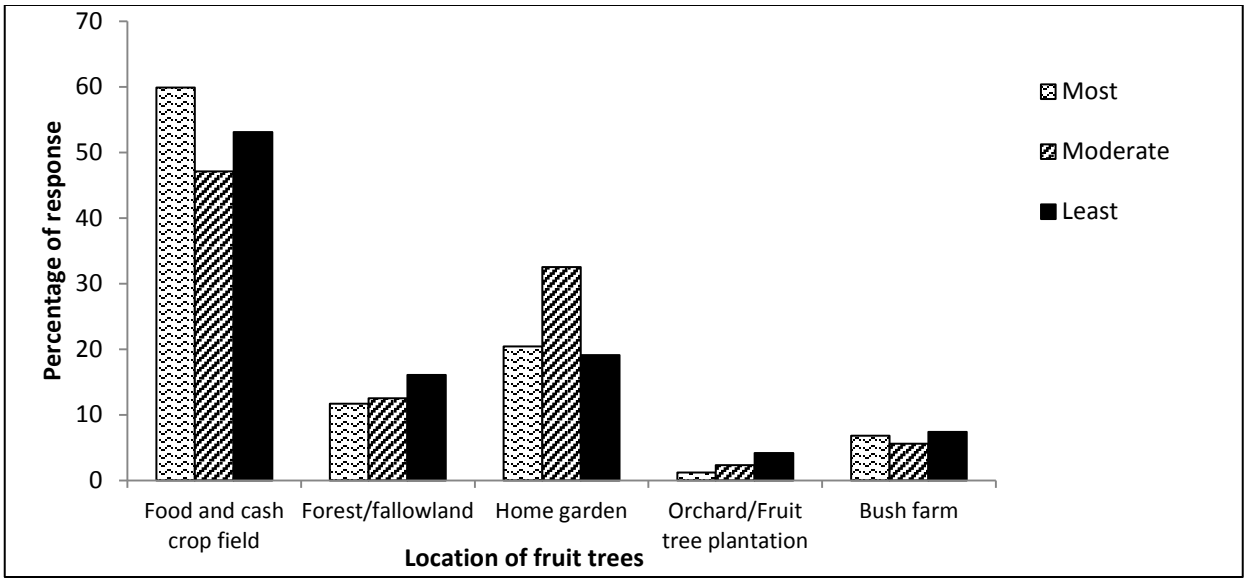

Figure 4.3: Location of FTs per deforestation zone

This PCA explains 87% of the variance observed. For the least deforested zone (Figure 4.4c), the PCA explained 89% of the variance and most trees were located in the food and cash crop field and home gardens. Forest/fallowland and bush farms showed similar trends in tree location and harboured some wild fruits like komngoei, casmango and blackfruit. In all three graphs, orchard/FT plantation showed similar trends and was always close to the horizontal negative axis (Figure 4.4).

From Figure 4.4, Anova showed no significant difference between the number of FTs and location in the most and the least deforested zones ($F = 0.89$ $p = 0.470$ and $F = 2.04$ $p = 0.089$), respectively but was significant for the moderately deforested zone ($F = 4.52$ $p < 0.001$). This means that FTs were evenly distributed on the land use types in the most and least deforested zones and was not for the moderately deforested zone in which home gardens dominated with an average of 6.8 ± 10.8 trees.

Comparing the kind of FT, deforestation gradient and location of FTs, χ^2 suggested no significant relationship ($\chi^2 = 45.45$ $p = 0.578$; Cramer's V = 0.545 p = 0. 578). But there was a significant relationship in the food and cash crop field ($\chi^2 = 66.27$ $p = 0.027$; Cramer's V = 0.208 p = 0.027) and with home garden ($\chi^2 = 71.06$ $p < 0.001$; Cramer's V = 0.325 p < 0.001). This confirms that that these two land use systems were more recorded in the most and the moderately deforested zones, respectively.

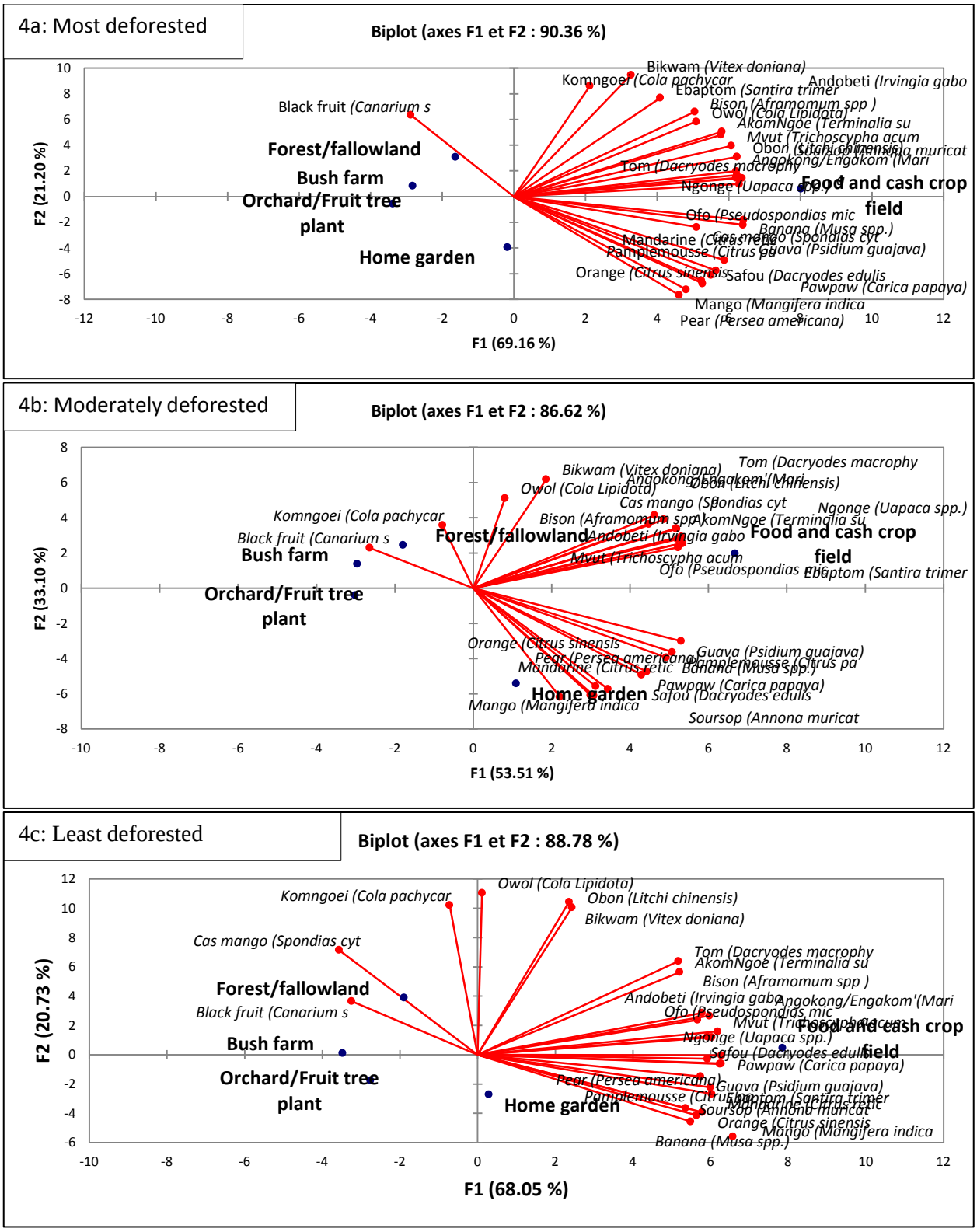

Figure 4.4: PCA vector plot for location and FTs per deforestation zone

4.3.2. Fruit tree planting and management activities

Farmers' perspectives on fruit tree planting material and access to seeds

Farmers' knowledge on whether they knew the difference between improved and local FT species was evaluated to bring out the rationale behind the type of seeds they use. More than 80% of FTs found at all levels of deforestation were local varieties. A few farmers mentioned species coming from IRAD (Institute of Agricultural Research for Development) Cameroon, maybe because the current research team was introduced as scientists from IRAD. No wild fruit species was listed as improved. The sources of planting material were; found in the field when bought/established (29%), natural regeneration on the farm (24%), neighbour/family (21%), locally collected and pregerminated seeds (20%), bought from a nursery (3%), from an NGO (3%) and orchard/FT plantation (1%). The sources of seeds per deforestation gradient are summarised on Figure 4.5 in which the PCA scatter plot shows how the various FT species are related to the source of planting material per deforestation zone. On the PCA graph, very few farmers obtained seeds from an NGO, bought from a nursery and orchard or FT plantation. The graph explains 83% (Figure 4.5a), 79% (Figure 4.5b) and 77% (Figure 4.5c) of the variation observed in the most, moderately and least deforested zones.

The PCA between FT species and the sources of seeds suggests that in the most deforested zone (Figure 4.5a), the planting materials of planted FT species were from neighbour/family, locally collected and pregerminated seeds. For the wild species, the seeds were found in the field when bought or natural regeneration. Not many seeds were obtained from NGOs, nurseries and orchards. This trend was similar for the moderately deforested zone (Figure 4.5b) although locally collected and pregerminated seeds were almost absent. In the least deforested zone (Figure 4.5c), the sources of planting material were natural regeneration and found in the field when established for wild species. For planted species, it was locally collected and pregerminated seeds. No fruit trees species showed any relationship with the other sources of planting materials. The percentage of households that had access to a nursery was 45%, 34%, and 24% respectively, for the most, moderately and least deforested zones. A majority of those who said they had access to a nursery in the most deforested zone either locally collected and pregerminated their seeds (48%) or got their seeds from neighbour/family (29%).

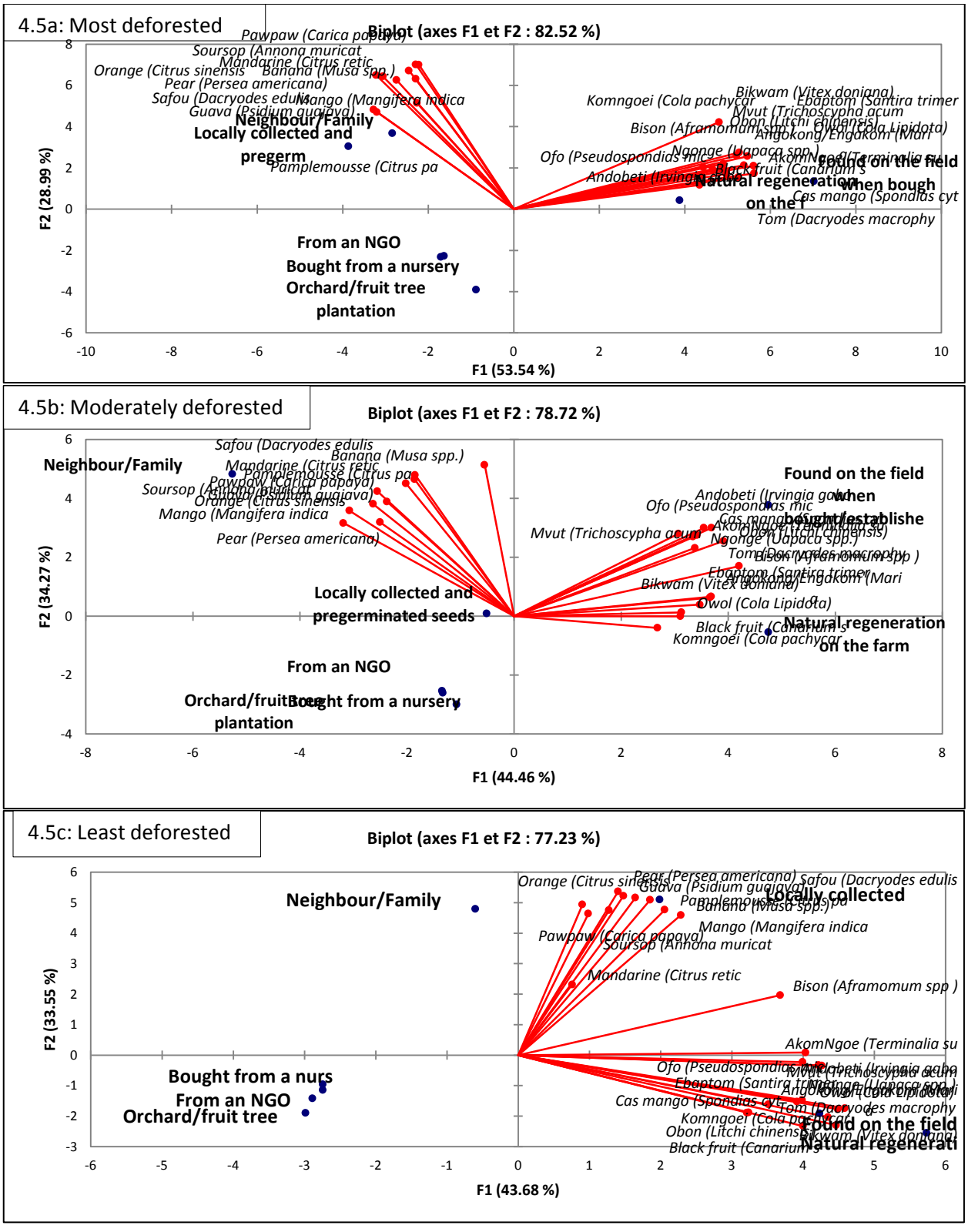

Figure 4.5: Vector diagram for the types of fruits and sources of seeds per deforestation zone

For the moderately deforested zone, the majority of those who said they have access to a nursery got their seeds through neighbour/family 60%, natural regeneration on the farm (13%) and found on the field when bought/established (7%). In the least deforested zone the majority either locally collected and pregerminated seeds (36%) or got from neighbour/family (36%). These results may suggest that farmers' use of nurseries is still limited and access to improved seedlings from modern nurseries is poor.

4.3.3. Factors that influenced farmers' capacity to plant and maintain more fruit trees

Land acquisition and use

Households were asked to evaluate the means of land acquisition and quantity of land they could have for FT planting. Whereas 74% of households acquired land through inheritance, 16% obtained it through personal establishment and only 10% bought land (Figure 4.6). ANOVA showed a significant difference between size of land area and mode of land acquisition ($F = 5.71$ $p = 0.004$). The surface area of land varied with means of acquisition – purchase (3.6 ha ± 2.5 ha), inheritance (2.9 ha ± 2.5 ha), personal establishment (5.1 ha ± 3.5 ha). Figure 4.6 shows that the mode of land acquisition significantly relates to deforestation zone ($\chi^2 = 30.86$ $p < 0.001$; Cramer's $V = 0.331$ $p < 0.001$). Whereas many households in the most deforested zone bought land, many more in the least deforested zone were acquiring land through personal establishment.

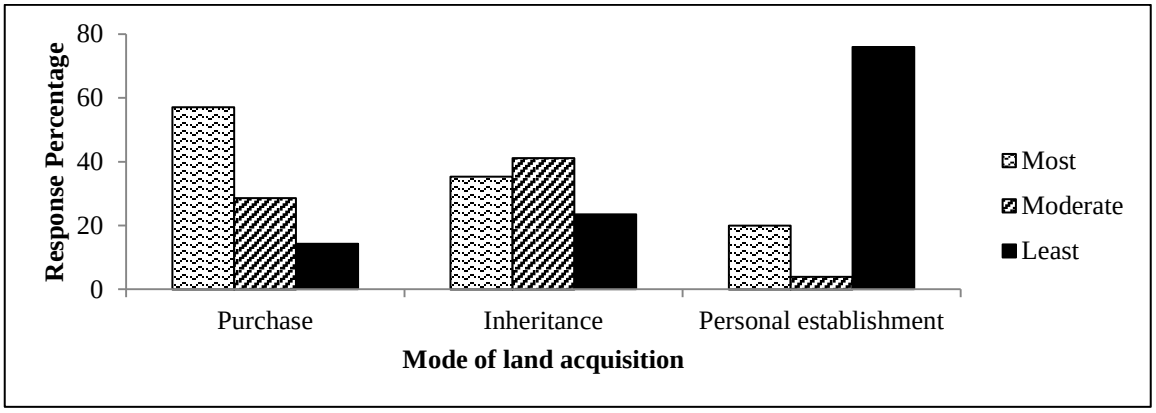

Figure 4.6: Mode of land acquisition per deforestation gradient.

Land areas ranged between 0 – 10 ha with a mean of 2.3 ± 1.89 in the most deforested zone; 0 – 11 ha and a mean of 2.6 ± 2.36 ha in the moderately deforested zone and 1 – 14 ha with a mean of 5.4 ± 3.97 ha in the least deforested zone. This shows that, there are some households which did not have access to land for FT planting. This is either because they did not have enough land as a whole or because of other family problems. Generally, as the rate of deforestation increases, land becomes scarce for FT planting.

Respondents were asked if they have planted FTs over the last three years, 106 households (76%) said yes while 34 households (24%) said no. The reasons for planting FTs were as follows; for consumption 38%, for consumption and processing 34%, for consumption and sales 19% and to have a big plantation or protect land and for children 8% and 2%, respectively. These responses indicate that the most important reason for planting FTs was for consumption. Meanwhile, no association was observed between reason for planting FT and the means of land acquisition ($F = 1.39$ $p = 0.232$).This signifies that the land area owned by farmers could not be used to determine the willingness to plant FTs.

The reasons for not planting FTs were many. To begin with, was the inability to work alone as and lack of money/ time and cited by 35% and 16% of respondents respectively. Then, that lack of improved seeds and fear of climate change was listed by 12% of respondents in each case while 9% of respondents each mentioned lack of land and destruction by insects after first trial as another constrain. Finally, a small proportion of 6% of respondents remarked that fruits trees were not as beneficial as vegetables and food crops. It is recommended that strategies to promote FT planting in the study area should address the above cited constraints.

4.1.1.1. Destination of harvested fruits

Farmers were asked to indicate the destination of harvested fruits in four portions - consumed, sold, given away and lost (Table 4.3). Multivariate general linear model between subject and effects suggest no significant difference between the means of various shares of fruits destination and deforestation gradient (% consumed $F = 2.58$ $p = 0.084$; % sold $F = 0.63$ $p = 0.535$; % given $F = 0.57$ $p = 0.567$; % lost = 0.21 $p = 0.812$). This means that the destination of harvested fruits were similar at all levels of deforestation and the percentage lost was quite high. Huge loss after harvesting could significantly discourage farmers from planting and maintaining FTs on their fields.

Table 4.3: Percentage of share use of fruits along a deforestation gradient

	Deforestation zone	Mean ± SD	N	F	p
% Consumed	Most	40.2 ± 18.1	23	2.58	0.084
	Moderate	30.8 ± 23	24		
	Least	45.3 ± 19.2	15		
	Total	37.8 ± 20.9	62		
% Sold	Most	32.4 ± 19.7	23	0.63	0.535
	Moderate	39.2 ± 27.1	24		
	Least	32.7 ± 19.1	15		
	Total	35.1 ± 22.6	62		
% Given	Most	11.1 ± 5.8	23	0.57	0.567
	Moderate	10.4 ± 11.1	24		
	Least	8.3 ± 2.4	15		
	Total	10.2 ± 7.8	62		
% Lost	Most	12.6 ± 9.9	23	0.21	0.812
	Moderate	12.1 ± 11.7	24		
	Least	14.3 ± 10.5	15		
	Total	12.8 ± 10.6	62		

4.4. Discussion

Iron and vitamin A deficiencies that are prevalent in most parts of sub-Saharan Africa affect around 50 million African children. Vitamin C from fruits is essential for absorbing iron from other foods (Agudo, 2005). Indigenous fruits contribute to the vitamin and mineral supply of local communities. Local availability and accessibility of fruit to households members in poor communities has a major impact on the consumption of fruits (Bernholt et al., 2009). In urban and peri urban gardens (Larinde and Oladele, 2014) and home gardens (Kehlenbeck and Maass, 2004), FTs provide fruits to households. People living in poor environments with less access to financial resources and markets (Simitu et al., 2009) acquire fruits from planted and unplanted FTs for improved livelihoods (Kehlenbeck et al., 2013; Viviany et al., 2013; Schreckenberg et al., 2006). Increasing rate of deforestation is a global threat in the Congo Basin (De Wasseige et al., 2012; Robiglio et al., 2010) but how this influences planted (planted) and unplanted (wild) FTs availability and accessibility is poorly understood. In this chapter, I have explored FT ownership and diversity and management strategies as mechanisms that can help boost local availability and accessibility of fruits for improved food security along a deforestation gradient.

4.4.1. Dynamics surrounding fruit tree ownership and diversity for increased food security

Many forest based livelihoods are declining in Cameroon and elsewhere (Dawson et al., 2011; Robiglio et al., 2010). The related decline in availability of forest products such as food, medicine, fodder, timber and fuel wood with its negative impact on traditional diets, health systems and income can be partly offset by promoting diverse agroforestry systems (Kehlenbeck et al., 2013; Quinion et al., 2010). Fruit tree ownership and diversity has been studied by many authors around residential areas (Larinde and Oladele, 2014; Bernholt, 2009), in home gardens (Shackleton et al., 2008), on farmers' fields (Degrande et al., 2006) and in adjacent forest (e.g. Boedecker et al., 2014; Assogbadjo et al., 2013). This study examined household FT ownership and diversity along a deforestation gradient. Results showed that there was no significant relationship between deforestation zone and mentioned fruits species. It is generally estimated that increased deforestation will contribute to climate change and thus could probably shift the natural geographic ranges, and reduce density and productivity of some wild fruit species (Dawson et al., 2011). The HFZ of Cameroon which include my study sites was affected by high levels of deforestation in the 1990's and early 2000's (de Wasseige et al., 2014; Mertens et al., 2000) and consequently has been distressed by climate change in different ways (Sonwa et al., 2012) whose effect on food security are becoming more evident (Bhaskar et al., 2015). On a smaller scale, this study has confirmed Dawson's results by showing that the moderately deforested zone registered the least number of wild FTs while the most deforested zone registered the highest number of wild and planted FTs species.

Results by Simitu et al. (2009) on diversity of indigenous FTs and their consumption in Kenya showed a total of 57 indigenous FTs species mentioned as being consumed by the respondents. In this study, it was found that the rich species diversity and high number of FTs per field was obscured by the problem of ownership of FTs. Additionally, the definition of households that was unpredictable in the context of FT ownership. As described by McFalls Jr. (2003), a household was made up of people who dwell under the same roof and compose a family or those living and eating from the same pot daily. Furthermore, a household was defined as "one person who lives alone or a group of persons related or unrelated, who live together and share food or make common provisions for food and possibly other essentials for a living" (Cogill, 2001). From this perspective, a household is supposed to exclude grown up

children that have established homes elsewhere out of the main compound. Following this description it was easy to separate households on the field. However, when linking the concept of households to FT ownership, it became complicated. Land acquisition was predominantly through inheritance and someone may be living out of the village or in another neighbourhood but owns FTs elsewhere because they own the land. This was the case of a 49-year-old woman whom, although is married in Avebe village, owned FTs in Akomnyada where she originally comes from. However, in asking farmers in Akomnyada about the number of FTs they own, they obviously included the FTs that this lady owns. Likewise, in the same community, I also noticed that more than two households may mention the same FT to belong to them because they have access to it through social relationships and organisations. This is the case of a 63 year old man in Biyeyem who mentioned that he had farm/FTs in Meyos village. Therefore, it is generally difficult to understand the number of people that may be benefiting from the fruits from a single tree. While this is good to increase food security and fruit consumption locally, it poses a problem because sometimes the number of FTs mentioned may mislead expectations on fruit supply and consumption. This means that generally, high number of FT on farmers field may be recorded but since many people can claim ownership to the same trees, the quantity of fruits that each household will harvest will be low and eventually, consumption level will be lower than expected. This is similar in the case of Simitu et al. (2009) who counted 4 048 trees found on farmers' fields in Kenya but fruit consumption was still very low for that community. Mean daily consumption of fruits was 19 g per person for adults and 23 g for children who ate more wild fruits, and varied between 19 g to 28 g when exotic fruits from markets were included. Despite the high FT diversity, the mean consumption of fruits in this Kenyan society was below the WHO recommended 400 g/person/day (Agudo 2005). This suggest that once planted FT may not belong to a single household but to other people even those in urban areas. This therefore suggests the need for some real actions to boost up FT planting in order to enhance fruit availability/accessibility and subsequently intake.

4.4.2. Constraints to fruit tree planting

This study gives the impression that farmers' understanding of nurseries was limited and they did not have access to improve planting material from nurseries. However, such findings supports results by Bharucha and Pretty (2010) who noted that "what has also become

clear is that farmers, hunters, gatherers, fishers and foragers do not simply take resources from a compliant environment. They manage and amend resources in much the same way as is standard practice on farms". Additionally, Leakey and colleagues have shown in a number of locations that rural farmers actively select for desirable traits, indicating the initial stages of domestication (Meyer et al., 2012; Leakey et al., 2004). Seeds were a major constraint as a majority of farmers used poor quality material from traditional nurseries.

Wild and planted FTs were found in all forms of land uses in the most and least deforested zones. In the moderately deforested zone, and particularly in bush farms, only wild fruits were found. This could mean that there is some level of management going on in this zone although timidly. The training of farmers on FT domestication and the use of improved planting material from modern FT nurseries should be promoted. ICRAF is one of the leading institutions in Cameroon for the promotion of FTs cultivation through capacity building, mainly participatory domestication (Tchoundjeu et al., 2010). This strategy has proven to be effective and thus needs to be reinforced and valorised.

4.1.2. Fruit tree existence versus land ownership

Land is a key social and economic asset, crucial for cultural identity, political power and participation in policy decision making (Fon, 2011; Davison, 1998). Land ownership has always been recounted as a factor that promotes FT planting (Goenster et al., 2011; Tchoundjeu et al., 2010; German et al., 2009; Schrekenberg et al., 2006). But regarding general patterns of land acquisition, this will not be thesame for many strangers and women. Fon (2011) noted that the results of access to arable small-scale land and control of arable small-scale land indicate that the prevailing pattern of land accessibility for women was not reliable. This is because women usually depended on their spouses (husband's family) for land acquisition. Once the woman divorced, or the spouse passed away, she often lost access to such land. From village meetings and key informant interviews, it was recounted that all land, including forest land belonged to the family head or village chief, and social redistribution is done to all family members as need arises. This is similar in most African countries, for instance as reported by German et al. (2009) in Malawi and Zambia. In the case of forestland, all family members were free to establish a new farm by clearing down the forest but after the approval of the family head – 'for blessings'. Once the land is left on fallow, it becomes the property of the family

head once more. Since FTs are permanent crops, they automatically belong to the family head even those in the fields of other family members, although when a family member establishes a farm or plants a FT, they can in principle own that tree. But, the family head had a right to harvest and use (even sell) the fruits when deemed necessary (which has often resulted to tension between family members). Thus, family heads laid a lot of importance on FTs because it gave them extra power to intrude into the lives of all family members and impose their position/authority.

Overall, FTs served as a source of guarantee on land and power to the owners. Some farmers exaggerated the number of fruits trees they own by making claims over FTs that in reality did not belong to them because they wanted to show their strength in the village. Such exaggerated figures mask the rationale of a study that wants to determine the local availability of FTs for increased fruits supply to communities. Then, FTs were a source of income and family property. For example, in Mbong/Mintom, a 33 year-old man noted "I am now establishing a new FT farm on a plot I established myself in the forest - the other FTs I planted when I was young my grandfather claims they belong to him because he is the family head. And everybody in the village supported him – but now I have told everyone to know about this new effort I am making… I will not accept that situation again. However I cannot stop family members to gather the fruits under the trees when they are ripe for it will be an abomination – for instance the *Irvingia spp*. trees I found there, all family members go to gather its fruits when they fall – I have made it clear I am to the only one to climb and harvest – not even my wife". This means that all family members not household members had the right to gather fruits from FTs on all family land (cultivated, fallow or forest land). Although this is advantageous, it does not guarantee sufficient fruit supply as the beneficiaries from the fruits will be on a come first serve first basis. This was most prevalent in the least deforested zone wherein > 90% of households acquired land through inheritance and clearing of a forest.

4.5. Conclusion

Fruit tree ownership, planting and management strategies are key to increasing fruit availability for enhancing the contribution of fruit intake to better nutrition in poor regions. Although a wide range of FTs exist in forest areas of Cameroon, the numbers, types and species of trees owned by individual households, as well as the problems, on-going FT planting

(nurturing) and management strategies, are poorly known, as are the effects of increasing deforestation. Consequently, it is hard to develop strategies to stimulate local fruit supply amongst households in forest areas.

With 25 registered FT species, a total of 6 167 trees individuals were recorded across all households with an average of 4.7 ± 6.9 trees per household. Both wild and planted fruit tree species were found at all levels of deforestation although the occurrence of planted species was significantly higher than for wild species and this was similar for all levels of deforestation. Fruits trees with the highest prevalence on peoples' fields were avocado pear (*Persea americana*), banana (*Musa* spp.), mango (*Mangifera indica*), andobeti (*Irvingia gabonensis*), safou (*Dacryodes edulis*), and orange (*Citrus sinensis*). PCA showed that FTs species richness was highest in the most deforested zone with some similarities in existence of FT in the Ekali and Beyeyem villages although found in the most and the moderately deforested zones, respectively, while Meyo-eli in the least deforested zone was different from all other villages. This means that villages in the least deforested zone, specifically those close to the road side showed the poorest prevalence FTs prevalence.

Land for FT planting was more scarce with increasing rate of deforestation. Some households did not have access to land for fruit tree planting. This is either because they did not have enough land as a whole or because of other family problems. Therefore, for the effective promotion of fruit tree activities they is a need to institute some sort of a guarantee on land for the community members. Further, the main people to target for the promotion of fruit tree planting should be the family head or the person that decides on how to reallocate family land.

People are aware of the importance of fruit tree planting and are practising it even though at a traditional scale. It will be important to initiate a fruit tree planting program at household and community level in the study villages. In this way, those with limited land spaces, children and other vulnerable groups could benefit from fruits within the community spaces like school premises. The people that take part in fruit tree planting meetings and participate in the initiative are important for the sustainability of the imitative and land allocation. Therefore, fruit tree planting programs should target family heads and those that make decisions about land allocation within families and the villages. Particularly for the least deforested zone, the best land use systems for FT planting will be home gardens and food and cash crop fields. This is logical because with the high forest canopy, most fruit trees will likely

have more disease infestation and more wild animals will probably compete for the ripe fruits with the plantation owners (See chapter 6) if other land use forms are used.

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CHAPTER 5

HOUSEHOLDS' AWARENESS OF THE IMPORTANCE OF FRUIT CONSUMPTION IN THE CONTEXT OF DEFORESTATION IN CAMEROON

Children under the age of two ate fruits. Photo by Tata P.

5.1. Introduction

Of about one billion hungry people in the world today, 98% live in developing countries. Approximately 70% of chronically hungry people are smallholder farmers. Forty-three percent (43%) of total farmers worldwide are women and 38% of youths in Africa are working in agriculture (Conway and Wilson, 2012; FAO, 2011). Frequently, the livelihood and food security of smallholder land users are often at risk as a result of unpredictable harvests, land degradation and climate change (Paumgarten and Shackleton, 2011; Mertens et al., 2000; Ndoye and Kaimowitz, 2000; Sunderlin et al., 2000). Thus, curbing the rate of undernourishment in the world is a great challenge, especially in sub-Saharan Africa (Vicenti et al., 2013; Arnold et al., 2011; Goenster et al., 2011). For instance, in the forest areas of Cameroon, stunting and chronic cases of malnutrition affect 30% of children aged between 24-47 months in the South region and 28% in the Centre region (Socpa et al., 2008). Promoting the consumption of fruit in poor communities and amongst vulnerable groups could help in addressing problems of nutrient deficiency and malnutrition (Paumgarten and Shackleton, 2011). Fruit trees (FT) are particularly advantageous given that they are perennial and can contribute to fruit supply at the local level over several decades. At the same time, they can contribute to environmental conservation, carbon storage and soil fertility, thereby increasing agricultural production in the long run (Tee et al., 2009; Degrande et al., 2006; Ambe 2001; Duguma et al., 2001). Fruit can serve as safety nets in the diet of households when agricultural products are scarce and households are vulnerable to food shortages (Cruz-Garcia and Price, 2012; Paumgarten and Shackleton, 2011).

Fruit trees are planted (cultivated) or unplanted (wild-naturally existing in the forest or retained on farm land) (van Djik, 1999), and can be exotic (imported from a different region) or indigenous (local to the habitat) (Luczaj et al., 2013; Jaenicke, 2008; Matig et al., 2006; van-Wyk, 2005). In this study both cultivated and wild FTs are considered irrespective of whether they are indigenous or exotic. With the exception of Kenya, no country in sub-Sahara African consumed more than half of the WHO/FAO recommended quantity of fruit and vegetables (Ruel et al., 2005). Although richer households expend more on fruit and vegetables, across the continent, only 30% of households were able to reach the recommended minimum consumption. Considering the lowest five countries, less than 10% of households were able to

meet the minimum requirements (Ruel et al., 2005). Such statistics suggest that food insecurity and micronutrient deficiency facing a significant proportion of rural communities could be exacerbated as a result of limited consumption of fruit. Moreover, although increased consumption of fruit and wild foods could help in reducing the incidence of undernourishment (Vicenti et al., 2013; Powell et al., 2011), current awareness and perceptions of local fruit accessibility and use is undernarrated in scientific literature, especially in developing countries (Tatry et al., 2011; Braun and Venter, 2008). Thus, it is hard to design strategies and policies to target the improvement of fruit consumption from natural sources or local markets.

Countless studies have demonstrated the diversity of wild and planted FTs and their contribution to local peoples' livelihoods (Luczaj et al., 2013; Vicenti et al., 2013; Matig et al., 2006). Jaenicke (2008) notes: "Of the thousands of plant species in the world, only 150 species are used and commercialised on a global scale. Over 95% of human protein come from only 30 crop species and only 10 species and species clusters made up 90% of international trade in temperate and tropical fruit worldwide. However, local people made use of 7 000 plant species for food and other uses". Ingram and Schure (2010) reviewed the use of NTFPs in Cameroon, in which a wide range of FTs were identified to be useful in household food security. Additionally, through a socioeconomic and ecological assessment, van Djik (1999) distinguished as many as 39 species producing edible fruit in the Bipindi-Akom II region of Cameroon. Likewise, in forest areas of Cameroon, Matig et al. (2006) inventoried and classified 74 edible species across into 34 families. Elsewhere, in Benin, Assogbadjo et al. (2013) inventoried 43 fruit species in farmer agroforestry systems. In the drier savannas, Shackleton et al. (2008) inventoried 45 indigenous and 83 exotic species of trees in home gardens of six villages in South Africa and 57% were used primarily as fruits. According to Cruz-Garcia and Price (2012) of 87 wild food plants belonging to 47 families inventoried amongst rice farmers in Thailand, 39% were used as fruits. Likewise, in an inventory of wild edible plants in Belarus using the Rostafinski's questionnaire of 1883 to present day (Luczaj et al., 2013), 58 plant species were mentioned altogether with the largest group being soups (27 species), and the second largest groups being made of fleshy fruit (18 species). Of the species included in the list from the 19th century, only 32 species were mentioned to be used in the 20th and 21st centuries with 98 new plants being used mainly as children's snacks or exotic species of fruit. This shows that there is an increased awareness of new varieties of plants used as fruits

most of which are trees. However, inconsistencies are still observed with the advice on the quantity of fruit intake per region. Abu-Basutu (2013) demonstrated that HIV-affected households and children harvested and ate wild fruit to supplement their nutrient intake. Shackleton and Shackleton (2012) recommended that in poor regions, more effort should be put in place to make available cheap and reliable sources of micronutrients, especially for poverty afflicted and vulnerable groups, especially, women and children. However, the sources of information on fruits were scarce and limited to traditional communication channels. Thus, it is necessary to design improved strategies to share information on FTs propagation, management and fruit consumption within local communities (Leakey, 2012).

Globally, the consumption of wild and home grown fruit is gaining recognition on the international agenda around food security. First, in 2008, the *Fruit Journal* dedicated a special issue to underutilised fruits in which an inventory of indigenous species and characterisation of species to be improved was made (Jaenicke, 2008). Later, in 2011, the editorial of the *International Forestry Review* Vol. 13(3), emphasised the importance of forest foods dominated by fruit, which are particularly important in coping with cyclical (seasonal) and transitory food shortages due to drought, illness or other external shocks. As such, forest foods and income are widely important in helping the poor cope with poverty although they may not provide them with a pathway out of poverty (Arnold et al., 2011). Furthermore, the editorial of the *Fruit Journal* 2013 Vol. 68 1-2 (Ganry, 2013) stressed that fruit and vegetables have been recognised by WHO and FAO as important components of healthy diets. A fruit intake of 400 g per person per day is recommended for the prevention of chronic diseases as well as in the prevention and alleviation of several micronutrient deficiencies, especially in less developed countries (Ganry, 2013; Grutzmacher and Gross, 2011, WCRF/AIRC, 2007; WHO, 2003). Linking fruit to health, Ganry (2013) reported that with limited consumption of fruit and vegetables, individuals run the risk of being infected by chronic diseases. Increasing consumer awareness of the recommended daily intake of fruit for good health is thus a priority (Ganry, 2009; Beydoun and Wang, 2008; Braun and Venter, 2008). This is because, knowledge of fruit availability, accessibility and the recommended intake would in part determine an individual's ability to assess the adequacy of his or her current intake (Beydoun and Wang, 2008; Jaenicke, 2008; Blanchette and Brug, 2005).

The capacity of fruit to promote improved health varies from one species to another. For instance, according to a review by Stadlmayr et al. (2013), the highest vitamin C contents were found in *A. digitata* (237 mg per 100 g), *S. birrea* (167 mg per 100 g) and *I. gabonensis* (55.9 mg per 100 g), whereas the other fruit species only contained about 3 - 25 mg per 100 g. Additionally, while ripe and raw bush butter/African pear pulp, (*D. edulis*) had a mean fat content of 21.0 g per 100 g, the fat content of the other fruit species was below 1 g per 100 g. It is therefore advisable to consume a variety of different fruits (Stadlmayr et al., 2013; van-Wyk, 2005). Thus, activities to promote fruit consumption also need to focus on diversifying the variety of fruit consumed as much as possible.

Fruit can be eaten fresh or in preserved form, such as fruit juice, dried, canned and jams (van-Wyk, 2005). Poor households and those in remote areas do not usually have access to fruit processing techniques and equipment (Trefry et al., 2014; Banwat et al., 2012; Edoum et al., 2011). They also often lack have access to markets, and even when they do, they do not have the financial resources to purchase fruit (Kehlenbeck al., 2013; Ganry, 2009). In Cameroon, Edoum et al. (2011) demonstrated that most fruit processing industries use gas for drying with very small capacities that can contain only 50 kg of wet fruit and long drying time of up to 10 hours. This limits the frequency and quantity of fruit consumption among vulnerable groups and compels in–season patterns of fruit consumption. Thus, people tend to eat more fruits when they are available in the home or farms (Arnold et al., 2011; Gregory et al., 2005). Wild harvested fruits provide necessary minerals and vitamins (Vicenti et al., 2013; Arnold et al., 2011) especially to children who eat them while they play (Jaenicke, 2008) and gatherers who eat them while in the forest (Levang et al., 2015). With current international recommendations on fruit consumption, assessing the level of awareness and knowledge of the importance of fruit consumption in Cameroon is necessary because statistics on fruit accessibility and consumption are limited.

Most food consumption studies in Cameroon mention fruit in passing, and, even when included, it is oil-palm fruit (Georgius et al., 1993). Ndikumagenge and Ngome-Tata (2009), Matig (2006) and Van Djik (1999) listed fruit species, providing to a limited extent their nutritional value but with no mention of fruit consumption patterns, frequency and quantities harvested or purchased and consumed in households. Ingram and Schure (2010) made mention of wild fruit, but had no information on their accessibility and use. The Cameroon report of the

forum on nutrition in 2011 captioned “nutrition and public health in Cameroon: combating the crisis” mentioned the word ‘fruit’ seven times (Tanya et al., 2011). The discussions during this forum centred on evaluating malnutrition in Cameroon and its associated problems and diseases (heart disease, cancer, diabetes and obesity, etc.), amongst different categories of people (infants, children, active adults, vulnerable groups and older people). In this report, it was clear that in the forest zone, the diet is monotonous and dominated by starchy foods. However, the reference list contained no article on the importance and frequency of fruit consumption by local people to supplement and diversify their diets. This shows that even at the expert and decision-making level, there is a need for sensitisation on the importance of monitoring and data recording on the level of fruit consumption. To substantiate this, Germaine et al. (2011) reported that in Cameroon, data on nutritional habits is limited, although the rate of micronutrient deficiencies in vitamin A, iron, and iodine are very high, while data on the other micronutrient deficiencies is limited. As such, Germaine et al. (2011) suggest that nutritional interventions are needed to determine the level of consumption of specific food groups to better address problems of houeshol nutritional security. As such, there is an urgent need to develop and promote innovative strategies for understanding, measuring and promoting the contribution of fruits from trees to household nutritional security. In as much we need both qualitative and quantitative data to address this, we need to revisit people’s mind-sets and knowledge on fruit consumption patterns and local perceptions. In this chapter, I seek to question peoples mind sets and perspectives on the use of fruits from planted and wild sources relative to different levels of deforestation. The objective was to investigate households’ access mechanisms to a variety of fruits and their awareness on the importance of fruit consumption. Specific aims were to:

- Investigate local availability of wild and planted fruit trees along a deforestation gradient;
- Analyse fruit consumption patterns and local perceptions of wild and planted fruits;
- Investigate the awareness on the expected frequency and importance of fruit consumption.

5.2. Methodology

5.2.1. Sampling approach and data collection tools

In all, 141 households were interviewed with a total ± 15 households per village. In the most deforested zone, the villages were Akomnyada, Avebe, Abang/Ekali (17, 17, and 15 households each), in the moderately deforested zone, the villages were Biyeyem, Mbong/Mintom and Meyos Yedjock (15, 14, and 18 households, respectively) and for the least deforested zone the villages were Meyo Elie, Mitypkwali, and Nkpwaeba (15 households per village). Balloting following the purposive sampling approach (Bryman, 2012) was conducted to choose the sample households in each village. Households from all parts of the village were selected. The most vulnerable households (female-headed households, pregnant women and households with many people) were identified during village meetings after prior informed consent and discussion with the village facilitator and key informants.

The questionnaire used for this study was modified to suit the local context in Cameroon from a similar FT survey questionnaire that was implemented in Kenya by ICRAF in 2013 (Table 5.1). This questionnaire had two main parts with both closed and open-ended questions. Part one explored the general information about the main respondent like age, gender and household attributes. Part two comprised of the technical questions divided into three sections: (i) knowledge and perceptions of households on known tree species used as fruits, and fruit consumption frequencies, (ii) the purchase of fruit and consumption by vulnerable groups, and (iii) the awareness of households on the importance of fruit consumption and the use of wild fruit. Likert scale items of 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree and 5 = strongly agree were used to measure respondents' attitudes to particular statements regarding fruit consumption, wild fruits harvesting and impression on purchased and harvested fruits.

5.2.2. Data collection

This study combined qualitative and quantitative methods coalescing participant observation, ethnography, village meetings and household interviews in data collection. The field work ran from August 2013 to December 2014. Questionnaire finalisation and village meetings took place from August to October 2013. Interviews were organised in November

2013. This period was short enough to avoid variations that might arise due to seasonal changes in the supply of fruit. Participant observation and ethnography was carried from October 2013 to October 2014 to provide depth to the responses on open questions and fine-tune the codification to be adopted during the field administration of such questions (Figure 5.1.).

Table 5.1: Variables used during field work

Group of variables	**Aspects being investigated**
Village/accessibility; Deforestation	Location of household (HH)
Age of respondent, Sex of respondent, Type of household, Marital status, Level of education of hh head, hh size, No. of children under two years of age, Gender of hh head	HH demographics
Hh income, Food expenditure (%), Non-food expenditure (%)	HH socioeconomics
Source of energy for cooking, Source of water, Distance to drinking water, Availability of electricity, Building material (Walls and roof),	HH wellbeing indicators and food security. Influence of living conditions and present household food supply conditions and fruit consumption
Do you experience general food scarcity? Which months of the year are the most food insecure? During food shortages how do you supplement your food requirements?	
Mentioned fruit, Harvesting months of fruit	Fruit diversity
How do you eat this fruit? Who in the house consumes? How many times (in season) eaten? What quantity eaten? Fruits eaten by children under two years of age?	In season fruit consumption practices
Do you buy fruit? If yes what quantities? How much money do you spend on fruit? If you had money, will you buy more fruits? If yes why? Do you buy artificial fruit juice? At what frequency? How much money do you spend on fruit and artificial fruit juice? Who drinks the artificial fruit juice?	Purchase and consumption of fruit/fruit juices (willingness of HH to purchase fruit for consumption)
How many times do you need fruit per week? Do you satisfy your fruit needs? If no why? Are there people who should not eat much fruit? Do you wish to eat fruit daily? If no why not?	Perceptions of fruit intake and desired frequency of fruit consumption
Have heard about vitamins? Do you know why vitamins are important? If yes why? Do you know vitamin C rich-fruit? List the vitamin C rich-fruit you know. Do you know vitamin A rich-fruit? List the Vitamin A rich-fruit you know.	Awareness on the nutritive value of fruit and the importance of fruit consumption
Do household members harvest wild fruit? Did you sell these fruit? Do you eat these fruit? Are you ashamed when people see you eating wild fruits? If I had more money, I will not eat wild fruit.	Harvesting and use of wild fruit
Household declaration on fruit	Perception on fruit sources and the use of fruits from various sources
Fruits from my plantation are less nice than those from the market, Fruits from my plantation help me fight against food insecurity; Some fruit are not suitable for pregnant women; If I had more money I will buy more fruits from the market; Some fruit are not good for children under the age of two years; I am ashamed when people see me eating wild fruit;	
Source of information on FT production	Perspectives
Best way to share information on FT activities	

Village meetings were organised at the beginning of data collection to introduce the purpose of the study and establish a list of all FTs found in the villages. Participants were asked to list the different species of FTs present in and around the villages using the free-listing approach (Ambe, 2001). After the free-listing exercise, a group of knowledgeable people were

brought together to write the names of the FTs correctly alongside with their equivalences in English/French. Participants were free to leave and join the groups as their time could permit. Two groups of 5 - 12 persons were usually set up, one with women and the other with men. After the groups were convened, the researcher guided them to identify a moderator and a secretary to facilitate discussions and write down the major conclusions. There was no age and time limit for the group work. However, other commitments and the absence of electricity in the villages obliged the group work to last between 30 minutes and two hours. Since the same exercise was repeated in nine villages, information from all villages complemented each other to bring out the final list of fruit.

The names of FTs obtained from the group sessions were later crosschecked with the help of knowledgeable experts who were familiar with the local language in these communities to bring out a final list. There was no specific research design in choosing the people to participate in the fine-tuning of the list and the number of people to be consulted per village or zone had no limit. Generally, such people were identified following field observation and informal discussions. In addition, colleagues with knowledge of the study area and additional grey literature were also consulted to verify some of the local and scientific names of FTs. For most wild/uncultivated species, most key informants did not know the English/French equivalent and thus, secondary literature was used to verify the names.

The questionnaire was first translated into French and three enumerators were recruited and trained at the Institute of Agricultural Research for Development (Institut de la Recherche Agricole pour le Développement-IRAD) office. One of the enumerators had an advance level certificate, while two others had a bachelor degree in sociology. After two days of training, the questionnaire was tested in the Ngout community near Yaoundé, and revised in line with the feedback from the pilot process. Questions vis-à-vis fruit and fruit juice purchase were based on a one-month recall period before the date of the interview. During the questionnaire testing, it was perceived that people did not generally allocate much income to fruit purchase; neither did they buy fruit and fruit juice frequently. Moreover, it was hard for households to say exactly how much they spent on these items. Thus, to capture the cash expenditure on fruit and fruit juice in more households, fruit expenditure classes were created starting with a very small amount of 100 FCFA (0.2USD) and a small interval and then increasing the intervals as the amount increased.

5.2.3. Data analysis

Codes were generated for all open ended questions, for example; the most food insecure months of the year, strategies to supplement food requirements during food shortages, list of vitamin A and vitamin C rich-fruits, etc. Data were captured in Excel and later transferred to SPSS 20.0 for analysis. All graphs were done in Excel. Totalling of citations, Likert scale summaries, descriptive statistics, χ^2-test, means and simple ANOVA were done in SPSS. Graphpadprism 5 was used to compute One-way ANOVA and Post-Hoc comparisons. Households' accessibility to a variety of fruit was measured through FT diversity and species abundance. Tree diversity was estimated from the number of FT species citations made by households. Species abundance was evaluated at four levels. First was the total number of times each species was cited that was considered as an index of fruit per species. Second, was the total number of FTs that were cited per household and per deforestation zone, which was abundance per household and deforestation gradient, respectively. Third, was the species abundance per wild and planted species.

Means and standard deviations were calculated for quantitative data on household size, age, household income, food and non-food expenditure, distance to drinking water, Number of times fruits were eaten, etc. Correlation tests employing the Pearson coefficient were used to show the relation between two-by-two quantitative variables, (for example between income and percentage expenditure on food items). The relationships between all qualitative and quantitative variables were established through means and ANOVA to test for significance. This was the case for deforestation zone and; household parameters and various aspects of fruits consumption such as frequency of consumption. Then, χ^2-test and Cramer's V was used to confirm if there existed a link between two qualitative variables, for instance deforestation gradient and fruit tree species.

5.3. Results

5.3.1. Socioeconomic characterisation of the population

The mean age of respondents was 46 ± 15 years ranging between 18 and 81 years (Table 5.2). Of all respondents, 40% were males and 56% were females. Females headed only 18% of the households sampled. Most households were male-headed (82%), along with

divorced/separated (2%), never married (11%), married but living apart (5%), married and living together (66%), and widowed (16%). The average household size was 6.8 ± 3.7 persons, ranging from one to 19 persons per household with 0 to 3 children under two years of age (mean = 0.9 ± 0.55). Only 7% of the household heads had not received any kind of schooling. The majority (93%) of household heads were educated with 41% having received high school education, 39% had attained only primary education level, 12% a secondary education, while only 2% had acquired university education. Households' average annual income ranged from 10 800 to 222 000 FCFA per month and they expended an average of 43% ± 19% on food items (Table 5.2). This shows that despite the high food production capacity in this area, the population still allocated a high percentage of household income on food items.

Table 5.2: Household socioeconomic characteristics along a deforestation gradient in Cameroon

Deforestation zone	Statistical Measure	Household size (No.)	Annual Income (FCFA)	Food expenditure (%)	Age of respondent (Years)	Children under two years of age (No.)
Most	Mean	7	264 000	44	48	1
	N	49	45	47	45	49
	Std. Dev.	4	256 400	17	15	1
	Min.	1	12 000	10	21	0
	Max.	17	1 064 000	70	81	3
Moderate	Mean	7	333 000	50	45	1
	N	47	45	45	43	45
	Std. Dev.	4	392 600	16	15	1
	Min.	1	20 000	10	18	0
	Max.	17	2 220 000	75	77	2
Least	Mean	7	189 000	32	44	1
	N	45	45	40	43	43
	Std. Dev.	3	204 700	21	15	0
	Min.	1	10 800	10	19	0
	Max.	19	680 000	80	75	2
Total	Mean	7	262 000	43	46	1
	Std. Dev.	4	299 000	19	15	1
	Min.	1	10 800	10	18	0
	Max.	19	2 220 000	80	81	3
Statistics	F	0.043	2.654	10.85	1.03	4.9
	Sig. (p)	0.958	0.074	< 0.001	0.359	0.009

ANOVA showed no significant difference between household income against deforestation zone (F = 2.65 p = 0.074). This means that the households income were the same within and between deforestation zones. A significant difference was observed for food expenditure, and the number of children under two years of age, per deforestation zone (F =

10.85 $p < 0.001$, and $F = 4.90$ $p = 0.009$, respectively). The least deforested zone had the lowest food expenditure of 32% ± 21%, while in the moderately deforested zone it was (50% ± 16%) and for the most deforested zone it was 44% ± 17%. This means that very few households in the least deforested zone relied on purchased food than in the two other zones. The most deforested zone had the highest number of children under the age of two years while the highest food expenditure was from the moderately deforested zone.

5.3.2. Wellbeing indicators and food scarcity

Living conditions and present household food supply provisions were analysed to provide insights on the extent of poverty and the dietary status of the population. From the selection of villages, trends in social amenities and wellbeing indicators were similar considering that these were all rural areas in the forest zone with little infrastructural development in terms of housing, water, cooking energy and lighting, although some villages had good roads. Drinking water was present in the villages although of doubtful quality. Sources of drinking water were portable/tap water (24%), stream water (43%) and rain/filtered water (33%). From field discussions, filtered water meant either rain or stream water that was allowed standing so that all particles sink to the bottom of the container. Then, the sieved water was drained into a clean receptacle and kept aside for drinking. The average distance and time to the closest drinking water spot was 56.9 ± 135.2 meters or 13.3 ± 11.9 minutes. Only 20.4% of households had electricity and these were mostly found in the accessible villages and within the most and moderately deforested zones. In addition, electricity was of extremely low voltage and with frequent (at least every other week) blackouts that could last for as long as two weeks. Regarding cooking energy, 2% of households used gas while 98% used firewood. Most houses were constructed using earth and bamboo (52%), sundried bricks (24%), cement blocks (15%), while 10% of houses were constructed of only wood. Similarly, 82% of houses were roofed with zinc, 15% had thatch roofs while only 3% had tiles.

A majority of households (95%) said they experienced general food scarcity. peak periods of food scarcity within a year were listed as January - March (38%); April - June (4%); July - September (3%); October - December (31%) and all year round (24%). Conversely, 5% of households said they did not experience food scarcity. Strategies to survive food shortages were borrowing money to buy food (26%), eating boiled cassava roots without sauce (8%),

food rationing (33%), scavenge on nearby farms (8%), harvesting wild foods (14%), donations from parents and friends (2%) and scavenge around the community (4%). Chi-square tests showed a significant association between months of food scarcity and survival strategies adopted (χ^2 = 218.14 $p < 0.001$; Cramer's V = 0.566 $p < 0.001$). Borrowing money was an important strategy during April to June, July to September and October to December 33%, 50% and 17%, respectively. Food rationing was important in January to March (70%), April to June (17%), July to September (2%) October to December (7%) and all year round (4%). This suggests that the main strategy to survive food scarcity was food rationing and when food became completely finish in the house (April to June) which corresponded to the planting season, many more households started borrowing money. Borrowing money was also very high during July to September probably due to schools reopening in September. No significant difference was observed between the means of food expenditure and the strategies to survive food scarcity ($F = 0.47$ $p = 0.853$).

5.3.3. Households' access mechanisms to a variety of fruits

5.3.3.1. Fruit tree species abundance and diversity

Fruits from trees were obtained from wild and planted sources across all three levels of deforestation. Figure 5.1 presents the abundance of wild and planted FTs within the three deforestation zones and suggests a wide diversity of fruits species in all cases. Wild FTs were cited less frequently (43%) than planted FT (57%). One-way ANOVA and Post-Hoc comparisons show that the mean occurrence of FTs was higher in the most deforested zone than in the least deforested zone ($F = 3.68$ $p = 0.033$), while there was no difference between the least and moderately and the moderately and the most deforested zones. However, there was a significant difference in the mean occurrence of planted and wild FTs at each level of deforestation ($F = 15.47$ $p < 0.001$).

Households had access to FTs at a ratio of one household to 10 trees, comprised of four wild trees and six planted trees. Per deforestation zone, it was a household to 10 trees in the most and moderately deforested zones and a household to nine trees in the least deforested zone. In all, 25 FT species were mentioned comprising 15 wild and 10 planted species (Table

5.3). The number of times that each household mentioned the tree species was considered to be the number of individual FTs to which the household had access to gather and harvest fruits.

Table 5.3[1]: Number (and proportional) citations of FT species per deforestation zone

Local Name	Scientific name	Most deforested	Moderately deforested	Least deforested	Total
Planted FT species					
Banana	*Musa spp.*	38 (4.7)	42 (5.2)	34 (4.2)	114 (14.1)
Guava	*Psidium guajava*	25 (3.1)	18 (2.2)	24 (3)	67 (8.3)
Grape fuit	*Citrus paradisi*	21 (2.6)	30 (3.7)	25 (3.1)	76 (9.4)
Mandarine	*Citrus reticulate*	14 (1.7)	15 (1.9)	7 (0.9)	36 (4.5)
Mango	*Mangifera indica*	38 (4.7)	37 (4.6)	32 (4.0)	107 (13.3)
Orange	*Citrus sinensis*	18 (2.2)	27(3.3)	18 (2.2)	63 (7.8)
Pear	*Persea americana*	32 (4.0)	37 (4.6)	34 (4.2)	103 (12.8)
Safou	*Dacryodes edulis*	36 (4.5)	37 (4.6)	28 (3.5)	101 (12.5)
Soursop	*Annona muricata*	35 (4.3)	25 (3.1)	11 (1.4)	71 (8.8)
Pawpaw	*Carica papaya*	21 (2.6)	20 (2.5)	27 (3.3)	68 (8.4)
	Total	278 (34.5)	288 (35.7)	240 (29.8)	806 (100)
Wild FT species					
AkomNgoe	*Terminalia superba*	16 (2.6)	18 (2.9)	19 (3.1)	53 (8.7)
Andobeti	*Irvingia gabonensis*	18 (2.9)	12 (2.0)	10 (1.6)	40 (6.6)
Angokong/Engakom	*Marianthus arboreus*	20 (3.3)	18 (2.9)	15 (2.5)	53 (8.7)
Bikwam	*Vitex doniana*	8 (1.3)	4 (0.7)	4 (0.7)	16 (2.6)
Bison	*Aframomum spp.*	20 (3.3)	11 (1.8)	13 (2.1)	44 (7.2)
Black fruit	*Canarium schweinfurthii*	1 (0.2)	1 (0.2)	4 (0.7)	6 (1.0)
Casmango	*Spondias cytherea*	14 (2.3)	11 (1.8)	5 (0.8)	30 (4.9)
Ebaptom	*Santira trimera*	25 (4.1)	21 (3.4)	17 (2.8)	63 (10.3)
Komngoei	*Cola pachycarpa*	16 (2.6)	7 (1.1)	3 (0.5)	26 (4.3)
Mvut	*Trichoscypha acuminata*	13 (2.1)	16 (2.6)	19 (3.1)	48 (7.9)
Ngonge	*Uapaca spp.*	18 (2.9)	19 (3.1)	16 (2.6)	53 (8.7)
Obon	*Litchi chinensis*	8 (1.3)	5 (0.8)	7 (1.1)	20 (3.3)
Ofo	*Pseudospondias microcarpa*	18 (2.9)	20 (3.3)	16 (2.6)	54 (8.8)
Owol	*Cola lipidota*	14 (2.3)	11 (1.8)	14 (2.3)	39 (6.9)
Tom	*Dacryodes macrophylla*	16 (2.6)	25 (4.1)	25 (4.1)	66 (10.8)
Total		225 (36.8)	199 (32.6)	187 (30.6)	611 (100)

Participants mentioned planted FTs 806 times with 278, 288 and 240 times for the most, moderate and least deforested zones, respectively. Of the 611 times that wild FTs were mentioned, the most deforested zone listed 225 times as against 199 times and 187 times listed for the moderate and least deforested zones, respectively. Slightly more FTs were cited in the

[1] On Table 5.3, while counts illustrate the number of households that mentioned each individual FT species, the percentage present the proportion of each FT of the total domesticated or wild species.

most deforested zone with FTs being mentioned 503 times as against 487 times and 427 times for the moderately and least deforested zones, respectively.

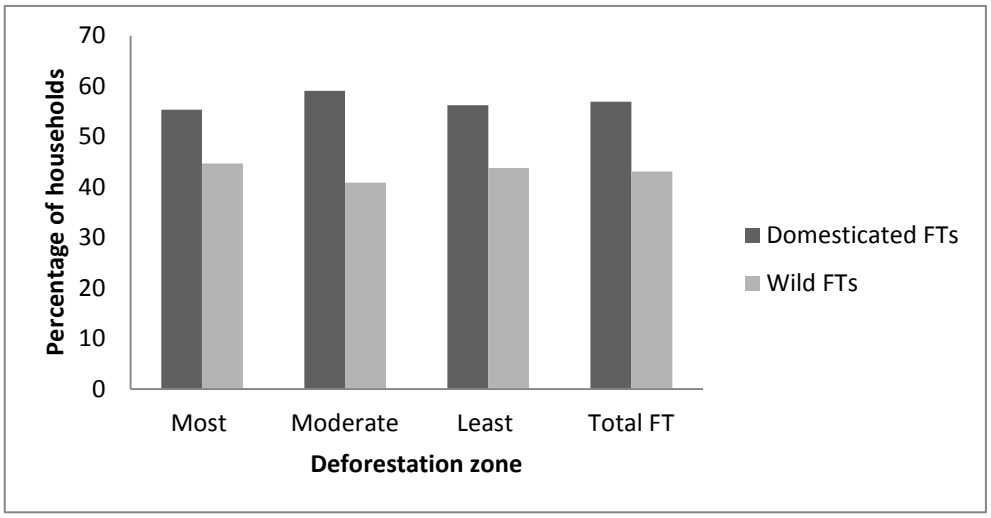

Figure 5.1: Fruit occurrence per deforestation gradient

The top four most abundant FT species were planted species. These were, *Musa spp.* (8%), *Mangifera indica* (7.6%), *Persea americana* (7.3%) and *Dacryodes* edulis (7.1%). The most abundant wild FTs were *Dacryodes macrophylla* (4.7%), *Santira trimera* (4.4%), *Pseudospondias microcarpa* (3.8%), *Terminalia superba* (3.7%), *Uapaca spp.* (3.7%) and *Trichoscypha acuminata* (3.4%). There was no significant association between FT species and deforestation zone (χ^2 = 52.10 p = 0.318; Cramer's V = 0.136 p = 0.318).

5.3.4. Purchase of fruit products and local perceptions vis-à-vis bought and harvested fruits

Approximately three-quarters of households (73%) bought fruits. The frequency of purchase was; daily (5%), weekly (2%), monthly (21%), and hardly (45%) while 27% of households did not buy fruit. The amount of money spent on fruit during the month of interview was 100 - 300 FCFA, 400 - 700 FCFA, 800 - 1 000 FCFA and > 1 000 FCFA according to 16%, 18%, 19% and 19% of households. Figure 5.2 presents the amount of money spent on fruit purchase per deforestation zone.

The amount of money spent on fruit did not show a significant difference with mean household income (F = 0.72 p = 0.879) and mean percentage of food expenditure (F= 0.911 p =

0.539), respectively. This means that the amount of money spent on fruit did not depend on household income neither did it depend on the percentage of money reserved for food.

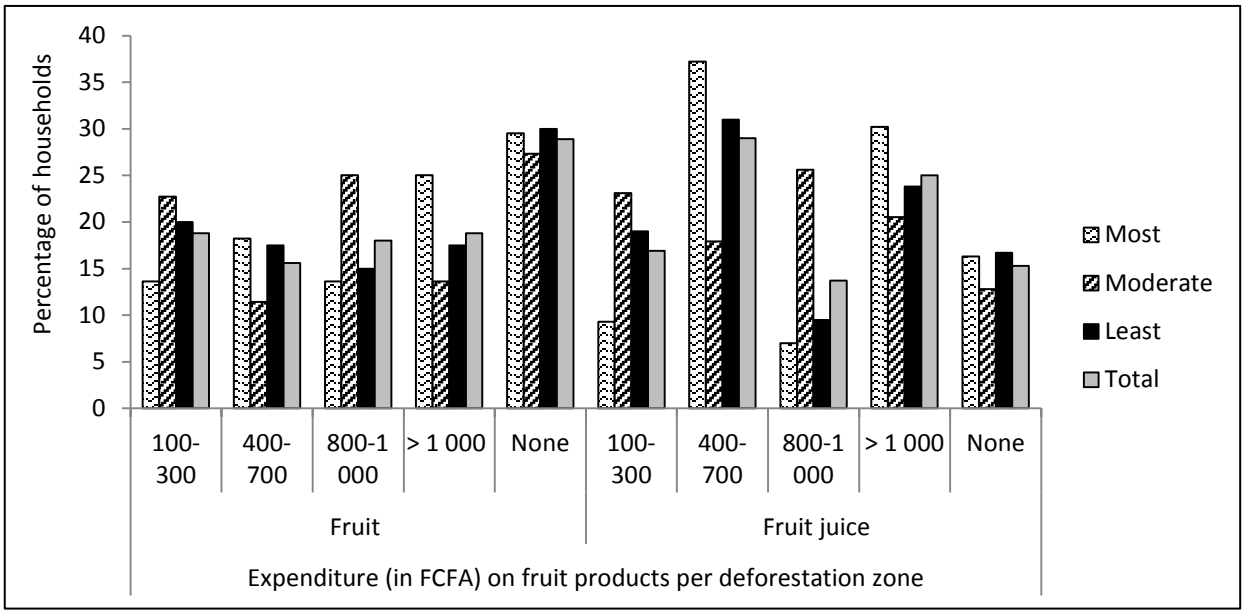

Figure 5.2: Expenditure on fruit and fruit juice in the last month

The frequency of fruit purchase was; hardly (37%, 46% and 51%); monthly (26%, 26% and 11%); weekly (2%, 4% and 2%); and daily (7%, 2%, 7%) for the most, moderately and least deforested zones. Fruit purchase rate did not show any relationship with deforestation gradient (χ^2 = 4.90 p = 0.768; Cramer's V = 0.166 p = 0.483). In addition, according to Figure 5.2, there was no significant relationship between deforestation zone and the amount of money spent on fruit (χ^2 = 5.30 p = 0.725; Cramer's V = 0.144 p = 0.725). Most households (63%) said if they had money they would buy more fruit while 37% said they will not buy fruit even if they had money. Reasons for buying more fruit were: for good health and energy (55%), balance their meals (15%), children need them (12%), for personal consumption (9%), eat as a desert (9%), for energy (2%), for seeds (2%), for sales (2%), as new variety/multiply seeds (2%), to fill the gap of lack of food (2%).

In the study area, no natural fruit juice was found. Thus, fruit juice as considered in this study was mainly sweet, non-alcoholic drinks formulated by brewery industries. From Figure 5.2, no significant relationship was also observed between deforestation gradient and money spent on fruit juice (χ^2 = 12.20 p = 0.142; Cramer's V = 0.222 p = 0.142). Numerically, 86% of

households bought fruit juice while 14% did not buy. The rate of juice purchase was hardly (45%), monthly (29%), weekly (9%) and daily (4%). Money spent on fruit juice was 100 - 300 FCFA, 400 - 700 FCFA, 800 - 1 000 FCFA and more than 1 000 FCFA for 16.9%, 29%, 14%, and 17% of households, respectively. However, 15% of households did not buy fruit juice. It is worth noting that while fruits could be bought with any amount of money, fruits are packaged and have standard prices per given quantities, e.g. 0.65 l bottle cost 500 FCFA. However, people (especially women) often contributed money to obtain individual units.

Regarding the intake of fruit juice, everybody (63%), children (13%), adults only (6%) and only women (4%) consume fruit juice. Only 14% of households did not consume fruit juice. Respondents' impressions of harvested and purchased fruit was examined using three statements rated using a Likert scale of one to five with one being strongly agree and five being strongly disagree (Figure 5.3). First, "fruits from my plantation are less nice than those from the market" in which 14% strongly agreed, 17% agreed, 17% disagreed, 28% strongly disagreed, while 25% were not sure. This question showed a significant relationship with deforestation gradient (χ^2 = 20.42 p = 0.009; Cramer's V = 0.277 p = 0.009). Each level of deforestation had a specific pattern that it followed with the most and the moderately deforested zones agreeing more while the least deforested zone disagreeing with the statement.

The second question was, "if I had much money, I will not plant FTs". Here, 14% strongly agreed, 17% agreed, 17% disagreed, 28% strongly disagreed, while 25% were not sure. From Figure 5.3, this statement showed no significant link with deforestation gradient, meaning the responses did not depend on the location of the households (χ^2 = 13.88 p = 0.085; Cramer's V = 0.230 p = 0.085). The last question was "if I had more money I will buy more fruits from the market" wherein 6% strongly agreed, 27% agreed, 26% disagreed, 23% strongly disagreed, while 18% were not sure. Here, looking at Figure 5.3, there was a clear trend from strongly agree to strongly disagree at all levels of deforestation, even though there was no significant relationship between deforestation zones for this statement (χ^2 = 8.60 p = 0.377; Cramer's V = 0.255 p = 0.377).

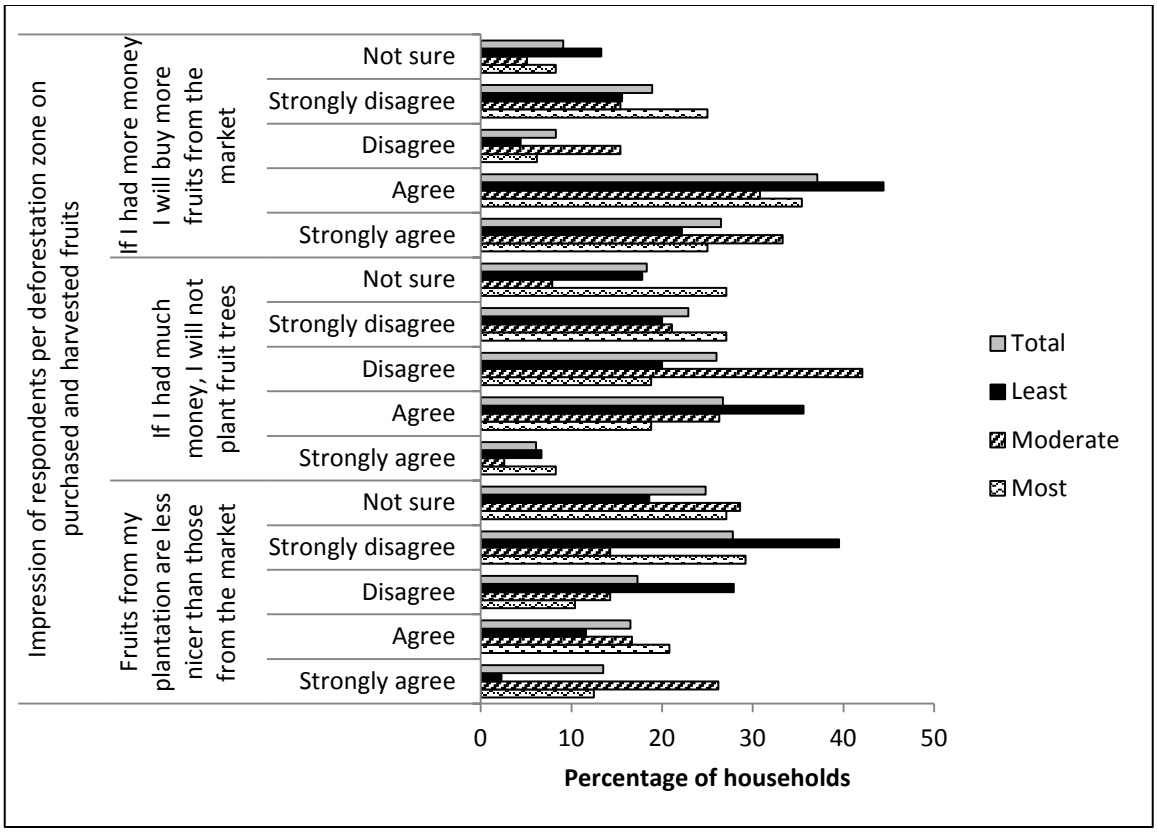

Figure 5.3: Impressions on harvested and purchased fruit per deforestation zone

5.3.5. Fruit consumption patterns and local perceptions

This survey was administered during the off season and the exercise was repeated in Chapter 6 during fruit ripening season. Households were asked to estimate the number of times they ate fruits during the harvesting period per week and when they were unable to provide a response, they were asked to provide the response per month. While 39% of households said they ate fruit daily, 47% ate fruit more than three times a week, while 14% confirmed that they ate fruit at least once a week (1 - 2 times) and only 1% of households ate fruit a few times a month (< 5 times). Per deforestation zone, the frequency was daily (44%, 36% and 37%); more than three times a week was (41%, 48% and 52%; at least once a week (1 - 2 times), (14%,15% and 11%); and a few times in a month was (<1% <1% and 0%) for the most, moderately and least deforested zones respectively. There was a relationship between frequency of fruit consumption and deforestation zone (χ^2 = 17.73 p = 0.007; Cramer's V = 0.113 p = 0.007). The most deforested zone showed higher fruit consumption patterns as up to 36% of households ate

fruits compared to 35% and 30% in the moderate and least deforested zones. Additionally, the households that reported to eat fruits daily, up to 40% were from the most deforested zone compared to 32% and 28% who were from the moderately and he least deforested zones.

Assessment of the quantity of fruit consumed was made based on fruits like mango or orange. This is because, first, it was difficult to agree on portion sizes that could be easily understood by all respondents. Second, these fruits were widely known and their whole size could be easily distinguished locally, nationally and internationally. Respondents were asked that simulating the different fruit species to mango or orange, about how many fruits did they often eat in a day during the harvesting season of the fruit in question? More respondents (37%) ate 5 - 10 fruits per day, 18% ate > 10 fruit, 18% ate 1 - 5 fruits, 15% ate in a random manner, 10% ate as much fruit as possible, and 2% consumed fruit depending on their level of hunger. Per deforestation level, the quantity was 1 - 5 fruits/person/day (22%, 12%, and 19%); 5 - 10 fruits/person/day (43%, 33% and 35%); 10 and above (15%, 22% and 17%); uncontrolled (10%, 21% and 15%); depend on hunger level (2%, 3% and 2%) and as much as possible (8%, 8% and 13%) for the most, moderately and least deforested zones. There was a significant relationship with deforestation and the quantity of fruits eaten per day ($\chi^2 = 59.73$ $p < 0.001$; Cramer's $V = 0.150$ $p < 0.001$). Again, the most deforested zone showed better trends since more households were able to provide an idea of the quantity of fruits consumed. Of those who ate 1 - 5 fruits and 5 - 10 fruits, 45% and 41% were from the most deforested zone compared to 25% and 32% and, 31% and 27% of households that were from the moderately and the least deforested zone. Conversely, a reasonable proportion of households also mentioned that the quantity of fruits eaten depended on their hunger level with the highest coming from the moderately deforested zone (50%) compared to 28% and 22% in the least and most deforested zones. This also justifies why up to 49% of household that reported to eat fruits in an uncontrolled manner were from the moderately deforested zone as against 28% and 23% in the least and the most deforested zones.

Regarding the way the fruits were eaten, most respondents (85%) ate fruit fresh, while others (11%) ate them ripe/fresh/fried/boiled, (4%) ate them as natural juice/jam and (< 1%) ate them in sauces/food. Fruit processing techniques and other innovative ways of fruit consumption were quite rare, which indicates that households relied on seasonal production of fruit for daily supply.

Use of wild fruit

The importance of wild fruit harvesting was investigated by asking whether or not household members harvested wild fruit. Overall, 91% of households said they harvested wild fruits. Whereas the majority of households that harvested wild fruits were from the most deforested zone (96%), 90% and 87% of households were from the moderately and least deforested zones, respectively. No significant relationship was observed between the harvesting of wild fruit and deforestation gradient (χ^2 = 3.15 p = 0.220; Cramer's V = 0.150 p = 0.210). Harvested fruits were sold and consumed by 47% and 46% of households while 7% were offered as gifts.

Two elements were analysed to appreciate impressions about wild fruit consumption using a Likert scale (Figure 5.4). First, was whether the consumption of wild fruit was regarded as shameful through the question "I am ashamed when people see me eating wild fruit". To which, 2.3% strongly agreed, 20% agreed, 27% disagreed, 40% strongly disagreed, while 12% were not sure. As per Figure 5. 4, no significant relationship was observed between responses and the deforestation gradient (χ^2 = 11.33 p = 0.184; Cramer's V = 0.208 p = 0.184), meaning that most people were aware of and like the consumption of wild fruit at all levels of deforestation. Secondly, the shifts in the consumption of wild fruit as income levels increased was analysed using the questions "if I had more money, I will not eat wild fruit". Here, 16% strongly agreed, 19% agreed, 26% disagreed, 26% strongly disagreed, while 13% were not sure. Again, there was no significant relationship with deforestation zone (χ^2 = 2.96 p = 0.937; Cramer's V = 0.107 p = 0.937).

This analysis suggests that wild fruit consumption was an acceptable practice in the study communities. However, from field discussion, the consumption of wild fruit was customary in the case of species that were already widely eaten. There were still a number of fruit like Bikwam (*Vitex doniana*), Bison (*Afromomomum spp.*), black fruit (*Canarium schweinfurthii*), etc. that were considered by household members as being fruit for children or local fruit for scavengers.

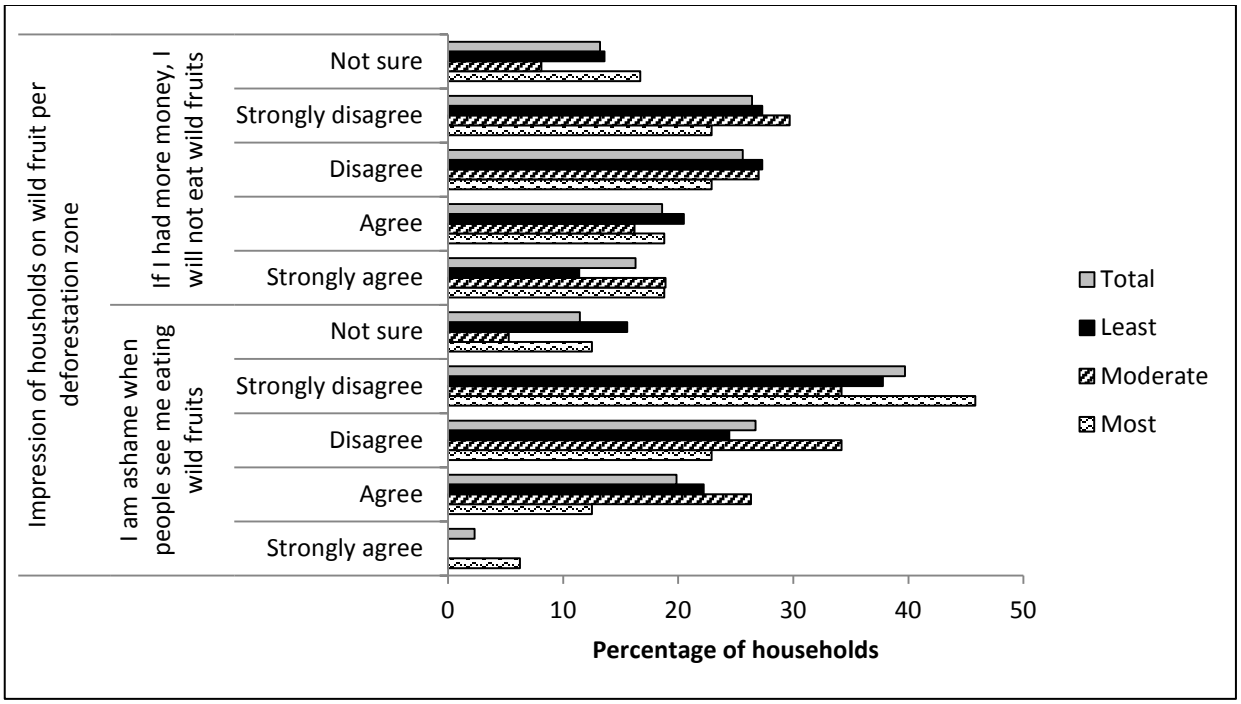

Figure 5.4: Impressions of wild fruit consumption per deforestation zone

Use of fruits in times of food scarcity

Fruits helped households cope with food scarcity. All disreputable ways of food acquisition was referred to here as scavenging. Three forms of scavenging were observed. First, was the gathering of little used crops (abandoned, waste, unplanted or disease infected crops) from households' own fields. Second, was the gathering of such crops from the fields of others and from the wild. Finally, was moving around "rich peoples'" houses in the community to eat any leftover food. This third form of scavenging was less common. It should be noted that the first two forms of scavenging were different from wild gathering which was a normal process of food acquisition, especially fruit, vegetables and other ingredients used for cooking. Using a Likert scale of strongly agree to strongly disagree, households' impressions on the use of fruit-on-farm to combat food scarcity was examined. While 44% of households strongly agreed that fruits from their plantation could help fight against food scarcity, 25% agreed, 3% disagreed, 21% strongly disagreed, and 7% were not sure. From Figure 5.5, impressions of the use of fruits from farmers' fields were similar at all levels of deforestation (χ^2 = 10.61 p = 0.23; Cramer's V = 0.200 p = 0.225).

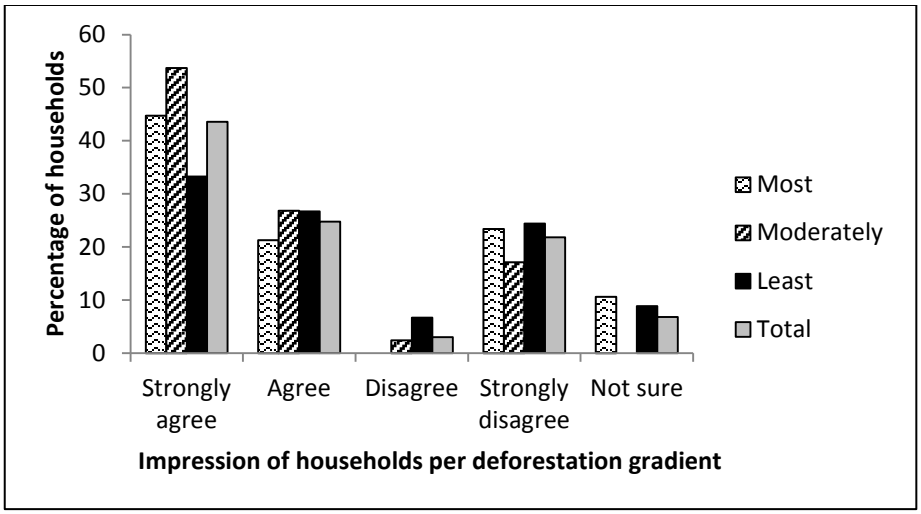

Figure 5.5: Impressions of the use of fruits from farmers' field to survive food scarcity

Comparing the harvesting of planted fruits to wild fruits, approximately one-quarter, (24% of households) said they harvested more wild fruit than planted fruit, 52% harvested more planted than wild fruits, 12% of households harvest as much planted as wild fruits and only 12% of households declared they have never harvested fruits from the forest. This is different in the results on the willingness to harvest wild fruits on page 129 in which 91% said they harvested wild fruits because it was comparing wild and planted fruits whereas the previous was simply dwelling on impressions on wild fruits. This means that many more households had preference for planted fruits but as well, appreciated wild fruits. The most common harvesting months of fruits were April to June (28%), July to September (35%), October to December (14%), January to March (7%) while 14% reported that they harvested fruit all year round. Corroborating this with insights from field observation and key informant discussions, it appears that most fruits were abundant from May to August that coincided with main harvesting season. This further suggests the likelihood of fruit waste if no adequate preservation infrastructure is put in place.

5.3.6. Awareness on the recommended frequency and importance of fruit consumption

This section was analysed in three parts. First, households' knowledge on the frequency of fruit consumption was evaluated by asking them how many times they needed fruit in a week and why. This was further confirmed by asking if they needed fruit daily and if not why?

Secondly, households were asked if they have heard about vitamins, if they knew why vitamins are important and if they know vitamin A and vitamin C rich-fruit. Finally, the consumption of fruit by vulnerable groups was examined.

5.3.5.1. Perceptions of and gaps in the recommended frequency of fruit consumption

Households' knowledge on the recommended frequency of fruit intake was assessed by asking them the number of times they think they needed to eat fruit per week and if they were able to satisfy this requirement. At all levels of deforestation, households said they needed fruit between one and seven times a week. Almost half of the households, (48%) said they needed fruit two times a week, 21% said they needed fruit three times a week while another 21% said they needed fruit once a week and only 7% of households said that they needed fruit daily (seven times a week) whereas 3.3% said they needed fruit four times a week. As per Table 5.4, on an average, households said they required fruit 2.4 ± 1.5 times per week with ANOVA showing a significant difference between deforestation zones ($F = 3.28$ $p = 0.041$) being highest in the least deforested zone. These results validate that people are not aware on the recommended frequency of fruit consumption. It also suggests that people will probably be eating fruit at less than half the recommended standard. The expected frequency of fruit consumption mentioned by households did not meet the WHO recommended level of daily fruit consumption. Even so, only 18% of households said they were able to satisfy their fruit needs whereas only 7% knew that they needed fruit daily (seven times a week), while a majority, (82%) were unable to satisfy their fruit needs. This entails that a reasonable number of households thought they were able to satisfy their fruit needs, whereas they were not eating fruits daily. This was the case in the moderately deforested zone in which five households said they were able to satisfy their fruit needs, but in effect, ate fruit a maximum of three times a week. Thus, there is a lack of knowledge re the recommended frequency of fruit consumption and ability to satisfy fruit needs. This was most acute in the moderately deforested zone where the highest number of times households said they needed fruit per week were three times.

Households said they were unable to satisfy their weekly fruit needs due to lack of resources (39%), insufficient production (33%), seasonal availability of fruit (5%), forgetfulness (4%) and in some cases it was not a habit (1%). This means that fruit

consumption could be greatly influenced by enhanced availability and accessibility, as well as sensitising the communities on the recommended rate of fruit consumption.

Table 5.4: Number of times respondents reported they required fruits per week

Deforestation zone	Do you satisfy your fruit needs	No. of times fruits were required per week			No. of Households
		Mean ± Std. Dev.	Range	% of Total N	
Most	No	2.5 ± 1.5	1 - 7	30.3	37
	Yes	2.6 ± 1.8	1 - 7	6.6	8
	Total	2.5 ± 1.6	1 - 7	36.9	45
Moderate	No	1.9 ± 0.8	1 - 3	27	33
	Yes	2.2 ± 0.8	1 - 3	4.1	5
	Total	2.0 ± 0.8	1 - 3	31.1	38
Least	No	2.9 ± 1.9	1 - 7	23.8	29
	Yes	2.5 ± 1.7	1 - 7	8.2	10
	Total	2.8 ± 1.8	1 - 7	32	39
Total	No	2.4 ± 1.5	1 - 7	81.1	99
	Yes	2.5 ± 1.5	1 - 7	18.9	23
	Total	2.4 ± 1.5	1 - 7	100	122

To further verify the respondents' knowledge of the daily requirement of fruit intake, households were further asked if they needed fruit daily. Whereas, 72% said they needed fruit daily, 28% said they did not. The main reasons for not eating fruit daily was due to the fact that fruits were seasonal (42%), insufficient production (20%) and lack of resources (20%). While all these reasons reflect problems of fruit availability and accessibility, at the local level, such results also depicted that people are not aware of the importance of daily intake of fruit. Statistics per deforestation zone are presented in Figure 5.6 which shows that the desire to or not to eat fruits daily were similar along the deforestation gradient with no significant relationship ($\chi^2 = 2.55$ p = 0.863; Cramer's V = 0.096 p = 0.863).

5.3.5.2. Knowledge about vitamins

Households were asked if they had heard about vitamins, if they knew why vitamins were important and if they knew vitamin A and vitamin C rich-fruit. In all, 93% of respondents said vitamins were important because they promote good vision/healthy growth (29%), provide calcium and iron (15%), combat diseases (12%), ease digestion/reduce stress (8%), promote blood circulation (2%), impede illness/fortifies the body (3%), provide energy and good health (10%), while 15% of the respondents had no reason. Vitamin C rich-fruit were listed by 74% of

the respondents as lemon (12%), lime, mandarin, guava, orange, pawpaw, palm nut (22%), orange (25%), orange, banana, mandarin, guava, mango, pawpaw, pineapple, palm nuts (14%) while 27% said they did not know. Most (61%) of respondents listed vitamin A rich-fruit as lemon (16%), lime, mandarin, guava, orange, pawpaw, lemon, palm nut (31%), orange (6%), orange, banana, mandarin, guava, mango, pawpaw, pineapple, palm nuts (7%) while 40% said they do not know.

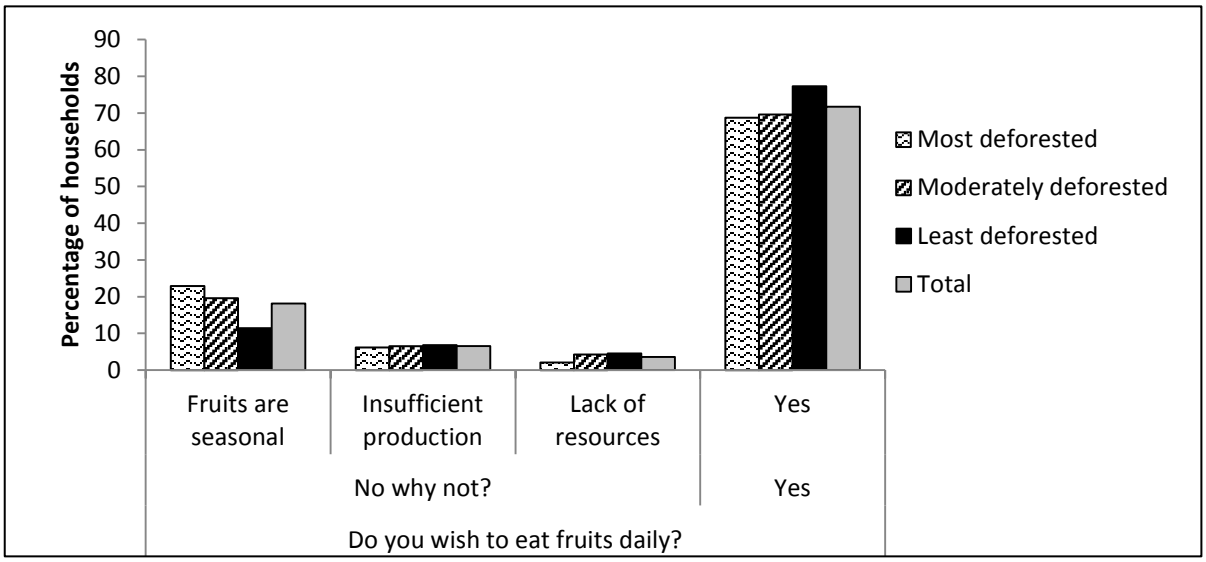

Figure 5.6: Assessment of whether household members wish to eat fruit daily and reasons

This long list shows that farmers are aware that vitamins come from a variety of fruits. Thus, it can be easy to promote fruit consumption by enlightening them about the importance of vitamins.

Awareness about fruit consumption by vulnerable groups

ICRAF has done much work to influence the enhance avaialability and accessibility/consumption of fruits in most rural areas in Cameroon. Most households (97%) reported that fruits were eaten by all household members. To assess awareness on the fruit consumption, a Likert scale item was constructed on the statement “fruits were good only for children”. Here, the majority of respondents disagreed (28%) and strongly disagreed (39%) that “fruits were good only for children”. However, 14% and 12% strongly agree and agree

respectively, with a neutral group of 8% who were not sure whether or not fruits were good for children. Furthermore, two other statements were analysed: “some fruit are not good for children under two years of age” and “some fruit are not good for pregnant women”. On some fruit are not good for children less than two years, 27% strongly agreed, 20% agreed, 19% disagreed, 17% strongly disagreed, while 26% were not sure. Looking at pregnant women, 14% of households strongly agreed, 21% agreed, 16% disagreed, 19% strongly disagreed, while 30% had no idea. This society generally had few traditional barriers that hinder the consumption of fruit by vulnerable groups. However, respondents’ perceptions suggested that most households agreed that some fruit are not appropriate for pregnant women and children under the age of two. These results are presented on Figure 5.7 per deforestation zone and show that there was no significant relation between deforestation zones.

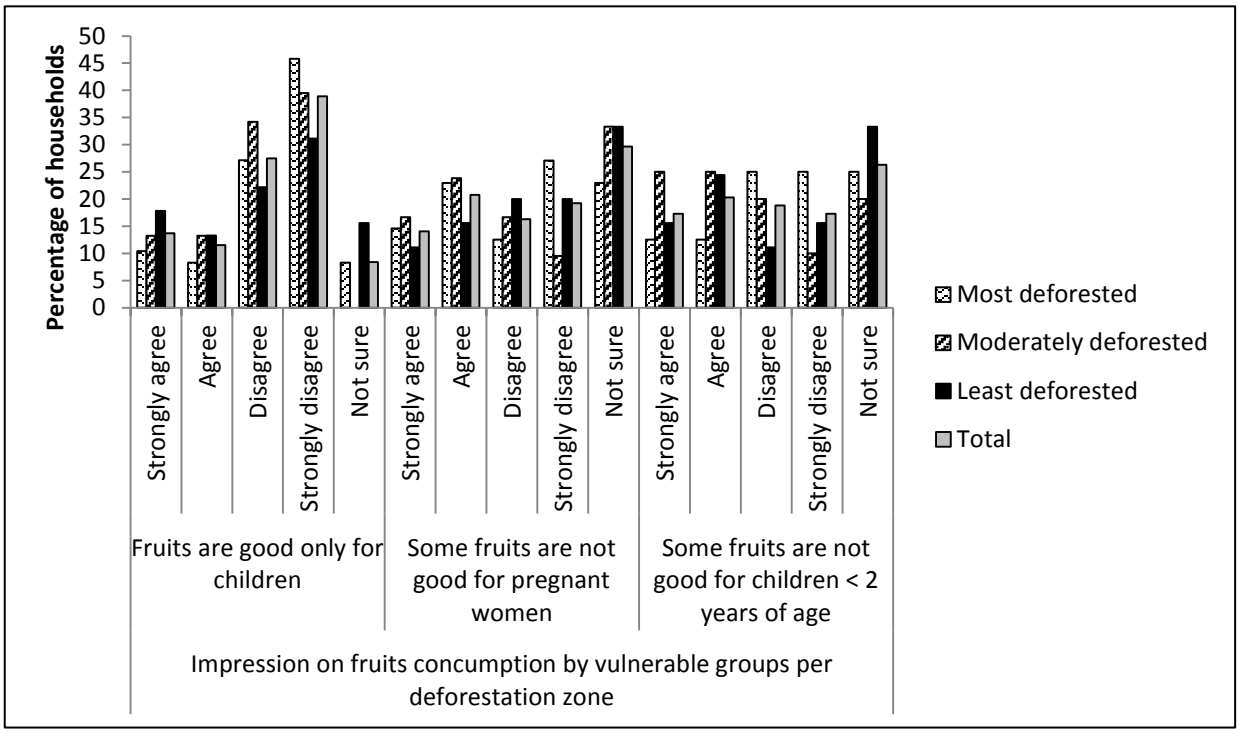

Figure 5.7: Impression of fruits consumption by vulnerable groups

Statistical significance was thus: some fruits are not good for pregnant women (χ^2 = 6.919 p = 0.545; Cramer's V = 0.16 p = 0.545; some fruits are not good for children < 2 years (χ^2 = 11.21 p = 0.19; Cramer's V = 0.205 p = 0.19) and fruits are good only for children (χ^2 =

9.89 p = 0.273; Cramer's V = 0.194 p = 0.273). These results confirm that most parents were conscious about the importance of fruit for children and all household members. From field discussions, some fruits were considered more suitable for children under the age of two such as, avocado pears (*Persea americana*), safou (*Dacryodes edulis*), oranges (*Citrus sinensis*) and banana (*Musa* sp.). Fruit like pawpaw, mango, grape fruit and most wild fruits were eaten by these children in smaller quantities because, according to their mothers, consuming too much of those fruit could lead to diarrhoea. However, some people said, if they did not give children fruit very often, it was due to scarcity and lack of money to buy fruit. They, therefore, gave children fruits when opportune from the farm or when they are able to buy. Others said that, even when they had money, it was difficult to find fruit to buy in the villages. Thus, they only could buy fruits when they went to an urban centre. This implies that fruit tree domestication has not spread to the study sites which were out of ICRAF pilot sites on domestication activities.

5.3.7. Sources of information on fruit trees

To further elicit the awareness on the importance of fruit and fruit products, sources of information and ways to share information on FTs were analysed. A high non response rate was observed with sources of information on FTs (14%) and the best ways to share information on fruits (33%). This initially suggests the possibility of lack of information on FTs and limited action of agricultural extension programs in the communities. According to households sampled, 23% declared that their source of information on fruit was through church announcements/village meetings, 19% said it was through experimental farms/exchange visits, 6% said a research institute (IRAD), 8% said radio/TV, 27% word of mouth while 27% of households had no source although they accepted that they know how to get information on FTs. In contrast, respondents felt that the best way to share information on FT activities was through church announcements/village meetings (28%), experimental farms/exchange visits (17%), radio/TV (4%), sensitisation/training/exchange visits/follow up (48%) while 2% of households had no idea. This is summarised in Figure 5.8. There was no relationship between the ways to share information on FTs and deforestation zone ($\chi^2 = 5.71$ p = 0.679; Cramer's V = 0.173 p = 0.679).

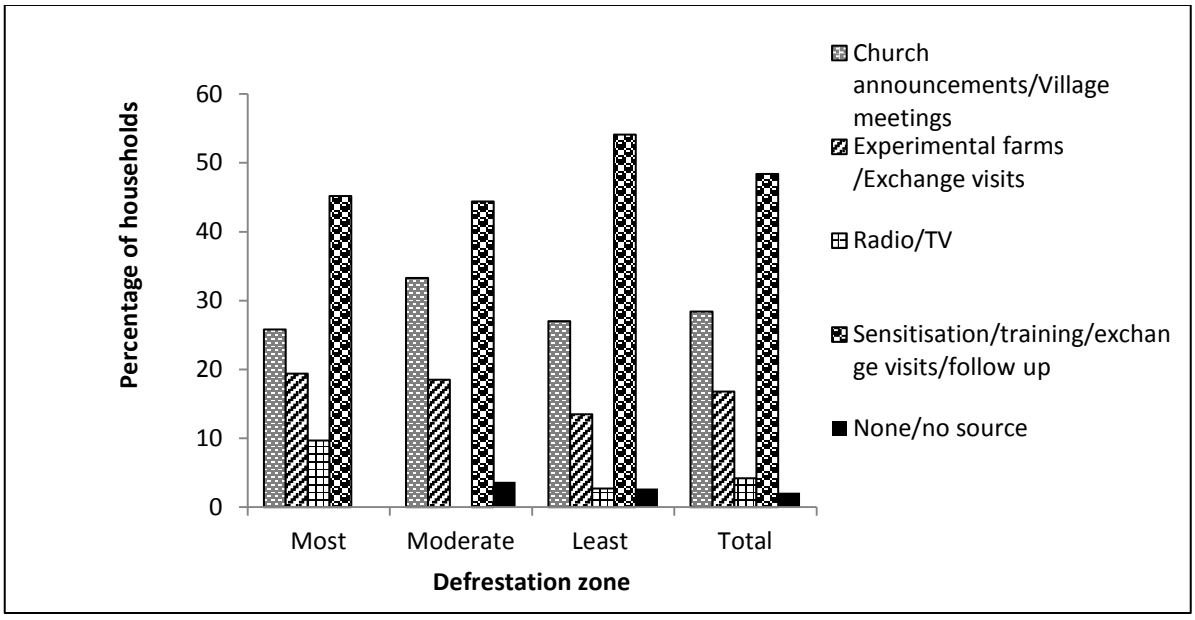

Figure 5.8: Ways to share information in villages

The study sites for this project were out of the ICRAF working sites. Thus, these results suggest that domestication activities that have been promoted in the past 30 years by IRAD/ICRAF have not spread naturally into other areas. Therefore, government action needs to focus on valorising such technologies and enhance local availability and accessibility to fruits trees.

5.4. Discussion

5.4.1. Food scarcity, fruit harvesting and deforestation

This study revealed that most households (95%) experienced food scarcity at a similar rate along the deforestation gradient, but, a significant difference was observed between the deforestation zone and food and non-food expenditure. The least deforested area had the lowest food expenditure, meaning more households in this zone relied on unpurchased food. Banwat et al. (2012) had noted that the factors that affect fruit and vegetable consumption include the cost of the food item and their seasonal availability. Ruel et al. (2005) noted that households in remote areas have less access to markets and money for the purchase of micronutrient rich foods and thus were more reliant on their own crops and wild foods. The result of this study shows that households invested very little in fruit purchases and bought fruit only occasionally, meaning that fruits did not constitute a priority place on their food-shopping list. This was

similar at all levels of deforestation. Therefore, households' fruit supply is mainly from local production which is subject to seasonal variation and natural productivity from wild or planted sources (Levang et al., 2015). Similarly, Modi et al. (2006) found that resource-poor people from Ezigeni in South Africa indicated that wild fruits were their only source of micronutrients.

The harvesting of fruits from trees was not conditioned by the deforestation gradient or periods of food scarcity. Moreover, harvesting months of fruit did not show any difference with deforestation zone, meaning food scarcity was possibly influenced by the local availability (Banwat et al., 2012). Levang et al. (2015) also showed that in two concessions in forest areas of Cameroon, the perceived importance of NTFP gathering as expressed during focus groups was much higher than the actual economic value obtained through surveys. Furthermore, people had developed various survival strategies for months of food scarcity which reaffirm the recommendations made by Shackleton and Shackleton (2012) that, in poor regions, more effort should be given to making available cheap and reliable sources of micronutrients especially to the most vulnerable groups, like women and children. At all levels of deforestation, more than 60% of households felt and agreed that fruits from their farms could help them fight against food scarcity, thus concurring with authors that observed that fruit could serve as safety nets (Arnold et al., 2011; Paumgarten and Shackleton, 2011) and could help in curbing the rate of undernourishment (Boedecker et al., 2014; Ganry, 2013; Vicenti et al., 2013; Grutzmacher and Gross, 2011).

5.4.2. Tree diversity, fruit purchase and consumption with increasing deforestation

Households listed fruits from trees that were commonly harvested and consumed. In all, 25 fruit species were listed with 15 wild and 10 planted fruit species. The most deforested area recorded the highest number of FTs. It also registered the highest percentage of wild fruit species in all three zones. This is contradictory to the results of Georgius et al. (1993) and van Dijk (1999) who found that more remote areas had more forest foods. The results of this study could be a consequence and evidence that as the forest opens up, more FTs are nurtured alongside subsistence agriculture (Mertens et al., 2000; Ndoye and Kaimowitz, 2000; Sunderlin et al., 2000). The study concluded that there was more FT abundance in the most deforested zone in which FTs were mentioned 503 times as against 487 times and 427 times for the moderately and least deforested zones, respectively. This means that as deforestation increases,

FT abundance increases. However, this was contrary to the findings of Ickowitz et al. (2014) that FT diversity and fruit consumption decreased as forest cover decreases. Likewise, in the most deforested area, fruit, and especially wild fruits, were more widely eaten than in the other two deforestation zones.

The amount of money spent on fruit was not related to mean household income and mean percentage of food expenditure, respectively. This is similar to the analysis of Ruel et al. (2005) on fruit and vegetable purchase in African countries. Ruel et al. (2005) noted that, although richer households spent more on fruit and vegetables, by comparing the income elasticity of fruit and vegetables expenditure by income quintiles, no clear patterns emerged. This analysis on the purchase of fruit and fruit juice reveals that households were willing and interested to consume more fruits from trees, but lacked the necessary financial resources to purchase fruit, echoing the findings by Banwat, et al. (2012).

Numerous studies have been carried out on the importance of on farm FTs and promoting local fruit consumption (Akinnifesi et al., 2008; Shackleton et al., 2008; Degrande et al., 2006; Ambe, 2001). Yet, this study has gone a step forward to test the impression of households regarding fruits from farms and those from the market along a deforestation gradient. From the responses, most households agreed that fruits from their plantation were as nice as those from the market. This means that this population was interested in eating fruits from local production sources, but required some support for tree planting activities to boost local supply.

5.4.3. Knowledge of FTs and awareness on fruit consumption was low

There was no significant change in the types of FTs that were found at different levels of deforestation. This signifies that loss of some species was not recorded with increasing deforestation, neither were there new species that were brought in. This is contrary to results of Luczaj et al. (2013) in Belarus, although the Belarus study was over a longer period of time and intended to verify this change. Approximately one-quarter of households said they harvested more wild fruit than planted fruit. Goenster et al. (2011) also investigated tree diversity of indigenous FTs in home gardens of the Nuba Mountains in central Sudan and the potential for improving the nutrition and income of rural communities. They found that wild fruits species were present in homes gardens with a mean of 2.5 per garden and none of these wild fruit trees

were planted, but were retained during land preparation for planting. Wild fruit consumption was not stigmatised nor did it represent a sign of poverty in the community as people were willing to continue to eat wild fruit even when they had more money. This contradicts studies that have often reported NTFPs to serve as food for the poor (Paumgarten and Shackleton, 2011; Nesbitt et al., 2010; Robiglio et al., 2010; Shackleton and Shackleton, 2004) and shows that wild food consumption is more culturally linked than being a result of poverty (Levang et al., 2015; Tee et al., 2009). It is also a matter of convenience and availability (Abu-Basutu, 2013; Banwat, et al., 2012; Termote et al., 2012; Georgius et al., 1993).

The present and desired frequency of fruit consumption was not in conformity with the WHO recommended level of fruit intake (WCRF/AIRC, 2007; WHO, 2003). Processing was limited (Edoum et al., 2011) which obliged people to rely on seasonal availability of fruit supply. Also, lack of knowledge was prevalent given that households did not know the recommendation on daily intake of fruit to maintain good health. The actual and desired frequency of fruit consumption was inconsistent meaning that there was a certain level of uncertainty vis-à-vis the importance of fruit consumption. It also showed that there was a likelihood of micronutrient deficiency in this population resulting from the inadequate consumption of fruit.

Households agreed that fruits were suitable for pregnant women and children under the age of two, although they noted that some fruit should not be eaten by these groups of people. This means that culturally, people were aware of some dangers that might occur from excessive consumption of some fruit species as also reported by van-Wyk (2005). Dindyal and Dindyal (2003) did a similar study and reported on the subject of how personal factors, including culture and ethnicity, affect the choices and selection of food. Therefore, it is necessary to appreciate and acknowledge the large impact of culture and ethnicity on food choices, eating styles and patterns in order to help people adopt healthier dietary habits.

5.4.4. Information on fruit consumption was informal

Daily intake of 400 g of fruit per person per day is a priority of international recognition (Ganry, 2013; Vicenti et al., 2013; WHO, 2003). Considering the inconsistent frequency and irregular quantities of fruits consumed amongst others, this study has shown that the recommended intake of fruits is not met. Efforts to adequately address problems of malnutrition

and micronutrient deficiency are constantly being impeded by limited understanding on the availability, accessibility and utilisation of micronutrient rich foods like fruit (Ickowitz et al., 2014, Motzke et al., 2012; Tatry et al., 2011; Dindyal and Dindyal, 2003). This could potentially be aggravated by increasing levels of deforestation in which up to date information on the relationship between fruit consumption, fruit diversity and deforestation is rarely documented (Levang et al., 2015, Ickowitz et al., 2014, Robiglio et al., 2010, Georgius et al., 1993). However, this study has demonstrated that the sources of information on fruit do not change with increasing deforestation and several households still rely on informal information outlets such as church announcements and word of mouth.

It also shows that State supported sources of information on fruit and fruit consumption are absent or lack a profile. This confirms the high neglect of the importance of fruit consumption and its contribution to human health in Cameroon as established by the study of Germaine et al. (2011) which noted that data monitoring and sensitisation on micronutrient deficiency was not a public health priority in Cameroon. Furthermore, the report on the national forum on nutrition showed that obesity has increased by 54% and 82% for women and men, respectively in the rural areas of Cameroon and that childhood obesity among school children aged 3 to 14 years was 16.2% (Tanya et al., 2011). Yet, in proposing solutions, the report completely neglected aspects related to fruit consumption (frequency and quantities) and other questions related to micronutrient deficiency. Nevertheless, WHO and FAO has warned that worldwide, 2.7 million lives per year could be saved through a better nutrition with fruit and vegetables, stressing attention on the fact that low fruit and vegetable consumption is among the top 10 selected risk factors for global mortality (WCRF/AIRC, 2007; WHO, 2003). In addition, fruit and vegetables are now recognised as important components of a healthy diet (Ganry, 2009; WCRF/AIRC, 2007; Blanchette and Brug, 2005; WHO, 2003). Therefore, it is of paramount importance for the public health department of Cameroon to embark on the promotion of and sensitisation on the importance of daily fruit consumption nationally. Results from this study shows that the best ways to share FT information locally were through sensitisation/training/exchange visits/follow up, church announcements/village meetings, experimental farms/exchange visits and radio/TV.

5.5. Conclusion and Recommendations

Data on the intake of micronutrient rich foods such as fruits is absent in many developing countries, including the forest areas of Cameroon. Yet, the report on the national forum of nutrition in Cameroon reveals increasing malnutrition in forest areas of Cameroon. From these results it can be observed that the level of fruit consumption is far lower than the WHO/FAO recommended standard and the frequency of consumption is irregular. Although the majority of households reported that fruits were eaten by all household members, that vitamins were important and fruits were an important source of vitamins, most people were not aware that they have to eat fruit daily as recommended by WHO. On average, households said they required fruit 2.4 ± 1.5 times per week, with less than 10% of households noting that they required fruit at least seven times a week. Therefore, present efforts to fight undernourishment may be undermined by poor fruit consumption practices. However, due to the absence of data on trends in fruit consumption practices and lack of monitoring of the evolution of micronutrient deficiency and food consumption data, this cannot be fully ascertained. On the other hand, this study has revealed daily practices of fruit consumption, the level of local awareness on the importance of fruit, the main sources of fruit seedlings and the diversity of FTs within three levels of deforestation. Furthermore, it has revealed the perceptions, importance and use of wild fruit, which is hardly, reported in most food consumption literature and informal food sources.

An asset in the study area is the availability of a wide range of up to 25 FT species that were known by household members and were often harvested and consumed. This means that there is a possibility to diversify the consumption of fruit with increased sensitisation and awareness raising. People were also conscious that although children under two years of age and pregnant women needed fruit, not all fruits were suitable to these categories of people as some fruit could cause diarrhoea and other negative effects. Fruits were mainly consumed fresh. Processing of fruit into juice, jam and other forms was absent. Thus, it will be important to design locally adaptable training programs on fruit processing techniques in these communities. This will help diversify fruit consumption by households and spread the consumption to the off season period. Generally one can say, irrespective of the level of deforestation, there is an urgent need to reinforce information dissemination on the importance

of fruit consumption and the required quantity and frequency of fruit consumption in the study area using local measures as a reference.

This study has also provided preliminary data on fruit consumption and the frequency of consumption along a deforestation gradient. The results reveal that households at all three levels of deforestation did not consume fruit or desired to eat fruit at the rate recommended by WHO. All levels of deforestation showed serious food shortages, most parameters measured did not differ with deforestation, meaning that the problem of malnutrition and undernourishment in this area may be linked to irregular fruit consumption. However, the results showed that although the problem with fruit consumption may be linked to the availability of fruit, lack of monitoring of fruit consumption patterns and, the problem of awareness on the right frequency and quantity of fruit consumption was an even bigger problem at all levels of deforestation. Therefore, it will be important to launch a nationwide study to appreciate the level of consumption of fruit within different ecological zones to make households perceive and understand the necessity of daily fruit consumption and to eat diverse fruit. In a nutshell, we need a strong social marketing to promote fruit consumption for better health in Cameroon.

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CHAPTER 6

THE AVAILABILITY, ACCESSIBILITY, UTILISATION AND STABILITY FACTORS AFFECTING THE INTAKE OF FRUIT IN THE CONTEXT OF DEFORESTATION IN CAMEROON

Lack of fruit storage facilities. Fruits were harvested only in the usage quantities. Safou fruit harvested by this seventy-year-old woman to entertain the interview team during field work (Photo by Tata P. September 2014).

6.1. Introduction

The present population growth rate combined with food insufficiency and low consumption of nutrient rich foods underlies widespread undernourishment in most poor regions of the world (Malézieux, 2013; FAO and WHO, 2003; FAO, 1997). The evaluation report on the advances made in curbing the rate of undernourishment in the world suggests that there has been a lack in progress in reducing the number of undernourished people in absolute terms in some regions (FAO et al., 2015). Sub-Saharan Africa is the most affected region wherein the number of undernourished people increased by 44 million between 1990 - 92 and 2014 -2016. On average, 23% of its population (220 million people) were undernourished (FAO et al., 2015), making it the second highest burden in the world in absolute terms. This is most severe in the Central African sub-region wherein, the number of undernourished people more than doubled between 1990 - 92 and 2014 - 16 (FAO et al., 2015). This state of undernourishment in Central Africa reflects prevailing problems in the sub-region, notably poor food consumption patterns caused, amongst others, by food shortages and limited understanding on the dimensions of food security, political instability and forest degradation (FAO et al., 2015; de Wasseige et al., 2014; Germaine et al., 2011; Tieguhong 2008; Georgius et al., 1993). The potential contribution of underutilised fruit in Africa to help mitigate the problems of food insecurity was emphasised by Malézieux (2013). He argued the nutritional benefits of fruit and the need for increased research on their supply and use to guarantee regular availability and accessibility to rural households.

The Central Africa region contains the Congo Basin forest which is the second largest continuous forest ecosystem after the Amazon, with a vital function in regulating the worlds' climate (de Wasseige et al., 2014). In this poor region, subsistence agriculture is being practiced resulting in intensive deforestation (FAO, 2014; Robiglio et al., 2010; Tieguhong 2008). The challenge of feeding the growing population in Central Africa by increasing agricultural fields continues to drive deforestation (de Wasseige et al., 2014; FAO et al., 2014, Gebbers and Adamchuck, 2010). In 1992, during the Rio convention, many directives were designed to monitor the world's forest cover, including the FAO report on the state of the world's forests (FAO, 2014; Gregory et al., 2005). Robiglio et al. (2010) note that "deforestation is not a uniform process and depending on the way in which the direct and

underlying factors that control land use change dynamics combine in a specific locality or region, dramatically different trends can be observed". Deforestation is thought to affect the food acquisition mechanisms of forest foods and their use by local people, which varies from one season to another, especially during the planting season and the harvesting season, leading to various levels of food insecurity (de Wasseige et al., 2014; FAO, 2014; Robiglio et al., 2010; Gregory et al., 2005). It is therefore necessary to carry out investigations to understand the dimensions of food security especially with changing environmental contents such as deforestation.

Progress towards food security and nutrition targets requires that food is available, accessible and of sufficient quantity and quality to ensure good nutritional outcomes (FAO et al., 2015; Barret, 2010; Tweeten, 1999). Proper nutrition contributes to human development; it helps people realise their full potential (Ickowitz et al., 2014; Jamnadass et al., 2013). The need to identify healthier and safer food items and promote their utilisation to reduce malnutrition levels has become crucial (Ickowitz et al., 2014; Malézieux, 2013). Food production policies targeting supply of sufficient, safe and nutritious food should go beyond the traditional agricultural systems (FAO, 2013; Leakey, 2012; Pinstrup-Anderson, 2009; Ericksen, 2008; Maren et al., 2008). This requires an improvement in understanding of the dimensions and causes of hunger to set better targets in achieving adequate nutrition for all. Fruit, because they are rich in micronutrients, fibre and vitamins; can contribute towards the achievement of an adequate nutrition for all if properly targeted and mainstreamed into the four dimensions of food security. It has been estimated that increased availability, accessibility and adequate fruit consumption would decrease the global non-communicable disease burden by almost 2% while 2.7 million lives could be saved each year (Mwema et al., 2012; Lock et al., 2005). There is huge potential for the diversification of fruit tree and fruit production in the wide range of species found in forests and other wooded lands (Kehlenbeck al., 2013; Malézieux, 2013; Banwat et al., 2012). Local people acquire foods such as fruit through daily practices of gathering and harvesting as well as local cultivation (Termote et al., 2012; Flyman and Afolayan, 2006; Shackleton and Shackleton, 2004), which are influenced by local factors such as pests and diseases, climate variation, land tenure and governance (Stanley et al., 2012).

Achieving global food security over time will require a sustained increase in agricultural productivity (Smyth et al., 2014) and an increase in awareness on the most

appropriate foods for better nutrition (FAO, 2013). As suggested by Smyth et al. (2014), if there are systemic reasons why agricultural productivity and proper use of foods are inhibited, they warrant investigation. One inhibiting aspect is the limited understanding of the dimensions of food security indicators and their applicability to elucidate the eradication of undernourishment in poor regions (Gebreyesus et al., 2014; Gebbers and Adamchuk, 2010). Till now, much emphasis has been paid to global aspects that impede food security, like agricultural productivity, taxation, food prices, etc. (Gebreyesus et al., 2014; Barrett, 2010; Gebbers and Adamchuk, 2010). Although much literature has reported findings on daily practices of harvesting and gathering of fruit, there is no link on how this may affect utilisation. Furthermore, fruit pests and diseases are not examined as problems of vulnerability and stability of fruit production, nor has this been analysed in a deforestation gradient context. Such limitations affect the quality and quantity of fruit supply and intake, thus compromising food security of local people. This chapter seeks to analyse local level processes that affect the dimensions of food security to guarantee proper nutrition through increased fruit consumption

Nutrition is increasingly underscored as an integral component of food security (FAO, 2013; Barrett, 2010). But, present day studies do not provide sufficient practical data on daily happenings that impede food availability, accessibility, utilisation and stability for better nutrition. Promoting the consumption of fruit in poor communities and amongst vulnerable groups could help in mitigating problems of nutrient deficiency and malnutrition (Jamnadass et al., 2013; Kehlenbeck et al., 2013; Tchoundjeu et al., 2012).Traditionally, fruit has been harvested from natural environments, but the availability of these resources is declining in many regions (Mwema et al., 2012; Tchoundjeu et al., 2012; FAO, 2010). There are many papers on the use, domestication and commercialisation of indigenous fruits/nuts/leaf species in Cameroon to create sustainable multifunctional farming systems for alleviation of hunger, malnutrition and poverty based on increasing the yields of staple foods and filling the yield gaps. This chapter buttresses such efforts and aims to assess levels of fruit intake through an analysis of the factors that affect the dimensions of food security. The objectives were to:

- Survey the factors that affect fruit availability;
- Analyse fruit acquisition mechanisms along a deforestation gradient;
- Investigate the present frequency of fruit consumption as deforestation increases and;

- Assess the impact of fruit accessibility, availability, utilisation and stability on fruit intake along a deforestation gradient.

6.2. The Fruits in the context of the food security concept

Fruit, because they are rich in micronutrients, fibre and vitamins; can contribute towards the achievement of all four dimensions of food security. There is huge potential for the diversification of fruit production and fruit intake using the wide range of fruit trees found around villages (Kehlenbeck al., 2013; Malézieux, 2013; Banwat et al., 2012). Traditionally, such fruit have been harvested in forests and woodlands, but the availability, accessibility and utilisation of these resources are declining due to deforestation and forest degradation (FAO, 2013). This chapter looks at a range of factors that enable progress towards food security and nutrition goals by examining the four dimensions of food security as deforestation increases.

Looking at the complexity of the concept of food security and to access respondents' knowledge on this concept, a multiple indicator measure (Bryman, 2012) was designed to access a set of attitudes towards the four dimensions of food security with a focus on fruit. The multiple indicator measure evaluated respondents' attitudes to measure the four dimensions of food security. These four dimensions of food security are articulated in relation to fruit are outlined below.

6.2.1. Availability

Fruit availability or home availability relates to the supply of sufficient quantities and appropriate quality of fruit through domestic production or imports, distribution, and exchange. In central Africa, most fruit trees flower from January to March and fruit ripens during April - June when harvesting often takes place (Troup, 1986). Fruit gain highest value after ripening (Sharma, 2012). The use of natural resources to grow fruit trees often compete with other uses such as urbanisation and cash crop production or lost to desertification, deforestation, and soil erosion (Akpeninor, 2013; Godfay et al., 2010). This, in the long run, can affect fruit production and food security. Fruit distribution involves the storage, processing, transport, packaging, and marketing of fruit and must be distributed to different regions (FAO, 1997). Fruit-chain, poor transport and storage infrastructure technologies on farms can also impact the

amount of food wasted in the distribution process and increase the price of moving food to regional, national and global markets and therefore the availability (Mwema et al., 2012; Godfay et al., 2010).

Few individuals or households less self-reliant for fruits (Ecker and Breisinger, 2012) This creates the need for a bartering, exchange and cash economy to acquire fruits. Thus, the exchange of fruit requires efficient trading systems and market institutions, which can have an impact on availability and food security. On their part, most poor households do not possess sufficient money to buy fruit (Mwema et al., 2012; Bodor et al., 2007). Therefore, Kehlenbeck et al. (2013) and Tchoundjeu et al. (2012) suggest the need for improved agroforestry and fruit tree planting activities as a means to boost local supply of fruit to poor farmers. Fruit availability can be determined by a variety of factors including land ownership and use, soil management, fruit crop selection, breeding, and management (Kehlenbeck et al., 2013; Leakey, 2012; Tchoundjeu et al., 2012). Demographic variables (age, sex, race/ethnicity and level of education in the households also influence the availability of fruit (Bodor et al., 2007).

Increasing consumer awareness of the recommended daily intake of fruit for good health is a priority (Beydoun and Wang, 2008). Knowledge of fruit availability, production techniques, distribution and marketing would in part determine an individual's ability to assess the adequacy of his or her current consumption rate and thus ensure food security (Blanchette and Brug, 2005). In this chapter, fruit availability is assessed by the level of scarcity, which has been identified as one of the causes of low fruit intake (Banwat et al., 2012; Ruel et al., 2005). Scarcity can be evaluated through variation in production and the appreciation by farmers on last production if it has increased, reduced or remained stable.

6.2.2. Accessibility

Accessibility, refers to the ability of an individual or household to purchase fruit at prevailing prices or acquire fruit from home grown or natural sources (Akpeninor, 2013; Bodor et al., 2007; Garrett and Ruel, 1999). Therefore, fruit access refers to the affordability and allocation as well as individuals’ and households’ preferences of particular fruits. Purchase of fruit is the most common indicator of fruit access (Ecker and Breisinger, 2012; Bodor et al., 2007). However, income poverty, spending preferences and remoteness can limit access to fruit through purchasing (Ecker and Breisinger, 2012; Bodor et al., 2007). In the case of income

poverty and remoteness, households depend on varying types of locally cultivated fruit or wild fruit harvested and gathered from the forest (Mwema et al., 2012; Garrett and Ruel, 1999; Tweeten, 1999). This can be accessed by the average quantity of fruit harvested per time from all fruit trees put together. A number of variables are put together to investigate the situation of fruit access within households including frequency of gathering and harvesting, number of fruit trees mentioned, income spent on fruit and frequency of fruit purchase. Through listing, fruit preferences were established following the frequency of citation.

6.2.3. Utilisation

The condition of intake of sufficient and safe food which is adequate according to an individual's physiological requirements forms the third dimension of food security - that is utilisation (Ecker and Breisinger, 2012). To achieve food security, the fruit consumed must be safe and enough to meet the physiological requirements of each individual. Fruit safety impacts fruit utilisation and could be influenced by storage and processing of fruit in the community or household. Sanitation can also decrease the occurrence and spread of pests and diseases/intestinal parasites that can absorb nutrients from the body and decrease fruit utilisation. Education about nutrition and fruit storage and preparation can impact fruit utilisation and improve this dimension of food security. Fruit utilisation refers to the metabolism of fruit by individuals or households (Tweeten, 1999). In this study, fruit utilisation was measured in terms of frequency of consumption and whether or not consumption is increasing, decreasing or stable.

6.2.4. Stability and nutrition

The effects of shocks and stressors on food security have often been analysed at the macro and micro level looking at spikes in food prices, financial and sovereign debt crisis on the one hand (Tweeten, 1999) and civil conflicts and natural disasters such as floods and droughts on the other hand (Sasson, 2012). However, recent studies show the effect of climate change as a stressor on food security **(**Jamnadass et al., 2012; Whiley et al., 1996) and households face various daily crisis in the supply of foods like fruit, which is not linked to income. This study sets out to analyse these daily stressors that limit the supply of safe, quality and sufficient fruit for a healthy lifestyle within households. The daily vulnerability to the

supply of fruit can lead to nutritional effects that may substantially differ between households subject to different levels of vulnerability (and exposure) and the household resources to mitigate the individual impact. Such stressors affecting fruit can have serious consequences on the nutrition of household members, particularly as people may eat infected fruits unconsciously.

Food security can be transitory, seasonal, or chronic and thus affect stability. In transitory food insecurity, food may be unavailable during certain periods of time. At the fruit production level, natural disasters and drought resulting in fruit crop failure and decreased fruit stability. Instability in markets resulting in food-price spikes can cause transitory food insecurity. Other factors that can temporarily affect fruit stability are loss of employment or productivity, which can be caused by illness. Seasonal fruit insecurity can result from the regular pattern of growing seasons in fruit production (Whiley et al., 1996). Fruit stability refers to the ability to obtain fruit over time. To ensure food security, households or individuals must have access to adequate fruit at all times. They should not risk losing access to fruit as a consequence of sudden shocks (an economic or climatic crisis) or cyclical events (seasonal fruit insecurity) (Whiley et al., 1996). The concept of stability can therefore refer to both the availability and access dimensions of food security. Problems such as the evolution and prevalence of attacks by pest and diseases manifested stability, during the last ten years and farmers' strategies to fight against pest and diseases (Sharma, 2012).

6.3. Methodology

Field experiences during a prior survey carried out from August to December 2013 informed the design of data collection tools for this study. I updated the list of fruit trees during the scoping visit to start the second phase. I executed two rounds of surveys of March to June and July to October with the same population because different fruit species ripen during different months of the year. These were the periods reported to be the peak-ripening season for most fruits during the previous interviews. Thus, these two surveys covering a period of six months captured a majority of fruit trees found in the study area and propounded a logic to generate within season information on all commonly found fruit trees. In the case of fruit purchase, quantity harvested, fruit consumption quantities and frequencies, the recall period

was one month. The reference period for comparing trends and changes in fruit tree activities was ten years, which is a period that most fruit trees go into full production in the traditional system (Jamnadass et al., 2013; Robiglio et al., 2010; German et al., 2009; Gregory et al., 2005). The same households interviewed for the fruit tree diversity survey were retained for this activity, meaning there were ±15 households per village. However, in the case that a household was unable to participate, it was replaced by any randomly selected household from the food security survey that was willing to participate. Overall, I collected data from 147 and 133 households during the first and second surveys, respectively. Frequency of representation of studied households per deforestation zone and data collection period is presented are Table 6.1.

Table 6.1: Sample size per village during the two survey periods

Deforestation zone	Villages	Number of households	
		March to May	June to August
Most	Ekali/Abang	18	15
	Akomnyada	17	15
	Avebe	17	13
Moderate	Biyeyem	16	15
	Mbong/Mintom	15	15
	Meyos	16	15
Least	MeyoElie	16	15
	Mitypkwali	17	15
	Nkpwaeba	15	15
	Total	147	133

6.4. Data collection and analysis

The research has approach and questionnaire development has been explained in chapter two. The two survey periods represent the peak-ripening season of fruits from trees in the study community. The suite of food security indicators as developed and explained by FAO et al. (2012, 2015) inspired data collection. This study investigated and analysed variables that could inform specific indicators on fruit trees per dimension of food security in a rural context (Table 6.2). I captured data in Excel and transferred it to SPSS 20.0 for analysis, and drew graphs in Excel. SPSS ran descriptive statistics, totalling of citations, χ2-test, means and simple ANOVA were done in. Graphpadprism 5 computed Post-Hoc Comparison and one-way ANOVA tests.

Table 6.2: Variables for verifying food security indicators and the four dimensions

Dimension of food security being measured	Measurement indicator	Variables
Availability	Production	Listing of fruit species
		Harvesting period
		Appreciation of last harvest
		Percentage of harvest lost
	Future availability	Local fruit conservation strategies
		Ensure fruit supply
Accessibility	Affordability	Harvesting mode Number of times fruit was bought during the last three months
		Reason for buying
		Frequency of gathering
		Frequency of harvesting
		Quantity harvested
Utilisation	Fruits intake	Frequency of fruits consumption by children < two years
		Past and present trends in fruits consumption
Stability	Variability and trends over time	Variation in production
		Evolution of pest attack from previous years
		Symptoms of fruit tree diseases

Availability to a variety of fruit was computed through fruit citations made by households. The perceived ripening period for fruits was obtained from percentage of farmers responses per individual fruits. Pearson Chi-square test ($\chi 2$) and Cramer's V was used to investigate the degree of relationship between all variables measuring availability, accessibility, utilisation and stability factors and deforestation gradient. A correlation test employing the Pearson coefficient were used to show the relationship between the average citation of individual fruit trees per deforestation zone during the two survey periods.

6.5. Results

6.5.1. Availability

In the study area, several households could gather fruit from a single fruit tree without necessarily being the owner of the fruit tree. During the period of March to May, households listed a minimum of one and a maximum of 27 fruit species being harvested with a mean of 9.2 ± 4.92 species listed per household. A total of 1 351 citations were made for all fruit put

together with 420 citations from the least deforested area, 545 citations for the moderately deforested and 386 citations for the most deforested area. For the period of June to August, a minimum of one and a maximum of 25 fruit species were cited. The total citation for all fruit tees put together for this period of June to August was 1 501 times with 486 times for the most deforested area, 528 times for the moderately deforested area and 487 times for the least deforested area. On an average, households cited 11.4 ± 4.9 fruit species during this period. A strong relationship was observed between the species of mentioned fruit and the survey period (χ^2 = 132.21, p < 0.001; Cramer's V = 0.215 p < 0.001). The most abundant fruit during the March to May survey were avocado pear (*Persea americana*), mango (*Mangifera indica*), orange (*Citrus sinensis*), pawpaw (*Carica papaya*), safou (*Dacryodes edulis*) and banana (*Musa spp.)*. For June to August, the most common fruit were pawpaw (*Carica papaya*), safou (*Dacryodes edulis*), mvut (*Trichoscypha acuminata*), avocado pear (*Perse aamericana*), orange (*Citrus sinensis*) and banana (*Musa* spp.). Chi-square test shows a link between deforestation gradient and the list of species cited during the March to May survey (χ^2 = 123.16 p < 0.001; Cramer's V = 0.213 p < 0.001), whereas, during the June to August survey, there was no significant relationship observed (χ^2 = 59.47 p = 0.222; Cramer's V = 0.141 p = 0.222).

Pooling the two periods together (Table 6.3), the most occurring species were avocado pear (*Persea americana*) 8.3% (236 citations), pawpaw (*Carica papaya*) 7.9% (226 citations),

Table 6.3: The top eight most abundant fruit per deforestation zone

Local name	Scientific name	Most deforested zone		Moderately deforested zone		Least deforested zone	
		No. of household citing fruit (N= 95)	Proportion of species in the zone (%)	No. of household citing fruit (N= 92)	Proportion of species in the zone (%)	No. of household citing fruit (N= 93)	Proportion of species in the zone (%)
Avocado pear	*Persea americana*	89	10.2	78	7.3	69	7.6
Banana	*Musa spp.*	69	7.9	57	5.3	52	5.7
Guava	*Psidium guajava*	47	5.4	52	4.8	54	6.0
Mango	*Mangifera indica*	68	7.8	74	6.9	62	6.8
Mvut	*Trichoscypha acuminata*	46	5.3	53	4.9	53	5.8
Orange	*Citrus sinensis*	62	7.1	72	6.7	66	7.3
Pawpaw	*Carica papaya*	82	9.4	70	6.5	74	8.2
Safou	*Dacryodes edulis*	68	7.8	75	7.0	72	7.9

safou (*Dacryodes edulis*) 7.5% (215 citations), mango (*Mangifera indica*) 7.2% (204 citations), orange (*Citrus sinensis*) 7.0% (200 citations) and banana (*Musa spp*.) 6.2% (178 citations). Following the deforestation zone, avocado pear (*Persea americana*) was the most abundant species for the most and the moderate deforested areas, while pawpaw (*Carica papaya*) was most occurring for the least deforested area (Table 6.3).

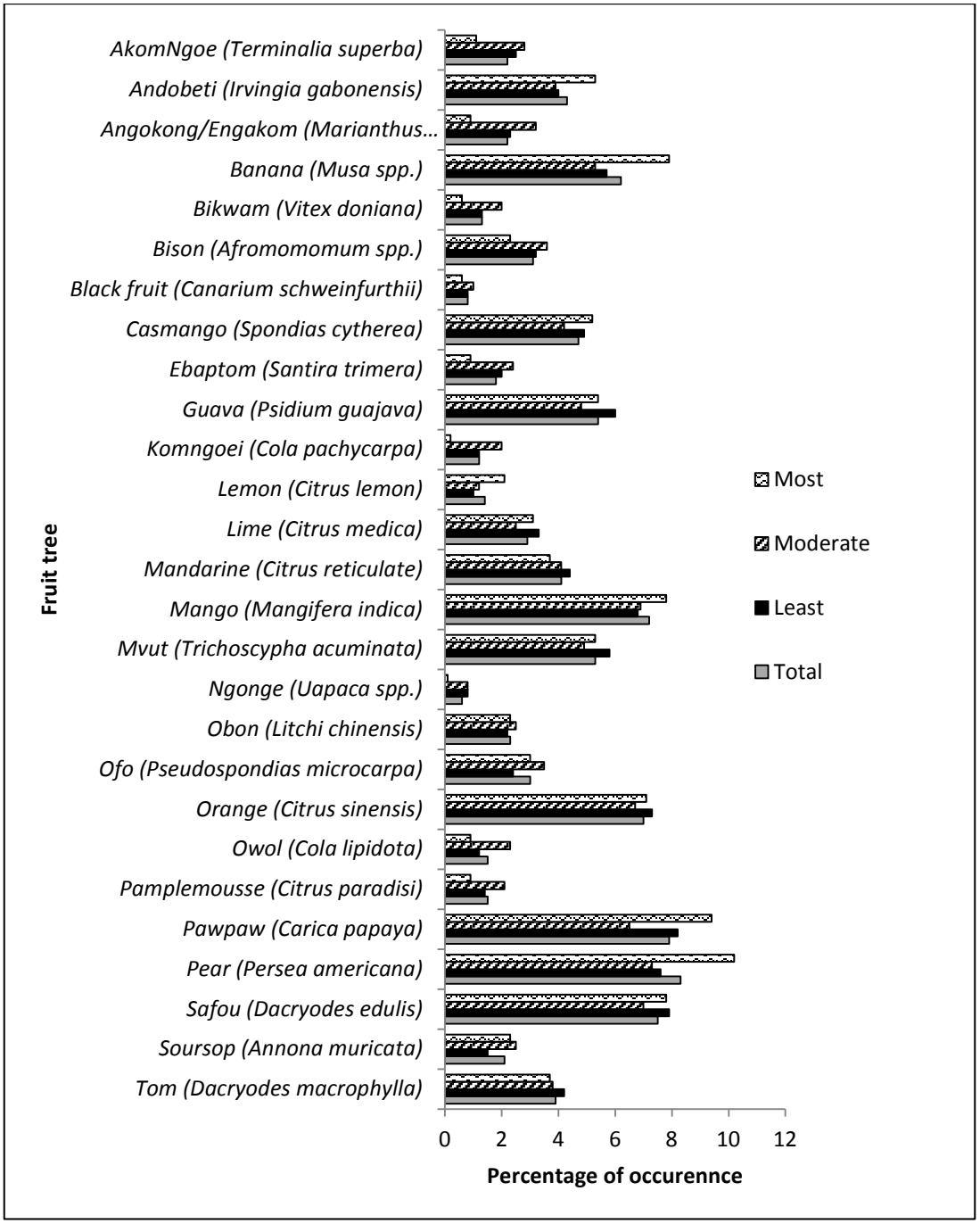

Figure 6.1: Occurrence of fruit tree per deforestation zone

All fruit tree species were cited 2 852 times. For the most, moderately and least deforested zones, species were mentioned 872 times, 1 073 times and 907 times, respectively. From Figure 6.1, there was a significant relationship between deforestation zone and the types of fruit trees that were mentioned ($\chi^2 = 97.55$ $p < 0.001$; Cramer's V = 0.131 $p < 0.001$). The correlation test ($p < 0.001$) indicated that there was high similarity between the composition and frequency of mention of fruits in the first period relative to the second period at all levels of deforestation. Across all species, some fruits were available every month of the year. Considering all species, the harvesting was July to October 30%, March to June 19%, April to July 16%, October to December 11%, all year round 11%, December to April 6% and not sure 7% (Figure 6.2).

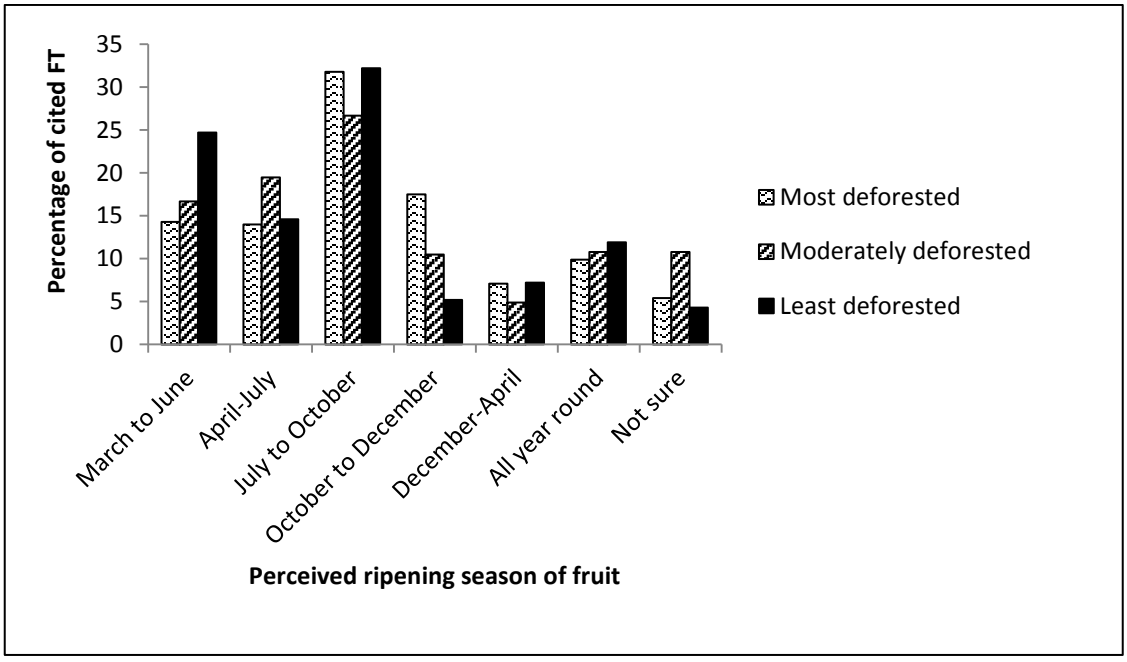

Figure 6.2: Perceived ripening period

There was a significant relationship between ripening period and deforestation zone ($\chi^2 = 149.86$ $p < 0.001$; Cramer's V = 0.162 $p < 0.001$). The peak fruiting period was perceived to be slightly later in the most deforested zones, than in the moderate or least deforested zone. As shown in Figure 6.2, the most important ripening season of fruit at all levels of deforestation

were July to October and this was mainly for fruits like safou (*Dacryodes edulis*) and mvut (*Trichoscypha acuminata*). March to June and April to July were the second and third most recorded harvesting period. Whereas more planted fruit were reported to be harvested during March to June (mango (*Mangifera indica*), avocado pear (*Persea americana*), orange (*Citrus sinensis*), safou (*Dacryodes edulis*)), wild fruit topped the list of fruit for the period of April to July (tom (*Dacryodes macrophylla*), mvut (*Trichoscypha acuminata*), andobeti (*Irvingia gabonensis*) and casmango (*Spondias cytherea*). Crossing field observation data, information from the first part of the survey and this monitoring survey, the harvesting months for the most cited fruit was established as in Table 6.4. Banana and pawpaw were cited to ripen be all year round.

Table 6.4: Perceived harvesting period for most cited fruit versus months of food scarcity

Species		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Andobeti	*Irvingia gabonensis*												
Avocado pear	*Persea americana*												
Banana	*Musa spp.*												
Casmango	*Spondias cytherea*												
Guava	*Psidium guajava*												
Mango	*Mangifera indica*												
Mvut	*Trichoscypha acuminata*												
Orange	*Citrus sinensis*												
Pawpaw	*Carica papaya*												
Safou	*Dacryodes edulis*												
Peak periods of household food scarcity													

From previous chapters, peak periods of food scarcity within a year were listed as January - March (38%); April - June (4%); July - September (3%); October - December (31%) and all year round (24%). Thus, fruit such as banana, pawpaw and guava have the potential to contribute to food supply during food scarcity periods. Generally, not many fruits were harvested during the period of January to March suggesting the likelihood of more hunger during the period with lowest fruit ripening.

6.5.2. Accessibility

Ways of acquiring fruit were harvesting 45%, gathering 36% and both 20% for the most deforested zone; for the moderately deforested zone it was harvesting 36%, gathering 35% and

both 29% and; gathering 62%, harvesting 28% and both 10% for the least deforested zone. Each activity was classified rarely if its execution was done less than five times throughout the harvesting season of a given fruit species. The frequency of wild gathering was rarely 51%, once a month 3%, once every two weeks 1%, twice a week 9%, three times a week 19%, and daily 18%. No household harvested fruit daily. The frequency of harvesting was rarely 47%, once a month 14%, once every two weeks 9%, twice a week 17% and three times a week 13%. From here, it can be noticed that although farmers mention many fruit species, these species were rarely collected by household members either by harvesting or gathering. There is a high chance that consumption will be low. The results on the frequency of harvesting and gathering per deforestation zone are summarised on Figure 6.3.

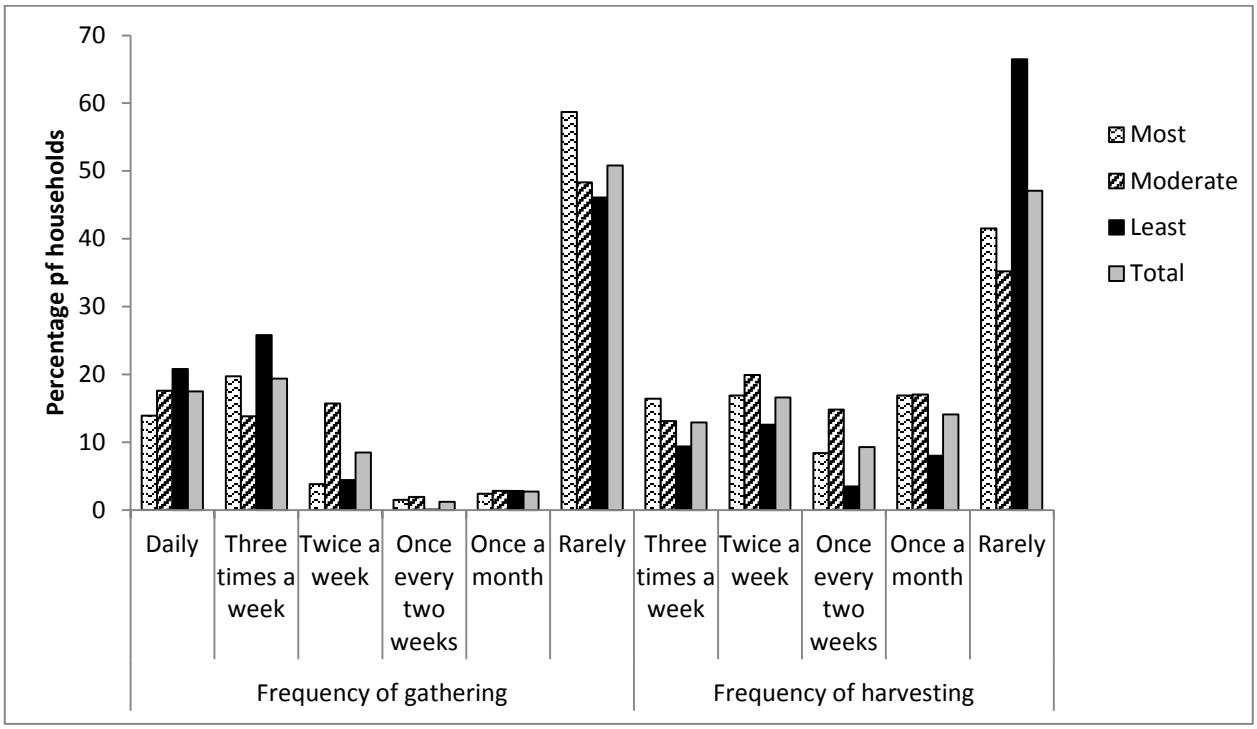

Figure 6.3: Frequency of fruits harvesting and gathering per deforestation zone

Not all the collected fruit were consumed within households. Some fruit were sold, although the frequency of sales was reducing as mentioned by 78% of households. The frequency of selling fruit was none 56%, once every month 15%, every fortnight 3%, weekly 25% and daily 2%. Sales of fruit reduced the quantity of fruit available for home consumption. From field discussions, it was noted that most healthy looking fruit were reserved for sales and

the infected and waste ones were consumed in the home. Also, some healthy looking fruits were reserved for entertaining visitors or sent to the family in the cities.

Of the 25% of households that bought fruit, 16% said they bought just to eat, 6% bought for a sick child and 3% bought for a sick adult. The frequency of purchase and money spent on the fruit were very low, often less than two American dollars per purchase. The number of times fruit were bought during the last three months was none 75%, rarely (< 5 times) 20%, and many times (almost once weekly) 5%. Income spent on fruit was quite low (100 FCFA 11%, 101 - 300 FCFA 9%, 301 to 500 FCFA 4%, and > 500 FCFA 1%. During the ripening season, for the most, moderately and least deforested zones, 9%, 4% and 2% of households bought fruit many times (> 10 times) while 20%, 18% and 23% of households bought fruit rarely (< 5 times) and 71%, 78% and 75% of households never bought (Figure 6.4). There was a link between the deforestation gradient and purchase of fruit ($\chi^2 = 54.19$ $p < 0.001$; Cramer's $V = 0.097$ $p < 0.001$). This means that the frequency of fruit purchase in the most deforested zone was significantly higher than the other two zones.

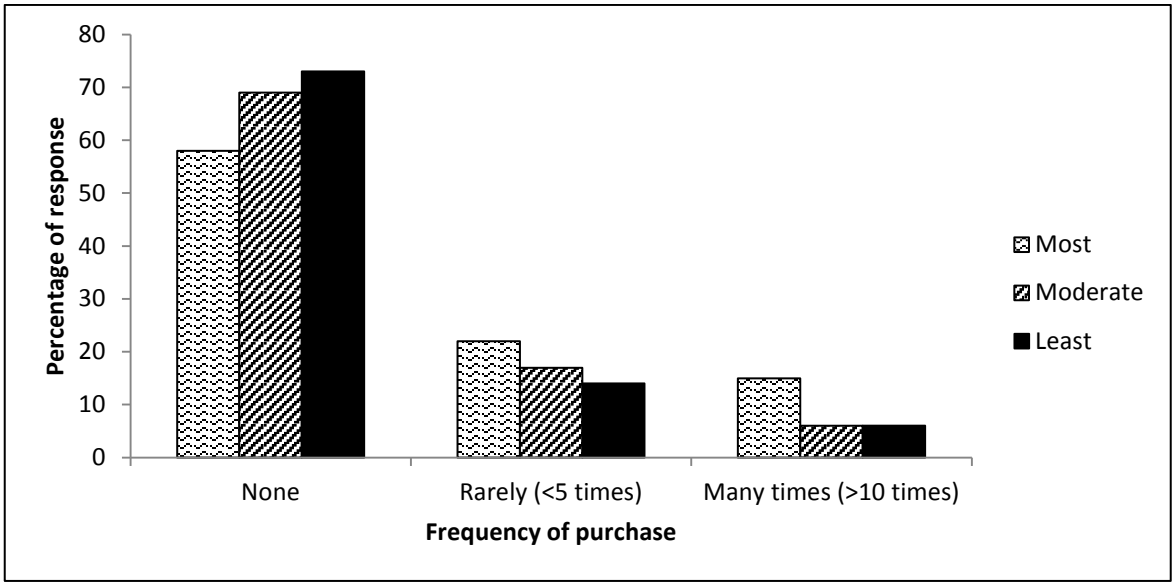

Figure 6.4: Frequency of purchase of fruit per deforestation zone

There was also a significant difference between deforestation gradient and income spent on fruit purchase ($\chi^2 = 38.42$ $p < 0.001$; Cramer's $V = 0.082$ $p < 0.001$). A large majority did not buy fruits 71%, 78%, and 75% for the most, moderate and least deforested zones, respectively. Income spent on fruits was 100 FCFA (13%, 10% and 10%); 101 - 300 FCFA it

was (9%, 8% and 10%); for 301 to 500 FCFA it was (4%, 3% and 5%) while > 500 was (3%, 1% and 0%) per zone.

6.5.3. Utilisation

The majority of households said they ate more fruits now than 10 years back ,72%, 79% and 67% from the most, moderately and least deforested zones. A tiny minority (0.7%, 0.2% and 0.6%) from the most, moderately and least deforested zones, respectively, said their fruit consumption rate has not changed while around one-third noted that effectively, they were unable to eat more fruit now than before (27%, 38% and 21%). Secondly, the frequency of fruit consumption was further examined wherein households noted that they consumed fruit daily 50%, once a week 29%, three times per week 16%, and a few times during the season (5%). Generally, households in the moderately deforested zone consumed fruit most frequently with 48% daily and 34% once a week. Conversely, households in the most and least deforested zones ate fruits almost equally and many more households in the least deforested zone ate fruits only a few times during the season than those in the most deforested zone (Figure 6.5).

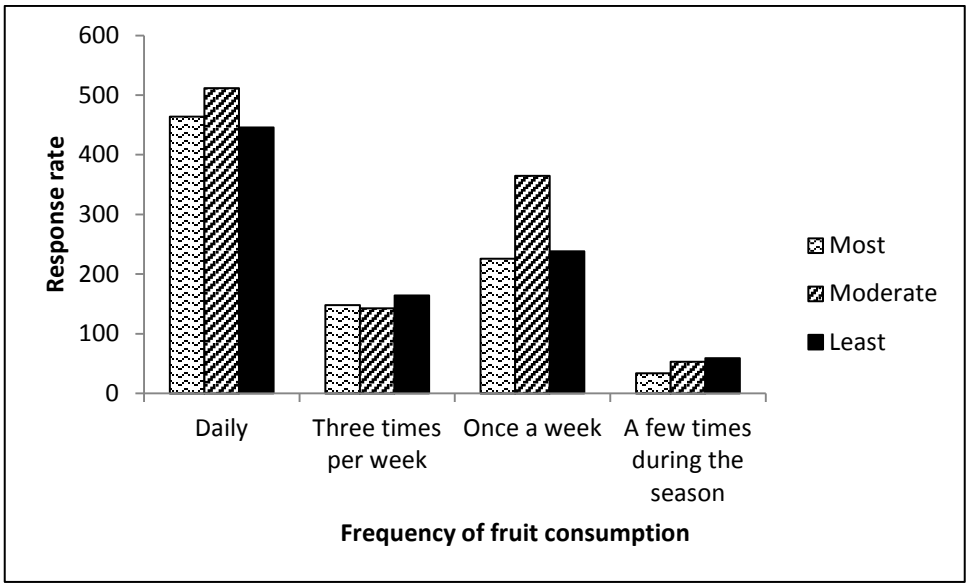

Figure 6.5: Frequency of fruit consumption per deforestation zone

From Figure 6.5, there was a significant link between the frequency of fruit consumption and deforestation zone ($\chi^2 = 31.34$ $p < 0.001$; Cramer's V = 0.074 $p < 0.001$). The moderately deforested zone showed the highest frequency of fruit consumption compared to the

two other zones. On fruit consumption by children below two years, the rate was daily 27%, a few times in a week 54%, rarely 6% and never 14%. Whereas a good proportion of children within each level of deforestation never ate fruit (8%, 14% and 19% for the most, moderately and least deforested zones, respectively), less than one tenth 7%, 4% and 7% ate fruit rarely while the majority 56%, 51% and 55% ate fruit a few times per week correspondingly for the most, moderately and least deforested zones. About one-third of children (30%, 28% and 22%) ate fruit daily from the most, moderately and least deforested zones (Figure 6.6).

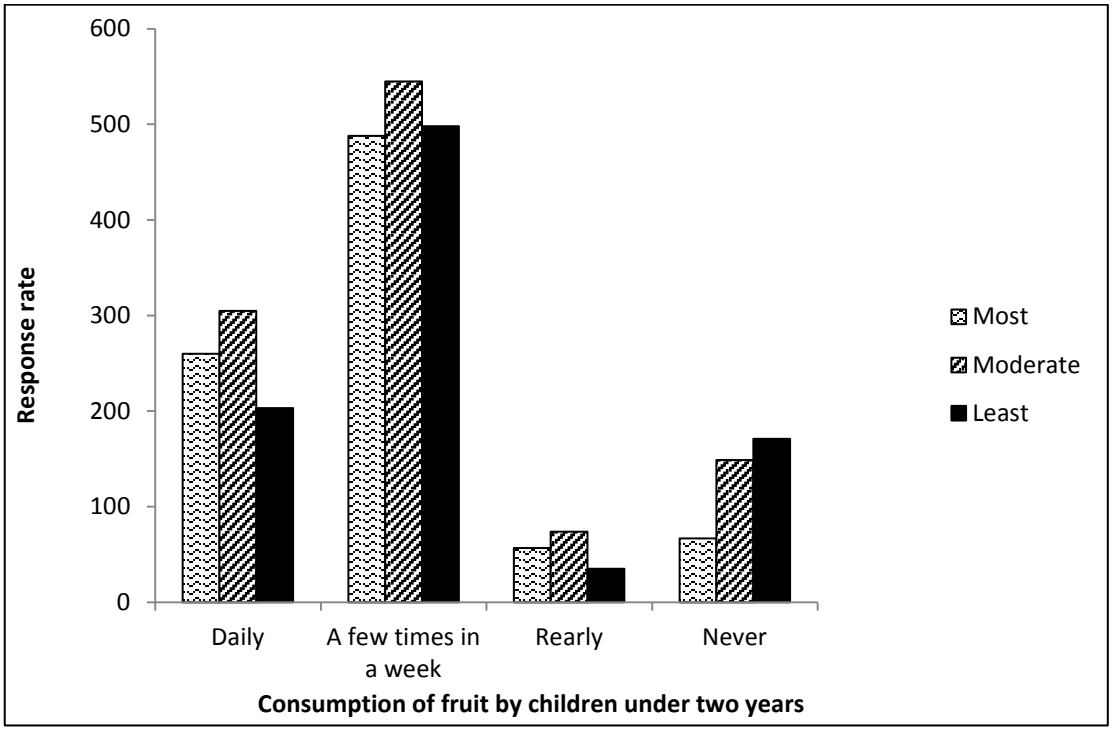

Figure 6.6: Consumption of fruit by children below two years per deforestation zone.

As per statistics on Figure 6.6, the moderate zone showed no difference to either of the other two. However, for households in the most deforested zone consumption were significantly higher than for those in the least deforested zone. A significant relationship was observed between deforestation zone and the consumption of fruit by children below two years ($\chi^2 = 63.23$ $p < 0.001$; Cramer's $V = 0.105$ $p < 0.001$) suggesting that many more children ate fruits daily and a few times in a week in the moderately deforested zone compared to the other two zones.

Lastly, local fruit conservation strategies were examined to appreciate how households store fruit to promote regular home consumption. During the first survey, most households (up

to 80%) did nothing to preserve fruit and during the second period these percentage reduced to about 60% at all levels of deforestation (Table 6.5). Across both periods, 61% of households did not have any special storage facilities nor storage means for fruit. Traditional storage strategies were to spread fruits on the ground in a cold, dry place (30%), to harvest only what is needed (3%) and harvest just before ripening (6%). These fruit storage strategies per survey period and deforestation zone are presented on Table 6.5.

Table 6.5: Local fruit conservation strategies used by households during the two surveys and per deforestation zone

Period	Deforestation zone	Fruit conservation strategy			
		None	Spread on the ground in a cold, dry place	Harvest only what is needed	Harvest just before ripening
March to May	Most	82.1	7.1	2.4	8.5
	Moderate	61.2	5.1	15.2	18.5
	Least	85.2	10.3	4.5	
June to August	Most	35.6	56.4	0.4	7.6
	Moderate	61.1	38.9		
	Least	52.2	47.8		
Total	Most	55.3	35.5	1.2	8.0
	Moderate	61.2	22.5	7.4	9.0
	Least	65.9	32.3	1.9	
Overall total		60.6	30.2	3.4	5.7

6.5.4. Stability/vulnerability factors affecting fruit supply

The main problems that farmers faced with fruit trees were insects, pest and diseases (57%); low productivity and premature ripening of fruits (11%); drying up (wilting) of some trees (17%) and unpredictable fruiting due to climate change (15%). These effects were differently felt by farmers at the various levels of deforestation ($\chi^2 = 203.39$ $p < 0.001$; Cramer's $V = 0.189$ $p < 0.001$). Three symptoms were most prevalent in the most and the least deforested zone than in the moderately deforested zones. Insects, pest and diseases was, most (62%), least (60%) and moderately deforested (51%); low productivity and premature ripening of fruits was least (14%), most (12%), moderate (9%) and; unpredictable fruiting due to climate change was most (18%), least (17%) and moderately (11%) deforested. On the other hand, drying up (wilting) of some trees was more severe in the moderately deforested zone (30%) than in the least (10%) and the most deforested zones (9%). This confirms the χ^2 results and

shows that the most and the least deforestation zones had similar disease prevalence, which was different from the moderately deforested zone.

Although pest and diseases were reported to have generally increased in the last ten years, the rate of increase was not similar at all levels of deforestation ($\chi^2 = 50.34$ $p < 0.001$; Cramer's $V = 0.094$ $p < 0.001$). The most deforested zone registered the highest number of households that experienced increasing trends (86%) followed by the moderately (83%) and the least (78%) deforested zones. Households that felt that the trend was stable were 3%, 9% and 9% for the most, moderately and least deforested zones, respectively. On the reducing trends, the recording was 11%, 8% and 13% for the most, moderately and least deforested zones, respectively. This results show that there was a tendency of higher disease infestation with increasing deforestation wherein there was more prevalence in the most and the moderately deforested zones.

Various symptoms were listed at all levels of deforestation with rotting and premature ripening being the highest listed symptoms at all levels and this increased with decreasing deforestation (Figure 6.7). This means that the greater the forest cover the more likely fruits were going to rot in the fields. Then dark hard spots where present at all levels of deforestation although slightly less in the least deforested zone than the other two while parasites was more prevalent in the other two than in the least zone. Finally, drying up of some branches (wilting) was more prevalent in the most than the moderately and the least deforestation zone.

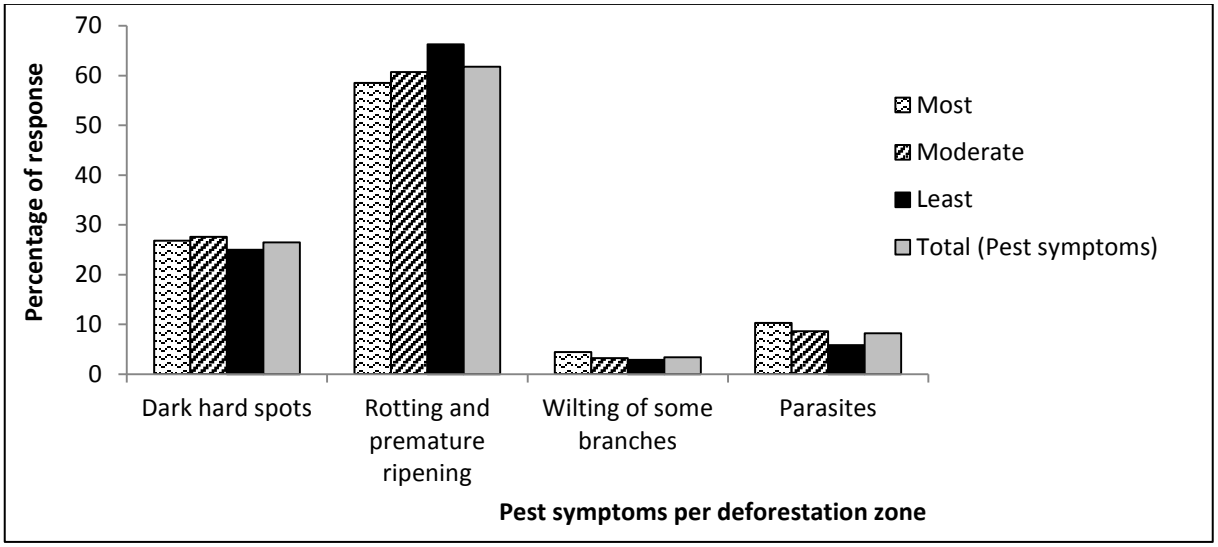

Figure 6.7: Fruit pest symptoms as reported by households

All these differences established a relationship between deforestation zone and pests and diseases symptom (χ^2 = 20.23 p = 0.003; Cramer's V = 0.06 p = 0.003). Two-way ANOVA was carried out to investigate the pest symptom that was most severe and how it varied with deforestation gradient. The results suggest that pest symptoms had the same effect at all levels of deforestation and the interaction accounted for 1.69% of the total variance. The interaction is considered extremely significant (F = 7.36 p < 0.001) while deforestation gradient does not affect the results (p = 0.999). Pest symptoms accounted for 85.6% of the total variance after adjusting for matching, the effect was considered extremely significant (F = 627.90 p < 0.001) but the matching was not effective (F = 1.18 p = 0.153). Therefore, rotting and premature ripening was the most important symptom of pest and diseases followed by dark hard spots. There was a significant difference between rotting and premature ripening between the least and the moderately deforested zones (p < 0.001) with the least deforested zone having the most infection. Rotting and premature ripening (p < 0.001) and dark hard spots (p < 0.001) significantly differed between the least and most deforested zone with the least deforested zone being the most infected by the former and the most deforested zone by the latter.

Last but not least, how farmers deal with these diseases was examined. It turned out that the majority (80%) of farmers did nothing with 76%, 83% and 81% in the most, moderately and least deforested zones, respectively. Timidly, 15%, 3% and 2% of farmers reported to cut off dry branches; cut down the tree and spray with cocoa treatment, respectively. These strategies were most applied in the most deforested zone than in the other two (χ^2 = 41.09 p < 0.001). Cut off dry (wilting) branches (16%, 14%, and 16%); cut down the tree (3%, 2%, and 3%) and spray with cocoa treatment (4%, 1% and 1%) for the most, moderately and least deforested zones.

Harvest lost

Harvest lost was estimated using the percentage of mature fruits that farmers were unable to harvest or that was harvested and wasted due to lack of storage facilities (Figure 6.8).

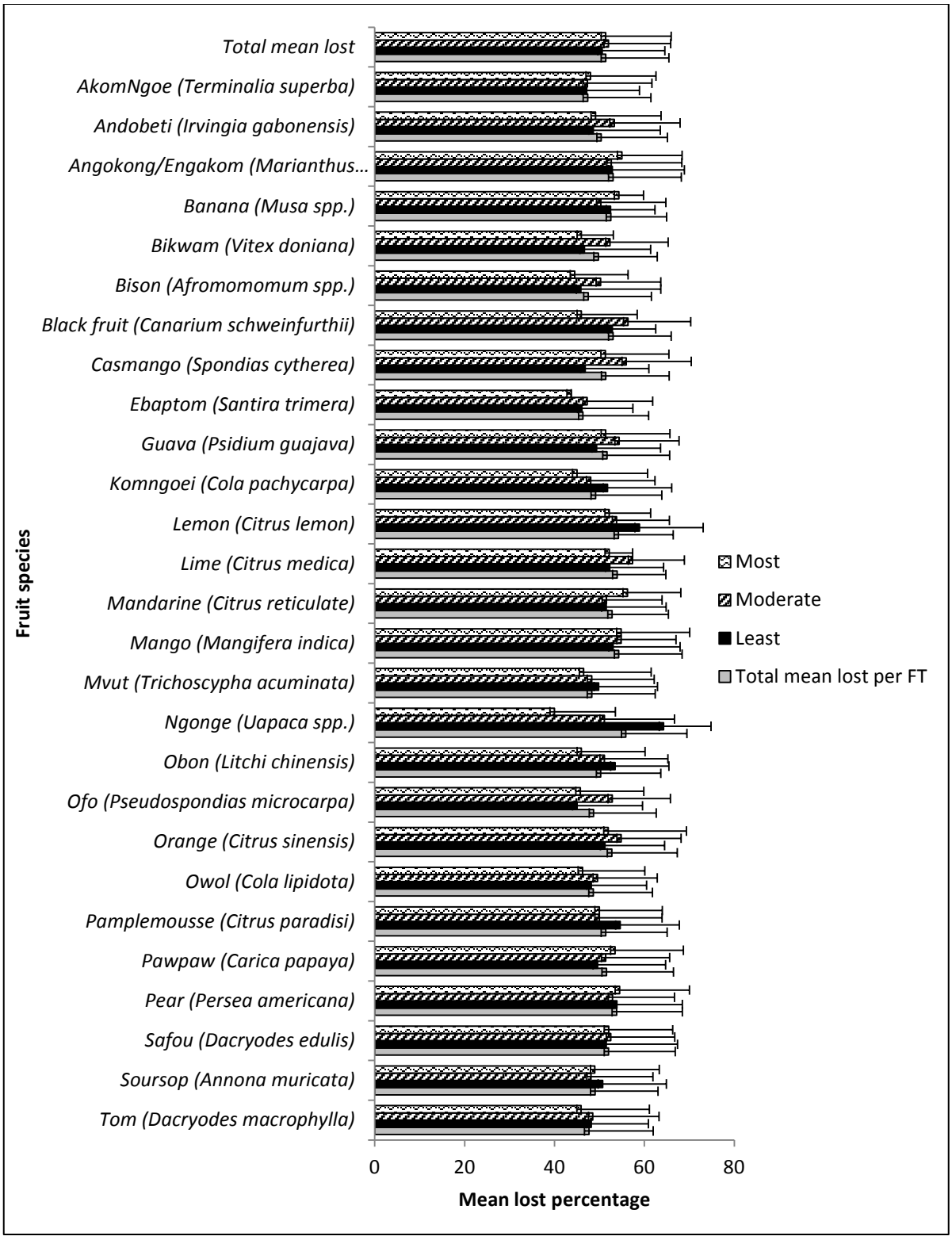

Figure 6.8: Mean percentage of harvest lost per fruit type and deforestation zone

With the narrated problems of fruit trees, farmers reported to loose between 10% and 80% of fruit produced with a mean loss of 51 ± 14%. Figure 6.8 shows that there is a significant difference between mean percentage of harvest lost per fruit species ($F = 2.76$ $p < 0.001$), but there was no difference between deforestation zone ($F = 2.45$ $p = 0.085 > 0.05$). During field discussions, all households noted that healthy fruit were rarely abandoned in the field. The majority of healthy fruits were reserved for sales or the entertainment of visitors while the infested ones were eaten. Thus, households, said most fruit were abandoned in the field because they were from infested fruit trees or of bad quality. Some of the infected fruits were collected and eaten in the households, abandoned to be gathered by children at their convenience or by hungry passers-by who lack fruits.

6.6. Discussion

Efforts to reduce malnutrition and promote nutritional outcomes in poor countries are routinely being impeded by poor food consumption patterns and limited intake of micronutrient rich foods like fruit (Jamnadass et al., 2013; Kehlenbeck et al., 2013; Ruel et al., 2005). Although strategies to promote daily consumption of fruit and vegetables is taking a central stage in food security and nutrition debates (Smyth et al., 2014; WCRF/AICR, 2007; WHO, 2003), this seems not to be promoted in most poor regions. In this study area like many poor regions, fruit intake is still regarded as optional, luxury or food for children or the poor (Mwema et al., 2012). This is further aggravated by the limited understanding and poor operationalization of the dimensions of food security in analysing the sources, intake and limitations in the intake of food items such as fruits that are usually eaten outside of main meals. In this chapter, the food security dimensions have been operationalised to show the factors that may influence fruit consumption in the context of deforestation. These are discussed in the following sections.

6.6.1. Influence of availability, accessibility and utilisation on fruit intake

Local availability of fruit is often assured through fruit tree planting in agroforestry systems (Tchoundjeu et al., 2012; German et al., 2009). Fruit availability has often been measured in terms of kg/capita/year (Ganry, 2009) and the number of fruit trees found locally

(Kehlenbeck et al., 2013). This measure is suitable in market economies where measurements are standardised. However, this measure is difficult to apply in local contexts and in remote villages with poor social amenities and infrastructural development and therefore difficult to use practically for explaining the food security dimensions. Arnold et al. (2011) noted that food insecured households may live where there is enough food, but they lack income or 'entitlements' (production, trade, labour or transfer-based) to get it. This means if the diemesions of food insecurity as not properly operationalised in such contexts, then the application of programs to combat FISH may not feasible. Thus, in this study availability in examined in terms of the number of fruit trees to which households were able to provide responses on the frequency of harvesting and/or gathering. My results revealed the occurrence of 25 tree species which households mentioned as having gathered or harvested fruit during the last three months, with a mean of 9.2 ± 4.9 species listed per household. The number of times that fruit trees species were mentioned varied significantly with deforestation zone, with the moderately deforested zone having the highest number of individual fruit tree species 1 073, followed by the least deforested zone and last by the most deforested zone. This confuse link is also acknowledged by Parrotta et al. (2015) who summarised a number of studies that have shown a link between tree cover and dietary diversity and consumption of nutritious foods although the pathways of this relationship is not yet understood. The pathway resulting from this study is that as deforestation increased, the number of fruit trees available for harvesting fruits by households decreased. It infers that deforestation could be leading to the disappearance of valuable tree species that are useful for the production of fruits locally. Or that as deforestation increases, people turn to be more strict on their planted fruit trees and thus 'open access' is limited. This justifies the results of Powell et al. (2011) who found out that in the East Usambara Mountains of Tanzania, households living closer to the forest were more likely to use forest foods. Therefore, with increasing deforestation, special actions need to accompany reforestation programs to promote fruit tree planting in community spaces.

Gathering and harvesting has been reported worldwide as the most common methods of fruit acquisition by local community and in poor environments. These were similarly discussed by Abu-Basutu (2013) in South Africa, Kehlenbeck et al. (2013) in Cameroon and Kenya, Tchoundjeu et al. (2012) in Cameroon, Banwat et al. (2012) in Nigeria, Troup (1986) in India. This study has confirmed this same trend and shows that fruit were acquired through gathering

44%, harvesting 36.3%, gathering and harvesting 20%. With no storage facilities and hot climatic conditions, coupled to the fact that some of the acquired fruit were sold, these results suggest the likelihood of irregular fruit intake in households. Another way of acquiring fruits was through purchasing (Beydoun and Wang, 2008; Blanchette and Brug, 2005). The results have further confirmed the literature that most poor households do not possess sufficient money to buy fruit (Mwema et al., 2012; Bodor et al., 2007). It shows that although some households purchased fruit, the frequency of purchase and money spent was very low often less than 2 USD per purchase. The number of times fruit were bought during the last three months was none for 75% of households while 20% of households bought fruit less than five times and only 5% bought fruit almost weekly. The low rate of fruit harvesting and purchase coupled with the fact that some fruit were sold, suggest a low rate of fruit intake, which belies the abundant number of fruit trees mentioned by households.

The frequency of fruit consumption was very low, with just around one fifth of households consuming fruit daily. Not just this, households noted that the nice looking fruit were reserved for sales and entertainment of visitors, while the bad (over ripe, soft or infected) fruits where reserved for home consumption, especially by children. Therefore, although 72% of households said they ate more fruit now than before, the majority ate infected fruit, which can lead to another health consequence such as Ebola which was said to have been transmitted by the fruit bat (Parrotta et al., 2015). This is insinuated by the large majority of 79% who said they don't sell more fruits now than before. Main reasons for not selling fruit were because most fruit were infested by pests and diseases meaning most fruit were reserved for home consumption. This means that although many more households think that they eat more fruit now than before, they still do not attain the daily requirements for a healthy and active life (Ruel et al., 2005; WHO, 2003). Even with this, up to 61% of household did nothing to preserve fruit and an additional 20% did not respond to the question. Ruel et al. (2005) have discussed the problem of no storage facilities as an impediment to fruit consumption. The contribution of diseases to low fruit consumption has been discussed earlier. Lock et al. (2005) analysed the global burden of disease attributable to low consumption of fruit and vegetables and their implications for the global strategy on diet. This finding reveals the possibility of unhealthy fruit eating habits and makes this community susceptible to disease infections

especially with the reports on the recent outbreak of diseases like Ebola in 2014 (Parrotta et al., 2015).

6.6.2. The influence of deforestation on fruit acquisition and household fruit intake

Most food security and nutrition studies in Cameroon do not discuss fruit consumption or mention it only in passing, indicating that data on fruit consumption is rare in Cameroon. Germaine et al. (2011) reviewed data from fifteen nutritional and epidemiological studies on natural food resources and nutritional habits in Cameroon. This review showed that, although Cameroon is rich in natural food resources, factors like climate, household income, nutritional knowledge, urbanisation, gender and age and health have a great impact on the nutritional habits of the people. Urbanisation is an important driver of deforestation (Robiglio et al., 2010). While the number of FT per fruit species mentioned during the March to May survey were significantly different between the deforestation zones. This was not evident during the June to August survey. As well, number of times that fruit trees were mentioned varied significantly with deforestation zone. In these two cases, the moderately deforested zone showed the presence of more fruit per species followed by the least deforested zone and last was the most deforested zone. Thus, households in the intermediate level of deforestation showed better trends in the availability of fruit trees.

Parrotta et al. (2015) noted that one negative effect of forest on food security was the harbouring of diseases that affected food crops. Generally, pest and diseases infestation was increasing at all levels of deforestation. The type of symptom varied with the level of deforestation. As deforestation increased, rotting and premature ripening reduces while dark hard spots increased and parasites and drying up of some branches remained the same. This means that although the number of fruit trees mentioned in the least deforested zone were many, diseases infection is likely to reduce the quantity of harvested food. This is confirmed in that the smallest percentage of households' that consumed fruit more frequently were recorded in the least deforested zone and daily fruit consumption as lowest for children in the least deforested zone as well.

6.7. Conclusion

This study has suggested that there is a problem with fruit intake despite the abundant number of fruit present locally. First, the harvesting and gathering frequency are very low during the peak fruit-ripening period. Additionally, a large quantity of harvest was lost, up to 50%, for some fruit. Most households were vulnerable to pest and diseases infestation of fruit trees, especially fruit trees in the least deforested zone. This affected the quantity of fruit gathered and the frequency of consumption. Disease infection was greatest for the least deforested zone while fruit consumption frequency was feeblest for the least deforestation zone compared to the other two.

Overall, fruit consumption frequency was very low, hardly more than three times a week for a majority of households and just around once a week for children below two years. Fruit storage was done locally and processing was absent. This calls for some public actions to boost up local supply and consumption of fruit. The villages present a large advantage that can help boost up fruit supply since households were free to gather fruit from trees that were not planted by them. Thus, fruit supply can be increased by maximising harvesting and gathering from existing fruit trees to reduce the harvest lost. Furthermore, simple fruit storage education and processing techniques need to be designed and proposed to these communities. Thirdly, there is need for a general sensitisation in Cameroon on the importance of daily fruit consumption, the required quantity to be eaten per fruit variety and the frequency of consumption per day. Finally, it is important to establish village fruit tree planting program on community land that will be subsequently harvested by all especially in the most deforested zone. With increase awareness on the need for daily intake of fruit, many more households particularly in the study sites will engage more actively in fruit gathering and harvesting.

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CHAPTER 7

GENERAL DISCUSSION AND CONCLUSION

A variety of fruits presented in the market for sales (Left) and a the process of preparation of oil palm sauce (right)

7.1. Introduction

The Cameroon Humanitarian Needs Overview (HNO) report of June 2015, recounted that the food security and nutrition situation in Cameroon has deteriorated with a 300% increase in food insecurity between 2012 and 2014 (OCHA, 2015). The country registered an estimated 1.08 million food insecure people in 2015, counting about 190 000 malnourished children. In 2014, Cameroon was declared to stand among the 36 countries in the world with the largest number of children under five suffering from stunted growth (SUN, 2014). It is worth noting that very recently in 2011; the Cameroon Academy of Science organised a high level expert forum on nutrition and public health in Cameroon: Combating the Crisis. In spite of the caption, more focus was put on public health than on nutrition and when dealing with nutrition, more emphasis was put on under five nutrition and food fortification than adequate household food intake. One important outcome of this meeting was that the public health and nutrition situation of Cameroon was indeed critical and would demand action by various stakeholders in the short, medium and long term to improve it (Tanya et al., 2011). It was agreed that malnutrition had negative effects on health in Cameroon. However, nothing was mentioned about the consumption of fruits, although there has been a general awareness raising on the importance of daily intake of fruits for the prevention of chronic diseases since 2003 (Kehlenbeck et al., 2013; Malézieux, 2013; Banwat et al., 2012; Nesbitt et al., 2010; Agudo, 2005; Ruel et al., 2005; WHO, 2003).

The problem of targeting and assessing FIS in developing countries, especially in rural communities has been insinuated by many authors (Johnston et al., 2014; Deitchler et al., 2011; Sharafkhani et al., 2011; McGarry and Shackleton, 2009; Webb et al., 2006). This is glaring in Cameroon wherein, food insecurity interventions have been concentrated in the northern region plagued with many environmental problems. They assume that, agricultural conducive environments are food self-sufficient and thus food secure. Working in the context of increasing deforestation, this thesis particularly brings evidence on the situation of household FIS access experience in forest areas which is not reported in present day discussion at the national level. It further investigates the knowledge and awareness of households on the availability, accessibility, utilisation, vulnerability and consumption of naturally existing nutrient rich food items using the example of fruits from trees. Thus, the aim of this research

was to investigate strategies for addressing household FIS through increased domestic supply and consumption of fruits from trees in the context of deforestation in Cameroon. The objective was to analyse daily practices that enable and constraint the contribution of fruits from trees to assist households to deal with FIS in the context of deforestation in Cameroon. The research results have been reported in four chapters of this PhD thesis.

7.2. Key findings (See annex for summary results)

7.2.1. Offsetting the effects of deforestation on household food insecurity through the consumption of wild and planted fruits is complex to capitalise

To appreciate how forest could contribute to nutrient intake, this thesis investigated the occurrence of fruits trees on farmers' fields and the species richness and analysed the effects of deforestation. Fruit tree diversity and species richness did not differ with deforestation gradient. This means that the occurrence of wild and planted fruits trees did not depend on the level of deforestation. Numerically, the moderately deforested zone registered the highest number of planted FTs while the most deforested zone registered the highest number of wild fruits and in both cases the least deforested zone came second. These results present a different scenario from the results of Powell et al. (2011) and Ickowitz et al. (2013). It however reaffirms Bhaskar et al. (2015) stance that, although many studies have shown a link between tree cover and dietary diversity, the path ways of the relationship is not yet understood but suggests that it is important the maintain forest cover around the home for increase fruit supply.

The potential of forest food to contribute to nutrient intake has been highly underscored in food security literature of late. Powell et al. (2011) investigated forest cover, dietary intake in Tanzania and concluded that in 270 households across six villages, individuals that consumed forest foods had significantly more diverse and nutrient dense diets. As well, those who consumed forest foods also had greater tree cover in close proximity to their houses. Another study from 21 African countries by Ickowitz et al. (2013) using demographic health survey data, demonstrated a similar relationship between forest cover and consumption of fruits and vegetables. Enhancing global production of food through productivity increase will not guarantee that those who are hungry in poor and remote areas will increase their intake of food (Bhaskar et al., 2015). Wild and planted fruits represent an affordable source of food, especially

for those with limited livelihood options, markets and income to spend on nutritious foods (Vinceti et al., 2014). Delang (2006) notes that forest food gathering is important in many rural communities with low economic growth and likely to remain so. This study has shown that in such circumstances, fruits could be acquired through harvesting and gathering.

The conceptual framework showed that it is possible to offset the effects of deforestation on FIS through increase fruit harvesting and consumption. Overall, the results of this study affirm one part of the conceptual framework that FIS existed and was high at all levels of deforestation. This confirms FAO et al. (2012) that FIS will remain a reality in most poor regions in the next decade. Although a substantial number of wild and planted fruits were found, fruit consumption frequency was low as is the case with most poor regions (Ickowitz et al., 2013). This means that even with increase wild and planted fruits, improve diet and nutrition may not be attained. This study showed that there was lack of nutrition education and sensitisation supporting the several authors who have underscored the importance of increase sensitisation on the consumption of nutrient rich food such as fruits (Grutzmacher and Gross, 2011; Tatry et al., 2011; Braun and Venter, 2008). The enhancement of fruit supply through planting was possible because farmers were willing to plant more fruits trees but some lack guarantee on land was scarce, nurseries were absent and disease infestation was high. These problems are being tackled by fruit domestication activities (Kehlenbeck et al., 2013; Leakey et al., 2012; Tchoundjeu et al., 2012; Akinnifesi et al., 2008) but the results of domestication were not felt in the communities during field activities. Regular fruit access could be assured but this will guarantee daily intake of 400 g of diverse fruits because households were not aware of the right quantity and frequency of fruit consumption. Overall, adequate food intake and good nutrition cannot be assured for this population if no special efforts are employed by the government to boost the consumption of fruits and other nutrient rich foods.

7.2.2. The effects of deforestation is nuanced and fruits can help address food insecurity

The first results chapter presents a baseline situation of food insecurity access experience in the study area. Its main aim was to quantify the extent and intensity of household FIS access experience along a deforestation gradient and demonstrate the degree to which households may be vulnerable to the effects of FIS. It demonstrated that only three percent of households were food secure, and about one-third of households were affected by the severe

form of food insecurity. This confirms the presence of FIS in agricultural collegial environments. It indicates that while government efforts to eradicate hunger and malnutrition are being concentrated on the obvious groups, some food insecure people are overlooked in other neglected regions. It also concurs with the findings of authors who had reported that FIS assessment in developing countries is often still ad hoc and limited in scale, resulting in misleading efforts in targeting and assessing FIS, especially in rural communities (Johnston et al., 2014; Deitchler et al., 2011; Sharafkhani et al., 2011; McGarry and Shackleton, 2009; Webb et al., 2006). This means that FIS will continue to prevail and to increase if no action is taken. The least deforested area appeared to be the least affected by FIS. However, statistically, no particular trend was established for food insecurity experience within the three levels of deforestation. This means that although these sites differed geographically according to the level of deforestation (Robiglio et al., 2010), according to the level of FIS, they were not different. Thus, other than environmental and household dynamics, different set of factors are responsible for the experience of FIS in household in forest areas.

7.2.3. Food availability does not necessarily guarantee food security

A recent review on the state of undernourishment in the world reveals that FIS will remain a major challenge in sub-Saharan Africa during the next decade (FAO et al., 2012). A further review on food systems for better nutrition suggests that FIS policies need to go beyond food production and examine other aspects of food access and utilisation (FAO, 2013; Barret, 2010). By examining the situation of FIS in agricultural communities and shortly after the harvesting season, this study has confirmed that FIS is more than just having food. This contends with results of Sneyd (2013), who reported that Cameroon could achieve a more sustainable and equitable food system if greater policy attention is directed towards understanding the range of perspectives that influence food security policy. The results have provided insights that can spur governments and development partners to set concrete actions to address FIS and undernourishment at all levels of deforestation. Overall, the study has confirmed the assertions that ample food availability is necessary but does not guarantee accessibility and utilisation (Barrett, 2010) and thus food security. Results on the prevalence of FIS access suggest that at least one-third of households at all levels of deforestation were severely food insecure and more than half of the population suffered from moderate to severe

FIS. Being a poor environment, this corroborates results that food security indicators reflect general patterns of poverty and poor distribution and use of food (Cordeiro et al., 2012). It also supports findings by Johnston et al. (2014) on understanding sustainable diets and suggests the importance of measuring food accessibility to better address problems of FIS in rural communities.

Iron and vitamin A deficiencies that are prevalent in most parts of Sub Saharan Africa affect around 50 million African children. Vitamin C from fruits is essential for absorbing iron from other foods (Agudo, 2005). Indigenous fruits contribute to the vitamin and mineral supply of local communities. During the harvesting season, the frequency of fruit consumption was very low with just around 5% of households consuming fruits daily. Despite the very low reported level of fruit consumption, households noted that nice looking fruits were sold while the unhealthy, infected ones were reserved for home consumption. The contribution of diseases to low fruits consumption has been discussed earlier. Lock et al. (2005) analysed the global burden of disease attributable to low consumption of fruit and vegetables and their implications for the global strategy on diet. One of the factors that could limit fruit consumption was processing (Edoum et al., 2013) that obliged people to rely on seasonal availability of fruit supply.

The amount of money spent on fruits purchase was not related to mean household income nor mean percentage of food expenditure. This is similar to the analysis of Ruel et al. (2005) on fruits and vegetable purchase in Africa countries. Ruel et al. (2005) noted that, although richer households spent more on fruits and vegetables, by comparing the income elasticity for fruits and vegetables expenditure by income quintiles, no clear patterns emerged. This analysis on the purchase of fruits and fruit juice reveals two things. First, households were willing and interested to consume more fruits from trees but lacked the necessary financial resources to purchase fruits, similar to findings by Banwat et al. (2012). Secondly, households invested very little on fruit purchase and bought fruits only occasionally, meaning that fruits did not constitute a priority place on the food-shopping list of households in this area. This was similar at all levels of deforestation. Therefore, household fruit supply continues to rely mainly on local production which depends on seasonal variation and natural productivity from wild or planted sources (Levang et al., 2015). Similarly, Modi et al. (2006) found that resource-poor

people from Ezigeni in South Africa indicated that wild fruits were their only source of micronutrients.

7.2.4. Fruit tree diversity and ownership is high but consumption is low

Fruit tree ownership and diversity has been studied by many authors around residential areas (Larinde and Oladele, 2014; Bernholt, 2009), in home gardens (Shackleton et al., 2008) and on farmers' fields (Degrande et al., 2006). In examining FT ownership and diversity, households were asked to list fruits from trees that were commonly harvested and consumed. Irrespective of the level of deforestation, as many as 25 FT species were counted, including 15 wild and 10 planted species. Of these, only two species pear (*Persea americana*) in the least deforested zone and andobeti (*Irvingia gabonensis*) were considered to be both wild and planted. The most common fruits in terms of number of fruit trees were not necessarily the most harvested. The five most occurring fruits in order of importance were banana (Musa spp.), pear (*Persea americana*), mango (*Mangifera indica*), safou (*Dacryodes edulis*) and bikwam (*Vitex doniana*). In all, the most common FTs were banana and pear for the three levels of deforestation. Although the most common FTs for the most and moderately deforested zones were all planted species, the third, fourth and fifth most occurring FTs in the least deforested zone were wild species. This means that as deforestation increased, wild fruits occurrence reduced. Whereas owol (*Cola Lipidota*) was the most cited wild fruit for the most deforested zone, *Irvingia spp* was the most cited for the least and the moderately deforested zones. The fruits most harvested were pear (*Persea americana*), banana (Musa spp.), mango (*Mangifera indica*), andobeti (*Irvingia gabonensis*), Safou (*Dacryodes edulis*) and orange (*Citrus sinensis*).

This study examined household FT ownership and diversity along a deforestation gradient from the least deforestation zone to most deforested zone. Results showed that there was no significant difference between deforestation zone and mentioned fruits, meaning all the 25 mentioned fruits were found at all levels of deforestation. But, the most deforested area had the highest number of fruit trees than the moderately and least deforested areas. Additionally, the most deforested zone registered the highest percentage of wild fruits. This is contradictory to results of Georgius et al. (1993) and van Dijk (1999) who found that more remote areas had more forest fruits. Such results could be an evidence that as forests open up more exotic trees species are introduced alongside subsistence agriculture (Mertens et al., 2000; Ndoye and

Kaimowitz, 2000; Sunderlin et al., 2000). The study concluded that there was higher FT diversity in the most deforested zone than in the moderately and least deforested zones. However, this was contrary to the findings of Ickowitz et al. (2014) that, FT diversity and fruit consumption decreased as forest cover decrease. It is generally estimated that increased deforestation will lead to increase climate change and thus could probably shift the natural geographic ranges, and reduce density and productivity of some wild fruit species (Brown and Sonwa, 2015; Dawson et al., 2011). The results from this study shows that the moderately deforested zone registered the least number of wild FTs while the most deforested zone registered the highest number of wild and planted FTs. This could be that since the most deforestated zone was closer to the urban centres, there has been some farmer to farmer dessimination (Leakey, 2014b) of the participatory domestication activities from ICRAF (Tchoundjeu et al., 2012) although this was not verified. However, the results on nursery suggest the need for a greater effort in encouraging this technique in the study area following the seventh principle of Leakey's 12 principles for better ood and more food from mature perennial agroecosystems (Leakey, 2014b).

7.2.5. Wild fruit harvesting was substantial and access to nurseries was low

Approximately one-quarter of households said they harvested more wild fruits than planted fruits. Goenster et al. (2011) also investigated tree diversity of indigenous FTs in home gardens of the Nuba mountains in central Sudan and potential for improving the nutrition and income of rural communities. Wild fruits consumption was not a shame nor did it represent a sign of poverty in the community as people were willing to continue to eat wild fruits even when they had more money. This contradicts studies that have often reported NTFPs to serve as food for the poor (Nesbitt et al., 2010; Robiglio et al., 2010) and shows that wild foods consumption is more culturally linked than being a problem of poverty (Levang et al., 2015; Paumgarten and Shackleton, 2011; Tee et al., 2009; Shackleton and Shackleton, 2004). It is also a matter of convenience and availability (Abu-Basutu, 2013; Banwat et al., 2012; Termote et al., 2012; Georgius et al., 1993).

Local availability and accessibility of fruit to households in poor communities has a major impact on the consumption of fruits (Bernholt et al., 2009): In urban and peri urban gardens (Larinde and Oladele, 2014) and home gardens (Kehlenbeck and Maass, 2004), FTs

provide fruits to households. People living in poor environments with limited access to financial resources and markets (Simitu et al., 2009) acquire fruits from planted and unplanted FTs (Kehlenbeck et al., 2013; Viviany et al., 2013; Schreckenberg et al., 2006). There is no doubt that many studies have been carried out on the importance of on farm FTs and promoting local fruit consumption (Shackleton et al., 2008; Degrande et al., 2006; Ambe, 2001). Yet, this study has gone a step forward to test the impression of households between fruits from farms and those from the market along a deforestation gradient. From the responses, most households disagreed that fruits from their plantation were less nice than those from the market. This means that this population was interested in eating fruits from local production sources but required some support on tree planting activities to boost the local supply.

Households' knowledge about various food items, their acquisition and utilisation mechanisms determine the ability of household members to consume sufficient quantities and a variety of fruits and foods (Stadlmayr et al., 2013; Ericksen, 2008; Dindyal and Dindyal, 2003). The ownership of fruit trees through increased planting and management strategies are key to increasing fruit availability for enhancing the contribution of fruits to better nutrition (Kehlenbeck et al., 2013; Goenster et al., 2011; Lock et al., 2005). Problems observed with fruit tree planting include the absence of modern nurseries, lack of guarantee on land and lack of local training on fruit tree planting activities. Fruit tree domestication has been promoted in the forest areas of Cameroon other than our study sites through rural resource centres as hubs for participatory domestication (Kehlenbeck et al., 2013; Tchoundjeu et al., 2012). This thesis suggests the necessity of extending these resource centres in the study areas. Desired training domains on FTs were control of diseases and parasites, fruits importance on human health, new fruit varieties, fruits processing, technical procedures on FTs activities and market information and market prices.

7.3. General conclusion

The aim of this research was to investigate strategies for addressing household FIS through increase domestic supply and consumption of fruits from trees in the context of deforestation in Cameroon. The objective was to analyse daily practices that enable and constraint the contribution of fruits from trees to assist households deal with FIS in the context

of deforestation in Cameroon. It was found that households' food insecurity did not differ with the different levels of deforestation since most parameters showed no significant difference with deforestation zone. Rather, problems of deforestation where manifested in different ways at the household level within each zone. For instance, there was no significant relationship between deforestation zone and household food scarcity. However, whereas the effects of deforestation in the most and medium deforested zones was perceived at the level of crop maturity and the absence of free food from the forest, in the least deforested zone, deforestation was felt in the form of seasonal variation that lead to household food shortages.

As well, the presence of fruit tree pest infection did not vary with deforestation zone but the symptom of pests and diseases showed a relationship with deforestation zone. Consequently, different deforestation zones were affected by different forms of pests and diseases. Furthermore, although they were many fruit types at all levels of deforestation meaning a wide diversity of wild and planted species, the mean occurrence of FTs was higher in the most deforested zone than in the least deforested zone while there was no difference between the least and moderately and the moderately and the most deforested zones. ANOVA further shows that there was a significant difference in the mean occurrence of planted and wild FTs at each level of deforestation. This confirms that the consequences of deforestation on food security vary depending on the aspect being examined and not at the level of deforestation. Also, that deforestation affects food insecurity in a continuous manner and whereas global aspects may not show any difference with deforestation zone, the manifestations differ.

Although there has been much wonder about the alarming rate of food insecurity and high levels of undernourishment in Cameroon, accompanying policy actions have been weak and insufficient to safe the situation. So, there is need for more robust actions. This study has demonstrated that food insecurity is high and can be severe in forest areas of Cameroon which is considered a food self-sufficient area. It also proved that food availability does not necessarily guarantee adequate food intake. Therefore food insecurity can prevail even with available food on the ground. This is the case in the study area wherein households reported to own and have access to gather and harvest fruits from a wide range of fruits trees. But, globally, fruit consumption frequency was very low, hardly more than three times a week for a majority of households and just around once a week for children below two years. Fruit storage was done locally and processing was absent.

As well, households' knowledge on fruits consumption was weak. On average households said they required fruits 2.4 ± 1.5 times per week with less than a tenth of households noting that they required fruits at least seven times a week meaning at least once daily. Therefore, present efforts to fight undernourishment may be weakened by poor fruit consumption practices. However, due to the absence of data on trends on fruit consumption practices and lack of monitoring on the evolution of micronutrient deficiency, this cannot be fully ascertained. On the other hand, this study has generated some data on daily practices of fruit consumption, the level of local awareness on the importance of fruits, main sources of fruits and the diversity of FTs within three levels of deforestation. Furthermore, it has revealed the perceptions, importances' and use of wild fruits which is hardly reported in most food consumption literature and in formal food sources.

The results further suggest the likelihood of low harvest of fruits despite the abundant number of fruits present locally. First, the harvesting and gathering frequency are very low during peak ripening period of fruits for the monitoring survey. As well, a large quantity of harvest was lost upto 50 % for some fruits. Most households were vulnerable to pest and diseases infestation of fruits trees especially fruits trees in the least deforested zone. This affected the quantity of fruits gathered and the frequency of consumption. Disease infection was greatest for the least deforested zone and fruit consumption frequency was feeblest for the least deforestation zone compared to the other two. Fruits were mainly consumed fresh. Processing of fruits into juice, jam and other forms was absent. Thus, it will be important to design training programs on fruits processing techniques in these communities. This will help diversify fruit consumption by households and spread the consumption to off season period.

From this study, it could be concluded that using the HFIAS approach, adequate food access is still rare in the rural areas of Cameroon irrespective of the level of deforestation. It also suggest that women's ill health situation is an important factor that affects food access and needs to be reinforced with the perspective of improved food access in rural areas. Finally, the risk of hunger at community level was the most important risk factor meaning that 'free' food obtained through gathering and scavenging is scarce in the study area. Thus, conventional food access mechanisms need to be improved to ensure adequate food supply in rural and forest areas. Furthermore, improved access to other food sources as well as some sensitisations on the management of food from farmers' fields needs to be buttressed.

7.4. Recommendations

Household FIS was high but fruit consumption was low. Here, fruit supply can be increased by maximising harvesting and gathering from existing fruit trees to reduce the present loss in harvest. Furthermore, simple fruit storage education and processing techniques need to be designed and implemented in these communities. Besides, households and Cameroonians in general will require increased sensitisation on the importance of daily fruit consumption, the required quantity to be eaten per fruit variety and the frequency of consumption per day. With increased awareness on the need for daily intake of fruits, many more households will engage more actively in fruits gathering and harvesting.

As well, farmers had very little knowledge on nursery and fruit tree activities. This suggests that the existing domestication activities that has been carried out in Cameroon by IRAD, ICRAF and other institutions has not been properly capitalised, valorised and adopted by local farmers. Therefore, this suggests the need for a reorientation on domestication research to focus on dissemination and valorisation to communities out of research sites. It would be interesting to repeat this survey within the working sites of organisations like ICRAF to appreciate the level of adaptation and use of improved planting material. This study dwelled only on household information reported by people. This has provided a base for understanding users' mind-sets and perspectives on nutritional security and fruits consumption. However, there is need to do a field inventory to actually appreciate the number of trees on farmers field and confirm the various land use systems associated with fruits trees.

This research has also revealed that eating habits was a problem and ignorance about the frequency and intake of nutrient rich food was serious. For instance, people were not aware on the right frequency of fruit consumption and people ate infested fruits while reserving the healthy ones for sale. This is the trap of the food insecurity problem in some regions-knowledge about foods and ways of food utilisation. This is neither a problem of availability nor accessibility but rather a problem of limited knowledge and lack of sensitisation. This is a global problem in most poor regions and even in rich areas affected by obesity. Thus, there is a need to establish a high level policy framework, maybe in the form of a convention or an intergovernmental panel at the level of the United Nations and/or the African Union on 'reducing malnutrition in all its forms (rates, drivers and consequences on human health and the

environment)'. Here priorities, strategies, monitoring on peoples eating habits, setting nutritional standards, and principles and indicators for observing undernutrition, overnutrition and associated problems within all population strata will be generated.

7.5. References

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ANNEX: SOME TRENDS ON FRUIT TREE, DEFORESTATION AND NUTRITIONAL SECURITY IN CAMEROON

Variable (unit)	Most deforested	Moderately deforested (%)	Least deforested (%)	Conclusion
Sick person in the household (%)	41	37	14	The most deforested zone had the highest number of sick people and the highest number of sick women
Food scarcity months				-No relationship was observed between food insecure months and deforestation zones (X^2 =13.32 p= 0.086; Cramer's V =0.319 p =0.086) - 55% of households declared the presence of a sick person during January-March food insecure period.
January-March (%)	9	13	16	
April-June (%)	3	2	0	
July-September (%)	0	3	0	
October-December (%)	6	18	7	
Reason for experiencing food scarcity	Crops were not ready for harvest	Crops were not ready for harvest	Seasonal variability	The most predominant reason for food scarcity is that crops were not ready for harvest
Worried about lacking food (%)	87	82	55	F=14.8p<0.001
Unable to eat preferred foods (%)	87	85	64	F = 8.33 p <0.001
Ability to eat just a few kinds of food (%)	84	86	62	F = 8.63 p <0.001
Ability to cook a standard meal (%)	97	100	87	F = 7.04 p <0.001
Unable to cook food appreciated by children (%)	81	66	40	
-Eat fewer meals in a day -No food of any kind to cook -Day's food gotten		Most affected		

through neighbor, a feast or the forest				
Going to bed hungry Sometimes (%)				There is no significant relationship between going to bed hungry and deforestation zone (X^2 = 4.31 p= 0.366; Cramer's V= 0.115 p =0.3666). Thus the phenomenon of going to bed hungry was not influenced by the level of deforestation.
	37	33	40	
Often (%)	16	7	6	
Compromise on quality and variety	60	77	60	66% of households compromised on quality and variety. This was most intense in the moderately deforested zone.
HFIAS Score	12.9 ± 5.79 and ranging between 1 and 24	14.1 ± 4.41 ranging between 2 and 22	11.7 ± 6.18 ranging between 0 and 24	
Mild FIS access (%)	18	30	16	
Moderate FIS (%)	45	46	57	
Severe FIS (%)	37	24	24	
Overall prevalence of severe FIS (%)	44	28	28	
Severe hunger at household level (%)	27	31	43	The hunger scale did not show a significant relation with deforestation gradient (X^2 = 5.34 p= 0.254 ; Cramer's V= 0.099 p =0.254)
Low risk of hunger at the community level	3	6	12	The least deforested area recorded the lowest risk of hunger at the community level
Moderate risk of hunger at the community level (%)	24	24	29	'Free' food obtained through gathering and scavenging is scarce in the study area meaning that the conventional food access mechanism need to be improved to ensure adequate food supply

Serious risk of hunger (%)	55	38	7	
Conclusion on hunger parameters		Area most prone to serious hunger	Recorded the lowest risk of hunger at the community level	
Number of fruit trees per household				
Planted (%)	6.15 ±7.897	6.51 ±9.410	6.33 ±9.984	Total = 6.31 ± 9.014. The most abundant FTs species for the most and moderately deforested zones were all planted
Wild (%)	3.06 ±2.490	2.77 ±2.471	3.22 ± 2.734	Total = 3.02 ± 2.557. In the least deforested zones, the third, fourth and fifth most abundant FTs species were wild species
Planted FTs (%)	48	53	51	-There was no relationship between the various FTs cited and deforestation zone (X^2 = 49.93 p= 0.397 ; Cramer's V= 0.128 p =0.397) - Fruit trees were evenly distributed on the land use types in the most and least deforested zones and was not for the moderately deforested zone in which home gardens dominated with an average of 6.8 ± 10.8
Wild FTs (%)	52	47	49	
Access to a nursery	45	34	24	
Land area	0-10ha 2.3 ± 1.89 ha	0-11 ha 2.6 ± 2.36ha	1-14ha 5.4 ± 3.97ha	
Share use of fruits				
consumed	40.2 ± 18.1	30.8 ± 23	45.3 ± 20.9	37.8 ± 20.9
Sold	32.4 ± 19.7	39.2 ± 27.1	32.7 ± 19.1	35.1 ± 22.6
Given	11.1 ± 5.8	10.4 ± 11.1	8.3 ± 2.4	10.2 ± 7.8
Lost	12.6 ± 9.9	12.1 ± 11.7	14.3 ± 10.5	12.8 ± 10.6
Frequency of fruits purchased				
Hardly (%)	37	46	51	Fruit purchase rate did not

Monthly (%)	26	26	11	show any relationship with deforestation
Weekly (%)	2	4	2	
Daily (%)	7	2	7	
Fruit consumption				
Daily (%)	44	36	37	There was no relationship between fruit consumption and deforestation zone (X^2 = 17.73 p = 0.007; Cramer's V = 0.113 p = 0.007
>3 times a week (%)	41	48	52	
At least once a week (1-2 times) (%)	14	15	11	
Few times in a month (%)	<1	<1	0	
Fruit consumption per day				
1-5 fruits/person/per day (%)	22	12	19	There was a significant relationship with deforestation and the quantity of fruits eaten per day (X^2 = 59.73 p < 0.001; Cramer's V = 0.150 p < 0.001)
5-10 fruits/person/per day (%)	43	33	35	
10 and above fruits/person/per day (%)	15	22	17	
Uncontrolled (%)	10	21	15	
Depend on hunger level (%)	2	3	2	
As much as possible (%)	8	8	13	
Households ate more fruits today than 10 years back (%)	72	79	67	
Consumption rate has not changed (%)	0.7	0.2	0.6	
Fruit consumption by children				
Never (%)	8	14	19	A significant relationship was observed between deforestation zone and the consumption of fruit by children below 2 years (X^2 = 63.23 p < 0.001; Cramer's V = 0.105 p < 0.001)
Rarely (%)	7	4	7	
Few times per week (%)	56	51	55	
Daily (%)	30	28	22	
Harvesting of wild fruits				

Wild fruits (%)	96	90	87	No significant relationship was observed between the harvesting of wild fruit and deforestation gradient (X^2 = 3.15 p = 0.220; Cramer's V = 0.150 p = 0.210)
Do you satisfy your fruit needs				
No	2.5 ± 1.5	1.9 ± 0.8	2.9 ± 1.9	Total = 2.4 ±1.5
Yes	2.6 ± 1.8	2.2 ± 0.8	2.5 ± 1.8	Total = 2.5 ± 1.5
Total	2.5 ± 1.6	2.0 ± 0.8	2.8 ± 1.8	Total = 2.4 ± 1.5
Citation of fruits				
Most cited fruit	Pear (*Persea americana)*	Pear (*Persea americana*)	Paw paw (*Carica papaya)*	
Citation of all fruit tree species	872	1073	907	There was a significant relationship between deforestation zone and the type of fruit trees that were mentioned (X^2 = 97.55 p < 0.001; Cramer's V = 0.131 p < 0.001
Ways of acquiring fruits				
Harvesting (%)	45	36	28	
Gathering (%)	36	35	62	
Both (%)	20	29	10	
Purchase of fruits during the ripening season				
Many times (>10 times)	20	18	23	
Rarely (< 5 times)	71	78	75	
Did not buy fruits	71	78	75	
Income spent on fruits				
100 (FCFA)	13	10	10	
101-300 (FCFA)	9	8	10	
301-500 (FCFA)	4	3	5	
>500	3	1	0	
Symptoms on fruit tree disease prevalence				
Insects, Pest and diseases (%)	62	60	51	The most and the least deforestation zones had similar disease prevalence
Low productivity	12	9	14	

and premature ripening (%)				which was different from the moderately deforested zone
Unpredictable fruiting due to climate change (%)	18	11	17	
Wilting (%)	9	30	10	
Trend of fruit tree diseases				
Increasing (%)	86	83	78	There was a tendency of higher disease infestation with increasing deforestation wherein there was more prevalence in the most and the moderate deforested zones
Stable (%)	3	9	9	
Reducing (%)	11	8	13	
Strategies to overcome insect pest and diseases on fruit trees				
Did nothing (%)	76	83	81	
Cut off dry branches (%)	16	14	16	
Cut down the tree (%)	3	2	3	
Spray with cocoa treatment (%)	4	1	1	