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The link between self-production of food and diet quality in adults living in rural Lebanon

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Résumé

La transition nutritionnelle et l'insécurité alimentaire sont parmi les facteurs externes majeurs diminuant la qualité de l'alimentation. Les effets du déclin de celle-ci se résument par l'augmentation de la prévalence des maladies chroniques et des carences nutritionnelles. Afin de combattre ces problèmes, plusieurs études ont trouvé que la qualité de l'alimentation a été améliorée par l'autoproduction d'aliments (autorécolte[1]). Cette étude vise à identifier si un lien existe entre la qualité de l'alimentation et l'autorécolte d'aliments végétaux dans le contexte rural libanais, à partir de 748 748 répondants en provenance des régions du Chouf, Hermel et Aarsal.

Afin de décrire l'alimentation selon le statut de récolte en ajustant pour différentes variables confondantes, des tests de χ^2, d'ANOVA et des comparaisons multiples (Bonferroni) ont été effectués. Une interaction significative a été trouvée entre les deux types de récolte à tous les niveaux montrant que les collecteurs de plantes/fruits sauvages avaient tendance à produire domestiquement des fruits/légumes et vice versa. Le statut d'autorécolte d'aliments-sauvages avait une association positive et significative avec la variété et la fréquence de consommation à l'exception de celle des fruits et l'autorécolte domestique avait une association significativement positive avec la variété de consommation de légumes et la fréquence de consommation de fruits et légumes. Une forte association a été trouvée entre la région de résidence et les tendances de consommation de fruits/légumes. En outre, l'association entre l'autorécolte domestique et la fréquence de consommation des fruits et légumes s'est avérée positive dans la région où leur fréquence de consommation est la moins élevée (Hermel).

Cette étude démontre que l'autorécolte des aliments végétaux, qu'ils soient produits dans un jardin-maison ou récoltés dans la nature, est significativement associée à une plus grande variété (diversité) et fréquence de leur consommation et que ces associations sont généralement liées à l'intensité de la récolte.

Mots-clés: Transition nutritionnelle, insécurité alimentaire, autorécolte, autoproduction de fruits et légumes, collecte de plantes sauvages, variété, fréquence de la consommation alimentaire.

[1] Dans ce document, le terme autorécolte d'aliments est utilisé pour inclure l'autoproduction et l'autocueillette d'aliments sauvages et le terme « aliments » reflète les groupes suivant : les fruits, légumes, plantes sauvages et fruits sauvages.

Abstract

The nutrition transition and food insecurity are among the major external factors diminishing diet quality. The effects of diet quality decline can be summarized by the increase in the prevalence of chronic diseases and nutritional deficiencies. To combat these problems, several studies have found that diet quality has been improved by self-production of food (self-harvest[2]). This study aims to identify whether a link exists between diet quality and self-harvest of plant-food in the Lebanese rural context using data from 748 adult participants living in Chouf, Hermel and Aarsal.

To describe dietary patterns of the study population according to the harvest-status, χ^2, ANOVA and multiple comparisons (Bonferroni) were used while adjusting for various confounding variables. A significant interaction was found between the two types of harvest at all levels showing that collectors of wild plants/fruits tended to also have some domestic production of fruits and vegetables, and vice versa. While wild-food harvest had a significant positive association with the variety and frequency of consumption except for fruit consumption frequency, domestic harvest had a significantly positive association with vegetable consumption variety and fruit and vegetable consumption frequency. A strong association was found between the region of residence and fruit/vegetable consumption trends. Moreover, the association between domestic harvest and fruit/vegetable consumption frequency was only positive in the region where the consumption frequency was lowest (Hermel).

This study demonstrates that self-harvesting of plant foods, whether produced in a home garden or collected from the wild, is significantly associated with greater consumption variety (diversity) and frequency of these foods and that these associations are generally related to the intensity of harvesting.

Keywords: Nutrition transition, food insecurity, self-harvest of food, self-production of fruits and vegetables, wild plant harvest, food consumption variety, food consumption frequency.

[2] In this document, the term self- harvest used to include the self-production of food and wild food collection. The term "food" reflects the following groups: fruits, vegetables, wild plants and wild fruits.

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List of acronyms and abbreviations

AUB: American University of Beirut

BMI: Body Mass Index

CDR: Council for Development and Reconstruction

CERES: Comité d'éthique de la recherche en santé

CIA: Central Intelligence Agency

DDS: Dietary Diversity Score

DQI: Diet Quality Index

DQI-R: Diet Quality Index Revised

DRI: Dietary Reference Intake

DVS: Dietary Variety Score

FAO: Food and Agriculture Organization

FCS: Food Consumption Score

FD: Functional Diversity

FFQ: Food Frequency Questionnaire

FVS: Food Variety Score

HDDS: Household Dietary Diversity Score

IDRC: International Development Research Center

IFPRI: International Food Policy Research Institute

IHS: Integrated Household Survey

MAR: Mean-Adequacy Ratio

MOA: Ministry of Agriculture

MDS: Mediterranean Diet Score

MOE: Ministry of Environment

MVs: Modern varieties

NAR: Nutrient Adequacy Ratio

NCD: Non-communicable disease

QFFQ: Quantitative Food Frequency Questionnaire

RDA: Recommended Dietary Allowance

SSA: Sub Saharan Africa

UNDP: United Nations Development Programme

UNICEF: United Nations Children's Fund

USD: United States Dollar

USDA: United States Department of Agriculture

WHO: World Health Organization

CHAPTER I: Introduction

The prevalence of household food insecurity has declined worldwide as measured by food availability and access with the percentage of undernourished people dropping from 23 % in 1992 to 15 % in 2012; still, 870 million people in developing countries are currently suffering from hunger (United Nations, 2013). Meanwhile, the less noticeable hunger, which is at the micronutrient level, is seriously threatening the health and wellbeing of people in developing countries as populations neglect their traditional foods and dietary habits (Amuna and Zotor, 2008).

In Lebanon, a middle-income developing country on the eastern Mediterranean shore, the existence of some forms of micronutrient deficiencies has been documented (Hwalla, Adra and Jackson, 2004). In 2006, five percent of children under the age five were reported to have wasting and 27 % were stunted. Also, 31.6 % of pregnant women were anaemic in 2005 (WHO, 2008). On the other hand, non-communicable chronic diseases and obesity are on the rise. Cardiovascular disease mortality alone accounted for 45% of total deaths according to WHO estimates in 2008 and total non-communicable diseases were responsible for 84% of total mortality. Also, the rate of obesity increased in the country from 17.4% in 1997 to 28.2% in 2009 (WHO, 2008; Nasreddine *et al.*, 2012a; Nasreddine *et al.*, 2012b).

Additionally, Lebanon has been witnessing a dietary shift drifting away from traditional diets towards simplified and westernized diets. This shift was described in some aspects as the addition of modern ingredients in the food preparation of traditional recipes for example; white flour and rice are used more commonly than whole-wheat items (Noah and Truswell, 2001; Hwalla, Tannous and El Khoury, 2008). Other reported-aspects of this dietary shift include the decreased consumption of plant-based foods and increased consumption of animal-based foods with lower fibre and higher fat and sugar intakes (Issa *et al.*, 2011; Naja *et al.*, 2011; Nasreddine *et al.*, 2012a; Naja *et al.*, 2013).

A number of studies investigating diet patterns in relation to nutritional status, disease risks and food security in rural Lebanese settings have been conducted in recent years (Sibai, Hwalla and Rahal, 2003; Hunter, 2008; Jeambey *et al.*, 2009; Issa *et al.*, 2011). A common

finding in these studies was that the Lebanese traditional dietary pattern and diet quality are being compromised as a result of the nutrition transition. Therefore, it is easy to stipulate that problems caused by unbalanced nutrition will only worsen if measures are not taken to offset the dietary shift.

In the Lebanese rural population, nutrient deficiencies prove to be highly correlated with socioeconomic status (Melzer, 2002; Naja *et al.*, 2011). Nonetheless, food security was found to be higher in households where self-production of food exists regardless of socioeconomic status (Hunter, 2008). Given that self-production of foods, whether harvested from the wild or grown domestically, has been associated in different settings with different dimensions of diet quality (Ruel, 2003; Fanzo, *et al.*, 2013; Powell *et al.*, 2015), studying this link in the context of rural Lebanon could be of particular importance for nutrition intervention programs addressing the improvement of diet and health status of this population.

Therefore, this research aims at exploring whether individuals who grow some of their food or harvest it from the wild have a higher diet quality than their counterparts who buy their food products from the market in some rural areas of Lebanon.

CHAPTER II: Review of the literature

1. Nutritional challenges in developing countries

1.1. The hidden hunger

In the past few decades, a lot of the famine-combatting measures have focused on increasing food productivity, availability and security. This trend has been generally credited to the Green Revolution that emphasized mono-cropping, especially that of cereals, to provide energy needs at reduced food costs (Pingali, 2012).

Even though noticeable progress has been witnessed in this regard, degradation of dietary patterns has been also found to be a major accompanying setback. Foods that are virtually labeled as empty-calories —in our nutritional knowledge— have emerged. They are characterized by being deprived from vitamins, minerals and other nutrients while being loaded with calories almost solely sourced from sugar, fat, and are often very rich in sodium. These types of foods have become extensively available in developing countries and have started to replace traditional diets (Popkin Adair and Ng, 2012). As a result, food intake of many developing world populations has become energy rich yet nutritionally poor, thus creating a new form of hunger, the hidden hunger, characterised by caloric sufficiency and micronutrient deficiency (Micronutient-Initiative, 2009).

The hidden hunger is a term used to describe a form of micronutrient malnutrition that is chronic and invisible. Unlike severe vitamins or minerals deficiencies that have clear symptoms, the effects of this malnutrition are less obvious but are nonetheless detrimental to health and can lead to impaired mental function and weakened immune system, in addition, it hinders the healthy growth and development of children (Scrimshaw, 1994; Muthayya *et al.*, 2013).

With at least one billion people affected by micronutrient deficiencies (Micronutient-Initiative, 2009), the hidden hunger contributes to causing stunting to 159 million children under the age of five and is twice as high in rural areas compared to urban areas (UNICEF, WHO and World Bank, 2015). It is also responsible for leaving five million children suffering

from night blindness caused by vitamin A deficiency (WHO, 2009). Consequently, the hidden hunger is a serious problem obstructing the normal development of children, adults, societies and countries.

1.2. The transition towards simplified diets

The nutrition transition refers to the shift in dietary patters or behaviour of populations. It was first described by Popkin in 1993 (Popkin *et al.*, 1993) and was linked to socio-demographic and epidemiologic factors that inter-influence dietary patterns.

With processed fats, simple carbohydrates and sugars being more readily available and cheaper than ever for populations in low and middle-income countries, the nutrition transition accompanying urbanization is being characterized by simplified diets. These dietary changes occur at the detriment of diversified diets that are high in complex carbohydrates, fibres, fruits and vegetables and are low in fat (Drewnowski and Popkin, 1997). These dietary changes are being coupled with reduced physical activity (Ferro-Luzzi and Martino, 1996) and the nutrition transition is considered one of the main culprits for the increased incidence in Non-Communicable Disease (NCD) (Popkin and Gordon-Larsen, 2004). Meanwhile, many developing countries are still challenged by high rates of nutrient deficiencies with food intakes lacking in essential nutrients. Thereby, when accompanied by simplified diets high in fat and sugar, another problematic by-product of the nutrition transition arises, the double-burden of malnutrition, where malnutrition is present in the same households, or the same individuals, as both over- and under-nutrition (Garrett and Ruel, 2005).

1.3. Food insecurity and malnutrition

The definition of food security is one that evolved with time. In 1974, at the World Food Summit, Food security was defined as ensuring "availability at all times of adequate world food supplies" (United Nations, 1975). In 1983, this definition was revised to include the concept of accessibility stating that food security as a requirement to food security by having "physical and economic access to basic food" (FAO, 1983). Later on, the concept of utilization was added to the definition of food security. Utilization is a concept that covers food preparation and safety, the diversity and energy/nutrient sufficiency, and the household

distribution of food. Another concept was also included in the definition of food security that is "stability" of access to food (FAO, 2008). Therefore, food security was redefined in the World Food Summit 1996 as a condition that exists "when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life" (FAO, 1996). Inversely, food insecurity is a condition described by people's lack of access to sufficient, safe and nutritious food leading to insufficient consumption of dietary elements required for healthy growth, development and maintaining a healthy and productive lifestyle. Food insecurity is divided into two types by FAO: chronic and transitory. Chronic food insecurity is defined by a persistent or long-termed inability of people to meet their minimum food requirements resulting from extended periods of poverty, lack of assets and inadequate access to resources. Meanwhile, transitory food insecurity is short-termed and occurs when there is an abrupt decrease in accessing or producing enough food to maintain a good nutritional status. It results from shocks and fluctuations in food availability and food access including year-to-year variations in the domestic food production, food prices and household income. Seasonal food insecurity is also identified by FAO as a concept that falls between chronic and transitory. It has a chronic aspect as it is recurrent in nature and predictable and its transitory nature is due to its limited duration. Seasonal food insecurity occurs in a cyclical pattern relative to climate fluctuations, cropping pattern changes, work opportunities and disease (FAO, 2008).

It is worth mentioning that previous to the concept of food security, hunger was used to describe food insecurity (Jones *et al.*, 2013). Hunger is defined by FAO as "an uncomfortable or painful sensation caused by insufficient food energy consumption. Scientifically, hunger is referred to as food deprivation" (FAO, 2008). An extreme form of food insecurity is defined as undernourishment by FAO "which occurs when caloric intake is below the minimum dietary energy requirement" (FAO, 2012).

Undernutiriton is a form of malnutrition that is defined by FAO as "resulting from undernourishment, poor absorption and/or poor biological use of nutrients consumed." (FAO, 2012). Undernutrition is also defined as the outcome of insufficient food and includes being underweight for one's age, too short for one's age (stunted), dangerously thin for one's height (wasted) (UNICEF, 2006). Micronutrient deficiencies describe the lack of essential vitamins

and minerals without always having a chronic caloric deficiency. Another form of malnutrition is overnutrition or dysnutrition which is characterized by overweight or obesity from excessive energy intakes vis-a-vis requirements with some forms of micronutrient deficiencies as a result of consuming low quality food products (UNICEF, 2006; Delisle, 2008).

According to the World Bank's most recent estimates (2011), there are 2.2 billion people in developing countries living on 2 USD or less per day. Poverty affects food security and is a leading cause of malnutrition (Delisle, 2008; Shetty, Thompson and Amoroso, 2011), which in turn increases the incidence of morbidity and mortality (Doak *et al.*, 2005; Gómez *et al.*, 2013; Nyhus *et al.*, 2013). Hence, food insecurity, hunger, undernutrition and poverty contribute to the deterioration of health and wellbeing of individuals.

1.4. Threatened biodiversity

An interesting definition of biodiversity is that of De Schutter: "Biodiversity underpins ecosystem functioning and is essential to many aspects of our health and well-being, including nutrition"; he states that through biodiversity, sustainability in food production systems and nutritional quality is maintained (De Schutter, 2013). Through this definition, the complex link between biodiversity, nutrition and health is showcased. This section attempts to shed light on the importance of biodiversity as a contributing factor to sustainable food production by giving examples on factors that threaten it.

As part of the Green Revolution development, the agricultural production has increased tremendously. Cereal production doubled in Asia alone between 1970 and 1975 while the total land area cultivated with cereals increased by only 4 % (IFPRI, 2002). This spike in agricultural production was only possible thanks to the agricultural intensification and the adoption of high yielding technologies such as the use of commercial high-yield modern varieties (MVs) and fertilizers (Wik, Pingali and Brocai, 2008). As a result, wheat and rice prices dropped, the energy availability per person increased by approximately 30 % (i.e. from 2100 kcal to 2700 kcal) and hunger has fallen by half (IFPRI, 2002; Wik, Pingali and Brocai, 2008).

Despite the benefits of the Green Revolution, its adverse consequences and threats to the environment and to human health drew multiple concerns (FAO, 1996a). As the use and consumption of chemical fertilizers increases, waterways became prone to pollution, agricultural workers prone to poisoning and beneficial insects and wildlife prone to extermination (Hazell and Ramasamy, 1991; IFPRI, 2002). These problems add up to soil erosion and degradation, crop diversity erosion and monoculture (De Schutter, 2013). Matson and co-workers discussed the effects of agricultural intensification and monocropping on the ecosystems and soil quality and concluded that the reduction in diversity of soil biota under intensified agricultural practice may profoundly alter the biological regulation of decomposition and nutrient availability in the soil and reduce biodiversity (Matson *et al.*, 1997). Furthermore, when only three crops (i.e. rice, wheat, maize) out of more than 80,000 plants species available to humans supply the bulk of our protein and energy needs (Frison *et al.*, 2006), it is evident that the simplified cropping systems not only contribute to micronutrient malnutrition in developing countries (Demment, Young and Sensing, 2003) but also contribute to the erosion of crops diversity and thereby threatens biodiversity (De Schutter, 2013).

Finally, a decrease in crop diversity renders the climate change problem even more threatening to our planet because agricultural outputs depend on the degree of crops adaptation to the climate change. As global temperatures could rise by 2-3 °C within the next five decades, a decrease in crop diversity reduces the number of crops with resilience capability against climate change and harsh conditions (DeClerck *et al.*, 2011; Stern, 2007). These conditions include water scarcity, to which dry areas such as the Mediterranean basin, Southern Africa and South America are especially disposed (Stern, 2007).

2. The case of Lebanon

2.1. The situation of agriculture

Lebanon is situated on the eastern shores of the Mediterranean with a total area of 10,452 km^2. It is bordered by Syria from the north and east and by Palestine / Israel from the south. The country has two parallel mountain ranges separated by the Bekaa valley and coastal

plains thus allowing for diversified farming systems (Walley, 2001). The major cultivated crops in Lebanon are cereals, legumes, vegetables, fruits and olives having a prominent place (MOA, 2007). Wheat production accounted for 60% of the total value of cereal production in 2005 (FAO, 2009), still, Lebanon is a net importer of wheat (MOA, 2007). The vegetable production includes leafy vegetables such as artichokes, cauliflowers, cabbages, lettuce and salad greens; tuber vegetables including potatoes and carrots and fruit-bearing vegetables like peppers, cucumbers, eggplants, tomatoes, melons and watermelons. Potatoes constituted for almost half of the total vegetable cultivation in 2005 (MOA, 2007). The fruit production includes citrus, pome fruits, stone fruits, tropical fruits and nuts with apples, oranges, bananas, grapes and cherries being the main exported fruits (FAO, 2009). Small size farms form more than half of Lebanese farms and 85 % of total farms are located on private lands (MOE, 2001).

Despite the fact that almost half of Lebanon's total surface area is cultivable (CDR, 2005), the country is still a major food importer with local production satisfying only 20 % of local consumption (FAO, 2014).

Agriculture in Lebanon is one of the most vulnerable sectors to climate change due to the limited availability of water and land resources and the pressure exerted by population growth, urbanization and the abandonment of lands (FAO, 2014). In fact, in the 1960s, the urban population of Lebanon constituted only 39.6 % of the total population while according to estimations in 2014; the urban Lebanese population was at 87.8 % with a rate of urbanization of 3.2 % annually (CIA, 2015). The lack of interest in the agricultural sector and lands was mainly due to the wars that the country has witnessed, economical crisis and economical policies favouring the tertiary services sector over the primary and secondary sectors. Consequently, agricultural production has decreased by 12 % between 1970 and 2008 (FAO, 2011).

The effect of reduced agricultural lands also extends to affecting the ecosystem, the modification of the landscape and the biological equilibrium of the environment leading to a loss in biodiversity (FAO, 2011). Hence, efforts are being made by the Ministry of Environment and the Ministry of Agriculture, in collaboration with international organization, to enhance agricultural productivity in the country and preserve biodiversity (MOE/UNDP, 2011; FAO, 2014).

2.2. The traditional diet and food consumption patterns

The Lebanese traditional diet shares its characteristics with the Mediterranean diet, particularly the Mediterranean Middle Eastern diet (Batal and Hunter, 2007; Hwalla, 2008). Cowan and co-workers described that in the 1960s half of daily caloric intake of the rural Lebanese population was derived from cereals, mostly in the form of bread, bulgur and kishk (i.e. a mixture of bulgur and ground dried yogurt) (Cowan, Chopra and Houry, 1964). The consumption of dairy products was in low to moderate amounts in the form of labneh (i.e. strained yogurt), cheese and yogurt. Wild edible plants, garlic, herbs such as thyme and mint were used in many traditional dishes whereas fish, poultry and red meat were consumed in moderation (Cowan, 1965).

The ingredients of the Lebanese traditional diet provide important nutrients and phytochemicals that carry health benefits such as omega-3 fatty acids, fibre and antioxidants (Hwalla and El Khoury, 2008). For example, Jew's mellow leaves, which constitute a traditional Lebanese dish, were found to lower serum cholesterol levels and improve blood glucose profile (Innami *et al.*, 1995; 2005). Also, wild edible plants, that were highly collected and consumed by poor rural communities, are thought to have anti-cancerous and anti-inflammatory properties and to be rich in vitamins and minerals (Hwalla and El Khoury, 2008). Chicory, one of the most consumed wild edible plants in Lebanon is rich in potassium, vitamin C, folate and vitamin A and was reported to be beneficial for asthma, cancer, macular degeneration and stroke (Francis *et al.*, 2014) Mallow, on the other hand, containing high levels of mucilage, flavonoids and anthocyanin, has a protective role against irritation, mild and chronic inflammation, cancer and autoimmune disorders (Hwalla and El Khoury, 2008).

In summary, the Lebanese traditional diet has an abundance of minimally processed or fresh fruits and vegetables, cereals, legumes, nuts and olive oil as the main source of fat (Hwalla and El Khoury, 2008). As the Lebanese traditional diet shares many of its ingredients with the Mediterranean diet of southern European countries, it also shares with it its positive effects on chronic disease and mortality (De Lorgeril *et al.*, 1998; Fung *et al.*, 2009; Martinez-Gonzalez *et al.*, 2009; Couto *et al.*, 2011). The high content of micronutrients, the use of wild edible plants and food diversity within recipes or meals make the healthful traditional Lebanese diet worthy of preservation and promotion (Batal *et al.*, 2007).

2.3. The nutrition transition

The dietary habits changes of populations towards western diets have been described as the nutrition transition (Drewnowski and Popkin, 1997). Underlying factors of these changes include urbanization, economic growth and low physical activity (Drewnowski and Popkin, 1997). While traditional diets are diverse and offer a high content of fibres and micronutrients, mainly from cereals and vegetables, and moderate amounts of fat, westernized urban diets are characterized by being high in fat, sugar, sodium, refined cereals and processed-food, all the while being low fruits, vegetables, whole grains and dietary fibre (Hwalla and El Khoury, 2008; Drewnowski and Popkin, 1997).

In Lebanon, along with the increasing speed of urbanization, the traditional diet is facing a nutrition transition threat even in rural areas (Batal, 2009). In fact, the traditional Lebanese diet is being gradually replaced by one that is westernized and simplified, containing fewer ingredients and is poorer in micronutrients (Batal and Hunter, 2007; Sibai *et al.*, 2010).

As a consequence of the nutrition transition in Lebanon, energy per capita supply increased by 1042 calories per day between 1960s and 2002 (FAO, 2007). Non-communicable diseases have drastically increased with hypertension having increased three folds in the last decade and the metabolic syndrome by 31.2 % (Nasreddine *et al.*, 2012b). According to a study conducted between 1983 and 1993 in Beirut, Lebanon's capital, cardiovascular disease accounted for 60 % of total mortality in persons aged 50 years and older and cancer represented 15 % (Sibai, 2001). On the other hand, the rates of obesity among Lebanese adults increased by almost 33 % from 17.4 % in 1997 to 28.2 % in 2009 (Nasreddine *et al.*, 2012a).

According to the FAO nutrition assessment profile (2006): "The nutritional status of the Lebanese population is characterized by a nutrition transition with the persistence of micronutrient deficiencies and chronic malnutrition in young children (i.e. stunting), especially in the rural areas, and the emergence of a high prevalence of overweight in all age groups, both in rural and urban areas." The same profile states that iodine deficiency persists in Lebanon while iron deficiency is prevalent in addition to deficiencies in vitamins D, B12 and folate among childbearing-aged women.

2.4. The situation of food security

Lebanon produces half of the population's consumption in terms of value. The value of exported products such as fruits and vegetables only partially covers the value of imports (i.e. cereals, meat and dairy products, sugar and vegetable oils) with increasing imports and demographic growth that cannot be covered by an increase in exports (Nasr *et al.*, 2009).

According to a UNDP study in 2007, around 30 % of the Lebanese population is considered to be living below the upper poverty line (4 USD per capita per day) of which 8 % (nearly 300,000) are under the lower poverty line (2.5 USD per capita per day). The same study revealed poverty rates have regional disparities with the highest rates in the North (53 %) and in Bekaa region (40 %) (UNDP, 2007). In a Word Bank report (2013), poverty in Lebanon was expected to increase by an additional 170 000 Lebanese individuals at the end of 2014 topping over the present 1 million living below the poverty line, as a result of the Syrian conflict. Also, the flux of Syrian refugees into Lebanon increased food prices, which inevitably aggravates the food insecurity problem (FAO, 2014). The poor are mainly engaged in the agriculture and construction sectors. Agriculture is the main source of livelihoods for the majority of rural communities in Akkar, Hermel and northern Baalbek, areas that are particularly prone to climatic risks and dry land (FAO, 2014).

The situation of food security is expected to worsen within the next years if adaptation and resilience measures are not put into action (FAO, 2014). Food insecurity is an alarming health issue as it can lead to under-nutrition and to over-nutrition all whilst inducing micronutrient deficiencies (FAO, 2010).

3. Self-production of food: towards a permanent solution

3.1. A contribution to agro-biodiversity conservation

The Mediterranean basin ranks third among the 25 recognized global biodiversity hotspots in both plant diversity and endemism (Myers *et al.*, 2000). A hotspot for biodiversity can be defined as a sector where there is an exceptional concentration of species and a high rate of endemism. In Lebanon, 12 % of plant species are endemic (Medail and Quezel, 1997) and many species are threatened of extinction (MOE, 2001).

Biodiversity ensures the genetic diversity of crops and contributes to the resilience of food production against climate changes (De Schutter, 2013; Reidsma and Ewert, 2008). In fact, systems featuring the farming of a diversity of products at the regional and farm levels have better resilience and adaptation to extreme climate shocks than other agriculture production systems (Reidsma and Ewert, 2008). In return, and in contrast with intensive agriculture that reduces agricultural biodiversity, subsistence, and local agriculture systems encompassing diverse ecosystems often result in higher productivity than simpler systems (Hector and Hooper, 2002; Frison, Cherfas and Hodgkin, 2011). Multi- and inter-cropping systems were found to increase yield, maintain sustainability of ecosystems, conserve soil health and enhance yield's resistance to pests (Zhu, *et al.*, 2000; Bullock, Pywell and Walker, 2007; Ives and Carpenter, 2007; Frison, Cherfas and Hodgkin, 2011).

Appreciating the role of biodiversity and ecosystems has inspired a new trend in nutrition interventions (Bailey, Gutschall *et al.*, 2006; Iannotti, Cunningham and Ruel, 2009; Nyhus, 2013; Talukder *et al.*, 2014), one that resorts to agricultural biodiversity as a primary source for food security and health by mobilizing and reintroducing indigenous and traditional foods known to be rich in micronutrients and phytochemicals to food systems (Frison *et al.*, 2006).

3.2. Effects on food security and malnutrition

Small-scale farming systems and home-gardens provide a gateway to a chain of effects that combat malnutrition. Small-scale farming systems featuring product diversity offer better resilience and adaptation to climate changes therefore allowing for sustainable agricultural practices that protect the environment from degradation and improve yield. Improving yield leads to alleviating the malnutrition problem and thereby decreasing the incidence of disease (i.e. infectious and chronic disease) (Reidsma and Ewert, 2008; Oxfam, 2009, Deckelbaum *et al.*, 2006; Blasbalg, Wispelwey and Deckelbaum, 2011; DeClerck *et al.*, 2011). The concept behind the mentioned chain of effect is called eco-nutrition. It integrates the interactions between agriculture, ecology and human nutrition to account for the wellbeing of the environment and human heath (Deckelbaum *et al.*, 2006).

Interventions to tackle food insecurity and under-nutrition include nutrient supplementation, food supplementation, food fortification and agricultural empowerment (Blasbalg, Wispelwey and Deckelbaum, 2011). Agricultural empowerment through home gardens and improvement of farming techniques has been gaining interest in the past decade (Fanzo *et al.*, 2013). Home gardens help ensure food security, dietary diversity and improve access to micronutrient-rich foods by providing the ability to grow various seasonal plants throughout the year thus offering a sustainable way in tackling hunger in the event of seasonal shifts and droughts (Alaimo *et al.*, 2008; Chadha *et al.*, 2009; Blasbalg, Wispelwey and Deckelbaum, 2011). In addition, they were found to provide a source of income and social acceptance (Akrofi *et al.*, 2010).

In Lebanon, the agro-climatic diversity allows for diversity in agricultural production. This is illustrated at the farm level where there is a variety of fruits and vegetables production (MOE/UNDP, 2011). Although the average cultivated area per farm does not exceed one hectare and that most farmers do not grow crops for their subsistence, at least one-third of the production is auto-consumed (FAO, 2006). With the increasing threats of food insecurity in Lebanon, home gardens and small farms seem to offer a reliable solution to face the vulnerability of food shortages and add to the positive effects of wild edible greens collection which provide a source of key micronutrients (Ogle, Hung and Tuyet, 2001; Batal *et al.*, 2007).

It is undeniable that small-scale agriculture has a large role to play in combatting nutrient deficiencies and food insecurity, offering resilience to climate extremes and enriching agro-biodiversity (Powell *et al.*, 2015). Hence, the holistic concept of relating environment, agriculture, food and nutrition provides a very attractive and promising solution to food insecurity, malnutrition and diminished diet quality.

4. Diet quality

Good and ill nutrition have been found to impact health in different ways. The pathways of this impact have been, and still are, extensively studied by scientists. Even though many of the diet quality links to health and illness have been established and documented, the rich variety of foods and food components in addition to both their singular and synergetic

effects on the human body make it difficult to determine these links accurately (Tardivo *et al.*, 2010).

Formerly, the emphasis of epidemiological studies has been on single-nutrient approaches in studying the relation between foods and health, relating dietary fat intake to the risk of cardiovascular disease for example, or high sodium intake to hypertension (Qizilbash, 1992; Harrap, 1984). Thereafter, a more comprehensive approach, assessing lifestyle habits and overall dietary patterns, was adopted to understand the relation between nutrition, lifestyle and disease. Along with it arose the necessity to have proper measuring-tools that allow obtaining analyzable and interpretable variables that can be linked to disease risk, behaviours, or lifestyle conditions. As a result, diet quality indices were created to obtain quantitative results for the assessment of nutrient adequacy and the compliance with national dietary guidelines.

4.1. From single-nutrient correlations towards overall dietary patterns

There are a number of reasons and considerations that have moved the attention of health researchers towards studying overall dietary patterns instead of studying single nutrients. First, the effects of individual nutrients may be different depending on whether these nutrients are consumed alone or in combination with other nutrients consumed at the same time. As an example, iron and calcium are known to compete for absorption while vitamin C enhances the absorption of both of these two minerals. This is also applicable for other nutrients when foods containing many nutrients are consumed or when foods are consumed as part of a larger dietary pattern containing many foods (Jacobs and Steffen, 2003). Second, the effect of single nutrients is often too small to be measured separately whereas the combined effect of many food elements and nutrients may be sufficient to generate measurable and identifiable outcomes (McCullough *et al.*, 2002).

Even though the reductionist approach, which links single nutrients to specific health outcomes, helped in understanding the specific roles and effect of nutrients, this approach was disregarded in many epidemiological studies because of the above mentioned reasons and the limitations it beholds (Messina *et al.*, 2001). Therefore, and because diets are complex and

interactions occur between foods and nutrients, many scientists adopted the concept of food synergies in order to associate dietary patterns with health outcomes (Messina *et al.*, 2001).

4.2. Defining diet quality

The word quality in general can be defined as " the standard of something as measured against other things of a similar kind"; or can also define a level of excellence and superiority from similar objects (Oxford Dictionary, 2013). Food quality reflects, in its generic term, the absence of defects and adulteration. In other terms, it is delivering a product to the consumer that is safe and free of health hazards (FAO/WHO, 2003).

The diet quality on the other hand is more complex as it does not only include the concept of food quality, by providing safe and nutritious products; it also encompasses the concept of obtaining sufficient energy, essential nutrients and non-nutrients components (e.g. fiber, phytosterols, flavonoids) to promote good health (Hawkes and Ruel, 2006). The concept of diet quality has evolved from reflecting nutrient adequacy to include the notions of proportionality, moderation and diversity (Ruel, 2003). The notion of proportionality reflects balance in the consumption of certain key nutrients such as the proportion of energy coming from fat compared to the energy from other macronutrients in a given diet. It can also reflect the proportion of servings from different food groups to ensure a nutritional balance of requirements from key nutrients. Moderation here applies to food components that are thought to increase the risk of chronic diseases such as fat, sodium and refined sugars and that should be consumed in limited amounts. Dietary diversity, on the other hand, is believed to ensure adequate intakes of essential nutrients and non-nutrients thereby improving nutritional status of populations. Dietary diversity, or its synonym dietary variety, is defined as the number of different foods or food groups consumed over a given reference period (Ruel, 2003; Hawkes and Ruel, 2006). Even though a consensus on the definition of diet quality has not been officially specified in the literature, many aspects of high quality diets resonate with these notions (Ruel, 2003).

In practice, diet quality is almost always defined according to specific dietary patterns and is objectified by measuring a given diet's level of adherence to nutrition guidelines or to a dietary pattern that is known for its healthful outcomes. The Dietary Reference Intakes for

Canada and the United States are an example of dietary standards that are updated regularly based on new scientific findings in a way to encourage healthy eating habits. Also, the Mediterranean dietary pattern is an example of a specific dietary pattern that is described as a high quality diet in virtue of its known impacts on health and longevity (Chrysohoou *et al.*, 2010; Frackiewicz *et al.*, 2010; Azzini *et al.*, 2011).

To summarize, a high quality diet can be linked to a health effect like reducing the risk of cardiovascular disease or cancer. Inversely, another identifiable dietary pattern can be found to increase such risks. No matter the context, dietary quality always necessitates the existence of reference values and depends on "standard" patterns to which the diets are being compared. As a result, many indices were created throughout the past three decades to allow the assessment of dietary quality and to reveal its importance especially in the areas of public health and epidemiology (Kant, 1996).

4.3. Measuring diet quality

Along with the interest in diet quality as an important indicator of health status and even food security (Huet, Rosol and Egeland, 2012), various indices or scoring systems were created to have objective measures that can translate the subjective attributes of diets and related health outcomes.

The methodology used for the assessment of diet quality is directly influenced by the dietary aspects intended to be measured. In general, the aspect considered is nutritional adequacy, which comprises both energy adequacy and nutrients adequacy. A diet quality index is therefore a measuring tool that allows researchers to identify the degree of compliance of an individual or a population to a single or multiple dietary patterns that are determined according to the study context and population.

Numerous diet quality indices exist in the literature and are used for various purposes. A systematic review of the literature between 2004 and 2007 was conducted by Wirt and Collins (2009) and has revealed 25 different indices of overall diet quality and/or diversity for the selected period alone, while the famous review done by Kant in 1996 for the first time and in 2004 for the second time has revealed 62 different dietary scores between 1972 and 1996. Noteworthy is the fact that many of the newly emerging indices are just updates of their old

versions or bearing selected modifications. That being said, many diet quality indices share similarities since most are based on national dietary guidelines and nutrition recommendations.

Two main approaches are recognized in the scientific literature for diet quality measurement; the first is known as the *a-priori* approach and the second as the *a-posteriori* approach. In the current review of literature, definitions and uses of both categorical approaches will be discussed and examples of the most eminent diet quality indices pertaining to each of these approaches will be explained in detail.

4.3.1. The *a-priori* approach

The *a-priori* dietary patterns methodology relies on previously established evidence of links between diet and a specific disease. This approach can be country or culture specific and focuses on the construction of patterns that are hypothesis-oriented based on nutrition knowledge and on available scientific evidence for specific diseases (Hu, 2002).

In a very important review on dietary quality indices (Kant, 1996; Kant and Graubard, 2005), Kant categorizes the indices measuring dietary quality into three main categories: 1) nutrient-based indices of overall diet quality, 2) Food- and food-group-based indices of overall diet quality and 3) A combination of nutrient and food- and food-group-based indices of overall diet quality. Each of these three indices-categories is also further classified according to whether the indices examined the relation with nutrients intake or with health outcomes.

The classification by Kant will be respected in this section of our review for its relevance and tracking simplicity. For each classification, the most commonly used indices of overall diet quality in the field of nutrition epidemiology and relatively the most recent will be demonstrated.

4.3.1.1. Nutrient-based indices of overall diet quality

Nutrient adequacy refers to the achievement of recommended intakes of energy and other essential nutrients (Ruel, 2003). Therefore, indices examining diet quality using the nutrient-adequacy approach include the Nutrient Adequacy Ratio, the Adequacy Ratio, the Index of Food Quality, The Nutritional Score, Nutritional Quality Index, Index Nutrients, Diet

Quality and the Diet Quality Score. All of these scores were developed between 1972 and 1994 and are means of measuring either the nutrient adequacy, fat intake or both. Other indices relating nutrient intake to health outcomes include: Dietary Rating, Nutrient Adequacy Ratio, Vegetable Foods Score and Animal Foods Score, Diet Clusters and Diet Quality and Quantity Component Scores (Kant, 1996).

The Nutrient-Adequacy Ratio and Mean-Adequacy Ratio are hitherto among the most used diet quality scores. They are reliable measures and they also represent a tool to test the validity of other diet quality measures.

The Nutrient Adequacy Ratio (NAR) is the ratio between the intake of a nutrient and its Recommended Dietary Allowance (RDA). NARs can be calculated for any given nutrient, but they are most often used for nutrients for which intakes are inadequate in the group or population. In cases where the actual intake of a nutrient exceeds the recommended intake, the NAR value is considered as 100 %: this is to avoid concealing possible deficiencies in other nutrients when many NARs are combined together in a diet quality index (Madden and Yoder., 1972).

The Mean-Adequacy Ratio (MAR) is an example of a diet quality index, which combines mean values of NAR for given number of nutrients. It is calculated by summing the NARs of evaluated nutrients divided by the number of nutrients evaluated and expressed as percentage with 100 % being ideal. The MAR can be used for evaluating the overall adequacy of selected nutrients in a population (Kant, 1996).

In a study analyzing dietary quality using a measure of overconsumption and a measure of underconsumption, Murphy, Rose and co-workers (1992) used a version of MAR that counts the number of low-intake nutrients only. Nutrients are considered of low intake in this study if their mean consumption measures are below 67 % of RDA. Overconsumption is measured on the basis of the percentage of energy from fat and does not follow the same calculation method as underconsumption. Another study followed Murphy's concept to assess dietary quality where the actual intake is divided by the recommended intake to build the deficient index. Twenty-two nutrients at risk of deficient intake accounted for this index and the same cut-off point of 67 % below the RDA is considered deficient. The total deficiencies

index is calculated by counting the number of deficient nutrients where higher values reflect higher dietary quality. As for the nutrients at risk of excess, this dietary quality index accounted for seven nutrients that are calculated in the same way as the nutrients at risk of deficiency where the actual intake is divided by the recommended intake and the number of nutrients consumed above the recommended values is counted. Higher values for overconsumption reflect lower dietary quality. Because the indices of over and underconsumption follow different diametric scales, they cannot be combined into a single overall dietary quality measure (Balcells *et al.*, 2011).

Thiele, Mensink and co-workers (2004) created two diet quality indices inspired by the same concept of excess and deficient intakes as well but unlike its precedents, higher values for both indices implied better dietary quality. This way, the combination of both indices into a single dietary quality index became possible. For the deficient index, single nutrient scores are calculated following the NAR: if the reference intake reaches more than 100 % of the reference intake, the single nutrient deficient score is truncated at the maximum of 100; For the excess index, six nutrients were chosen for risk of excess intake. The adjusted NARs calculated for excess nutrients can reach the value of zero in case the consumption of this specific nutrient reaches more than 200 % of the recommended reference value and the score reaches a maximum of 100 if the nutrient intake is lower or equal to the reference value. The adjusted NARs are then subtracted from the maximum. This ensures that the higher intake of nutrients consumed in excess reflects a lower dietary quality and the adjusted NARs are thereafter added together for the final excess score.

4.3.1.2. Food- and food-group-based indices of overall diet quality

In the 2010 dietary guidelines for Americans, the word 'variety' is repeated throughout the text as to emphasize and encourage the consumption of a variety of vegetables, protein sources be it animal-based sources, dairy products, nuts and seeds or legumes and even a variety of seafood types (USDA, 2010). This emphasis on dietary variety stands for the increasing interest in this aspect of dietary patterns among the nutrition community. Formerly, and for the purpose of developing easy-to-use and short methods for the evaluation of dietary patterns – mainly in epidemiological studies – indices based on foods or food groups were also

created (Kant, 1996). One of the primary attempts in this area was developed by Heady (1961) where foods were grouped and an association between the food scores and the intake of nutrients was determined. Later on, the notion of overall dietary variety derived from the total number of foods consumed was conceptualized by Romero and Sanjur (1974). Since then, many scoring systems were developed and updated based on variety among and within major food groups. This was often in relation to recommended servings and guidelines. A correlation was generally found between these scores and nutrient intake (Duyff, 1975; Ries and Daehler, 1986; Kant, 1996). In this section, the Dietary Diversity Score and the Dietary Variety Score (or Food Variety Score) are reviewed as they are among the most commonly used Food- and Food-group based indices to reflect diet quality. Krebs-Smith and co-workers identified three types of dietary variety scores (1987):

(1) An overall variety score including a simple count of food items;

(2) A variety score among major food groups

(3) A variety score within major food groups counting separate foods and another variety score within major food groups counting minor food groups.

Dietary diversity is presently defined as the number of different foods or food groups consumed over a given period. The term "dietary variety" is used in the literature as a synonym for dietary diversity (Ruel, 2003). Dietary diversity can be simply measured by counting the total number of the different foods consumed (Black and Sanjur, 1980). Most measures of dietary diversity consist of a simple count of food groups consumed over a reference period; sometimes more weights are given to different food groups per servings consumed (Ruel, 2002). Krebs-smith and co-workers (1987) found that dietary diversity was a good indicator of diet quality based on nutrient adequacy (energy, fat, sugar, cholesterol and sodium). They also concluded that scores assessing dietary variety (or food variety) among groups was found to better reflect variations in the MARs of 11 nutrients than food variety scores accounting for variety within the major food groups.

For example, a study was conducted in 1995 in Mali using a Food Variety Score (FVS) defined as a simple count of food items consumed and a Dietary Diversity Score (DDS), defined as a count of food groups to validate these scores against nutritional adequacy

measures. Seventy-five single foods were part of the FVS and the DDS was constructed with the following eight food groups: staples, vegetables, fruits, meat, milk, fish, eggs and green leaves. The study concluded that "Although a simple count of food items or food groups cannot give a full picture of the adequacy of nutrient intake, […] food scores can give a fairly good assessment of the nutritional adequacy of the diet" (Hatløy, Torheim and Oshaug, 1998). While in 2001, a study was conducted in Vietnam in order to assess the association between food variety on the one hand and nutrient intake and health outcome on the other hand in a low-income country with an emphasis on the contribution of wild edible plants to dietary variety. In this study, the same FVS and DDS measures, as developed by Hatløy and co-workers, were used and 12 food categories were included (rice, other staples, green leafy vegetables, other vegetables, meat/poultry, fish/ shellfish, eggs, legumes/nuts/seeds, fruits, oils/fats, sauces/ condiments and beverages/biscuits/sweets). Wild vegetables species were taken into account in the vegetable group in this study. A consumption of 21 or more food items based on a 7-day food frequency questionnaire was considered of high diversity and correlated with a high intake of most studied nutrients compared to a consumption of 15 foods or less. The correlation with dietary diversity and nutrient adequacy was also found significant for food group diversity (Ogle, Hung and Tuyet, 2001). Recently, dietary diversity was assessed to serve as a proxy indicator of micronutrient adequacy for population-level assessment, particularily, for women of reproductive age. Five countries took part in the study (i.e. Burkina Faso, Mali, Mozambique, Bangladesh, and the Philippines) where eight food group indicators (i.e. starchy staples, legumes and nuts, dairy, organ meat, eggs, fish/meat/poultry, vitamin A-rich vegetables and fruits, other vegetables and fruits) were identified from 24-h recalls and used to calculate the mean probability of adequacy for eleven nutrients: vitamin A, thiamine, riboflavin, niacin, vitamin B-6, folate, vitamin B-12, vitamin C, calcium, iron and zinc. The study concluded that simple food-group dietary diversity was significantly associated with mean probability micronutrient adequacy in all sites (Arimond *et al.*, 2010).

Even though many scientists are in favour of using dietary diversity scores as an assessment tool of overall diets, some concerns persist. Greater food variety was not only found to ensure nutritional adequacy but has also been associated with decreased risk of

mortality and chronic non-communicable disease (Hatløy, Torheim and Osaug, 1998; Wahlqvist and Specht, 1998; Kant, Schatzkin *et al.*, 1995). However, as dietary diversity scores were validated against a key element of dietary quality assessment (i.e. nutrient adequacy) it still falls behind with regard to the assessment of proportionality and moderation (Kennedy *et al.*, 1995). For instance, diversity in certain foods, such as energy-dense foods, has been associated with higher body mass index (BMI) and obesity (Kennedy, 2004; Ponce, Ramirez and Delisle, 2006). This underscores the importance of moderation and balance, while requiring a refined definition of dietary diversity and its measurement.

In developing countries, a particular interest was given to dietary diversity scores as a proxy to assess dietary quality because of their simplicity in comparison to other dietary quality scores and their effectiveness in providing a good reflection of diet quality in the absence of food composition data (Ruel, 2003). In a study conducted in rural Lebanon, a dietary diversity score was applied to assess the food security status. In this study, a food-item score and a food-group score were used to account for the total number of individual food-items and also diversity of consumption among food groups based on a food frequency questionnaire. For this purpose, eight food groups were identified as follows: meats, starches, fats and oil, legumes, dairy products, fruits and fruit juice and wild fruits, vegetables and wild edible plants (Frese *et al.*, 2008).

4.3.1.3. Diet quality indices regrouping nutrients and foods

Indices based on nutrients contents, single foods consumed and food groups all at once also exist. These indices offer an interesting comprehensive approach taking advantage of the general view offered by food and food-group based approaches without compromising the benefits of the reductionist approach in measuring diet quality. Two diet scores will be reviewed in this section; first, the Mediterranean Diet Score and second, the Diet Quality Index, and its derivative the Diet Quality Index Revised.

Disclosed by its name, the Mediterranean Diet Score was created to evaluate the benefits and outcomes of the adherence to a Mediterranean pattern. Its first acknowledged use investigated its relation to lower mortality rates among rural elderly populations in Greece (Trichopoulou *et al.*, 1995). The reason of choosing this score in this review is because of the

relevance of the Mediterranean dietary pattern to the study context and because of the multiple proven health benefits related to the adherence to this dietary pattern.

The original Mediterranean Diet Score is measured based on 8 components to reflect diet quality. These components are: high monounsaturated to saturated fat ratio; high legume consumption; high cereal consumption (including bread and potatoes); high fruit consumption; high vegetable consumption; moderate ethanol consumption; low meat and meat product consumption and low dairy product consumption including milk. The scoring system is based on median values, specific for each gender, as cut-off points and ranges from zero to one for a maximum total of 8 for 8 elements. A higher MDS reflects good adherence to the Mediterranean dietary pattern.

In order to illustrate other features making part of diet quality indices regrouping nutrients and food, and to illustrate indices that were validated in populations outside and inside the Mediterranean region, we focus on the Diet Quality Index and the Diet Quality Index Revised.

The Diet Quality Index is an index based on the American nutritional recommendations (Patterson, Haines and Popkin, 1994). It was created by Patterson and co-workers to measure overall dietary intake patterns and use them to predict chronic disease risk. This index used the dietary recommendations from the 1989 National Academy of Sciences. Only three categories for scoring were used, meeting dietary goal was assigned a score of zero, subjects having a fair diet but not meeting the dietary goal were assigned a score of one and a score of two was given to subjects with poor diets. Recently, the Diet Quality Index was used in a study aiming to reflect the risk of diet-related chronic disease based on nutrients (Seymour *et al.*, 2003). The DQI has eight components complying with the National Research Council Diet and Health recommendations in the United States. Six of these components are nutrient-elements (i.e. total fat, saturated fat, cholesterol, protein, calcium, sodium) and two are food groups (i.e. vegetables and fruits, and grains). In the study done by Seymour and co-workers, scores ranged from 0 to 16; zero indicating excellent adherence to recommendations. The Diet Quality Index was also used as a means of measuring dietary quality in a Mediterranean population (Gerber *et al.*, 2000). Scores ranged from zero to 14 based on seven components adjusted for Mediterranean populations. The components included in this score

were saturated fat; cholesterol; olive oil; fish; meat; cereals; vegetables; fruits. The same 0-2 scoring method was used based on meeting recommendations.

On the other hand, the Diet Quality Index Revised was developed in 1999 (Haines, Siega-Riz and Popkin) to reflect the dietary guidelines for Americans at that time and to incorporate measures of dietary variety and moderation. A 100-point score was used in this index with the maximum score reflecting higher adherence to guidelines. In 2006, the DQI-R was also used according to the recent dietary guidelines for reference (Fung *et al.*, 2006). The components used were total fat; saturated fat; cholesterol; fruits; vegetables; grains; iron intake; calcium intake in addition to a dietary diversity score and a dietary moderation score. Each one of these components was assigned 0-10 points with maximum points reflecting better diets.

The Mediterranean Diet Score, the DQI and the DQI-R are diet quality assessment tools that rely on measuring both specific nutrient intakes and food group consumptions. Though unlike the other two, the DQI-R includes behavioural aspects; moderation and diversity. Interestingly, all of these indices were successfully used to predict the risk of morbidity and mortality in a number of studies.

4.3.2. The *a-posteriori* approach

Dietary patterns streaming from the *a-posteriori* method are not pre-defined in contrast to the *a-priori* approach. They are empirically identified patterns from statistical modeling of actual dietary data that have been collected as part of a selected study. This approach was developed for the purpose of reducing data in statistical analysis when handling large data sets with numerous variables. Another purpose for using this methodology is theory building as this method characterizes the covariance among multiple variables in terms of a small quantity of unobservable features (Wirfalt, Drake and Wallstrom, 2013).

This approach depends primarily on statistical analysis; factor analysis, cluster analysis and linear or multivariate regression analysis as its main tool to analyze data (Alles *et al.*, 2012). The method of factor analysis is food oriented. When using this method, the first factor contains maximum variability; foods are then removed and reclassified into other factors that explain the remaining variance. Because of the inter-individual scoring difference for each

factor, the deduced overall dietary pattern is represented on all factors for each individual depending on his or her scores (i.e. low, medium, high). Therefore, factor analysis aims to reduce the number of explanatory variables into factors that capture the primary source of dietary variation (Miller *et al.*, 2010). On the other hand, the cluster analysis, which is a subject-oriented method, allows characterizing similar groups of subjects by given dietary patterns (Hu, 2002). As a result, individuals are assigned to the data-driven dietary patterns (Newby and Tucker, 2004). In this analysis method, subjects are separated into clusters based on the Euclidean distances. For example, in order to minimize the variance within clusters, the Ward method is used. While the K-means method is used to create the most distance between clusters. Another method that is used as part of the *a-posteriori* approach to identify dietary patterns is the regression models analysis. Regression models, such as reduced rank regression, use two sets of variables. This method aims at describing linear combinations of variables belonging to one set of variables, called "predictor variables", by maximizing the variation in variables of the "response variables" set (Aranceta *et al.*, 2003; Mishra *et al.*, 2006). However, regardless of the statistical analysis methodology chosen by the researcher, decisions must be taken as to how many patterns to keep and analyze, how to interpret and how to label these patterns.

One of the strengths of the *a-posteriori* approach is that dietary patterns are not based on a previous knowledge of a 'healthy diet' as they result from the data modeling (Hu, 2002). The most common dietary patterns that result from this approach are the 'prudent dietary pattern', 'western dietary pattern' and the 'Mediterranean pattern'. The prudent dietary pattern is characterized by high intakes of vegetables, fruits, legumes, fish and seafood and whole grains, while the western pattern mainly comprises red and processed meats, butter, potatoes, refined grains and high-fat dairy products (Hu, 2002).

The identification of these dietary patterns were then linked to heath risks or benefits. For example, the western dietary pattern has been linked to an elevated risk of cancer (Adlercreutz, 1990), heart disease (Hu *et al.*, 2000) and other chronic diseases (Cordain *et al.*, 2005). Whereas both the prudent diet and the Mediterranean diet were linked to a reduction of chronic disease risks (Willett *et al.*, 1995; Hu *et al.*, 2000).

In a recent study conducted in Lebanon aiming at linking dietary patterns with obesity and socio-demographic factors (Naja *et al.*, 2011), using a nationally representative adult-Lebanese sample of 2048 subjects, four dietary patterns were identified using the *a-posteriori* approach; the western pattern, the traditional Lebanese pattern, the prudent pattern and another uncommon pattern labeled the fish and alcohol pattern. Thus, this approach permits to highlight the different dietary patterns in a particular population even if this pattern was unpredictable.

5. The link between self food harvest and diet quality

This section draws a picture of the association between local and self-food production and diet quality by reviewing the scientific literature for documented links. Studies with secondary outcomes related to diet quality are presented at first, followed by a thorough review of articles associating primarily home food production with diet quality or dietary variety/diversity.

The search terms used to find admissible scientific papers for the food production aspect of this research are 'Local food production', 'self-production of food', 'self-food production', 'home food production' and 'home-gardens', 'homestead food production', 'traditional foods', 'livestock rearing', 'wild foods', 'wild plant collection' and 'wild food gathering' with partial or complete 'self-sufficiency farming' or 'subsistence agriculture'. As for the diet quality feature, the search terms included 'diet quality score', 'diet diversity', 'diet diversity score', 'nutrition', and 'food consumption'.

In this literature review and current thesis, the term 'self-food harvesting' comprises home-gardening practices, subsistence farming, livestock farming and wild plant and fruit harvesting. It is noteworthy to mention that the term 'food-harvest' was chosen because it groups both the notions of wild food gathering and self-food production (i.e. Oxford dictionary's definition of the word harvest: the process of gathering in crops). The definition of home-gardening is a traditional land use practice that is carried out around a homestead consisting of several species of plants that are grown by the family members with the primary objective of fulfilling the family's consumption needs (Abdoellah *et al.*, 2002; Eyzaguirre and Linares, 2004).

Although many studies have reviewed the impact of agricultural interventions on nutritional status, the impact outcomes measured vary greatly. While many studies examining this link lead to interesting conclusions, they were not included in this review because of their specific nutrient-oriented measurement techniques (Ruel, 2001; Leroy and Frongillo, 2007; Girard *et al.*, 2012). Therefore, interventions measuring impacts on micronutrient intakes without documenting specific foods consumed were not selected for this review due to methodological comparability aspects with the present study.

5.1. Studies linking domestic and wild food harvest with selected aspects of diet quality

In a study conducted by Receveur and Kuhnlein about the benefits of traditional foods in Native Canadian communities, the authors found that traditional food harvesting and consumption positively affect the nutritional quality of these populations among other benefits (Receveur and Kuhnlein, 1998). This finding was further investigated among Inuit populations in Nunavut, Canada, where subjects consuming traditional foods in isolated communities were found to have better nutrient adequacy compared to non-traditional foods consumers (Sheehy *et al.*, 2015). Traditional diets are known to be of higher nutrient density than processed-food based diets (Monteiro, 2009). In the Middle-Eastern region, the Bedouin Nutritional Study conducted in the Southern Negev Desert in southern Israel, found a significantly higher intake of total energy and macronutrients in the whole wheat bread[3] consumers compared to the white bread or rice consumers. In addition, the study found that traditional whole wheat bread consumers had significantly higher intakes of dietary fibres, iron, zinc, magnesium, potassium, vitamin E and the B vitamins. The study also found a positive association between rural residency of this Arab minority population and whole wheat bread consumption (Abu-Saad *et al.*, 2009).

Masset and co-workers (2012) reviewed published and unpublished literature on agricultural interventions including home gardens to improve the nutritional status of children by improving incomes and diets of the rural poor. The review concluded that the interventions were, as expected, successful in promoting consumption of specific foods – in the case of

[3] Whole wheat bread is a traditional staple for this particular Bedouin population.

home gardens, fruits and vegetables – but very little evidence was available on their effects on the nutritional status. The authors reported that the absence of any statistically significant impact of agricultural interventions on nutritional status was not to be attributed to the inefficacy of these interventions but rather to the lack of power of the studies reviewed that could have prevented the identification of such impact; their comparisons were further hindered by the disparities in measurement variables among the different studies. The following studies illustrate the variety of methods and findings documented.

In a study valuing the role of agriculture education, a household-education-intervention encouraging the cultivation of vitamin-A rich fruits and vegetables and increasing the vitamin A consumption of children in a coastal rural area in Bangladesh resulted in drastically alleviating the problem of night-blindness (Yusuf and Islam, 1994).

Another study from Bangladesh, conducted by the Asian Vegetables Research and Development Center, examined the effect of a particular design of home gardens with regard to food consumption. The specially designed home gardens (with an area of approximately 16 m^2 and having the potential to supply a five-member family with 40 % iron and calcium requirements, 80 % and 100 % of vitamins A and C respectively) were found to result in increasing significantly the per capita vegetable consumption in families adopting the mentioned home-gardening plan compared to those who did not adopt it (Marsh, 1994).

A study conducted in Ethiopia, (Megersa *et al.*, 2014), examining the role of livestock diversification in alleviating food insecurity among the pastoral community in Borana, found a positive significant difference in the dietary intakes of individuals living in households with diversified livestock farming compared to non-diversified livestock farming households. The study data was collected by interviewing 339 individuals from 242 households in September and December 2011 using a 24-h recall and a dietary diversity questionnaire which included 14 food-groups (cereals, milk, oils and fats, legumes, fresh meat, vitamin A vegetables, tubers, green vegetables, other vegetables, vitamin A fruits, other fruits, organ meat, eggs, fish) (FAO, 2011). Even though dietary diversity was generally low among the study population with 81 % consuming one to three food groups and only 19% consuming 4 to 8 food groups, the study found a very significant association between livestock holding and diversification.

Santhakumari and Krishnakumar (2010) studied the outcomes of a project aiming at improving food and nutrition security of coconut farmers in India. Part of the project's mechanisms of intervention to improve food and nutrition security was using homestead gardening and livestock rearing. Pre- and post project data were gathered on food production (as a coping mechanism against food insecurity) and food consumption quantity and frequency. The data were collected by interviewing 50 participants randomly selected from each of the three coconut-farming communities endorsed by the project. A pre-tested questionnaire was used with statements about the adequacy of foods to measure food security, about the nutritional quality of foods to measure the nutritional security and about coping mechanisms during times of food shortage. All the statements reflected inadequacy of food and nutritional conditions; the option 'never' was taken as a completely secure condition, 'sometimes' as a moderately secure condition and 'always' as insecure condition. Frequency analysis was used to obtain percentages of respondents in each food security category (completely secure, moderately secure, and insecure). Homestead gardening almost doubled (41 % versus 87 %) from pre-project to post-project and livestock rearing also increased by 32% (32 % versus 64 %). It was noticed also that borrowing money decreased by 55 % as a coping mechanism. Dietary data were sorted according to the following food groups: fish/meat/poultry, eggs, milk and dairy products, green/leafy/yellow vegetables, other vegetables, fruits, cereals and tuber crops, fats and oils, sugars and sugar products, others including pulses. The percentages of adults having daily consumption of the stated food categories generally increased after the project with inter-regional variations except for cereals/tubers, fats, sugars and other foods where the daily consumption was positive for all participants. For all food categories, an increase in the quantity of consumption (g/day) was also found after the project, except for milk consumption in one of the study communities where it actually decreased. The consumption amounts were compared to the suggested levels of intakes by the Indian Council of Medical Research and referenced in the article as 'Recommended Dietary Intake' levels for Indian adults. It was found that consumption was lower than RDIs for all foods according to the pre-project data except for fish consumption, which was 30% higher prior to the project and increased further after the project. Other vegetable consumption, fruits and fats also increased beyond RDI levels by 35 %, 10 % and 5 % respectively. A dietary diversity measure for the overall adult population was rated

excellent if 10 food items were consumed per day, very good for 8-9 food-items, good for 6-7. The dietary diversity scores revealed a reduction of 30 % in the good dietary diversity measure in favour to the very good and excellent dietary intake classification where 65 % of participants had a very good dietary diversity rating post-project (compared to 51 % pre-project) and 20 % had excellent dietary diversity. This paper provides concrete evidence on the role of homestead food production in alleviating food insecurity and increasing consumption quantity and diversity of fruits, vegetables and other foods.

In 1990, Helen Keller International launched the homestead food production program, in Cambodia, Nepal, Bangladesh and the Philippines, with the objective of reducing maternal and child mortality and malnutrition (including micronutrient deficiencies). To achieve this objective, the program's plan was to increase fruit, vegetable and animal-source food consumption through the increase in food production in addition to raising the nutrition-related awareness, improving income and the health status of participating women and children (Talukder *et al.*, 2010). A study assessing the impacts of this program (i.e. homestead food production) in Cambodia on household, mother and child nutrition (Olney *et al.*, 2009) compared two cross-sectional survey-results. The same questionnaire was used to examine the differences in food production and consumption between baseline (October 2005) and endline (May 2007) using data for 300 intervention and 200 control households. The questionnaire included recall questions about the household consumption of eggs, liver in the previous week and dark green leafy vegetables, yellow or orange vegetables and yellow or orange fruits in the past three days. The differences in production and consumption were assessed using t-tests and chi-square tests. Multivariate logistic regression analysis was used at endline to test for associations between the type of gardens, the amount of food production, and food consumption. A dietary diversity score was calculated by summing the household's consumption of these food items/groups ranging from 0 to 6. At baseline, sociodemographic characteristics were similar for both intervention and control households but intervention households were more likely to have more varied gardens with year-round produce, known as improved or developed gardens, compared to control households who mainly had traditional

gardens[4]. Also animal ownership was significantly more frequent at baseline in intervention households than in control households. Food production was examined according to (1) the number of varieties of fruits and vegetables produced by home gardens at the time of the survey and over the past three months and (2) the total amount (weight) of harvested fruits and vegetables within the previous month. Animal-source food production was assessed as the mean number of animals owned by the households for the proportion of households owning animals. At baseline, household food consumption and dietary diversity were similar in both groups but intervention households had a higher consumption of liver and less consumption of yellow orange fruits. The total fruit and vegetable production in the previous month was higher in the intervention group for both the baseline survey and the endline survey and the number of owned animals was higher. At endline, a higher proportion of households in the intervention group consumed dark-green leafy vegetables, yellow/orange fruits, eggs and liver. It was found that an increased quantity of produced vegetables was positively and significantly associated with increased household dietary diversity. Also, the variety in vegetable production was positively associated with the total household consumption of vegetables other than dark green leafy vegetables. Meanwhile, fruit consumption was not significantly associated with fruit production.

As part of the same home gardens project (2002-2013), in Nepal[5], a variety of crops were re-introduced to improve the dietary diversity in households, mainly aiming to improve diets of women and children. Therefore, cropping techniques with multi-layers were implemented in rural disadvantaged communities. An increase in diversity was noticed, indicating the success of the program and also women and children's heath was improved as cropping patterns changed with the intervention. Home gardens were found to supply 60 % of the total family consumption. In the middle hill areas of Nepal (Illam), more than 50 % of home gardens had 21 to 50 different species per household, while in Gulmi, a drier climate area, the number of species per household varied from 11 to 40 (Gautam, Suwal and Sthapit,

[4] Traditional gardens are seasonal with scattered plots while improved gardens have fixed plots and produce more seasonal varieties of fruits and vegetables. Developed gardens also have fixed plots but their fruits and vegetables production is more varied and sustainable over changing seasons.

5 A country where home gardening is one of the key components of the population's farming system with over than 70 % of households maintaining home gardens ranging from 2 to 11 % of the family's landholding (Sunwar et al., 2006)

2004). The different species grown in Nepalese home gardens fell in the following order: vegetables, fruits, spices, fodder, medicinal, ornamental and other species (Sunwar *et al.*, 2006). The "Enhancing family nutrition and income for improved livelihoods of resource poor and disadvantaged groups through integrated home gardens in Nepal" project resulted in increasing species richness of home gardens and also increased the sources of nutrients available to households such as proteins, iron, vitamin A and folate. Another study assessing dietary diversity in the Nepalese areas of the project found that wild foods made an important contribution to the nutrition of the rural people in the studied areas and played a major role in survival strategies for these communities, especially during the period of food shortage (Sthapit, Gautam and Eyzaguirre, 2006).

In summary, although there is evidence from some of the above-mentioned case studies from around the world suggesting a positive association between self-food harvesting and dietary diversity, a recent review by Powell and co-workers (2015) clearly shows that this link is not universal.

A study conducted in the villages of Oussoubidiania and Ouassala in rural Mali (n = 502) examined the association between nutrient adequacy and dietary diversity. Fifty-five percent of the study population were women aged 15-45 years from 319 households. Household and individual information was obtained using questionnaires and administered by interviewers in a local language. The household questionnaire was directed to household heads and collected demographic and socioeconomic information, in addition to food production, food expenditure for non-staple foods, such as meat and milk, and non-food expenditures. Individual data included food-producing and income-generating activities, health status and anthropometric measurements. A 7-day quantitative food frequency questionnaire (QFFQ) comprising a list of 104 food items that included parts recording frequency of consumption, estimated portion size and mealtime (breakfast, lunch, dinner or snack) for each food-item was used to assess food intake patterns. The 7-day quantitative food frequency questionnaire was validated for the study population twice where both validation studies found that the QFFQ was able to rank and classify subjects adequately but better for men than for women (Torheim *et al.*, 2001;

Parr, Barikmo *et al.*, 2002). Diet quality was measured using MARs[6] as a measure of overall nutrient adequacy. The number of crops cultivated in the household was positively associated with MAR but not with FVS and DDS[7]. Whereas socioeconomic status was associated with VS and DDS but not with MAR in the multivariate model. Due to the significant positive association found between socioeconomic status and the number of crops cultivated, socioeconomic status was substituted in the regression model for FVS and DDS by the number of crops cultivated and the resulting association was positive for FVS but not for DDS. The study concluded that dietary diversity is a useful indicator of nutrient adequacy and that examining the contribution of various food groups to the nutrient adequacy of diets in a given area is important (Hatløy, Torheim and Oshaug, 1998; Torheim *et al.*, 2004).

In 2011, a study by Remans and co-workers used nutritional functional diversity[8] (FD) measures to associate species diversity and nutritional diversity. The nutritional FD metric was used to summarize and compare the diversity of nutrients provided by farms in three sites in Sub Saharan Africa (SSA) that are part of the United Nations Millennium Villages Project; Mwandama in Malawi, Sauri in Kenya, and Ruhiira in Uganda. These sites are representative of the agro-ecosystem of SSA where the main source of livelihood for over 75 % of households is from subsistence farming. Data for the Ruhiira and Mwandama were collected from 60 farms in each site from June to September 2009 and data from 50 farms for Sauri were collected during November 2009. For each of the 170 farms, all plots including home gardens were sampled to document all plant and tree species that were thereafter added to a database of plant nutritional composition data (developed based on existing studies and databases). The nutritional composition data were standardized and weighted by converting values to the percentage of the Dietary Reference Intake (DRI) provided by 100 g of the consumable crop, which were used to calculate the FD scores. Seventeen nutrients were selected for FD calculation: protein, carbohydrates, dietary fibre, fat, calcium, iron, potassium, magnesium, zinc, sulphur, vitamin A, vitamin C, thiamin, riboflavin, folate and niacin[9].

[6] Mean Adequacy Ratio
[7] Food Variety Score (the number of food items consumed) and Dietary Diversity Score (the number of food groups consumed)
[8] The nutritional FD metric uses plant species' nutritional composition to identify nutrients and nutrient groups in a given farm thus reflecting the diversity of nutrients provided by the farm.
[9] Vitamins B12 and D were not included because plants are not their proven source.

Species richness was defined by the number of identified edible species per farm and nutritional functional diversity was measured using Petchey and Gaston's FD (2002). This method relies on summing the number of branch length of a functional dendrogram showing a species by trait matrix and a farm by species matrix and multivariate distances between crop species are calculated where distances between species is a function of distinctness in nutrient composition. Household diet diversity was assessed using a score for the consumption of 15 groups: cereals; vitamin A rich vegetable and tubers; white tubers; roots and plantains; green leafy vegetables; other vegetables; vitamin A rich fruits; other fruits; legumes and nuts; oils and fats; meat; fish; eggs; milk; sweets; spices and tea obtained from 24 hour recall data. Iron and vitamin A deficiencies were examined for 30 women aged 13-49 by analysing blood samples. The mean edible species production variety was found to differ significantly between villages when measured by ANOVA regression analysis with 11 species in Mwandama, 15 in Sauri and 18 in Ruhiira and the mean household dietary diversity scores for the villages were 8, 8, and 9 respectively. Other measured indicators such as the nutritional FD score, the household food insecurity score and iron deficiency percentage were found to differ significantly by village except for vitamin A deficiency where the difference was not significant. It was found that low species richness and FD score at the village level were paired with low diet diversity. However, this association was not significant at the household level.

To our knowledge, only a few studies focused on the specific association between crop diversity and fruit and vegetable consumption with most of these studies being conducted in Africa.

A study by Ng'endo and co-workers, published in 2016, examines the associations between dietary patterns and plant/animal production diversity with regard to socioeconomic variables during two seasons in Western Kenya. The study hypothesizes that dietary diversity among smallholder farming households in the researched area is not necessarily increased with higher on-farm plant/animal food production. The timelines of the study were from September through October 2012 (planting season) and from July through August 2014 (harvesting season) and it was conducted in two agro-ecologically different zones in the districts of Mumias and Vihiga in Western Kenya. Data collection for the study was conducted through

farm surveys covering three villages from each district. Dietary diversity was assessed at the household level for the 15 households from each district covering six villages using one-day dietary diversity score (DDS) and seven-day food consumption score (FCS). A semistructured questionnaire was used to collect data from both the household head and the spouse pertaining to: demographic and socioeconomic household characteristics; types, amounts and uses of plant/livestock species produced on the farm; plant/livestock species available and/or consumed by the household; and the main sources for obtaining food items (in the last one year period in the 2014 survey and during the last five times of consumption from 24-hours to the last three months in the 2012 survey). Plant produced/collected were assigned to one of the seven food plant groups defined by FAO in 2011 (cereals, starchy roots, vegetables, fruits, pulses, sugarcane, spices) according to their reported main use. Descriptive statistics were used to characterize farms according to species richness and abundance. Individual density of plant-foods was calculated to account for the difference in farm sizes. Species dominance was measured according to three different indices: Shannon diversity index, Simpson's index of diversity and Shannon evenness and were computed using the Multi-Variate Statistical Package. In order to account for both plant and livestock on-farm production, a single farm diversity measure was used that sums up the number of different plant and livestock species produced by each household. Farms were compared among each other on the basis of their nutrient composition according to relative nutrient functional diversity using a list of species per farm and a list of content of seven nutrients (carbohydrates, proteins, folic acid, iron, zinc, and vitamins A and C). DDS was calculated by adding the different food groups from which foods are consumed within the past 24-hour recall period by women only and by all household members. Women's DDS served as an indicator of nutritional adequacy based on nine food groups (i.e. starchy staples; dark green leafy vegetables; other vitamin A rich fruits and vegetables; other fruits and vegetables; organ meat; meat and fish; eggs; legumes, nuts and seeds; milk and milk products) (FAO, 2011). While household DDS was considered a proxy for households economic access to foods based on 12 food groups (i.e. cereals; white tubers and roots; vegetables; fruits; meat; eggs; fish and other seafood; legumes, nuts and seeds; milk and milk products; fats and oils; sweets; spices, condiments and beverages) (FAO, 2011). Cutoff points were used to categorize women DDS as follows: low (0-4), medium (5) or high (6-9), and for the household's DDS, cutoff points were categorized as follows: low (0-7),

medium (8), or high (9-12). Afterwards, women and household FCS were computed by multiplying the frequency of consumption of eight food groups in the last seven days by weight assigned to each food group according to WFP (2008), and were distributed according to three categories: low food consumption level (0-28), borderline (28.5-42), or acceptable (42 or more). The associations of food scores with farm diversity were determined by using bivariate correlations and multiple regression models and the associations between the variables were tested with Spearman's rank-order coefficient. The mean farm sized 0.36 ha and the study found seasonal variations in income sources as only 17 % of households relied on farming as their main income source during the 2014 harvesting season compared to 40 % in the 2012 planting season. The study found an average of 11.2 and 13.4 plant food species per farm during the 2012 and 2014 surveys respectively. In both surveys, plant species comprised seven main food groups: cereals, starchy roots, vegetables, fruits, pulses, sprices/condiments, and one high-sugar food species, sugarcane. A ten percent increase in animal farming was noted between the two seasons surveyed. During both seasons, most food groups were used for household consumption except for 60 % of sugarcane, 29 % of animal products and 31 % of spices, which were sold. The study interestingly found that 75 % of the mean combined farm harvest products from the two seasons were used for home consumption and only 14 % were sold in markets. Also, almost half (48 %) of the foods consumed during the two seasons came from farms and 26 % came from markets. The household DDS was between two and nine food groups during the planting season and between five and 11 during the harvesting season suggesting a low mean for both seasons. There were intra-household variations to the food groups consumed by different members of the household. As an indicator of women's diet quality within households, the women's DDS scored between one and seven different food groups during the planting season and between two and seven during the 2014-harvesting season and the mean women's DDS was as low as four, implying low diet quality. As for the associations between the different farm and dietary diversity indicators, the study found that none of the farm diversity indicators correlated with any of the dietary diversity indicators. However, relative nutrient functional diversity was found slightly positively correlated with women's DDS (rho= 0.447, $P< 0.05$) and household DDS (rho= 0.387, $P< 0.05$) during the planting season. Noteworthy, a trend of biggest farm sizes correlating with the highest nutrient functional diversity among women was also found. At the

household level, the DDS negatively correlated with the on-farm produced and consumed foods (rho = -0.465, P<0/001) as an indicator of household economic access, meanwhile, it was slightly positively associated with the proportion of sold produce (rho = 0.380, P< 0.05) during the 2015 harvesting season. In summary, this study concluded that farm diversity does not necessarily translate into dietary diversity as other food sources may interfere with this relationship (procurement from markets or family/friends). Seasonality is correlated with the food groups consumed and socioeconomic characteristics influence dietary diversity.

A study by Pellegrini and Tasciotti (2014) investigated the relationship between food crop diversification in rural household settings and both dietary diversity and crop income (i.e. crops sold) using household survey datasets from eight different countries: Malawi, Nepal, Vietnam, Pakistan, Nicaragua, Indonesia, Albania and Panama. Land was classified according to area with class 0-1 indicating a land space up to one hectare, class 1-2 indicating owned area between one and two hectares and class >2 indicating land areas larger than two hectares. Using t-tests for the association between the number of crops produced and the number of foods consumed per household, the study found a positive relationship between the two variables. This result, in comparison with specialising the crop production for one particular crop, indicates that selling the harvest does not correlate with increased household food count indicator (i.e. number of foods consumed) but the diversification in crop production does. Regression analysis while controlling for socioeconomic factors were used to further examine the correlation between crop production diversity and dietary adequacy indicators (i.e. a food count and a 13-food group count). Within each land class, an interesting result was found: the food count indicator increases until a certain threshold after which dietary diversity stops increasing as crops diversity continues to increase. On the other hand, the number of produced crops was positively and significantly related to increased agricultural revenues.

In Malawi, Jones and co-workers (2014) examined the correlation between crop diversity and dietary diversity from cross-sectional data from a nationally representative sample of farming households using an Integrated Household Survey (IHS3) from three major rural regions of Malawi (north, central, and south). Only households involved in agricultural activities for which agricultural data were complete for the 2009-2010 rainy season to the 2010 dry season, thus covering a full year (n = 6623), were included in the study. Farm

diversity data were used based on three measurements: the sum of the different types of crops cultivated during the one year study period, crop and livestock count where the number of animal species raised by the household is added to the crop count, and the Simpson's Index which accounts for number of crops and their distribution through the cultivated area and ranges from 0-1 (zero: only one crop cultivated, 1: all cultivated crops are equally distributed). For the dietary data, 7-day recall data for each selected household were used to calculate a Household Dietary Diversity Score (HDDS) that was modified from its 24-h recall form to a 7-day recall form and accounted for 113 different food items with a continuous score between zero and 12 based on 12 food groups (i.e. cereals, tubers and roots, vegetables, fruits, meat, eggs, fish and seafood, pulses and nuts, dairy products, oils and fats, sugar, condiments) and was scored if any food item from the group was consumed by anyone in the household. A second dietary diversity measure was the household's Food Consumption Score (FCS), it combines the HDDS data with the frequency of consumption of eight food groups: grains and tubers, pulses, vegetables, fruits, meat and fish, dairy products, sugar and oil. The association between farm production diversity and dietary diversity was obtained using multiple linear regression models controlling for the following factors: household size, age of household head, sex of household head, total cultivated area, total household expenditure, number of non-agricultural income sources, proportion of food consumed from own production, whether household decision maker is a woman, weighted national quintile of per-person-consumption, regional differences using dummy variables. Regression models were used to examine the associations between dietary diversity and farm-crop diversity with a consistent positive relationship found regardless of socioeconomic factors. However, regional differences appeared with the central rural region having lower dietary diversity scores compared to the overall mean. A strong association was found between crop diversity and the consumption of vegetables, fruits and legumes. This association was also significantly higher in wealthier households and households headed by women. Correlations between HDDS and FCS and also among the three measures of farm diversity were positive with the following coefficients: 0.85 for crop count and crop/livestock count, 0.79 for crop count and Simpson's Index and 0.67 for crop/livestock count and Simpson's index. The study concluded that farm diversity measured by a combined crop and livestock scores increase dietary diversity especially in wealthier households and women-headed households.

Keding and co-workers (2012) investigated among rural Tanzanian women the association between dietary diversity and vegetable production or collection from the wild using three cross-sectional survey datasets to account for the fluctuation in food production and consumption caused by seasonal differences. Data were collected for the 252 final participants using semi-quantitative 24-h recalls and questions on vegetable production during the time of interviews which noted the different types of vegetables produced and collected from the wild. The Dietary Diversity Score (DDS) was calculated from the 24-h recalls by summing the number of food groups consumed based on a total of 14 food groups (cereals, starchy tubers and fruits, legumes, nuts and seeds, vegetables, fruits, meat, poultry, eggs, fish, dairy products, sugars, fats, beverages), whereas the Food Variety Score (FVS) was calculated by summing up the single food items consumed in the previous 24 hours. Data analysis on food production was based on simple counts of the number of vegetables grown in gardens and collected from the wild while the DDS and DVS were grouped into one variable with three categories (low, medium, high) reflecting dietary diversity. The low DDS/DVS tercile was assigned when the DDS ranged between 2-4 and the DVS between 2-6, the medium tercile reflected a DDS of 5-6 and a DVS between 7-9 and the high tercile participants had a DDS between 7-11 and a DVS ranging between 10-16. Non-parametric Friedman test and t-test were used to check for seasonal dietary differences and bivariate correlations were assessed using chi-square test and Spearman's coefficient rank to identify whether the number of harvested (produced/collected) vegetables was associated with dietary diversity. The results of the association between these variables were significantly positive; the higher the number of vegetables cultivated, the more diversified was the diet.

Finally, a study linking crop diversity and dietary diversity in Kiambu in central Kenya and in Arusha in northern Tanzania (Herforth, 2010) surveyed 169 households in Kiambu and 207 households in Arusha. The survey was conducted by interviews in the local language of respondents over four to five weeks simultaneously in both study areas to ensure comparable seasonality. Demographic data, assets and income sources, agricultural production and household diet including the source of foods consumed were collected from one or two respondents from each household. Crop diversity was measured by counting the number of crops grown in the past 12 months that respondents responsible for the majority of agriculture

in households were asked to list freely. Dietary data was obtained using a 24-hour food list recall and a 33-item seven day validated food frequency questionnaire including the source of foods consumed. Several indicators were used to assess diet quality including a household dietary diversity score (cereals; roots/tubers; vegetables; fruits; meat/poultry; eggs; fish; pulses/nuts; milk/yogurt/cheese; oil/fat; sugar/honey; miscellaneous), a household dietary variety score and a count of the number of fruits and vegetables consumed. Logistic regression models were run to test the association between crop diversity and consumption while controlling for wealth and other potential confounding covariates with all terms in the model being tested for significant interactions. It was found that in each site, almost half of food items stated in the FFQ were purchased and a small proportion of food came from wild collection and other sources. In Kiambu, crop diversity was found to be significantly positively associated only with household dietary variety with each crop grown being associated with 0.2 additional foods consumed; the association between crop diversity and household dietary diversity was not significant. In Arusha, crop diversity was found to be significantly positively associated with both household dietary diversity and dietary variety scores while controlling for socioeconomic status, land size, household age and education. Also, each additional crop was associated with an 18 % increased chance of having fruit consumption in the past 24-hours in Arusha and 14 % increased chance of egg consumption in Kiambu. In conclusion, the study found that crop diversity, in both sites, was positively associated with diet diversity from home-produced foods but not from purchased foods and that each additional traditional vegetable grown was associated with a 0.49 unit increase in the number of fruits and vegetables eaten the day before the survey.

CHAPTER III: Research rationale, context and objectives

1. Research rationale and context

Hunger, and thereby food insecurity at large, is a problem that burdens 795 million people globally (FAO, IFAD and World Food Programme, 2015). Many communities in the developing world suffer from the complications and consequences of food insecurity. As a result, the world leaders agreed that eradicating extreme poverty and hunger should be set as a priority goal for the Millennium Development Goals that were established in the year 2000 (United Nations, 2013).

As food aid programs fail to offer a sustainable solution for the impoverished, and because the majority of the poor in the world live in rural areas and have access to farming (in 2010, 3.1 billion people out of the estimated total world population of 7.3 billion people lived in rural areas of developing countries, about 34 % them are classified as extremely poor and about 80 % of rural households engage in farm activities) (United Nations, 2011), subsistence or partially subsistence agricultural practices reinforced or reintroduced in farming communities through governmental policies, intervention programs and education may offer suitable sustainable solution for these communities –and the environment– to save them from hunger, micronutrient deficiencies, improve their diet quality and health status (Eyzaguirre and Linares, 2004; Bhattacharjee *et al.*, 2006; Frison *et al.*, 2006; Bullock, Pywell and Walker, 2007; Fanzo *et al.*, 2013).

In fact, evidence from the literature shows that home gardens and self-food provisioning, generally, but not always, contribute to enhancing diets with more diversified foods and nutritious choices. They also contribute to household and community economic improvement and wellbeing (Fanzo *et al.*, 2013). Besides, research proves that dietary diversity and nutritional status are strongly related (Ruel, 2003; Arimond and Ruel, 2004; Moursi *et al.*, 2008; Arimond *et al.*, 2010). Furthermore, dietary diversity is an essential component of diet quality (Ruel, 2002), which in turn is a vital element of food security (Ruel, 2002).

In Lebanon, the abandonment of agricultural lands associated with a higher consumption of fats, refined carbohydrates and sugars paired with a decreased consumption of fruits, vegetables and variety crops (i.e. the nutrition transition) (FAO, 2014) contributed in part to the increase in health problems (WHO, 2011; UNICEF, 2012). A number of studies investigated the link between dietary patterns and nutritional status, disease risks and food security in rural settings in Lebanon in recent years (Sibai, Hwalla and Rahal, 2003; Hunter, 2008; Issa *et al.*, 2011), but none has yet explored whether self-production (i.e. harvesting) directly affects the diet quality of these rural populations. As self-production and self-gathering of wild foods continue to last in rural Lebanon, the pace of the nutrition transition is therefore slower in these regions compared to cities (Batal *et al.*, 2007). Finding that self-provisioning of food contributes positively to the diet quality of rural Lebanese populations, could be of great importance in order to counteract the escalation of the nutrition transition in Lebanon and its effects. This finding could be especially valuable to nutritional intervention programs aiming at improving the food security and health status of these populations.

2. Research objective

This research is connected to the second phase of a larger research project that was funded by Canada's International Development Research Centre (IDRC) and carried out by the American University of Beirut's Department of Nutrition and Food Science, entitled *Food and Health in Rural Lebanon: Options to Improve Dietary Diversity, Food Security, Livelihoods and Ecosystem Management*.

The project's general objective was to develop practical interventions and provide policy options for improved dietary diversity, food security and health in poor and vulnerable communities in Lebanon. The present study helps to better understand the benefits of rural ecosystems by looking into the link between the level of consumption of foods and the degree of self-production of foods which would help determine how much the community participants are streaming away from consuming traditional foods (IDRC, 2009).

For this thesis, we hypothesized that plant harvesting –whether it is the collection of wild edible plants and fruits or self-production of plant-foods, or both– is associated with greater dietary variety (diversity) and plant-food consumption frequency; we also

hypothesized that if associations exist between the harvest of plant-foods and diet quality, those associations would be region-specific (i.e. vary from a region to another) revealing thereby overall positive, but possibly not generalized, relationships. Such observations would be relevant for programs aiming at improving diet quality through the promotion of household food production and wild food collection.

CHAPTER IV: Methodology

This is a primary data analysis covering one of the objectives of the general project *Food and Health in Rural Lebanon: Options to Improve Dietary Diversity, Food Security, Livelihoods and Ecosystem Management* that took place under the patronage of the International Development Research Centre (IDRC) in collaboration with the University of Ottawa and the American University of Beirut. Data collection and entry was done between 2005-2006 by the Nutrition and Food Science Department at the American University of Beirut (AUB) under the direction of Dr. Malek Batal. The present thesis uses the existing data from the above-mentioned project while implementing new measures of data cleaning, adjustment of variables and analyses to pertinently correspond to its objectives. This is an observational, cross-sectional study due to the nature of its data collection methodology and design.

1. Survey area and methodology

Three regions (including six communities) from rural Lebanon were selected for the purpose of this project in order to have a somewhat representative population of the rural poor where wild plant collection was still practiced. Households asked to participate in the project were randomly selected from each community using municipal tax files. Adult subjects from each household aged between 40 and 60 years were interviewed upon their participation-approval. The justification behind the age criterion is that food traditions are believed to be stronger in older rural residents and the project's interest was around traditional foods. If more than one person in the household met the age criterion, the person interviewed was the one considered to be the head of the household regardless of gender.

The project regions are Hermel, Chouf and Aarsal. Seven hundred and ninety eight subjects were interviewed in total. Each interview took about 60 minutes and was administered by a trained interviewer. The interviewers were residing close to each community and were trained in dietary assessment techniques, survey administration and anthropometric measurements. Below is a summary about each area and population's

characteristics followed by a map of Lebanon showing the location of the three regions. Information in this section is cited from Hunter (2008) master's thesis.

Region 1: **Hermel** (and Kuakh)

Geography and climate: The towns of Hermel and Kuakh are located in the Bekaa region at close proximity (8 Km distance between the two towns). Hermel and Kuakh are at a 16 Km and 12 Km distance from the Syrian border respectively and at altitudes of 750 m and 650 m respectively. The total land area of Hermel is 3 Km^2 and only 0.1 Km^2 in Kuakh. Climate is semiarid in both towns with red rose soil in Hermel and red soil in Kuakh supporting little agricultural activities.

Population: 50 % of the 100,000 official population of Hermel still reside in the town and 20 % of the 3,000 Kuakh-population are still residents in this small town. There are 15 touristic and historical locations in Hermel that provide a source of income to the families and there is a small milk factory that supplies the village. On the other hand, the families in Kuakh mainly depend on livestock farming (sheep, cows and goats) as a source of income.

Agriculture: The most widespread agriculture products in Hermel are watermelon, green peas, beans, potato and eggplants distributed in the Lebanese market. Fruit trees cultivated in this village are olive, apricot, green plum, pomegranate, figs and grape vines. Like in Kuakh, sheep, cows and goats are herded and supply the local community with a small portion marketed in Beirut. The main agricultural production in Kuakh is wheat, which is used for local consumption and cattle feeding. Fruit trees cultivated in this town are olive and almond trees.

Infrastructure: Infrastructure is poor in both locations. Electricity is provided but restricted in some neighbourhoods and although telephone landlines are provided in Hermel, only cellular networks reach Kuakh. There is no sewage disposal system in this region. Water from artesian wells is distributed to households in Kuakh and Hermel. Spring water is distributed in Hermel for drinking and some access to the nearby Assi River water is possible. There are eight elementary schools in Hermel (three public and five private), an intermediate school, two secondary schools and two vocational institutes. There is only one primary school in Kuakh. While Hermel has a relatively good access to healthcare from various specialty clinics, five

dispensaries and two hospitals (one public and one private), there is only one dispensary in Kuakh that opens one day per week.

Socioeconomic indicators: According to calculations based on information from the 255 respondents from Hermel and 44 respondents from Kuakh, the mean income in is 931,673 LBP. (931 CAD) and 327,273 LBP. (327 CAD) for Hermel and Kuakh respectively. Kuakh has the lowest mean income level among the surveyed communities. The mean number of people living in the household was 5.8 (SD 2.2) for Hermel and 7.1 (SD 2.1) for Kuakh. The average number of children living in the household for Hermel was 5.1 (SD 2.5) and 6.5 (SD 1.5) for Kuakh.

Region 2: the **Chouf** cluster (Batloun, Kfar Nabrakh and Warhaniyeh)

Geography and climate: There are three closely located villages from the Chouf Mountains that were selected for the survey: Batloun, Kfar Nabrakh and Warhaniyeh. All three are located approximately 60 Km away from Beirut.

- Batloun is located at an altitude of 1250 m above sea level. A river flows through the village of 5.5 Km^2 land area.
- Kfar Nabrakh is located at an altitude of 1000 m above sea level with a land area covering 4.4 Km^2.
- Warhaniyeh is located at an altitude of 1200 m above sea level.

Batloun and Kfar Nabrakh are abundant in groundwater and soils in the three villages are varied among red, rose and clay soils. All three villages enjoy moderate climate.

Population: Batloun's official population is 4500 with 80 % of its population residing in the village and engaging in agricultural activities, government jobs, local trade and industries. In Kfar Nabrakh, the official population is 9000 having agriculture as a main income source. Other income sources include some local industries (i.e. carpentry, stone quarrying, printing press and welding metal for cars). As for Warhaniyeh, the official population count is of 3000 people and there are two factories that sell their frozen meats and bulgur production to the Lebanese market.

Agriculture: vegetable and fruit production intended for local consumption and distribution in nearby markets include apple, peach, pear, cherry, figs, almonds, grapes, olives, tomato, cucumber and onions. Dairy and meat products are used for local consumption.

Infrastructure: The infrastructure in the three villages is relatively good with electricity, telephone networks and minimal quality sewage disposal systems being available. There is one school offering all educational levels starting from kindergarten in Batloun in addition to a vocational institute. In Kfar Nabrakh, a public school and a private school provide kindergarten, elementary and intermediate levels each. There is only one school in Warhaniyeh offering elementary education. Barouk springs provide water for all three villages in addition to artesian wells.

Socioeconomic indicators: There were 200 subjects included in the survey from all three villages with a mean household income of 943,379 LBP. per month (943 CAD). The mean number of people living in the household was 4.4 (SD 1.3) and the average number of children was 2.9 (SD 1).

Region 3: **Aarsal** (also called Irsal)

Geography and climate: Aarsal is located in the Bekaa valley area at an altitude of 1400-2000 m above sea level. It is in close proximity to the Syrian border (14 Km), 35 Km away from Baalbeck and 122 Km away from the capital Beirut. The total land area covers 360 Km^2 and is divided into a vast eastern arid region and a mountainous region. The climate is varied as well, humid in the north and dry desert in the south. Its yellow calciferous soil is suitable for dry farming and pasture activities and covers most of its land while the rest of the land is covered by red and gray soil.

Population: While some 35,000 people constitute the Aarsali population, only 24,500 of them are permanent residents. Their major source of income is stone quarrying, agriculture and sheep and goat farming.

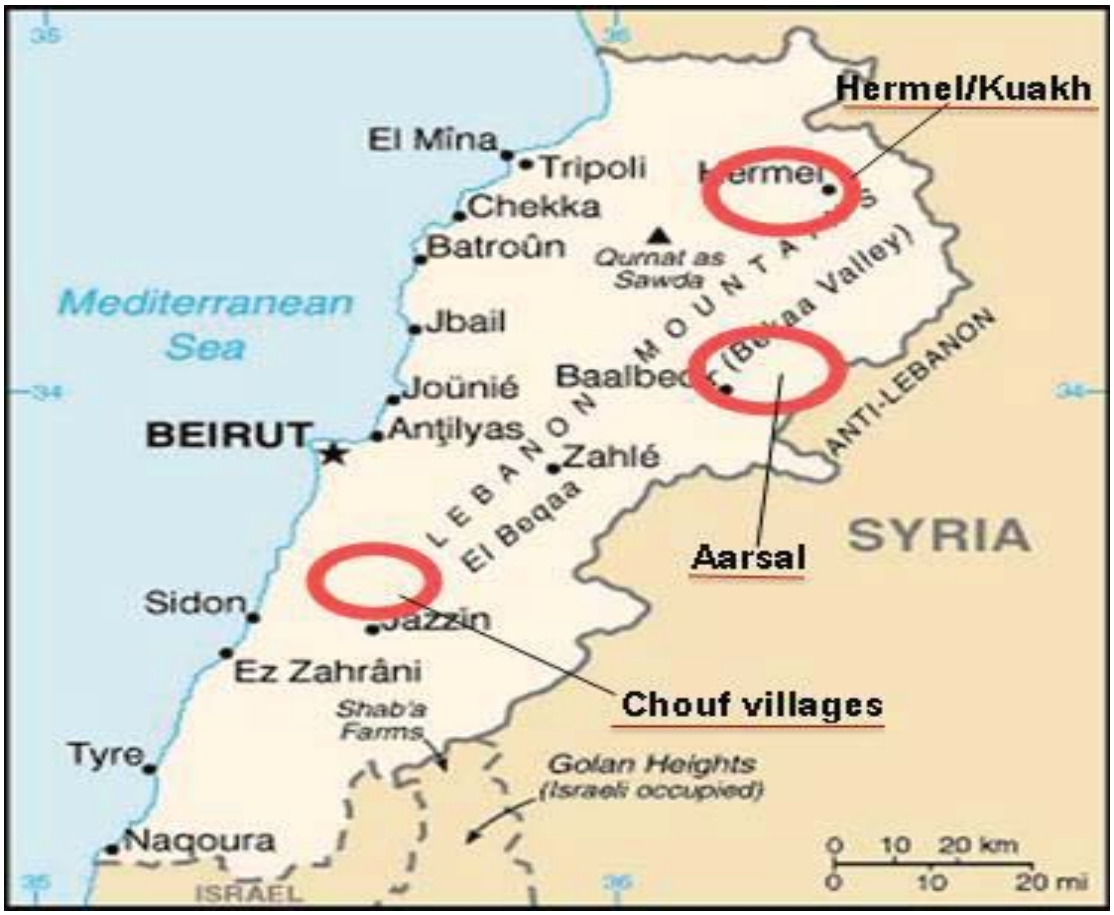
Agriculture: Wheat, Barley and chickpeas are produced for local consumption. Since the 1950's, fruit trees, especially cherries and apricots, became the major produce of the village and a main source of income for 60 % of villagers. Cultivated vegetables include eggplants, tomatoes and cucumbers. Wild plants and trees include hawthorn, sumac, grapes, wild pear

trees and wild almond trees. Dairy and meat coming from 60,000 sheep and goats are used for local consumption in the Bekaa area and by industries in nearby Chtaura, a regional centre.

Infrastructure: Telephone and electricity services are provided in the region but there is no sewage disposal system. Water for household consumption comes from artesian wells and is distributed and stored in water tanks. There are five public schools in the village, seven private schools and a single vocational institute. Five dispensaries and doctors of various specialties provide local healthcare.

Socioeconomic indicators: According to subjects included from the original-survey (n= 282), the mean household income was 872,051 LBP. per month (almost 872 CAD). The mean number of people living in the household was 6.4 (SD 2.3) and the average number of children per household was 5.7 (SD 3)

Figure 1: Map of Lebanon showing the three areas of the study



2. Data cleaning and adjustments

The Questionnaire data (including the Food Frequency Questionnaires) were obtained from the Nutrition and Food Sciences department at the AUB in the form of SPSS and Excel datasets.

Out of the study population of 798 subjects initially included in the dataset, 50 subjects were excluded after data cleaning where only subjects with complete records on all studies variables were retained (748 subjects). Data cleaning consisted of several steps; first, excluding subjects with missing values for the population characteristics variables used in the study, such as age, crowding index, educational level (a total of 26 subjects). Except when the missing values were for the answer on INC1 (total of four subjects), a calculation was made based on the subject's expenditure data obtained from questions INC18.1-INC18.17.

Then, for the food consumption frequency, an adjustment of the consumption frequency was made according to seasonality of consumption because the FFQ timeline was over the year preceding the questionnaire's interview. So whenever a food-item was reported to be seasonal in the FFQ by a participant, its consumption frequency was divided by three in order to reflect seasonality[10]. Two subjects did not have answers about the seasonality of food items consumed and therefore were ultimately excluded from the analysis.

To identify outliers for the consumption frequency variable, some observations' values were clearly beyond normal, for example, a reported fruit intake of 196 times per week obviously reflecting an impossible value, so we based the exclusion on the 99 percentile, if:

- Fruit consumption frequency was greater than 93 times per week,
- Vegetable consumption frequency was greater than 108 times per week,
- Wild plant consumption frequency was greater than 20 times per week,

For wild fruits, the consumption frequency was kept at the 100 percentile because the highest value at 100 % was of 14 times per week, which reflects a realistic consumption frequency.

[10] The typical growing season for seasonal fruits and vegetables was set at an average of four months based on fruits and vegetables availability calendar (FAO, 2016). Since the questionnaire period extends over the past 12 months, consumption was divided by three in order to better reflect the average consumption.

After the elimination of outliers and observations with incomplete records, 748 subjects were kept for analysis.

3. Examined determinants and identified variables

3.1. Population characteristics

The mean age, gender, number of people living in the household, crowding index, level of education, region and the economic status of participants were the variables chosen to describe the study population based on their food-harvest status. In addition, the same population characteristics were associated with consumption patterns (reflecting diet quality) and thus helping in portraying a descriptive image of the population of interest. Below are the detailed descriptions for each of the population characteristics' variables retrieved from the questionnaire:

- The age of each participant was obtained by an automated calculation by SPSS 20 using the difference between the "Date of birth" of the interviewee and the "Date of the interview" (GEN2 and Questions IV).
- "Gender" of participants was obtained from the question GEN1.
- The question "Number of people living in the household" (GEN11) was used as a variable to portray population characteristics.
- The regions of residence of participants were obtained from the question "Place of residence" (GEN5) where the village of Aarsal consisted of the first region; the second region comprised the villages of Hermel and Kuakh and the villages of Batloun, Kfar Nabrakh and Warhaniyeh constituted the Chouf region.
- The crowding index was obtained using the questionnaire's "Number of people living in the household" (GEN11) and dividing it by the "number of rooms in the house excluding kitchen and bathrooms" (GEN13) (Melki *et al.*, 2004).
- The level of education variable was identified from the question "Educational level" (GEN10). In our present study results, and in order to have representative results, we reorganized the seven different answer choices (i.e. illiterate, reads

and writes, primary school, intermediate, secondary, university, technical/vocational) into four options: illiterate, reads/writes or elementary, intermediate, secondary or post-secondary that include also the technical/vocational education.

Economic status characteristics with information about the total annual or monthly income value were obtained from the question "Overall, what was your family's total income in the past year (including in- kind gifts)" (INC1). The questionnaire data for INC1 contained the following classification: 1) 300,000 LBP / month; 2) 300,000- 799,999 LBP / month; 3) 800,000- 1.6 million LBP / month; 4) 1.6 million- 3.2 million LBP / month; 5) more than 3.2 million LBP / month. The last three categories of income were grouped together because only a small number of respondents fell in these categories. Therefore, income categorization became as follows: 1) < 300,000 LBP / month; 2) 300,000- 800,000 LBP / month; 3) > 800,000 LBP / month. (For more details, refer to the questionnaire in appendix 3).

3.2. Food production and harvesting indicators

A food production/harvest variable was created using the 'source of food items' answers from the Food Frequency Questionnaire (DIE2). Data about food sources was translated from the FFQ into six categories of answers: 1) I buy it from the market; 2) I buy it directly from the grower; 3) I grow or make it; 4) grouping 1 and 2; 5) grouping 1 and 3; and 6) grouping 2 and 3. So, for the creation of our food-harvesting variable, subjects were non-harvesters unless options including the answer 'I grow or make it' (i.e. categories 3, 5 and 6) were chosen, the subject was subsequently classified as a food harvester. The harvest status of each participant was therefore created using the classification: harvester and non-harvester for each food-species.

Then, harvest status was categorized into two main categories: harvest from the wild and domestic harvest. Each of these categories had three levels of harvest depending on the number of fruit and vegetable species harvested: 1) None; zero species, 2) Moderate; 1-4 species (i.e. below median number of harvested species), 3) High; 5 species or more (i.e. above median number of harvested species). The following Lists the harvested fruit, vegetable (including legume) and wild plant and fruit species and their respective food groups in

descending order with the fruits group being the most produced among food groups listed and grapes being the most harvested among fruits listed.

A list of harvested species and food groups in descending order according to harvest-intensity

Fruits	**Wild plants**	**Vegetables**	**Wild fruits**
1- Grapes	17- Mallow	27- Mint	52- Hawthorn
2- Cherry	18- Purslane	28- Parsley	53- Blackberry
3- Apricot	19- Thyme	29- Tomato	54- Myrtle
4- Fig	20- Ebbo	30- Radish	55- Prickly pears
5- Green almond	Apleppicum	31- Wild cucumber	56- Wild almonds
6- Plum	Taraxacum[11]	32- Green beans	57- Barberry
7- Raspberry	21- Arugula	33- Cucumber	58- Mastic tree
8- Pears	22- Chicory	34- Squash	59- Wild prunes
9- Apple	23- Eryngo	35- Watercress	60- Wild pears
10- Green plum	24- Palestarthisle	36- Onion	
11- Persimmon	25- Gundelia	37- Lettuce	
12- Strawberry	26- Sorrel	38- Eggplant	
13- Muskmelon		39- Broad beans	
14- Watermelon		40- Garlic	
15- Citrus fruits		41- Cabbage	
16- Banana		42- Spinach	
		43- Potato	
		44- Rocket leaves	
		45- Chick peas	
		46- Green peas	
		47- Kidney beans	
		48- Beat/turnip	
		49- Cauliflower	
		50- Fava beans	
		51- Lentils	

Three variables were then created to describe the harvesting tendencies; the first variable comprising all harvested species from the wild (including wild plants harvested and wild fruits harvested) named **harvest from the wild**, the second variable including all

[11] The Latin name is used for this wild plant because no English equivalent was found according to our search.

domestically produced (harvested) species, named **domestic harvest** and the third variable inclosing all harvested species (i.e. either collected from the wild, domestically produced or both), named **all harvest** (Hunter, 2008).

3.3. Diet quality and food consumption indicators

The FFQ is a widely used data collection method in epidemiological studies because of its advantage in reflecting the habitual food intake patterns and therefore obtaining information about dietary habits over a longer period of time compared to the 24-hour recall technique (Thompson, Subar *et al.*, 2008). A full-year period was covered by the FFQ in this study to reflect changes in seasonality.

Two diet quality indicators were extracted from the initial questionnaire; the variety and frequency of fruit and vegetable consumption. Food groups were created for each of these indicators by summing up the food species pertaining to the following food groups: fruits including wild fruits, vegetables including legumes and wild plants, and a third group including both fruits and vegetables. Table 1 below describes the food-group-variables used.

Table 1: Variables' description for consumption variety and frequency indicators according to food groups

Variable	**Description**
All fruits (variety)	Each fruit species consumed reflects one count for this variable
All vegetables (variety)	Each vegetable species consumed reflects one count for this variable
All fruits and vegetables (variety)	Each fruit or vegetable species consumed reflect one count for this variable
All fruits (frequency)	The weekly consumption frequency for each fruit species consumed
All vegetables (frequency)	The weekly consumption frequency for each vegetable species consumed
All fruits and vegetables (frequency)	The weekly consumption frequency for all fruit and vegetable species consumed

Below is a description of the way these variables reflecting the diet quality and food consumption indicators were created.

3.3.1. Fruit and vegetable consumption variety indicator

A variable reflecting the consumption variety for each fruit and vegetable species consumed was created deriving from the food consumption frequency variable using the FFQ for each food-species. Whenever the consumption frequency of a selected food-species was higher than zero, the consumption variety score within the food-group was increased by one. A variable reflecting food-group variety was then created by summing-up all the food-species variety-count (Ruel, 2002; 2003).

3.3.2. Fruit and vegetable consumption frequency indicator

In order to obtain the annual frequency of consumption, we converted the data obtained from the questionnaire 'the number of times per day, per week, per month or per year each food item is consumed' (a total of five variables for each food item) into one variable for each food item reflecting the annual frequency of consumption expressed weekly that we obtained from the database answers on consumption frequency for each food species. The consumption frequency from each food species was then summed-up according to food-groups (see Table 1 above) to reflect the consumption frequency from selected food-groups according to the harvesting status (Hu *et al.*, 1999).

4. Statistical methods

The main independent variables in this study are the wild species harvest and the domestic species harvest variables, while the response variables are the fruit, vegetable, and fruit/vegetable combined consumption variety and frequency (dependent variables).

Analyses of correlation between the study's population characteristics and food consumption patterns were carried out to reveal the association between the population characteristics and the fruit and vegetable consumption variety and frequency variables. One-way ANOVA and Bonferroni corrections were used in these analyses to describe comparisons. When the association between any of the population characteristic variables and the food-harvesting variable or the food consumption variables was suggestively significant ($P<0.20$)

(Selvin, 2004)[12], these variables were considered as potentially confounding variables and were adjusted for in the multivariate models. In order to compare the effect of domestic harvesting per se, the effect of harvesting from the wild per se or the effect of both harvesting types on consumption (i.e. diet quality), ANOVA testing was used. To examine the association between the variables of interest while controlling for potentially confounding variables (i.e. region, level of education, level of income and crowding index), multivariate analyses were carried out. In the multiple comparisons test model, Bonferroni corrections and least squares mean tests were used. This model is adjusted for education, crowding index and income. In addition, harvest from the wild is adjusted for domestic harvest and domestic harvest is adjusted for harvest from the wild.

In the region-stratified models, the association between the three levels of harvesting and consumption variety and frequency was tested using ANOVA and expressed by least squares means and standard errors. The model was adjusted for education, crowding index and income with the harvest from the wild status being adjusted for domestic harvest and domestic harvest status being adjusted for harvest from the wild. Significance in difference between groups was considered at $P<0.05$ and considered according to Bonferroni comparisons.

5. Ethical considerations

Ethical approvals were obtained from Université de Montréal's Ethics Committee on Health Research (Comité d'éthique de la recherche en santé CERES), the American University of Beirut Institutional Review Board and from the Ethics Committee on Human Research at the University of Ottawa. Information that reveals the identity of participants was not used in this thesis. The data that was obtained from the AUB, in the form of SPSS database, contained computerized identification numbers for each subject and no names, addresses, or any other identifiable information.

[12] The *P*-value of 0.20 is often referred to as suggestive evidence in epidemiological studies.

CHAPTER V: Results

1. 1. Descriptive statistics

1.1. Harvesting patterns

Table 2 describes the mean number (SD) of harvested species from the wild, domestically harvested species and all harvested species according to harvesting status (from the wild or domestic harvest) and shows the difference between the three harvesting status groups. The Table shows that harvesters from the wild also tend to domestically produce more fruits and vegetables and those who did not harvest any or some domestic species are not significantly different from each other when it comes to their level of wild plant and fruit harvesting (means 2.9 and 2.7 respectively) in contrast with the high domestic harvesters who had a significantly higher harvest from the wild (mean of 3.9). A significance of $P<0.0001$ at all levels shows that there is a clear interaction between wild and domestic harvesting statuses in the sense that subjects who harvest more wild fruits and vegetables tend to also harvest more domestic fruits and vegetables and vice versa.

Table 2: Mean (SD) number of food items harvested either from the wild or domestically categorized according to the harvest status (total n = 748)

	Fruit and vegetable harvest status									
	Harvest **from the wild**					**Domestic** harvest				
	None Zero (n=131)	Moderate 1 – 4 (n=335)	High ≥ 5 (n=282)	Total (n=748)		None zero (n=168)	Moderate 1 – 4 (n=273)	High ≥ 5 (n=307)	Total (n=748)	
Mean (SD)					***P*-value[4]**					***P*-value[4]**
Harvest from the wild[1]	0.0 (0.0) [a]	2.4 (1.1) [b]	7.5 (2.6) [c]	3.9 (3.4)	<0.0001	2.9 (3.0) [a]	2.7 (2.5) [a]	5.6 (3.7) [b]	3.9 (3.4)	<0.0001
Domestic harvest [2]	2.4 (3.1) [a]	4.3 (4.3) [b]	8.2 (6.9) [c]	5.4 (5.8)	<0.0001	0.0 (0.0) [a]	2.6 (1.1) [b]	10.9 (5.2) [c]	5.4 (5.8)	<0.0001
All harvest [3]	2.4 (3.1) [a]	6.7 (4.7) [b]	15.8 (8.0) [c]	9.4 (7.9)	<0.0001	2.9 (3.0) [a]	5.3 (2.7) [b]	16.5 (7.4) [c]	9.4 (7.9)	<0.0001

1 Mean number of species harvested from the wild
2 Mean number of species domestically harvested
3 Mean number of species harvested from the wild and/or domestically harvested/produced
4 *P*-value: ANOVA

- Superscripts are assigned horizontally for each fruit and vegetable harvest status indicating statistical difference with least squares means sharing different superscripts being significantly different ($P<0.05$) according to Bonferroni comparisons and means with no superscript are not significantly different.

1.2. Study population characteristics and harvesting patterns

Table 3 describes the sample characteristics where the mean age of participants is 48.1 years, 39 % of participants are from Hermel, 23 % from Chouf and 38 % from Aarsal. The Table shows that the age, gender, the number of people living in the household and the level of income are not significantly related to the harvest status. The crowding index is significantly associated with the domestic harvest status but not the harvest from the wild status with higher producers having lower crowding indices. The region and the level of education of participants were found to be significantly associated with the wild harvest status and the domestic harvest statuses ($P<0.0001$ for region, $P=0.002$ for the association between education and wild harvest and $P=0.012$ for the association between education and domestic production). It seems that participants from Hermel tend to be the highest collectors of wild plants and fruits among participants from other regions with approximately 52 % of the high wild plant/fruit harvesters coming from this village. On the other hand, the highest domestic fruit and vegetable producers among regions tend to prevail in the Chouf region with almost 45 % of the high domestic harvesters coming from Chouf. Aarsal tend to have the most moderate harvesting practices both from the wild and domestically with 47 % and 61.6 % of participants in this category coming from Aarsal. An inverse association between the level of education and both harvest statuses seem to be true except for the illiterate participants. Although income was not found to be significantly associated with the harvest status in this model according to $P<0.05$, there is still a suggestive evidence of significance ($P<0.20$) (Selvin, 2004) of increased level of income with the increased number of species harvested from the wild.

Table 3: A description of the study population characteristics by harvest status (n=748)

	Fruit and vegetable harvest status							
	Harvest **from the wild**				**Domestic** harvest			
	None Zero (n=131)	Moderate 1 – 4 (n=335)	High ≥ 5 (n=282)		None Zero (n=168)	Moderate 1 – 4 (n=273)	High ≥ 5 (n=307)	
Population characteristics				***P*-value[1]**				***P*-value[1]**
Mean age in years (SD)	47.2 (6.4)	48.4 (6.5)	48.6 (6.5)	0.120	47.7 (6.0)	48.3 (6.4)	48.5 (6.8)	0.445
Men % (n)	52.7 (69)	51.3 (172)	52.8 (149)	0.925	54.8 (92)	52.0 (142)	50.8 (156)	0.712
Mean number of people living in the household (SD)	5.7 (1.9)	5.6 (2.0)	6.1 (8.1)	0.479	5.6 (1.7)	6.2 (5.9)	5.6 (5.8)	0.365
Mean crowding index (SD)	1.6 (0.9)	1.8 (1.0)	1.8 (1.0)	0.245	1.8 (1.1) [a,b,c]	1.9 (1.0) [b]	1.6 (0.9) [c]	0.009
By Region % (n)								
Hermel (n=292)	26.7 (35)	36.4 (148)	51.9 (109)		73.2 (123)	26.8 (83)	31.9 (86)	
Chouf (n=174)	19.1 (25)	17.0 (69)	38.1 (80)		10.1 (17)	11.6 (36)	44.8 (121)	
Aarsal (n=282)	54.2 (71)	47.0 (190)	7.5 (21)		16.7 (28)	61.6 (191)	23.3 (63)	
				<0.0001				<0.0001

1. *P*-value: ANOVA for continuous variables and chi-square (χ^2) for categorical variables.

- Superscripts are assigned horizontally for each fruit and vegetable harvest status indicating statistical difference with least squares means sharing different superscripts being significantly different ($P<0.05$) according to Bonferroni comparisons and means with no superscript are not significantly different.

Table 3 (continued): A description of the study population characteristics by harvest status (n=748)

	Fruit and vegetable harvest status							
	Harvest **from the wild**				**Domestic** harvest			
Population characteristics	None Zero (n=131)	Moderate 1 – 4 (n=335)	High ≥ 5 (n=282)	***P*-value[1]**	None Zero (n=168)	Moderate 1 – 4 (n=273)	High ≥ 5 (n=307)	***P*-value[1]**
By Level of education % (n)								
Illiterate	18.3 (24)	17.9 (60)	19.1 (54)		17.3 (29)	23.1 (63)	15.0 (46)	
Read/write or Elementary	29.8 (39)	40.3 (135)	34.8 (98)		29.8 (50)	40.3 (110)	36.5 (112)	
Intermediate	20.6 (27)	26.9 (90)	30.1 (85)		30.4 (51)	22.7 (62)	29.0 (89)	
Secondary and post-secondary	31.3 (41)	14.9 (50)	16.0 (45)		22.6 (38)	13.9 (38)	19.5 (60)	
				0.002				0.012
By monthly income % (n)								
< 300,000 LBP [2]	16.8 (22)	20.9 (70)	16.0 (45)		21.4 (36)	19.8 (54)	15.3 (47)	
300,000LBP – 800,000 LBP	44.3 (58)	33.4 (112)	39.4 (111)		35.7 (60)	35.5 (97)	40.4 (124)	
>800,000 LBP	38.9 (51)	45.7 (153)	44.7 (126)		42.9 (72)	44.7 (122)	44.3 (136)	
				0.160				0.418

1. P-value: ANOVA for continuous variables and chi-square (χ^2) for categorical variables.
2. 100 USD = 150,650 LBP

- Superscripts are assigned horizontally for each fruit and vegetable harvest status indicating statistical difference with least squares means sharing different superscripts being significantly different ($P<0.05$) according to Bonferroni comparisons and means with no superscript are not significantly different.

1.3. Study population variables and fruit/vegetable consumption patterns

Table 4 shows the study population characteristics correlated with the variety and frequency of fruit and vegetable consumption patterns. Only some correlations, for the crowding index, region, level of education and income were significant. For instance, the crowding index was found to be negatively correlated with consumption frequency while correlations between regions and the consumption variety and frequency of fruits alone, vegetables alone and of fruits and vegetables combined were highly significant ($P<0.0001$). Aarsal had significantly the lowest consumption variety scores among the three regions according to Bonferroni comparisons except for the fruits' variety count that was similar to the Chouf region in contrast with the region of Hermel. Fruit and vegetable consumption frequency patterns were all significantly different among the three study regions according to Bonferroni comparisons with Hermel having the lowest consumption, Aarsal in the middle and Chouf the highest. Only the level of education had a positive significant association with fruit consumption frequency and thereby fruit and vegetable consumption frequency when put together ($P<0.0001$ and $P=0.002$ respectively). On the other hand, the level of income was only positively correlated with the consumption variety of fruits alone and the consumption frequency of vegetables alone ($P<0.05$) with the difference being apparent at the 300,000 LBP – 800,000 LBP income range.

Table 4: Associations between the study population characteristics and plant-food consumption patterns (n = 748)

	Consumption patterns					
	Variety (number of food-items consumed over a year)			**Frequency** (number of times per week food-items are consumed)		
	All fruits	All vegetables	All fruits and vegetables	All fruits	All vegetables	All fruits and vegetables
Population characteristics	**Corr. (*P*)**	**Corr. (*P*)**	**Corr. (*P*)**	**Corr. (*P*)**	**Corr. (*P*)**	**Corr. (*P*)**
Age	0.17 (0.64)	0.08 (0.02)	0.06 (0.10)	-0.09 (0.02)	-0.04 (0.24)	-0.07 (0.05)
Number of people living in the household	-0.02 (0.66)	0.0 (0.92)	-0.0 (0.87)	0.11 (0.0)	0.03 (0.46)	0.07 (0.04)
Crowding index	0.05 (0.17)	0.06 (0.09)	0.06 (0.08)	-0.21 (0.0)	-0.11 (0.0)	-0.18 (0.0)
	Mean (s-e)[2]	**Mean (s-e)**	**Mean (s-e)**	**Mean (s-e)**	**Mean (s-e)**	**Mean (s-e)**
Men	16.30 (0.16)	26.30 (0.19)	42.68 (0.32)	19.03 (0.74)	42.41 (0.89)	61.44 (1.47)
Women	16.08 (0.17)	26.61 (0.20)	42.68 (0.32)	20.91(0.89)	43.75 (0.83)	64.67 (1.51)
***P*-value**[3]	0.269	0.262	0.899	0.104	0.270	0.128
By Region						
Hermel	17.02 (0.20) [a]	27.61 (0.24) [a]	44.63 (0.40) [a]	11.19 (0.31) [a]	34.68 (0.68) [a]	45.87 (0.82) [a]
Chouf	16.03 (0.25) [b]	27.44 (0.28) [a]	43.47 (0.47) [a]	34.02 (1.58) [b]	52.91 (1.63) [b]	86.94 (2.92) [b]
Aarsal	15.47 (0.11) [b]	24.64 (0.14) [b]	40.11 (0.24) [b]	20.29 (0.76) [c]	45.64 (0.78) [c]	65.93 (1.25) [c]
***P*-value**	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

1. Corr. (*P*): Pearson's correlation coefficient with ANOVA for continuous variables and chi-square ($\chi 2$) for categorical variables.
2. Mean (s-e): Least squares mean with standard-error.
3. *P*-value: ANOVA for continuous variables and chi-square (χ^2) for categorical variables.

- Superscripts are assigned vertically for each fruit and vegetable harvest status indicating statistical difference with least squares means sharing different superscripts being significantly different ($P<0.05$) according to Bonferroni comparisons and means with no superscript are not significantly different..

Table 4 (continued): Associations between the study population characteristics and plant-food consumption patterns (n = 748)

	Consumption patterns					
	Variety (number of food-items consumed over a year)			Frequency (number of times per week food-items are consumed)		
	All fruits	All vegetables	All fruits and vegetables	All fruits	All vegetables	All fruits and vegetables
Population characteristics	**Mean (s-e)[2]**	**Mean (s-e)**	**Mean (s-e)**	**Mean (s-e)**	**Mean (s-e)**	**Mean (s-e)**
By Level of education % (n)						
Illiterate	16.0 (3.4)	26.8 (3.4)	42.8 (5.9)	14.6 (10.8) [a]	43.0 (12.9)	57.6 (19.6) [a]
Read/write or Elementary	16.4 (2.8)	26.5 (3.5)	42.9 (5.5)	18.1 (13.8) [a]	42.3 (15.6)	60.4 (26.1) [a,b]
Intermediate	16.3 (3.2)	26.5 (4.1)	42.8 (6.5)	23.2 (17.6) [b]	43.3 (18.7)	66.5 (33.0) [b,c]
Secondary and post-secondary	15.8 (3.4)	26.0 (4.2)	41.8 (6.5)	24.3 (18.7) [b]	44.2 (18.7)	68.5 (33.9) [c]
***P*-value[2]**	0.197	0.356	0.319	<0.0001	0.741	0.002
By monthly income % (n)						
< 300,000 LBP	15.6 (3.4) [a]	26.2 (4.1)	41.8 (6.7)	20.8 (16.0)	39.4 (14.5) [a]	60.2 (27.5)
300,000 LBP – 800,000 LBP	16.2 (3.1) [a,b]	26.5 (3.9)	42.7 (6.1)	20.0 (15.8)	44.4 (16.3) [b]	64.4 (28.7)
>800,000 LBP	16.5 (3.0) [b]	26.5 (3.5)	43.0 (5.7)	19.5 (15.8)	43.4 (17.5) [b]	62.9 (29.6)
***P*-value[2]**	0.017	0.605	0.136	0.716	0.012	0.368

1. Corr. (*P*): Pearson's correlation coefficient with ANOVAfor continuous variables and chi-square ($\chi 2$) for categorical variables.
2. *P*-value: ANOVA for continuous variables and chi-square (χ^2) for categorical variables.

- Superscripts are assigned vertically for each fruit and vegetable harvest status indicating statistical difference with least squares means sharing different superscripts being significantly different ($P<0.05$) according to Bonferroni comparisons and means with no superscript are not significantly different.

2. 2. The association between the harvest status and fruit/vegetable consumption

2.1. The general model

Table 5 shows the mean number of fruits, vegetables, and all fruits and vegetables consumed weekly over the year preceding the questionnaire's interview and categorized according to the harvest status (i.e. from the wild or domestically) and the three levels of harvest (none, moderate or high) thus reflecting the consumption variety. Table 6 reflects the mean weekly consumption frequency of the same food groups in the year prior to the interview and categorized according to harvest status. Both Tables show that variety and frequency of consumption were significantly associated with the harvest status and the different levels of harvest intensity. The harvest from the wild was found to be significantly associated with increased variety and frequency of consumption except for the frequency of fruit consumption (P=0.115). The domestic harvest on the other hand was found to be significantly associated with both consumption variety and frequency.

Table 5: Variety of fruit and vegetable species consumed over the 1-year period of the questionnaire categorized by the fruit/vegetable harvest status of households

	Fruit and vegetable harvest status									
	Harvest **from the wild**					**Domestic** harvest				
Yearly mean consumption variety (SD)	None Zero (n=131)	Moderate 1 – 4 (n=335)	High ≥ 5 (n=282)	Total (n=748)	***P*-value[1]**	None zero (n=168)	Moderate 1 – 4 (n=273)	High ≥ 5 (n=307)	Total (n=748)	***P*-value[1]**
All fruits	14.7 (2.7) [a]	15.4 (2.7) [a]	17.9 (3.1) [b]	16.2 (3.1)	<0.0001	16.3 (3.1) [a]	15.5 (2.7) [b]	17.0 (3.6) [a]	16.8 (3.3)	<0.0001
All vegetables	23.4 (3.7) [a]	25.6 (3.0) [b]	28.9 (3.1) [c]	26.5 (3.8)	<0.0001	26.3 (4.6) [a]	25.6 (3.2) [a]	27.3 (3.5) [b]	26.5 (3.8)	<0.0001
All fruits and vegetables	38.1 (5.7) [a]	41.0 (4.6) [b]	46.8 (5.2) [c]	42.7 (6.1)	<0.0001	42.6 (6.9) [a]	41.1 (5.0) [a]	44.1 (6.1) [b]	42.7 (6.1)	<0.0001

1. *P*-value: ANOVA.

- Superscripts are assigned horizontally for each fruit and vegetable harvest status indicating statistical difference with least squares means sharing different superscripts being significantly different ($P<0.05$) according to Bonferroni comparisons and means with no superscript are not significantly different.

Table 6: Frequency of fruit and vegetable species consumed weekly (number of times per week) categorized by the fruit/vegetable harvest status of households

	Fruit and vegetable harvest status									
	Harvest **from the wild**					**Domestic** harvest				
	None Zero (n=131)	Moderate 1 – 4 (n=335)	High ≥ 5 (n=282)	Total (n=748)		None zero (n=168)	Moderate 1 – 4 (n=273)	High ≥ 5 (n=307)	Total (n=748)	
Mean weekly consumption frequency (SD)					***P*-value[1]**					***P*-value[1]**
All fruits	21.2 (16.7)	18.6 (12.6)	20.9 (18.4)	19.9 (15.8)	0.115	14 .6 (11.6) [a]	18.7 (12.3) [b]	23.9 (19.2) [c]	19.9 (15.8)	<0.0001
All vegetables	43.5 (17.8) [a,b]	40.8 (13.4) [a]	45.5 (19.1) [b]	43.1 (16.6)	0.002	35.4 (14.0) [a]	42.6 (13.6) [b]	47.6 (18.7) [c]	43.1 (16.6)	<0.0001
All fruits and vegetables	64.6 (30.9) [a,b]	59.4 (22.8) [a]	66.4 (33.7) [b]	63.0 (28.9)	0.008	50.0 (22.4) [a]	61.3 (22.8) [b]	71.6 (33.7) [c]	63.0 (28.9)	<0.0001

1. *P*-value: ANOVA.

- Superscripts are assigned horizontally for each fruit and vegetable harvest status indicating statistical difference with least squares means sharing different superscripts being significantly different ($P<0.05$) according to Bonferroni comparisons and means with no superscript are not significantly different,.

2.2. The adjusted model

Tables 7 and 8 also show the association between the harvest status and the fruit and vegetable consumption patterns (variety and frequency) as in tables 5 and 6 but after adjusting for the potentially confounding variables except for region (crowding index, level of education and level of income). These two Tables show that, as the harvest from the wild increases, the variety of consumption of fruits and vegetables increases but not the frequency of consumption. On the other hand, as the domestic production of fruits and vegetables increases, the frequency of their consumption increases but not the variety.

Table 7: Variety of fruit and vegetable species consumed over the 1-year period of the questionnaire categorized by the fruit/vegetable harvest status of households adjusted for covariates (crowding index, education level and income level)

	Fruit and vegetable harvest status							
	Harvest from the wild				Domestic harvest			
	None Zero (n=131)	Moderate 1 – 4 (n=335)	High ≥ 5 (n=282)		None zero (n=168)	Moderate 1 – 4 (n=273)	High ≥ 5 (n=307)	
Yearly mean consumption variety (s-e)				***P*-value[1]**				***P*-value[1]**
All fruits	14.6 (0.3) [a]	15.3 (0.2) [a]	17.8 (0.2) [b]	<0.0001	16.2 (0.2)	15.6 (0.2)	15.8 (0.2)	NS
All vegetables	23.3 (0.3) [a]	25.7 (0.2) [b]	28.9 (0.2) [c]	<0.0001	26.4 (0.2) [a]	25.7 (0.2) [b]	25.9 (0.2) [a,b]	0.0475
All fruits and vegetables	37.9 (0.5) [a]	41.0 (0.3) [b]	46.7 (0.3) [c]	<0.0001	42.7 (0.4) [a]	41.2 (0.3) [b]	41.7 (0.3) [a,b]	0.0162

1. *P*-value: ANOVA.

- Superscripts are assigned horizontally for each fruit and vegetable harvest status indicating statistical difference with least squares means sharing different superscripts being significantly different ($P<0.05$) according to Bonferroni comparisons and means with no superscript are not significantly different.

Table 8: Frequency of fruit and vegetable species consumed weekly (number of times per week) of fruit/vegetable species categorized by the fruit/vegetable harvest status of households adjusted for covariates (crowding index, education level and income level)

	Fruit and vegetable harvest status							
	Harvest **from the wild**				**Domestic** harvest			
	None Zero (n=131)	Moderate 1 – 4 (n=335)	High ≥ 5 (n=282)		None zero (n=168)	Moderate 1 – 4 (n=273)	High ≥ 5 (n=307)	
Mean weekly consumption frequency (s-e)				***P*-value[1]**				***P*-value[1]**
All fruits	22.0 (1.3)	18.3 (0.9)	19.1 (0.9)	NS	14 .6 (1.2) [a]	20.3 (1.0) [b]	24.4 (1.0) [c]	<0.0001
All vegetables	44.1 (1.4) [a]	39.5 (0.9) [b]	42.6 (1.1) [a,b]	0.0092	35.3 (1.2) [a]	43.5 (1.1) [b]	47.4 (1.1) [c]	<0.0001
All fruits and vegetables	66.0 (2.5) [a]	57.8 (1.6) [b]	61.7 (1.8) [a,b]	0.0126	49.9 (2.1) [a]	63.8 (1.8) [b]	71.8 (1.8) [c]	<0.0001

1. *P*-value: ANOVA.

- Superscripts are assigned horizontally for each fruit and vegetable harvest status indicating statistical difference with least squares means sharing different superscripts being significantly different ($P<0.05$) according to Bonferroni comparisons and means with no superscript are not significantly different.

2.3. The adjusted model after stratification by region

Table 9 shows the fruit and vegetable consumption variety and frequency according to the harvest status after stratification by region. In all three regions of the study, fruit and vegetable consumption variety increased with the increase of harvest from the wild (in Chouf and Aarsal this association seems clearer between the moderate and high levels of wild species harvest). Per contra, the variety of species harvested domestically is not significantly associated with consumption variety of fruits and vegetables in any of the studied regions.

As for the frequency of consumption, the number of fruit and vegetable species consumed over a week was not significantly associated with the harvest from the wild in the study regions overall (except in Aarsal where the harvest from the wild was positively associated with the frequency of total vegetable consumption between the moderate and high harvester groups). The increase in domestically harvested species seemed to slightly increase the frequency of fruit and vegetable consumption. This increase, however, was only significant in one region (Hermel, where the consumption frequency is the lowest) mainly for vegetable consumption (and fruit and vegetable simultaneously) at the highest level of harvest.

Table 9: Fruit and vegetable consumption variety and frequency stratified by region and adjusted for covariates (crowding index, education level and income level)

		Consumption patterns					
		Variety (number of food-items consumed over a year)			**Frequency** (number per week food-items are consumed)		
Region		All fruits	All vegetables	All fruits and vegetables	All fruits	All vegetables	All fruits and vegetables
Hermel (n=292)							
Harvest from the wild	None (n=35)	13.9 (0.5) [a]	22.1 (0.6) [a]	36.1 (1.0) [a]	11.1 (0.9)	31.7 (2.0)	42.9 (2.5)
	1 – 4 (n=148)	15.7 (0.3) [b]	27.0 (0.3) [b]	42.6 (0.5) [b]	11.5 (0.5)	35.8 (1.0)	47.3 (1.3)
	≥ 5 (n=109)	18.7 (0.3) [c]	29.6 (0.3) [c]	48.3 (0.5) [c]	11.2 (0.5)	35.6 (1.0)	46.8 (1.3)
	***P*-value**[1]	<0.0001	<0.0001	<0.0001	NS	NS	NS
Domestic harvest	None (n=123)	16.2 (0.3)	26.4 (0.3)	42.6 (0.5)	11.3 (0.5)	30.9 (1.0) [a]	42.2 (1.3) [a]
	1 – 4 (n=83)	15.5 (0.4)	26.3 (0.4)	41.8 (0.7)	11.2 (0.7)	33.1 (1.4) [a]	44.3 (1.8) [a]
	≥ 5 (n=86)	16.6 (0.4)	26.0 (0.4)	42.6 (0.6)	11.3 (0.6)	39.0 (1.3) [b]	50.3 (1.7) [b]
	***P*-value**[1]	NS	NS	NS	NS	<0.0001	0.0002

1. *P*-value: ANOVA.

- Superscripts are assigned horizontally for each fruit and vegetable harvest status indicating statistical difference with least squares means sharing different superscripts being significantly different ($P<0.05$) according to Bonferroni comparisons and means with no superscript are not significantly different.
- Harvest from the wild is adjusted for domestic harvest and domestic harvest is adjusted for harvest from the wild.

Table 9 (continued): Fruit and vegetable consumption variety and frequency stratified by region and adjusted for covariates (crowding index, education level and income level)

		Consumption patterns					
		Variety (number of food-items consumed over a year)			**Frequency** (number per week food-items are consumed)		
Region		All fruits	All vegetables	All fruits and vegetables	All fruits	All vegetables	All fruits and vegetables
Chouf (n=174)							
Harvest from the wild	None (n=25)	14.3 (1.0) [a]	26.0 (1.1) [a]	40.3 (1.8) [a]	32.6 (6.5)	49.5 (6.7)	82.1 (12.0)
	1 – 4 (n=69)	15.1 (1.0) [a]	27.1 (1.0) [a]	42.2 (1.7) [a]	23.8 (6.3)	40.9 (6.5)	64.8 (11.6)
	≥ 5 (n=80)	17.0 (0.9) [b]	29.5 (1.0) [b]	46.5 (1.7) [b]	27.4 (6.2)	47.7 (6.4)	75.1 (11.4)
	***P*-value**[1]	0.0006	<0.0001	<0.0001	NS	NS	NS
Domestic harvest	None (n=17)	16.7 (1.0)	27.8 (1.1)	44.5 (1.9)	29.4 (6.9)	44.4 (7.1)	73.8 (12.7)
	1 - 4 (n=36)	14.5 (1.0)	27.7 (1.1)	42.2 (1.8)	24.5 (6.8)	46.9 (6.9)	71.4 (12.4)
	≥ 5 (n=121)	15.3 (0.9)	27.0 (1.0)	42.3 (1.6)	29.9 (6.0)	46.9 (6.1)	76.8 (11.0)
	***P*-value**[1]	NS	NS	NS	NS	NS	NS

1. *P*-value: ANOVA.

- Superscripts are assigned horizontally for each fruit and vegetable harvest status indicating statistical difference with least squares means sharing different superscripts being significantly different ($P<0.05$) according to Bonferroni comparisons and means with no superscript are not significantly different.
- Harvest from the wild is adjusted for domestic harvest and domestic harvest is adjusted for harvest from the wild.

Table 9 (continued): Fruit and vegetable consumption variety and frequency stratified by region and adjusted for covariates (crowding index, education level and income level)

		Consumption patterns					
		Variety (number of food-items consumed over a year)			**Frequency** (number per week food-items are consumed)		
Region		All fruits	All vegetables	All fruits and vegetables	All fruits	All vegetables	All fruits and vegetables
Aarsal (n=282)							
Harvest from the wild	None (n=71)	14.7 (0.3) [a]	23.1 (0.3) [a]	37.8 (0.4) [a]	22.8 (1.7)	45.8 (1.7) [a,b]	68.6 (2.8)
	1 – 4 (n=90)	14.8 (0.2) [a]	23.9 (0.2) [b]	38.7 (0.4) [a]	21.8 (1.4)	43.0 (1.5) [a]	64.7 (2.3)
	≥ 5 (n=21)	17.1 (0.4) [b]	26.4 (0.4) [c]	43.5 (0.6) [b]	20.8 (2.1)	51.1 (2.2) [b]	71.8 (3.6)
	***P*-value**[3]	<0.0001	<0.0001	<0.0001	NS	0.0016	NS
Domestic harvest	None (n=28)	15.1 (0.4)	24.0 (0.4)	39.0 (0.7)	18.2 (2.5)	46.1 (2.6)	64.3 (4.2)
	1 – 4 (n=191)	15.7 (0.2)	24.5 (0.2)	40.3 (0.4)	22.2 (1.3)	46.8 (1.4)	69.0 (2.3)
	≥ 5 (n=63)	15.8 (0.3)	24.9 (0.3)	40.8 (0.4)	25.0 (1.6)	46.9 (1.7)	71.9 (2.7)
	***P*-value**[1]	NS	NS	NS	NS	NS	NS

1. *P*-value: ANOVA.

- Superscripts are assigned horizontally for each fruit and vegetable harvest status indicating statistical difference with least squares means sharing different superscripts being significantly different ($P<0.05$) according to Bonferroni comparisons and means with no superscript are not significantly different.
- Harvest from the wild is adjusted for domestic harvest and domestic harvest is adjusted for harvest from the wild.

In summary, the significant associations between the wild and domestic harvest statuses ($P<0.0001$) at all levels shows that there is a clear interaction between them in the sense that subjects who harvest more wild fruits and vegetables tend to also harvest more domestic fruits and vegetables and vice versa. When it comes to the studied population characteristics in relation to the harvest patterns, only the crowding index, the region of residence and the level of education had significant associations with either one or both of the harvest statuses at $P<0.05$, while the level of income showed a suggestive positive association ($P<0.2$) with the level of harvest from the wild but not the domestic harvest. As for the study population characteristics in association with the fruit and vegetable consumption patterns, it was found that the higher the crowding index is, the lower the consumption frequency is of fruits and vegetables. There were significant differences in the consumption patterns among the different study regions according to Bonferroni comparisons with Hermel having the lowest consumption frequency and Chouf the highest. While the level of education was positively associated with the consumption frequency of fruits and the level of income being correlated to increased fruit consumption variety and vegetable consumption frequency at the 300,000-800,000 LBP level.

For the associations between the harvest status and consumption patterns, both the variety and frequency of fruit and vegetable consumption were significantly associated with the harvest status except for the frequency of fruit consumption in association with the harvest from the wild status. After adjustment of the model for covariates (i.e. crowding index, the level of education and the level of income), consumption variety was found to significantly increase with the harvest from the wild status for fruits and vegetables and with the domestic harvest for vegetables but not for fruits. On the other hand, consumption frequency had a positive significant association between vegetable consumption and the harvest from the wild status and between both fruit and vegetable consumptions and the domestic harvest status.

In the last model, adjusted for covariates and stratified by region, fruit and vegetable variety was found to increase with the increase in the intensity of the harvest from the wild in all of the three study regions. The consumption frequency of vegetables was significantly

associated with the domestic harvest status in Hermel and with the harvest from the wild status in Aarsal.

CHAPTER VI: Discussion

A recent systematic review on the contributions of edible plants and animal biodiversity to human diets found that locally available foods provided important sources of energy, micronutrients, and dietary diversification in the diet of rural and forest communities of highly bio-diverse eco-systems (Penafiel, Lachat *et al.*, 2011). Other reviews have also shown positive associations between self-production of foods, self-gathering of wild foods and aspects of diet quality (Masset *et al.*, 2012; Powell *et al.*, 2015). Though, to our knowledge, no studies have yet tested this type of associations in Lebanon, a country of high level of biodiversity and a promising potential for successful interventions.

According to Kennedy (2004), the identified strategies for tackling micronutrient malnutrition fall into three categories: dietary diversification, fortification and supplementation. Dietary diversification, which includes fruit and vegetable consumption, has been associated with decreased risk of mortality and chronic noncommunicable disease (Kant, Schatzkin *et al.*, 1995). It can effectively address most of the micronutrient deficiencies in developing countries (Jones, Shrinivas and Bezner-Kerr, 2014) by ensuring nutrient adequacy (Hatløy, Torheim and Oshaug, 1998; Wahlqvist and Specht, 1998; Ruel, 2003; Mirmiran, Azadbakht *et al.*, 2004). While a recent review by Fiorella and co-workers (2016) evaluating agricultural interventions for improved nutrition, identifies three intervention typologies that may co-exist in a single intervention: enhancement, diversification and substitution. Enhancement interventions are defined as those that adjust an aspect of a household's current agricultural production strategy to improve yield or provide more nutritious crops. The diversification typology, on the other hand, introduces a new food production method, activity or strategy to complement a household's on-going livelihood activities. Meanwhile, substitution refers to introducing a new and changed food production strategy or alternative livelihood. The review identifies interventions focused on home gardens and particularly on vitamin A rich crops as diversification/enhancement interventions, while home gardens with small animal production or just with diversified crops as a diversification typology. Interestingly, these typologies intersect with the ones identified by Kennedy while providing a

more focused view on production and the assessment of livelihood for the assessment of future studies.

In developing countries, links between dietary diversity and human health have emphasized the contribution of traditional, local foods, including wild vegetables (Hatløy, Torheim and Oshaug, 1998; Ogle, Hung and Tuyet, 2001; Savy, Martin-Prével *et al.*, 2005). Traditional and locally available foods are often associated with social and cultural characteristics, beliefs, knowledge and practices (Receveur and Kuhnlein, 1998). Many of these traditional food systems have allowed an adequate food intake and have been the major contributors to food and nutrition security (Kuhnlein, Erasmus *et al.*, 2009).

For poor households, these systems offer access to essential nutrients including micronutrients and amino acids through domestic production (de Pee and Bloem, 2007; Cabalda, Rayco-Solon *et al.*, 2011) and wild edible plant collection (Freiberger, Vanderjagt *et al.*, 1998; Batal *et al.*, 2007). Furthermore, an evaluation of many agricultural interventions on nutrition outcomes has concluded that home gardens (domestic produce) have impacts on improving diets (Tontisirin, Nantel *et al.*, 2002; Berti, Krasevec *et al.*, 2004; Girard *et al.*, 2012; Masset *et al.*, 2012). Several studies show that home gardens increased access to and intake of fruits and vegetables and/or vitamin A (Berti, Krasevec *et al.*, 2004; Masset *et al.*, 2012). The findings of this study are discussed in light of this scientific evidence.

1. Main findings

The present research has as its main objective the examination of whether plant-food self-harvest (self-production and self-gathering of wild foods) in rural Lebanese communities contributes to the improvement of their diet quality regardless of confounders. This objective falls into the first objective of the main study (i.e. Benefits of rural ecosystems) where the link between the level of consumption of foods and the degree of self-production of foods would help determine how much the community participants are streaming away from consuming traditional foods (IDRC, 2009).

This study demonstrates that self-harvest of plant foods, whether produced in a home garden or collected from the wild, is significantly associated with greater dietary diversity and

consumption frequency of these foods and that these associations are generally related to the intensity of harvest. It agrees with the literature from the review of Marsh and co-workers (1994), Sthapit and co-workers (2006), Herforth (2010), Santhakumari and co-workers (2010), Keding and co-workers (2012), Masset and co-workers (2012), Jones and co-workers (2014), and Sibhatu (2015).

It could be concluded that overall variety of fruits and vegetables is definitely improving as more food species are harvested from the wild and that consumption frequency improves as more food species are harvested domestically. As 82.5 % of all respondents tended to harvest from the wild to a certain degree and that wild plant harvest is highly affected by seasonality, it may be speculated that the non-persistent nature of wild harvesting is the reason behind its low contribution to the weekly consumption frequency. Another reason might be that wild harvest increases among food insecure households and therefore its contribution to food consumption frequency remains lower than that of domestic food production. In fact, other studies have also found that wild edible plant harvest increases among households with low food security as a possible means of addressing hunger in rural Lebanon (Hunter, 2008) and in rural Kenya (Shumsky, Hickey *et al.*, 2013). In the present study, the consumption frequency of the wild edible plant and fruit harvesters' falls behind that of their counterparts, perhaps as these species can be sold for higher prices than other fruit/vegetable products in city markets. Consequently, their consumption frequency among the people collecting them falls behind probably as they sell them. The investigation of this relationship between food harvest, consumption and income is particularly valuable to the assessment of food environments as a recent paper on the effects of food environments on dietary consumption and its potential for measurement in agriculture-nutrition interventions suggests (Herforth and Ahmad, 2015). It is noteworthy to mention that a great interaction takes place in the studied population between domestic harvest and that of the wild.

Although a high interaction was revealed by the analyses between fruit and vegetable harvest and their consumption, suggesting their strong association, some regional disparities appeared when exploring the association according to different types and levels of harvest and the variety and frequency of fruit and vegetable consumption (see tables 3 and 4). A strong association was found between the region of residence (among the three study regions) and the

consumption patterns of fruits and vegetables (variety and frequency). In all three regions of the study, the variety of fruit and vegetable consumption improved as a function of harvest from the wild with Hermel having the highest overall variety of consumption and Aarsal the lowest. Also in Aarsal, the frequency of vegetable consumption seemed to improve with the increasing intensity of harvest from the wild. In light of the previously discussed role of dietary diversification, including that of fruits and vegetables, in ensuring nutrient adequacy and defying chronic disease (Kant, Schatzkin *et al.*, 1995; Ruel, 2003) along with the important nutritional and health aspects of wild edible plants, found in rural Lebanese areas (Jeambey *et al.*, 2009), the results of this study have a great importance. It provides additional evidence justifying intervention programs to promote the collection and use of wild edible plants and fruits in rural Lebanon where noncommunicable disease is on the rise (Nasreddine *et al.*, 2012a). Also, the regional disparities found in this study look inviting for future investigations using food environment metrics (i.e. availability, affordability, convenience and desirability) as suggested by Herforth and Ahmad (2015), which may explain the reasons behind the regional differences. For example, the proximity of local markets and their access are important factors to consider in order to apply the appropriate intervention to improve diet quality.

In the case of domestic harvest, the study did not depict an association between it and an increased consumption variety in any of the study regions. Though, it seems that the frequency of vegetable consumption is increased as more species are harvested domestically in one region of the study, Hermel. Since Hermel is the region exhibiting the lowest overall frequency of consumption of fruits and vegetables, compared to Chouf and Aarsal, this finding may be of particular interest to possible future interventions. It shows that there is a high potential for success in interventions aiming at increasing the frequency of consumption of plant source species where it is most needed. According to FAO statistics (FAO, 2009), agriculture is the main source of livelihood in the poor communities of the Bekaa valley, where Hermel is situated.

2. Other potential research areas

The simplicity of the consumption variety/diversity count (using simple counts of the number of species consumed in each included food group) technique used in this research to reflect consumption diversity makes comparing the findings to other studies' findings easier. Whereas the robust analysis techniques used in testing the associations presented by this study give a high level of significance to its results. Therefore, associations between the population descriptive characteristics and the harvest or consumption patterns portray a clear descriptive picture of the study communities as well as display possible confounders.

With regard to population characteristics, it was found that gender was linked to neither the harvest status nor the consumption variables. For the harvest status relationship with gender, the result may be inconclusive because of the nature of data reporting on household harvest. Though, it would be interesting to reveal if gender disparities existed with regard to the level of harvest as suggested by Herfoth (2010) where men were more interested in market crop production, while women were responsible for growing crops for household consumption. Although there were no disparities in consumption between men and women, a negative correlation between the consumption frequency of fruits and vegetables and the crowding index suggests that the diet quality may be narrowed in larger families compared to smaller ones. Age also inversely correlated with the consumption frequency of fruits and vegetables, suggesting that older adults may be consuming less of these food groups.

While many nutritional epidemiological studies suggest that diet quality increases among educated subjects (Alaimo *et al.*, 2008), according to our study results shown in Table 3, the level of education is only positively associated with the frequency of fruit consumption (24.3 times per week for the secondary and post-secondary subjects versus 14.6 times per week for the illiterate subjects) which may suggest a higher frequency of consumption related to nutritional knowledge about the benefits of fruit consumption. However, a significant association was suggested between the level of education and the mean number of harvested species from the wild (P=0.002) and domestically (P=0.012). Curiously, when comparing the mean number of harvested species according to education level, the difference mainly appears between the illiterate group and the group with literacy or elementary education.

The level of income only had a suggestive evidence of a significant association with the harvest from the wild status in our study. This finding may be confusing because other studies suggest that harvest from the wild increases among poor households as a protective means against food insecurity (Hunter, 2008). Meanwhile, income level was positively associated with the diversity of the fruit species consumed and the frequency of vegetable consumption, suggesting a positive influence on diet quality.

Furthermore, in light of the rapid pace of urbanization and land abandonment in Lebanon (FAO, 2014), and with the evidence that urbanization affects food availability, stability, utilization and also food security (Szabo, 2016), it is especially important to look into the effects of urbanization on harvest and food consumption patterns in the studied region.

3. Limitations

Comparably to studies using cross-sectional data, this study has its limitation in failing to detect the causality of the observed associations (Levin, 2006). Furthermore, due to the nature of observational data, unmeasured confounding variables may have caused bias to a certain extent; an example of a possible confounder that was not taken into consideration in the questionnaire is the size of farms and the number and names of species harvested domestically as a separate question. While the questionnaire was exhaustive, covering many dietary, socioeconomic and health aspects, using a questionnaire has its drawbacks of under- or over-reporting. This is especially critical when using a Food Frequency Questionnaire to obtain dietary data about the habitual intake of individuals. One of the disadvantages of using an FFQ is that responses may emphasize recently consumed food items; another is that it relies on the perceptive frequency of consumption that has a subjectivity influence. Also, portion sizes and mixed dishes have a high risk of being under-reported (Decarli, Franceschi *et al.*, 1996; Fowke, Schlundt *et al.*, 2004). The interview technique has a high influence as well on the reported FFQ data, although interviewers came from the respective communities of the study and were trained, difficulty was reported with the quality of data retrieved from respondents and has lead to several repetitions of the FFQ. In summary, bias can emerge at different levels in the process of data collection, either from the respondent, interviewer or during data entry highlighting the importance of robust statistical techniques.

Concerning the access to market and food prices, a study by Herforth (2010) found that in a region with a limited access to market foods, a high, positive association exists between self-grown foods and diversity of consumption. We know that multiple markets exist in the three communities of the project from the Hunter (2008) study. Based on the average weekly cost of food baskets (items included in the food basket include bread, fruits, vegetables, nuts, oil, dairy products and other miscellaneous products. The list can be found in appendix 4), it appears that food prices in these markets are similar, however, the variability in fruit and vegetable prices and the available species in the markets were not presented in the mentioned study. Having this information may have helped explore the possibility whether market prices of fruits and vegetables is connected to their production/collection and eventually diversity of consumption.

It would have been particularly interesting to explore the possibility of a positive association between the level of harvest, the variety and frequency of fruit and vegetable consumption on the one hand and that of certain occupations such as farming. Though, as the study questionnaire was built for individuals interviewing rather than household reporting, with 92% of all women in the raw dataset reporting that they are homemakers, researching this association was not possible and therefore the occupation variable was dismissed. Also, it would have been interesting to include a larger adult population (versus adults of 40-60 years of age) to examine change in harvest and dietary behaviour. It goes without saying that also understanding the association between households with harvest and diet quality of children living in these households furthers the implications of this research and betters the understanding of its suggested links.

4. Conclusion

In Lebanon, and according to the Ministry of Agriculture, “although most farmers do not grow crops for their subsistence, at least one-third of the production is auto-consumed in small exploitations” (MOA, 2007). Our study findings tend to agree with the mentioned statement even though associations between occupation of respondents and their harvest status was not possible to retrieve. This is because of the high percentage of respondents reporting either moderate or high levels of harvest whether from the wild or domestically. This suggests

that regardless of occupation, these rural communities have maintained some kind of harvest and that it is related to two fundamental aspects of diet quality (i.e. diversity and frequency of consumption).

The strengths of this research are partially due to the relative representativeness of its data from three different rural communities and the fairly large sample size. However, some of its limitations, along with its results, open a window for future research that furthers the exploration of linkage suggested by this study. For example, research testing the effects of the relationship between self-food harvesting and diet quality on the nutritional status, and perhaps from a nutrient-adequacy viewpoint, may support the rationale behind intervention strategies to promote the collection of wild plants and fruits and the self-production of fruits and vegetables. But, a rather highly interesting in depth investigation about the relationship suggested by this research is to be able to specify the number of harvested species to be recommended for scaling improvement. Additionally, as many studies suggest the importance of livestock production in improving diet quality alongside with dietary diversification (Ruel, 2003; Torheim *et al.*, 2003; Megersa *et al.*, 2014), assessing the link between livestock production and diet quality enhances our understanding of the pathways towards improving diet quality in rural communities of developing countries. Finally, our future recommendations include conducting a longitudinal study to test whether these associations will hold over time and to test the effects of endangering-factors such as the nutrition transition and climate change on the livelihood of domestic and wild food harvesting practices as well as on the overall diet quality of the Lebanese rural population in particular and rural populations in general.

Bibliography

Abdoellah OS, Parikesit, Gunawan B, Hadikusumah HY (2002). “Home gardens in the upper Citarum watershed, West Java: a challenge for in situ conservation of plant genetic resources”. In: Watson JW, Eyzaguirre PB (eds) Home gardens and in situ conservation of plant genetic resources in farming systems. Proceedings of the second international home gardens workshop, 17–19 July 2001, Witzenhausen, Germany. IPGRI, Rome, p 140–147

Abu-Saad, K., I. Shai, V. Kaufman-Shriqui, L. German, H. Vardi and D. Fraser (2009). "Bread type intake is associated with lifestyle and diet quality transition among Bedouin Arab adults." British Journal of Nutrition **102**(10): 1513-1522.

Adlercreutz, H. (1990). "Western diet and Western diseases: some hormonal and biochemical mechanisms and associations." Scandinavian Journal of Clinical and Laboratory Investigation **50**(supplement 201): 3-23.

Akrofi, S., I. D. Brouwer, L. L. Price and P. C. Struik (2010). "Home gardens contribute significantly to dietary diversity in HIV/AIDS afflicted households in rural Ghana." Journal of Human Ecology **31**(2): 125-134.

Alaimo, K., E. Packnett, R. A. Miles and D. J. Kruger (2008). "Fruit and Vegetable Intake among Urban Community Gardeners." Journal of Nutrition Education and Behavior **40**(2): 94-101.

Alles, B., C. Samieri, C. Feart, M. A. Jutand, D. Laurin and P. Barberger-Gateau (2012). "Dietary patterns: a novel approach to examine the link between nutrition and cognitive function in older individuals." Nutrition Research Reviews **25**(2): 207-22.

Amuna, P. and F. B. Zotor (2008). "Epidemiological and nutrition transition in developing countries: impact on human health and development." Proceedings of the Nutrition Society **67**(01): 82-90.

Aranceta, J., C. Perez-Rodrigo, L. Ribas and L. Serra-Majem (2003). "Sociodemographic and lifestyle determinants of food patterns in Spanish children and adolescents: the enKid study." European Journal of Clinical Nutrition **57**: S40-S44.

Arimond, M. and M. T. Ruel (2004). "Dietary diversity is associated with child nutritional status: evidence from 11 demographic and health surveys." The Journal of Nutrition **134**(10): 2579-2585.

Arimond, M., D. Wiesmann, E. Becquey, A. Carriquiry, M. C. Daniels, M. Deitchler, N. Fanou-Fogny, M. L. Joseph, G. Kennedy and Y. Martin-Prevel (2010). "Simple food group diversity indicators predict micronutrient adequacy of women’s diets in 5 diverse, resource-poor settings." The Journal of Nutrition **140**(11): 2059S-2069S.

Azzini, E., A. Polito, A. Fumagalli, F. Intorre, E. Venneria, A. Durazzo, M. Zaccaria, D. Ciarapica, M. S. Foddai, B. Mauro, A. Raguzzini, L. Palomba and G. Maiani (2011). "Mediterranean Diet Effect: an Italian picture." Nutrition Journal **10**: 125.

Bailey, R. L., M. D. Gutschall, D. C. Mitchell, C. K. Miller, F. R. Lawrence and H. Smiciklas-Wright (2006). "Comparative strategies for using cluster analysis to assess dietary patterns." Journal of the American Dietetic Association **106**(8): 1194-200.

Balcells, E., M. Delgado-Noguera, R. Pardo-Lozano, T. Roig-Gonzalez, A. Renom, G. Gonzalez-Zobl, J. Munoz-Ortego, S. Valiente-Hernandez, M. Pou-Chaubron and H.

Schroder (2011). "Soft drinks consumption, diet quality and BMI in a Mediterranean population." Public Health Nutrition **14**(5): 778-84.
Batal, M. (2009). Food and Health in Rural Lebanon: Options to Improve Dietary Diversity, Food Security, Livelihoods and Ecosystem Management. IDRC.
Batal, M., S. Hamadeh, N. Hwalla, N. Kabbani and S. Talhouk (2007). Wild edible plants: Promoting dietary diversity in poor communities of Lebanon, Final Technical Report to IDRC. **(Project 102692)**.
Batal, M. and E. Hunter (2007). "Traditional Lebanese recipes based on wild plants: an answer to diet simplification?" Food and Nutrition Bulletin **28**(Supplement 2): S303-11.
Berti, P. R., J. Krasevec and S. FitzGerald (2004). "A review of the effectiveness of agriculture interventions in improving nutrition outcomes." Public Health Nutrition **7**(05): 599-609.
Bhattacharjee, L., F. Egal, L. Collette, B. Burlingame, B. Nandi and H. Kuhnlein (2006). "Protecting and strengthening local food systems: harnessing biodiversity and indigenous knowledge for food security, livelihoods and nutrition." In Hunger and poverty: the role of biodiversity in achieving the UN Millennium Development Goal of Freedom from hunger and poverty, Chennai, India, 18-19 April, 2005: 191-203.
Black, S. J. and D. Sanjur (1980). "Nutrition in Rio Piedras: A study of internal migration and maternal diets." Ecology of Food and Nutrition **10**(1): 25-33.
Blasbalg, T. L., B. Wispelwey and R. J. Deckelbaum (2011). "Econutrition and utilization of food-based approaches for nutritional health." Food and Nutrition Bulletin **32**(Supplement 1): 4S-13S.
Bullock, J. M., R. F. Pywell and K. J. Walker (2007). "Long- term enhancement of agricultural production by restoration of biodiversity." Journal of Applied Ecology **44**(1): 6-12.
Cabalda, A. B., P. Rayco-Solon, J. A. Solon and F. S. Solon (2011). "Home gardening is associated with Filipino preschool children's dietary diversity." Journal of the American Dietetic Association **111**(5): 711-5.
CDR (2005). National physical master plan of the Lebanese territory. Final report. Beirut, Council for Development and Reconstruction. 2005, December. Available from: http://www.cdr.gov.lb/study/sdatl/English/NPMPLT.PDF. Accessed 12 January 2013.
Chadha, M. L., A. K. Dutta, C. Triveni, S. K. Sain, P. Roohani and R. Y. Yang (2009). "Region-based home gardens for year-round household nutrition security and diet diversification in India." Annals of Nutrition and Metabolism **55**: 632.
Chrysohoou, C., D. B. Panagiotakos, P. Aggelopoulos, C.-M. Kastorini, I. Kehagia, C. Pitsavos and C. Stefanadis (2010). "The Mediterranean diet contributes to the preservation of left ventricular systolic function and to the long-term favorable prognosis of patients who have had an acute coronary event." American Journal of Clinical Nutrition **92**(1): 47-54.
CIA (2015). Lebanon Factbook, Central Intelligence Agency. Available from: https://www.cia.gov/library/publications/the-world-factbook/geos/le.html. Accessed 1 December 2015.
Cordain, L., S. B. Eaton, A. Sebastian, N. Mann, S. Lindeberg, B. A. Watkins, J. H. O'Keefe and J. Brand-Miller (2005). "Origins and evolution of the Western diet: health implications for the 21st century." The American Journal of Clinical Nutrition **81**(2): 341-354.

Couto, E., P. Boffetta, P. Lagiou, P. Ferrari, G. Buckland, K. Overvad, C. Dahm, A. Tjønneland, A. Olsen and F. Clavel-Chapelon (2011). "Mediterranean dietary pattern and cancer risk in the EPIC cohort." British Journal of Cancer **104**(9): 1493-1499.

Cowan, J. (1965). "Dietary survey in rural Lebanon. II." Journal of the American Dietetic Association **47**(6): 466-469.

Cowan, J. W., S. Chopra and G. Houry (1964). "Dietary Survey in Rural Lebanon." Journal of the American Dietetic Association **45**: 130-3.

De Lorgeril, M., P. Salen, J.-L. Martin, I. Monjaud, P. Boucher and N. Mamelle (1998). "Mediterranean dietary pattern in a randomized trial: prolonged survival and possible reduced cancer rate." Archives of Internal Medicine **158**(11): 1181-1187.

de Pee, S. and M. W. Bloem (2007). "The bioavailability of (pro) vitamin A carotenoids and maximizing the contribution of homestead food production to combating vitamin A deficiency." International Journal for Vitamin and Nutrition Research **77**(3): 182-92.

De Schutter, O. (2013). Foreward. In Diversifying food and diets: using agricultural biodiversity to improve nutrition and health, Earthscan, Routledge, London, UK**:** xviv-xxii.

Decarli, A., S. Franceschi, M. Ferraroni, P. Gnagnarella, M. T. Parpinel, C. La Vecchia, E. Negri, S. Salvini, F. Falcini and A. Giacosa (1996). "Validation of a food-frequency questionnaire to assess dietary intakes in cancer studies in Italy results for specific nutrients." Annals of Epidemiology **6**(2): 110-118.

Deckelbaum, R. J., C. Palm, P. Mutuo and F. DeClerck (2006). "Econutrition: implementation models from the Millennium Villages Project in Africa." Food and Nutrition Bulletin **27**(4): 335-342.

DeClerck, F. A., J. Fanzo, C. Palm and R. Remans (2011). "Ecological approaches to human nutrition." Food and Nutrition Bulletin **32**(Supplement 1): 41S-50S.

Delisle, H. F. (2008). "Poverty." Annals of the New York Academy of Sciences **1136**(1): 172-184.

Demment, M. W., M. M. Young and R. L. Sensenig (2003). "Providing micronutrients through food-based solutions: a key to human and national development." The Journal of Nutrition **133**(11): 3879S-3885S.

Doak, C. M., L. S. Adair, M. Bentley, C. Monteiro and B. M. Popkin (2005). "The dual burden household and the nutrition transition paradox." International Journal of Obesity **29**(1): 129-136.

Drewnowski, A. and B. M. Popkin (1997). "The Nutrition Transition: New Trends in the Global Diet." Nutrition Reviews **55**(2): 31-43.

Duyff, S., Nelson (1975). "Food behavior and related factors of Puerto Rican-American teenagers." Journal Nutrition Education **7**: 99–103.

Eyzaguirre, P. B. and O. F. Linares (2004). In Home Gardens and Agrobiodiversity. Smithsonian Books, Washington.

Fanzo, J., D. Hunter, T. Borelli and F. Mattei (2013). Introduction "Agricultural biodiversity, diverse diets and improving nutrition". In Diversifying food and diets: using agricultural biodiversity to improve nutrition and health Earthscan, Routledge, London, UK: 1-13..

FAO (1983). World food security: a reappraisal of the concepts and approaches. Director General's Report. Rome, Italy, FAO.

FAO (1996a). Lessons from the green revolution: towards a new green revolution. Technical background document. World Food Summit 1996. Rome, Italy, FAO.
FAO (1996b). Rome Declaration on Food Security and World Food Summit Plan of Action. Rome, Italy, FAO.
FAO/WHO (2003). "Food safety, quality and consumer protection". In Assuring Food Safety and Quality: Guidelines for Strengthening National Food Control Systems. FAO and WHO, 2003. FAO Food and nutrition paper 76: 3. Rome, Italy, FAO.
FAO (2006). Nutrition Assessment - Lebanon, Food and Agriculture Organization of the United Nations.
FAO (2007). Lebanese Republic Nutrition Profile, Nutrition and Consumer Protection Division. **2**. Lebanon, FAO.
FAO (2008). Food security information for action practical guides. Rome, Italy, FAO.
FAO (2009). Information system on agriculture – Lebanon, FAO.
FAO (2010). The State of Food Insecurity in the World: Addressing Food Insecurity in Protracted Crises. Rome, Italy, FAO.
FAO (2011). Country pasture / Forage Resource Profiles - Lebanon, FAO.
FAO (2011). Guidelines for measuring household and individual dietary diversity. Rome, Italy: FAO.
FAO (2012). World Food Programme, IFAD. The state of food insecurity in the world 2012. Rome, Italy, FAO.
FAO (2014). Lebanon FAO Plan of Action for Resilient Livelihoods 2014 – 2018. Lebanon, FAO.
FAO, IFAD and Wordl Food Programme (2015). The state of food security in the world. Meeting the 2015 international hunger targets: taking stock of eneven progress. Rome, Italy, FAO.
FAO (2016). Crop calendar – an information tool for seed security. Available at: http://www.fao.org/agriculture/seed/cropcalendar/welcome.do. Accessed 30 September 2016.
Ferro-Luzzi, A. and L. Martino (1996). "Obesity and physical activity". The origins and consequences of obesity. Ciba Foundation Symposium: 201: 207–221.
Fiorella, K. J., Chen, R. L., Milner, E. M., & Fernald, L. C. (2016). "Agricultural interventions for improved nutrition: A review of livelihood and environmental dimensions". Global Food Security, 8, 39-47.
Fowke, J. H., D. Schlundt, Y. Gong, F. Jin, X.-o. Shu, W. Wen, D.-k. Liu, Y.-t. Gao and W. Zheng (2004). "Impact of season of food frequency questionnaire administration on dietary reporting." Annals of Epidemiology **14**(10): 778-785.
Frackiewicz, J., W. Roszkowski, A. Brzozowska and J. Kaluza (2010). "[Diet quality and mortality in elderly people living in Warsaw Region]" Przeglad Epidemiologiczny **64**(1): 119-25. Polish.
Francis, F., S. Talhouk, M. Batal and A. Olabi (2014). "Sensory and quality parameters of raw and processed Chicory-Hindbeh, a commonly consumed dark leafy green in Lebanon (Cichorium intybus L.) during frozen storage." LWT - Food Science and Technology 58(1): 230-238.
Freiberger, C., D. Vanderjagt, A. Pastuszyn, R. Glew, G. Mounkaila, M. Millson and R. Glew (1998). "Nutrient content of the edible leaves of seven wild plants from Niger." Plant Foods for Human Nutrition **53**(1): 57-69.

Frese, R. N., J. C. Pàmies, J. D. Olsen, S. Bahatyrova, C. D. van der Weij-de, T. J. Aartsma, C. Otto, C. N. Hunter, D. Frenkel and R. van Grondelle (2008). "Protein shape and crowding drive domain formation and curvature in biological membranes." Biophysical Journal **94**(2): 640-647.

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

Frison, E. A., J. Cherfas and T. Hodgkin (2011). "Agricultural Biodiversity Is Essential for a Sustainable Improvement in Food and Nutrition Security." Sustainability **3**(1): 238.

Fung, T. T., F. B. Hu, M. L. McCullough, P. Newby, W. C. Willett and M. D. Holmes (2006). "Diet quality is associated with the risk of estrogen receptor–negative breast cancer in postmenopausal women." The Journal of Nutrition **136**(2): 466-472.

Fung, T. T., K. M. Rexrode, C. S. Mantzoros, J. E. Manson, W. C. Willett and F. B. Hu (2009). "Mediterranean diet and incidence of and mortality from coronary heart disease and stroke in women". Circulation **119**(8): 1093-100.

Garrett, J. and M. T. Ruel (2005). "The coexistence of child undernutrition and maternal overweight: prevalence, hypotheses, and programme and policy implications." Maternal and Child Nutrition **1**(3): 185-196.

Gautam, R., R. Suwal and B. Sthapit (2004). "Assessment of dietary diversity: a basis for promoting plant genetic species in home gardens." Home gardens in Nepal. Proceedings of a national workshop, Pokhara, Nepal.

Gerber, M. J., Scali D, A. Michaud J., Durant D., C. M. Astre M., J. Dallongeville and M. M. Romon (2000). "Profiles of a healthful diet and its relationship to biomarkers in a population sample from Mediterranean southern France." Journal of the American Dietetic Association **100**(10): 1164-1171.

Girard, A. W., J. L. Self, C. McAuliffe and O. Olude (2012). "The Effects of Household Food Production Strategies on the Health and Nutrition Outcomes of Women and Young Children: A Systematic Review." Paediatric and Perinatal Epidemiology **26 Supplement**(1): 205-222.

Gómez, M. I., C. B. Barrett, T. Raney, P. Pinstrup-Andersen, J. Meerman, A. Croppenstedt, B. Carisma and B. Thompson (2013). "Post-green revolution food systems and the triple burden of malnutrition." Food Policy **42**(0): 129-138.

Haines, P. S., A. M. Siega-Riz and B. M. Popkin (1999). "The Diet Quality Index revised: a measurement instrument for populations." Journal of the American Dietetic Association **99**(6): 697-704.

Hatløy, A., L. Torheim and A. Oshaug (1998). "Food variety- a good indicator of nutritional adequacy of the diet? A case study from an urban area in Mali, West Africa." European Journal of Clinical Nutrition **52**: 891-898.

Hawkes, C. and M. T. Ruel (2006). Overview. In Understanding the links between agriculture and health, International Food Policy Research Institute (IFPRI), Washington, DC, USA.

Hazell, P. B. and C. Ramasamy (1991). The Green Revolution reconsidered: the impact of high-yielding rice varieties in South India, Johns Hopkins University Press.

Heady, J. A. (1961). "Diets of bank clerks: development of a method for classifying the diets of individuals for use in epidemiologic studies." Journal of Royal Statistical Society **Series A.**(124): 336–361.

Hector and Hooper (2002). "Darwin and the first ecological experiment." Science **295**: 639–640.

Herforth, A. (2010). Nutrition and the Environment: Fundamental to Food Security for Africa. The African food system and its interaction with human health and nutrition. Pinstrup-Andersen. Ithaca, Ny, US, Cornell University Press in cooperation with the United Nations University.

Herforth, A., Ahmed, S. (2015). The food environment, its effects on dietary consumption, and potential for measurement within agriculture-nutrition interventions. Food Security, 7(3), 505-520.

Hu, F. B. (2002). "Dietary pattern analysis: a new direction in nutritional epidemiology." Current Opinion in Lipidology **13**(1): 3-9.

Hu, F. B., E. B. Rimm, M. J. Stampfer, A. Ascherio, D. Spiegelman and W. C. Willett (2000). "Prospective study of major dietary patterns and risk of coronary heart disease in men." The American Journal of Clinical Nutrition **72**(4): 912-921.

Hu, F. B., Rimm, E., Smith-Warner, S. A., Feskanich, D., Stampfer, M. J., Ascherio, A. & Willett, W. C. (1999). Reproducibility and validity of dietary patterns assessed with a food-frequency questionnaire. The American journal of clinical nutrition, 69(2), 243-249.

Huet, C., R. Rosol and G. M. Egeland (2012). "The prevalence of food insecurity is high and the diet quality poor in Inuit communities." Journal of Nutrition **142**(3): 541-7.

Hunter, E. (2008). "Food security in rural Lebanon - Links with diet and agriculture". Université Laval. **Master's thesis**. 178 p.

Hwalla, N., N. Adra and R. Jackson (2004). "Iron deficiency is an important contributor to anemia among reproductive age women in Lebanon." Ecology of Food and Nutrition **43**(1-2): 77-92.

Hwalla, N., D. Tannous D. El Khoury (2008). "Lebanese traditional diets and health effects". In Wild-type food in health promotion and disease prevention. Humana Press: 493-498.

Iannotti, L., K. Cunningham and M. Ruel (2009). Improving diet quality and micronutrient nutrition: homestead food production in Bangladesh. IFPRI - Discussion Papers. Washington, International Food Policy Research Institute.

IFPRI (2002). Reaching sustainable food security for all by 2020. Washington, D.C., International Food Policy Research Institute.

Innami, S., H. Ishida, K. Nakamura, M. Kondo, K. Tabata, T. Koguchi, J. Shimizu and T. Furusho (2005). "Jew's mellow leaves (Corchorus olitorius) suppress elevation of postprandial blood glucose levels in rats and humans." International Journal of Vitamin and Nutrition Research **75**(1): 39-46.

Innami, S., K. Nakamura, K. Tabata, M. Wada and T. Takita (1995). "Water-soluble viscous substance of Jew's mellow leaves lowers serum and liver cholesterol concentrations and increases fecal steroid excretion in rats fed a high cholesterol diet." International Journal of Vitamin and Nutrition Research **41**(4): 465-75.

Issa, C., N. Darmon, P. Salameh, M. Maillot, M. Batal and D. Lairon (2011). "A Mediterranean diet pattern with low consumption of liquid sweets and refined cereals is negatively associated with adiposity in adults from rural Lebanon." International Journal of Obesity **35**(2): 251-8.

Ives, A. R. and S. R. Carpenter (2007). "Stability and diversity of ecosystems." Science **317**(5834): 58-62.

Jacobs, D. R. and L. M. Steffen (2003). "Nutrients, foods, and dietary patterns as exposures in research: a framework for food synergy." The American Journal of Clinical Nutrition **78**(3): 508-513.

Jeambey, Z., T. Johns, S. Talhouk and M. Batal (2009). "Perceived health and medicinal properties of six species of wild edible plants in north-east Lebanon." Public Health Nutrition **12**(10): 1902-1911.

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

Jones, A. D., A. Shrinivas and R. Bezner-Kerr (2014). "Farm production diversity is associated with greater household dietary diversity in Malawi: findings from nationally representative data." Food Policy **46**: 1-12.

Kant, A. K. (1996). "Indexes of overall diet quality: a review." Journal of the American Dietetic Association **96**(8): 785-791.

Kant, A. K. and B. I. Graubard (2005). "A comparison of three dietary pattern indexes for predicting biomarkers of diet and disease." Journal of the American College of Nutrition **24**(4): 294-303.

Kant, A. K., A. Schatzkin and R. G. Ziegler (1995). "Dietary diversity and subsequent cause-specific mortality in the NHANES I epidemiologic follow-up study." Journal of the American College of Nutrition **14**(3): 233-238.

Keding, G., J. Msuya, B. Maass and M. Krawinkel (2012). "Relating dietary diversity and food variety scores to vegetable production and socio-economic status of women in rural Tanzania." Food Security **4**(1): 129-140.

Kennedy, E. (2004). "Dietary diversity, diet quality, and body weight regulation." Nutrition Reviews **62**(7): S78.

Kennedy, E. T., J. Ohls, S. Carlson and K. Fleming (1995). "The Healthy Eating Index: design and applications." Journal of the American Dietetic Association **95**(10): 1103-8.

Krebs-Smith, S. M., H. Smiciklas-Wright, H. A. Guthrie and J. Krebs-Smith (1987). "The effects of variety in food choices on dietary quality." Journal of the American Dietetic Association **87**(7): 897-903.

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

Leroy, J. L. and E. A. Frongillo (2007). "Can interventions to promote animal production ameliorate undernutrition?" The Journal of Nutrition **137**(10): 2311-2316.

Levin, K. A. (2006). "Study design III: Cross-sectional studies." Evidence-based Dentistry **7**(1): 24-25.

Madden and Yoder. (1972). "Program evaluation: food stamps and commodity distribution in rural areas of central Pennsylvania." Pennsyvania Agriculture Experiment Station Bulletin **78**: 1–119.

Marsh, R. (1994). "Nutritional benefits from home gardening." Informationcentre for Low External Input Agriculture Newsletter.

Martinez-Gonzalez, M. A., M. Bes-Rastrollo, L. Serra-Majem, D. Lairon, R. Estruch and A. Trichopoulou (2009). "Mediterranean food pattern and the primary prevention of chronic disease: recent developments." Nutrition Reviews **67**(suppl 1): S111-S116.

Masset, E., L. Haddad, A. Cornelius and J. Isaza-Castro (2012). "Effectiveness of agricultural interventions that aim to improve nutritional status of children: systematic review." British Medical Journal **344**: d8222.

Matson, P. A., W. J. Parton, A. G. Power and M. J. Swift (1997). "Agricultural Intensification and Ecosystem Properties." Science **277**(5325): 504-509.

McCullough, M. L., D. Feskanich, M. J. Stampfer, E. L. Giovannucci, E. B. Rimm, F. B. Hu, D. Spiegelman, D. J. Hunter, G. A. Colditz and W. C. Willett (2002). "Diet quality and major chronic disease risk in men and women: moving toward improved dietary guidance." American Journal of Clinical Nutrition **76**(6): 1261-71.

Medail, F. and P. Quezel (1997). "Hot-Spots Analysis for Conservation of Plant Biodiversity in the Mediterranean Basin." Annals of the Missouri Botanical Garden **84**(1): 112-127.

Megersa, B., A. Markemann, A. Angassa and A. V. Zarate (2014). "The role of livestock diversification in ensuring household food security under a changing climate in Borana, Ethiopia." Food Security **6**(1): 15-28.

Melki, I., H. Beydoun, M. Khogali, H. Tamim and K. Yunis (2004). "Household crowding index: a correlate of socioeconomic status and inter-pregnancy spacing in an urban setting." Journal of Epidemiology and Community Health **58**(6): 476-480.

Melzer, K. (2002). Nutritional status of Lebanese school children aged 6–9 years from different socioeconomic backgrounds. Beirut, American University of Beirut. **Master's Thesis**.

Messina, M., J. W. Lampe, D. F. Birt, L. J. Appel, E. Pivonka, B. Berry and D. R. Jacobs J (2001). "Reductionism and the narrowing nutrition perspective: time for reevaluation and emphasis on food synergy." Journal of the American Dietetic Association **101**(12): 1416-1419.

Micronutient-Initiative (2009). Investing in the Future: A united call to action on vitamin and mineral deficiencies. Global report: 2009. Ottawa, Canada: Micronutrient Initiative. 52p.

Miller, P. E., P. Lazarus, S. M. Lesko, J. E. Muscat, G. Harper, A. J. Cross, R. Sinha, K. Ryczak, G. Escobar, D. T. Mauger and T. J. Hartman (2010). "Diet index-based and empirically derived dietary patterns are associated with colorectal cancer risk." Journal of Nutrition **140**(7): 1267-73.

Ministry of Environment, L. (2011). "Lebanon's second national communication to the United Nations Framework Convention on Climate Change". Report. Available from: http://climatechange.moe.gov.lb/national-communications. Accessed 1 Augsut 2015.

Mirmiran, P., L. Azadbakht, A. Esmaillzadeh and F. Azizi (2004). "Dietary diversity score in adolescents-a good indicator of the nutritional adequacy of diets: Tehran lipid and glucose study." Asia Pacific Journal of Clinical Nutrition **13**(1): 56-60.

Mishra, G., S. McNaughton, G. Bramwell and M. Wadsworth (2006). "Longitudinal changes in dietary patterns during adult life." British Journal of Nutrition **96**(04): 735-744.

MOA (2007). Project of agricultural census 2005. Lebanon, Ministry of Agriculture.

MOE (2001). State of the Environment Report. Republic of Lebanon, Ministry of Environment.

MOE/UNDP (2011). Vulnerability, adaptation and mitigation chapters of Lebanon's second national communication, Ministry of Environment, United Nations Development Programme.

Monteiro, C. A. (2009). "Nutrition and health. The issue is not food, nor nutrients, so much as processing." Public Health Nutrition **12**(5): 729.

Moursi, M. M., M. Arimond, K. G. Dewey, S. Trèche, M. T. Ruel and F. Delpeuch (2008). "Dietary diversity is a good predictor of the micronutrient density of the diet of 6-to 23-month-old children in Madagascar." The Journal of Nutrition **138**(12): 2448-2453.

Mozaffarian, D., Chair, A. Afshin, N., Benowitz, V. ,Bittner, S., Daniels, H., Franch, D., Jacobs, W., Kraus, P. , Kris-Etherton, D., Krummel, B., Popkin, L., Whitsel and N., Zakai (2012). "Population Approaches to Improve Diet, Physical Activity, and Smoking Habits: A Scientific Statement From the American Heart Association." Circulation **126**(12): 1514-1563.

Murphy, S. P., D. Rose, M. Hudes and F. E. Viteri (1992). "Demographic and economic factors associated with dietary quality for adults in the 1987-88 Nationwide Food Consumption Survey." Journal of the American Dietetic Association **92**(11): 1352-7.

Muthayya, S., J. H. Rah, J. D. Sugimoto, F. F. Roos, K. Kraemer and R. E. Black (2013). "The global hidden hunger indices and maps: an advocacy tool for action". PLoS One;8:e67860

Myers, N., R. A. Mittermeier, C. G. Mittermeier, G. A. B. da Fonseca and J. Kent (2000). "Biodiversity hotspots for conservation priorities." Nature **403**(6772): 853-858.

Naja, F., L. Nasreddine, L. Itani, M. C. Chamieh, N. Adra, A. M. Sibai and N. Hwalla (2011). "Dietary patterns and their association with obesity and sociodemographic factors in a national sample of Lebanese adults." Public Health Nutrition **14**(09): 1570-1578.

Nasr, D., M. Massoud, R. Khoury and V. Kabakian (2009). "Environmental Impacts of Reconstruction Activities: A Case of Lebanon." International Journal of Environmental Research **3**(2): 301-308.

Nasreddine, L., F. Naja, M. Chamieh, N. Adra, A.-M. Sibai and N. Hwalla (2012a). "Trends in overweight and obesity in Lebanon: evidence from two national cross-sectional surveys (1997 and 2009)." BioMed Central Public Health **12**(1): 798.

Nasreddine, L., F. Naja, M. Tabet, M. Z. Habbal, A. El-Aily, C. Haikal, S. Sidani, N. Adra and N. Hwalla (2012b). "Obesity is associated with insulin resistance and components of the metabolic syndrome in Lebanese adolescents." Annals of Human Biology **39**(2): 122-8.

Newby, P. and K. L. Tucker (2004). "Empirically derived eating patterns using factor or cluster analysis: a review." Nutrition Reviews **62**(5): 177-203.

Ng'endo, M., Bhagwat, S., & Keding, G. B. (2016). Influence of Seasonal On-Farm Diversity on Dietary Diversity: A Case Study of Smallholder Farming Households in Western Kenya. Ecology of Food and Nutrition, 55(5), 403-427.

Noah, A., & Truswell, A. S. (2001). There are many Mediterranean diets. Asia Pacific Journal of Clinical Nutrition, 10(1), 2-9.

Nyhus Dhillon, C., K. Mosso, M. Haruni, V. Kamagenge and B. McIntyre (2013). "Hunger in the midst of plenty: The need for promoting nutrition through agriculture extension services." Annals of Nutrition and Metabolism **63**: 1828.

Ogle, B. M., P. H. Hung and H. T. Tuyet (2001). "Significance of wild vegetables in micronutrient intakes of women in Vietnam: an analysis of food variety." Asia Pacific Journal of Clinical Nutrition **10**(1): 21-30.

Olney, D. K., A. Talukder, L. L. Iannotti, M. T. Ruel and V. Quinn (2009). "Assessing impact and impact pathways of a homestead food production program on household and child nutrition in Cambodia." Food and Nutrition Bulletin **30**(4): 355-69.

Oxfam (2009). People-centered resilience. Working with vulnerable farmers towards climate change adaptation and food security.135 Oxfam briefing paper. Available from: https://www.oxfam.org.nz/sites/default/files/reports/bp135_people_centred_resilience_en_121109.pdf. Accessed 1 July 2016. 43p. Oxfam, New Zealand.

Oxford Dictionary online. Available from: https://en.oxforddictionaries.com/definition/quality Accessed 15 December 2013.

Parr, C. L., I. Barikmo, L. E. Torheim, F. Ouattara, A. Kaloga and A. Oshaug (2002). "Validation of the second version of a quantitative food-frequency questionnaire for use in Western Mali." Public Health Nutrition **5**(06): 769-781.

Patterson, R. E., P. S. Haines and B. M. Popkin (1994). "Diet quality index: capturing a multidimensional behavior." Journal of the American Dietetic Association **94**(1): 57-64.

Pellegrini, L., & Tasciotti, L. (2014). Crop diversification, dietary diversity and agricultural income: empirical evidence from eight developing countries. Canadian Journal of Development Studies/Revue canadienne d'études du développement 35(2), 211-227.

Penafiel, D., C. Lachat, R. Espinel, P. Van Damme and P. Kolsteren (2011). "A systematic review on the contributions of edible plant and animal biodiversity to human diets." Ecohealth **8**(3): 381-99.

Petchey, O. L. and K. J. Gaston (2002). "Functional diversity (FD), species richness and community composition." Ecology Letters **5**(3): 402-411.

Pingali, P. L. (2012). "Green Revolution: Impacts, limits, and the path ahead." Proceedings of the National Academy of Sciences **109**(31): 12302-12308.

Ponce, X., E. Ramirez and H. Delisle (2006). "A more diversified diet among Mexican men may also be more atherogenic." The Journal of Nutrition **136**(11): 2921-2927.

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

Popkin, B. M. and P. Gordon-Larsen (2004). "The nutrition transition: worldwide obesity dynamics and their determinants." International Journal of Obesity Related Metabolic Disorders **28 Suppl 3**: S2-9.

Popkin, B. M., G. Keyou, F. Zhai, X. Guo, H. Ma and N. Zohoori (1993). "The nutrition transition in China: a cross-sectional analysis." European Journal of Clinical Nutrition **47**(5): 333-46.

Powell, B., S. H. Thilsted, A. Ickowitz, C. Termote, T. Sunderland and A. Herforth (2015). "Improving diets with wild and cultivated biodiversity from across the landscape." Food Security: 1-20.

Qizilbash, N., Duffy, S. W., Warlow, C., & Mann, J. (1992). Lipids are risk factors for ischaemic stroke: overview and review. Cerebrovascular diseases: 2(3), 127-136.

Receveur, O. and H. V. Kuhnlein (1998). "Benefits of traditional food in Dene/Métis communities." International Journal of Circumpolar Health **57 Suppl 1**: 219-221.

Reidsma and Ewert (2008). "Regional farm diversity can reduce vulnerability of food production to climate change." Ecology and Society **13**(1): 38.
Remans, R., D. F. Flynn, F. DeClerck, W. Diru, J. Fanzo, K. Gaynor, I. Lambrecht, J. Mudiope, P. K. Mutuo and P. Nkhoma (2011). "Assessing nutritional diversity of cropping systems in African villages." PLoS One **6**(6): e21235.
Ries, C. and J. Daehler (1986). "Evaluation of the Nutrient Guide as a dietary assessment tool." Journal of the American Dietetic Association **86**(2): 228-233.
Romero de Gwynn E. , S. D. (1974). "Nutritional anthropometry diet: and health related correlates among preschool children in Bogota, Colombia." Ecology of Food and Nutrition **3**: 273–282.
Ruel, M. T. (2001). "Can food-based strategies help reduce vitamin A and iron deficiencies?", International Food Policy Research Institute (IFPRI). Washington, DC, USA.
Ruel, M. T. (2002). "Is dietary diversity an indicator of food security or dietary quality?", International Food Policy Research Institute (IFPRI). Washington, DC, USA.
Ruel, M. T. (2003). "Operationalizing dietary diversity: a review of measurement issues and research priorities." Journal of Nutrition **133**(11 Suppl 2): 3911S-3926S.
Santhakumari, K., V. P. Krishnakumar, R. J. Thomas, G. V. Thomas and M. L. George (2010). "Improving food and nutritional security of small and marginal coconut growers through diversification of crops and enterprises." Journal of Agriculture and Rural Development in the Tropics and Subtropics **111**(2): 101-109.
Savy, M., Y. Martin-Prével, P. Sawadogo, Y. Kameli and F. Delpeuch (2005). "Use of variety/diversity scores for diet quality measurement: relation with nutritional status of women in a rural area in Burkina Faso." European Journal of Clinical Nutrition **59**(5): 703-716.
Scrimshaw, N. (1994). "The consequences of hidden hunger for individuals and societies." Food and Nutrition Bulletin **15**(1): 3-24.
Selvin, S. (2004). Statistical analysis of epidemiologic data, Oxford University Press.
Seymour, J. D., E. E. Calle, E. W. Flagg, R. J. Coates, E. S. Ford and M. J. Thun (2003). "Diet quality index as a predictor of short-term mortality in the American Cancer Society Cancer Prevention Study II Nutrition Cohort." American Journal of Epidemiology **157**(11): 980-988.
Sheehy, T., F. Kolahdooz, C. Roache and S. Sharma (2015). "Traditional food consumption is associated with better diet quality and adequacy among Inuit adults in Nunavut, Canada." International Journal of Food Sciences and Nutrition **66**(4): 445-451.
Shetty, P., B. Thompson and L. Amoroso (2011). "Addressing micronutrient malnutrition to achieve nutrition security." Combating micronutrient deficiencies: Food-based approaches: 28.
Shumsky, S. A., G. M. Hickey, B. Pelletier and T. Johns (2013). "Understanding the contribution of wild edible plants to rural social-ecological resilience in semi-arid Kenya." Ecology and Society **19**(4): 34.
Sibai, A., A. Fletcher, M. Hills and O. Campbell (2001). "Non-communicable disease mortality rates using the verbal autopsy in a cohort of middle aged and older populations in Beirut during wartime, 1983-1993." Journal of Epidemiology and Community Health **55**: 271 - 276.

Sibai, A., N. Hwalla, N. Adra and B. Rahal (2003). "Prevalence and covariates of obesity in Lebanon: Findings from the first epidemiological study." Obesity Research **11**: 1353 - 1361.

Sibai, A., L. Nasreddine, A. H. Mokdad, N. Adra, M. Tabet and N. Hwalla (2010). "Nutrition transition and cardiovascular disease risk factors in Middle East and North Africa countries: reviewing the evidence." Annals of Nutrition and Metabolism **57**(3-4): 193-203.

Sibhatu, K. T., Krishna, V. V., & Qaim, M. (2015). Production diversity and dietary diversity in smallholder farm households. Proceedings of the National Academy of Sciences, 112(34), 10657-10662.

Stern, N. (2007). The Economics of Climate Change., The Stern review. Cambridge University Press. Cambridge, UK.

Sthapit, B., R. Gautam and P. Eyzaguirre (2006). "The value of home gardens to small farmers." In Home Gardens in Nepal: Proceeding of a workshop on: Enhancing the contribution of home garden to on-farm management of plant genetic resources and to improve the livelihoods of Nepalese farmers: Lessons learned and policy implications, 6-7 August 2004, Pokhara, Nepal. LI-BIRD, Bioversity International and SDC. Local Initiatives for Biodiversity.

Sunwar, S., C.-G. Thornström, A. Subedi and M. Bystrom (2006). "Home gardens in western Nepal: opportunities and challenges for on-farm management of agrobiodiversity." Biodiversity and Conservation **15**(13): 4211-4238.

Szabo, S. (2016). Urbanisation and Food Insecurity Risks: Assessing the Role of Human Development. Oxford Development Studies, 44(1), 28-48.

Talukder, A., N. Haselow, A. Osei, E. Villate, D. Reario, H. Kroeun, L. SokHoing, A. Uddin, S. Dhunge and V. Quinn (2010). "Homestead food production model contributes to improved household food security and nutrition status of young children and women in poor populations. Lessons learned from scaling-up programs in Asia (Bangladesh, Cambodia, Nepal and Philippines)." Field Actions Science Reports. The Journal of Field Actions (Special Issue 1).

Talukder, A., A. K. Osei, N. J. Haselow, H. Kroeun, U. Amin and V. Quinn (2014). Contribution of homestead food production to improved household food security and nutrition status - lessons learned from Bangladesh, Cambodia, Nepal and the Philippines. Wallingford, Improving diets and nutrition. CABI**:** 58-73 25 ref.

Tardivo, A. P., J. Nahas-Neto, E. A. P. Nahas, N. Maesta, M. A. H. Rodrigues and F. L. Orsatti (2010). "Associations between healthy eating patterns and indicators of metabolic risk in postmenopausal women." Nutrition Journal **9**: 64.

Thiele, S., G. B. Mensink and R. Beitz (2004). "Determinants of diet quality." Public Health Nutrition **7**(1): 29-37.

Thompson, F. E., A. F. Subar, A. Coulston and C. Boushey (2008). "Dietary assessment methodology." Nutrition in the Prevention and Treatment of Disease **2**: 3-39.

Tontisirin, K., G. Nantel and L. Bhattacharjee (2002). "Food-based strategies to meet the challenges of micronutrient malnutrition in the developing world." Proceedings of the Nutrition Society **61**(02): 243-250.

Torheim, L., F. Ouattara, M. Diarra, F. Thiam, I. Barikmo, A. Hatløy and A. Oshaug (2004). "Nutrient adequacy and dietary diversity in rural Mali: association and determinants." European Journal of Clinical Nutrition **58**(4): 594-604.

Torheim, L. E., I. Barikmo, A. Hatløy, M. Diakité, K. Solvoll, M. M. Diarra and A. Oshaug (2001). "Validation of a quantitative food-frequency questionnaire for use in Western Mali." Public Health Nutrition **4**(06): 1267-1277.

Torheim, L. E., F. Ouattara, M. M. Diarra, F. D. Thiam, I. Barikmo, A. Hatloy and A. Oshaug (2003). "Nutrient adequacy and dietary diversity in rural Mali: association and determinants." European Journal of Clinical Nutrition **58**(4): 594-604.

Trichopoulou, A., A. Kouris-Blazos, M. L. Wahlqvist, C. Gnardellis, P. Lagiou, E. Polychronopoulos, T. Vassilakou, L. Lipworth and D. Trichopoulos (1995). "Diet and overall survival in elderly people." British Medical Journal **311**(7018): 1457-60.

UNDP (2007). Living conditions of households.

UNICEF (2006). "Progress for children, malnutrition definition."

UNICEF (2012). Lebanon, Nutrition.

UNICEF, WHO and World Bank Group (2015). Levels and trends in child malnutrition- key findings of the 2015 edition.

United Nations (1975). Report of the World Food Conference, Rome 5–16 November 1974. New York.

United Nations (2011). Rural poverty report 2011 factsheet, IFAD.

United Nations (2013). "We can end poverty, Millennium Development Goals fact sheet".

USDA, (2010). "Dietary guidelines for Americans." Department of Agriculture, Department of Health and Human Services. Washington: US Government Printing Office.

Wahlqvist, M. L. and R. L. Specht (1998). "Food variety and biodiversity: Econutrition." Asia Pacific Journal of Clinical Nutrition **7**: 314-319.

Walley, C. (2001). "The Lebanon passive margin and the evolution of the Levantine Neo-Tethys." Peri-Tethys Memoir 6: Peri-Tethyan Rift/Wrench basins and passive margins. Memoires du Musee National d'Histoire Naturelle **186**: 407-439.

WFP (2008). Food consumption score: Construction of the FCS. Rome, Italy: World Food Programme.

WHO (2008). "Worldwide prevalence of anaemia 1993–2005" : WHO global database on anaemia. Spain, World Health Organization Library Cataloguing-in-Publication Data.

WHO (2009). "Global prevalence of vitamin A deficiency in populations at risk 1995-2005": WHO global database on vitamin A deficiency. Geneva**:** 55.

WHO (2011). "Global Status Report on Non communicable diseases". 2010, World Health Organization, EMRO.

Wik, M., P. Pingali and S. Brocai (2008). "Global agricultural performance: past trends and future prospects." Background paper for the World Development Report. World Bank, Washington, DC, USA.

Willett, W. C., F. Sacks, A. Trichopoulou, G. Drescher, A. Ferro-Luzzi, E. Helsing and D. Trichopoulos (1995). "Mediterranean diet pyramid: a cultural model for healthy eating." The American Journal of Clinical Nutrition **61**(6): 1402S-1406S.

Wirfalt, E., I. Drake and P. Wallstrom (2013). "What do review papers conclude about food and dietary patterns?" Food and Nutrition Research **57**.

Wirt, A. and C. E. Collins (2009). "Diet quality – what is it and does it matter?" Public Health Nutrition **12**(12): 2473-2492.

World Bank (2011). "Poverty data". Available from: http://data.worldbank.org/topic/poverty. Accessed 14 July 2015.

World Bank (2013). Lebanon: economic and social impact assessment of the Syrian conflict.

Yusuf, H. K. M. and M. N. Islam (1994). "Improvement of nightblindness situation in children through simple nutrition education intervention with the parents." Ecology of Food and Nutrition **31**(3-4): 247-256.

Zhu, Y., H. Chen, J. Fan, Y. Wang, Y. Li, J. Chen, J. Fan, S. Yang, L. Hu and H. Leung (2000). "Genetic diversity and disease control in rice." Nature **406**(6797): 718-722.

Appendix 1: Communities description (soil and agriculture): Hermel, Chouf, Aarsal

- Region 1: **Hermel** (and Kuakh)

  - *Soil and Agriculture:*

- Soil in Hermel is red rose soil.
- Most widespread agriculture is: Watermelon, green peas, beans, potato, and eggplant, which are distributed in Lebanon for consumption.
- Fruit trees cultivated in this village are: olive, apricot, green plum, pomegranate, figs, loquat, and grapes vines.

  - *Pastures and Animal production:*

- Major portion of the land is used as forage pastures.
- Sheep, cows, and goats are herded to graze from the land.
- Goods produced are used within the local community and a few are marketed in the capital Beirut.

- Region 2: **Chouf**

  - *Soil and Agriculture:*

- Red rose soil and clay soil are the most common.
- Vegetables and fruits: most widespread agriculture, used for local consumption and distributed in markets of Sidon.
- Most cultivated vegetable and fruit trees include; tomato, cucumber, onions, apple, peach, olive, cherry, fig, almonds, as well as grapes.

  - *Pastures and Animal production:*

- Animal rearing is no longer a source of living in the Chouf.
- Dairy and meat goods produced are used for local consumption.

- Region 3: **Aarsal**

  - *Soil and Agriculture:*

- Soil is arid.
- Wheat, chickpeas, and barley: used for local consumption.

- Fruits trees: cherries, apricots, hawthorn, sumac and grapes.
- Most cultivated vegetables: eggplants, tomatoes, and cucumbers.
- All production is used locally with some vegetables marketed in Zahle.
  - *Pastures and Animal production:*
- Raising livestock (cows, goats and sheep): common practice in Aarsal.
- Dairy and meat goods produced are used for consumption in local area, Bekaa, and by industries in Chtaura.

Reference: Issa, C (2010), "Traditional Mediterranean diet and adiposity in a rural population of Lebanon and nutritional quality of composite dishes." Doctoral thesis.

Appendix 2: Project's Questionnaire

– English version

Interviewer	Area	House	Gender	Interviewee

AMERICAN UNIVERSITY OF BEIRUT
FACULTY OF AGRICULTURE AND FOOD SCIENCES

Dietary diversity as a consequence of consumption of wild edible plants and health

I. Name of interviewer:	
II. Gender of interviewer:	□Male □Female
III. Time interview started:	_____ AM/PM (please circle one)
IV. Date of interview:	_____/_____/_____ Day Month Year
V. Case #:	Interviewer Area House Gender Interviewee
VI. Name:	First: Last: Father:

1

Interviewer | Area | House | Gender | Interviewee

Dietary diversity as a consequence of consumption of wild edible plants and health

(It is preferable to take the measurements after completion of the questionnaire)

MEA1	Measures	1. Weight (Kg): _____ 2. Height (m): _____	3. Waist circumference (cm): _____ 4. Body fat (%): _____
MEA2	Blood profile	1. Cholesterol (mg/dl) 2. Triglycerides (mg/dl) 3. Glucose level (mg/dl)	Result
MEA3	Blood pressure	1. Systolic blood pressure	2. Diastolic blood pressure

Interviewer | Area | House | Gender | Interviewee

General information

Number	Question	Answer
GEN1	Gender	1. Male 2. Female 2a.If you were a female, did you enter menopause? 1. Yes 2. No
GEN2	Date of birth	_______________ (day \ month \ year)
GEN3	Relation with the head of the household:	1. Spouse 2. Parent 3. Brother/sister 4. Head of the household 5. Child 6. Grandparent 7. Other relative 8. Other non relative, specify,_____
GEN4	Place of birth	1. Village: _____ 2. Mouhafazah: _____ 3. Country:_____ 4. Kadaa: _____
GEN5	Place of residence	1. Kadaa: _____ 2. Village: _____ 3. Mouhafazah:_____
GEN6	Marital status. Please specify the number of years	√ **Marital status** / **Number of years of marriage** / **Number of living sons** / **Number of living daughters** 1. Never married 2. Married 3. Separated 4. Divorced 5. Widowed
GEN7	Present occupation	1. Farmer 2. Employee (blue collar) 3. Unemployed (looking for a job) 4. Employee (white collar) 5. Self employed (specify):_____ 6. Unemployed (not looking for a job) 7. Homemaker 8. Student 9. Retired 10. Other, specify: _____

Interviewer | Area | House | Gender | Interviewee

GEN8	Number of hours spent daily at work 1 2 3 4 5 6 7 8 9 more NA									
GEN9	Number of working days per week (if applicable) 1 2 3 4 5 6 7 NA									
GEN10	Educational level	1. Illiterate 2. Reads and writes 3. Primary school		4. Intermediate 5. Secondary		6. University 7. Technical/vocational				
GEN11	Number of people living in the household: _____									
GEN12	Number of children under 15 living in the household: _____									
GEN13	Number of rooms in the house (excluding kitchen and bathrooms): _____									
GEN14	Is the house…	1. Owned		2. Rented		3. Other: _____.				

Interviewer | Area | House | Gender | Interviewee

Health status

HEA1	Have you been diagnosed with one of the following chronic diseases?	Chronic disease	Yes/No	Date of diagonosis (year)	Check if cured
		Diabetes			
		Hypertension			
		CVD			
		Cholesterol			
		High triglycerides			
		Cancer			
		Osteoporosis			
		Goiter			
		Anemia			
		Other chronic diseases			

HEA2	Has any member of your family been diagnosed with the following diseases?		Yes/ No	Relation (mother/ father,…)	Date of diagnosis (year)
		Diabetes			
		Hypertension			
		CVD			
		Cholesterol			
		High triglycerides			
		Cancer			
		Osteoporosis			
		Other chronic diseases			

Interviewer | Area | House | Gender | Interviewee

HEA3	Do you currently smoke?	1. Yes a. If Yes, # cigarettes per day? _____ b. If Yes, # years you smoked? _____	2. No a. If No, were you a previous smoker? i. Yes 1. If Yes, # years you smoked? ____ 2. If yes, # cigarettes per day? _____ ii. No
HEA4	Do you smoke the narguileh	3. Yes a. If yes, # minutes per day? _____ b. If Yes, # years you smoked? _____	4. No a. If No, were you a previous narguileh smoker? i. Yes 1. If yes, # years? ____ 2. If yes, # minutes per day?_____ ii. No

HEA5	Number of hours spent watching TV per day? (√):	1	Do not watch TV	
		2	Less than an hour	
		3	1-3 hours	
		4	3-5 hours	
		5	More than 5 hours	

Interviewer | Area | House | Gender | Interviewee

HEA6	Number of hours per day spent on computer playing games or working? (√)	1	Do not use the computer	
		2	Less than an hour	
		3	1-3 hours	
		4	3-5 hours	
		5	More than 5 hours	

			Number of times				Period of time			
	Type of physical activity	√	#year	#month	#week	#day	Less than 30 min	3060 min	1-1.5 hrs	More than an hour
HEA7	Physical activity: Please specify the type of physical activity you usually do.									
	Walking and hiking									
	Jogging- running									
	House work (house-cleaning...)									
	Gardening or farmwork									
	Group sports (football, basketball, volleyball, other…)									
	Individual exercise (swimming, dancing, aerobics, other…)									
	Other, specify:									

HEA8	On a scale of 1 to 10 how do you rate your level of stress in everyday life (10 being the most stressful and 1 being least stressful) _____
HEA9	On a scale of 1 to 10 how do you rate your level of happiness in everyday life (10 being the least happy and 1 being most happy)_____

Interviewer | Area | House | Gender | Interviewee

Income: We would like to ask a few questions concerning about the source of income for your household for the past year

INC1	Overall, what was your family's total income in the past year (including in- kind gifts)	-less than 3600 000 LBP (300 000 LBP per month) - 3 600 000 – 9 600 000 (300 000 – 800 000 / month) - 9 600 000 – 19.2 million (800 000 – 1.6 million / month) - 19.2 million – 38.4 million (1.6 million – 3.2 million - more than 38.4 million (more than 3.2 million/ month)

1. Yes, did have income 2. No, did not have income	8 . DK 9 . No answer	Net income (LBP), specify M for monthly income, Y for yearly income.

Did you have a regular income...

INC2	….from wages, salary?	1 2 8 9	
INC3	....from the government?	1 2 8 9	
INC4	....from associations (religious, private,…)?	1 2 8 9	
INC5	....from scholarships or retirement funds?	1 2 8 9	

Do you have an income from private work (or self- employment)?

INC6	Income from self-employment such as plumbing, carpentry, forgery painting, housecleaning, childcare, street vending of cigarettes or lottery coupons , cab driving, or any other similar work for cash or in- kind payments	1 2 8 9	
INC7	Income from sale of agricultural goods such as eggs, meat or vegetables	1 2 8 9	

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Interviewer | Area | House | Gender | Interviewee

Did you get money gifts or gifts in- kind (food, clothes, books, applicances...)

INC8	.... from relatives and friends ?	1 2 8 9	
INC9	.... from an employer?	1 2 8 9	
INC10	.... from the government (municipal help with renovation...)?	1 2 8 9	
INC11	.... from associations?	1 2 8 9	
	If any of these gifts are food, please specify which foods:		

Other income

INC12	Other sources of income • Renting of land or house or any other property	1 2 8 9	
	• Money interest from bank or savings	1 2 8 9	
	• Investment	1 2 8 9	
	• Grant insurance payments or compensation for damages	1 2 8 9	
	• Alimony	1 2 8 9	
	• Sale of material assets (cars, jewelry, clothes, furniture)	1 2 8 9	

Economic self evaluation

INC13	Generally speaking, how do you regard your household's economic situation in relation to people who live in Lebanon?	1. We are among the **rich** in Lebanon 2. We are not rich, enough to live well 3. We are **middle class** neither rich nor poor 4. We are **poor**

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Interviewer | Area | House | Gender | Interviewee

INC14	If your household had a sudden need for 150,000 LBP, would you be able to raise the money in a week?	1. Yes, would resort to my savings 2. Yes, with some help from others 3. Yes, by taking an advance on my salary 4. Yes, we would sell our belongings 5. No, impossible 6. DK 7. NA
INC15	If the answer is No or Maybe, since when has the economic situation of your household been so difficult?	1. More than 5 years or always 2. Last 2-5 years 3. Last 2 years 4. Last year 5. Situation not difficult 6. DK 7. NA
INC16	If your situation remains the same, what is the least amount of net monthly income that your household needs for living?	8 9 _____LBP
INC17	I am going to read a list of items. For each, please tell me whether your household has such items	

Kind	Yes	No	Number
1. Bicycle			
2. Refrigerator			
3. Electric or gas stove (cooking)			
4. Kerosene, diesel or wood oven (heating)			
5. Electric fan			
6. Washing machine (for clothes)			
7. Vacuum cleaner			
8. Sewing machine			
9. Motorbike			
10. Car or truck			
11. Tractor			
12. DVD player			
13. Air conditioner			
14. Personal computer			
15. Radio cassette player			
16. Electric blender			
17. Television set			
18. Satellite dish (or membership)			
19. Photo camera			
20. Video camera			
21. Mobile phone			
22. Landline			
23. Video recorder			

Interviewer | Area | House | Gender | Interviewee

INC18	Could you please estimate your monthly expenditures for the following items (Lebanese Liras L.L.)?	1. Food eaten at home 2. Food eaten outside the home 3. Rent 4. Electricity 5. Landline 6. Mazout, oil, charcoal (for heating) 7. Household items + personals (soap, detergents,…) 8. Entertainment 9. Cellular phone 10. Gas (for the car, motorcycle,…) and transport 11. Education (school, institution, university) 12. Payments on loans 13. Water 14. Furniture and housekeeping 15. Healthcare 16. Clothes and shoes 17. Other (tobacco?)

Interviewer | Area | House | Gender | Interviewee

Food security FS			
FS1	Which of these sentences applies the most to the food eaten by your family during the past 12 months?	1. We had enough to eat of the kinds of food we wanted (quantity and quality) 2. We had enough to eat but not always the kinds of food we wanted (only quantity) 3. Sometimes we did not have enough to eat (quantity) 4. Often we did not have enough to eat 5. DK/NA 6. Other, specify:_____	
I'm going to read two statements that people have made about their food situation. Tell me whether the statement was often, sometimes or never true for you.			
FS2	"In the past 12 months the food we bought did not last and we did not have enough money to buy more of it"	1. Often true 2. Sometimes true	3. Never true 4. DK/NA
FS3	"In the past 12 months we could not afford to eat healthy balanced meals"	1. Often true 2. Sometimes true	3. Never true 4. DK/NA
FS4	In the past 12 months, did you or any member of your family skip a normal daily meal because you did not have enough food or money to buy food?	1. Yes, almost every month 2. Yes, but for only for some months	3. Only for one or two months 4. Never
FS5	In the past 12 months, did you or any member of your family not eat for a whole day because there was not enough food or money to buy food?	1. Yes, almost every month 2. Yes, but only for some months	3. Only for one or two months 4. Never
FS6	(If Yes to questions 4 or 5), did you skip a meal in a specific season?	1. Yes 2. No If Yes, specify during which season: 1. Summer 2. Fall 3. Winter 4. Spring	

Interviewer | Area | House | Gender | Interviewee

FS7	(If Yes to questions 4 or 5), did you skip a meal during a particular time of the month?	1. Yes 2. No If Yes, specify which time of the month 1. Beginning of the month 2. Middle of the month 3. End of the month		
FS8	Did you ever foresee not having enough food for the next meal or for next day because of lack of money? (If more than one answer is chosen, all strategies used and which you relied on most and second most …)	1. Almost every month 2. Yes, but only some months	3. Only for one or two months 4. Never	
	If Yes, how did you cope	Check all that apply	Relied on most	Relied on second most
	1. Ate less quantity of food			
	2. Substituted less expensive foods for normally eaten foods			
	3. Reduced the variety of foods			
	4. Collected food from wild or garden			
	5. Asked for help from family, neighbors and friends			
	6. Worked more to obtain money for food			
	7. Sold assets to obtain money for food			
	8. Other, specify: _____			
FS9	Do you ever reduce the quantity of food you eat in order to have more for other members of the household?	1. Yes, almost every month 2. Yes, but only some months 3. Only during one or two months 4. Never	To whose benefit? (check all that apply) 1. Spouse 2. Children 3. Other	
FS10	How do you feel about the food in your house?	1.It is exactly what I want to eat 2.We do not eat enough of some foods (identify which foods)_____ 3.We eat too much of some foods (identify which foods)_____		
	For the previous question, categorize the foods. For example, grains, meat, dairy, fruits, vegetables, processed foods, fast foods…			

Interviewer | Area | House | Gender | Interviewee

Nutritional habits

DIE 1- 24 hour recall

List the food items consumed during the past 24 hours specifying the type, amount and timing.

Type of food	Amount	Time	Remarks and Ingredients for mixed dishes

Do the food items previously stated correspond to your normal eating pattern?

1. Yes 2. No

If No, why?

(If more space is needed, use the other side of the paper)

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Interviewer | Area | House | Gender | Interviewee

DIE 2 How frequently do you consume these foods? Food frequency questionnaire

type of food	amount	Seasonal?	number of times				source		
			# day	**# week**	**# month**	**# year**	**Buy it from store**	**Buy it directly from producer**	**Grow or produce it**
1. Breads and cereals									
1.1. Bread (whole wheat)									
1.2. Bread (white)									
1.3. Burghol									
1.4. Corn									
1.5. Rice (white)									
1.6. Pasta									
1.7. Cooked wheat									
2. Fruits									
2.1. Apples									
2.2. Bananas									
2.3. Grapes									
2.4. Citrus fruits (Oranges, …)									
2.5. Persimmon									
2.6. Apricots									
2.7. Melons									
2.8. Plum									
2.9. Water melon									
2.10. Green plum									
2.11. Cherries									
2.12. Strawberries									
2.13. Raspberries									
2.14. Pears									
2.15. Green almonds									

Interviewer | Area | House | Gender | Interviewee

type of food	amount	Seasonal?	number of times				source		
			# day	# week	# month	# year	Buy it from store	Buy it directly from producer	Grow or produce it
2.16. Other fruits									
3. Vegetables									
3.1. Cucumbers									
3.2. Tomatoes									
3.3. Lettuce									
3.4. Cabbages									
3.5. Mint									
3.6. Green beans									
3.7. Squash									
3.8. Eggplant									
3.9. Green peas									
3.10. Cauliflower									
3.11. Rocket leaves									
3.12. Watercress									
3.13. Spinach									
3.14. Radish									
3.15. Beet/turnip									
3.16. Garlic									
3.17. Onion									
3.18. Potatoes									
3.19. Wild cucumber									
3.20. Broad beans									
3.21. Parsley									
3.22. Tomato sauce									
4. Other vegetables									

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Interviewer | Area | House | Gender | Interviewee

type of food	amount	Seasonal?	number of times				source		
			# day	# week	# month	# year	Buy it from store	Buy it directly from producer	Grow or produce it
5. Legumes									
5.1. Lentils									
5.2. Fava beans									
5.3. Chickpeas									
5.4. Kidney beans									
5.5. other legumes									
6. Milk and dairy products									
6.1. Whole milk (please specify source: cow, goat…)									
6.2. Whole yoghurt									
6.3. Whole labneh									
6.4. Cheese (all kinds including the processed cheeses)									
6.5. Kicheck									
6.6. Shanklish									
6.7. Kachta									
6.8. Cooked yoghurt									
6.9. Rice with milk/mouhallabiah									
7. Meats									
7.1. Red meat									
7.2. Chicken									
7.3. Fish									
7.4. Organ meats									
7.5. Seafood									

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Interviewer | Area | House | Gender | Interviewee

type of food	*amount*	*Seasonal?*	*number of times*				*source*		
			# day	**# week**	**# month**	**# year**	**Buy it from store**	**Buy it directly from producer**	**Grow or produce it**
7.6. Birds									
7.7. Other wild animals:									
8. Fats and oils									
8.1. Olive oil									
8.2. Vegetable oil									
8.3. Margarine									
8.4. Ghee									
8.5. Butter									
9. Drinks									
9.1. Natural juice (100% fresh)									
9.2. Sodas/carbonated beverages									
9.3. Sweetened juices (Bonjus, tang)									
9.4. Tea									
9.5. Coffee									
9.6. Herbal tea (specify)									
9.7. Alcohol (specify)									
9.8. Other drinks									
10. Other									
10.1 Oriental pastry									
10.2 Foreign pastry									
10.3 Mixed nuts									
10.4 Chocolate									

Interviewer | Area | House | Gender | Interviewee

type of food	amount	Seasonal?	number of times				source		
			# day	**# week**	**# month**	**# year**	**Buy it from store**	**Buy it directly from producer**	**Grow or produce it**
11 Wild edible plants									
11.1 Chicory (Hindbeh)									
11.2 Mallow (Khebbayseh)									
11.3 Mokho bi Ebbo									
11.4 Rocket leaves (Jarjeer)									
11.5 Pale star thistle (Dardarieh)									
11.6 Thyme									
11.7 Eryngo (Qursaaneh)									
11.8 Purslane (Bakle)									
11.9 Other WEP									
12 Wild fruits									
12.1 Hawthorn(Zaarour)									
12.2 Wild pears									
12.3 Blackberry(Alleyk)									
12.4 Myrtle (Hinblass)									
12.5 Barberry (Barbariss)									
12.6 Wild almonds									
12.7 Wild prunes									
12.8 Mastic Tree (Shaashoub)									
12.9 Prickly pear									
12.10 Other wild fruits									

Interviewer | Area | House | Gender | Interviewee

DIE3a	**Do you hunt or raise animals?**			1. No Skip to number 5		2. Yes Continue	
				Animal 1	Animal 2	Animal 3	Animal 4
What animals do you raise or hunt?							
Hunt							
Raise							
What is the annual number of the animals you raise or hunt?	Number per year						
Approximately, how many hours/days you spend tending to them?	Labor (hours/day)	Yourself					
		Family					
		Worker					
What is the additional cost of raising or hunting animals? (if available)	Additional cost (health care, shelter, slaughter…)						
Where do you get the small animals from? (i.e.chicks,veal) and what is their cost?	Storage	Yourself					
		From the neighbor (cost/ L.L.)					
		Buying (cost/L.L.)					

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Interviewer | Area | House | Gender | Interviewee

DIE3b	Do you cultivate or collect any plants?			**1. No Skip to number 6**		**2. Yes Continue**	
				Plant 1	Plant 2	Plant 3	Plant 4
Plant							
What is the land area used for cultivating plants?	Land area (m^2)						
What is the annual outcome?	Outcome (kg or tons)						
Approximately, how many hours/days you, your workers or your family spend on collecting or tending to them?	Labor (days/hours)	Yourself					
		Family					
		Worker					
Do you use pesticides? If yes, what is amount and price?	pesticides	Quantity (L.)					
		Price (L.L.)					
Do you use fertilizers (chemical or natural)? If yes, what is amount and price?	Fertilizers	Natural (quantity/LL.)					
		Price (L.L.)					
		Chemical (quantity/L.)					
		Price (L.L.)					

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Interviewer | Area | House | Gender | Interviewee

Where do you get the seeds from? In case you buy them, what is their secondary cost?	seeds	Yourself					
		Neighbors (cost/L.L.)					
		Buy (cost/L.L.)					
	Additional costs						

2. No / 1. Yes Specify	Do you usually collect Wild Edible Plants?	***DIE3***
Feb / Mar / April / May / June / July	Yes, when do you collect these plants	
1 2 3 4 5 6 7 9 10 More than 10	How many times per season do you collect WEP? (√)	
Percentage (added up to equal 100%) Consume them Give to others (family, friends, neighbors,…) Sell	What do you do with the plants?	
	Can you estimate the market value of what you collect during the season?	

Interviewer | Area | House | Gender | Interviewee

1. No / 2. Yes Specify the kind _____ What do you do with it?	Do you produce any kind of food (plants, eggs, meat, milk...)?	***DIE4***
Percentage (total amount grow 100%) Consumption Gifts to others (family, friends, neighbors,…) Sell		
	Can you estimate the market value of what you grow during the season?	
5. From expert in village 6. From school/ university 7. Other (specify):_____ 8. Not applicable 1. From my parents 2. From my grandparents 3. From my siblings 4. From extended family members	How did you learn about WEP (collection, growing and information)? (√)	***DIE5***
1. Yes / 2. No / 3. NA	Do your children know about the collection and growing of wild edible plants?	***DIE6***
1. Lack of time 2. Lack of interest 3. Does not know 4. Other	If No, why not? (√)	
	What, in your opinion, are the benefits of wild edible plants?	***DIE7***

Interviewer	Area	House	Gender	Interviewee

DIE8	How much salt do you usually add to your food? (√)		1. Not at all 2. Only in cooking- small amounts	3. In cooking and on the table 4. In cooking and on the table- large quantities
DIE9	Do you usually use broth cubes?		1. Yes 2. No	
DIE10	Are you taking any vitamin/mineral supplements?	1. Yes If, yes: Kind: _____ # pills per day: # pills per week:	2. No	
DIE 11	Are you taking any medication?	2. Yes If, yes: Kind: _____ # pills per day: # pills per week:	2. No	
END	Comments			
	Time the interview ended:	_____ AM/PM (please circle one)		
	Total approximate time of interview	_____ minutes		

Appendix 3: Table listing the items included in the food basket average cost from the study communities

Comparison of basket item costs

Item	*Average Cost Normal Basket (LL)*	*Average Cost Healthy Basket (LL)*
whole wheat bread	**1418**	**2875**
white bread	**959**	**0**
cheese processed	**3373**	**0**
cheese white	**0**	**2367**
labneh (strained yogurt)	**2324**	**0**
low fat labneh	**0**	**3261**
whole laban (yogurt)	1578	1578
margarine	25	25
whole milk	**475**	**1599**
vegetable oil	**35**	**0**
garlic	19	19
olive oil	**66**	**249**
potatoes	324	324
cucumbers	340	340
cucumbers (summer)	165	165
lettuce	92	92
broad beans	603	603
tomatoes	374	374
tomato paste	426	426
fava beans	90	90
hindbeh	67	67
cabbages	80	80
parsley	31	31
mint	9	9
eggplant	135	135
beans	119	119
onions	92	92
radish	6	6
bakleh	46	46
thyme	1	1
figs	100	100
cherries	1146	1146
grapes	386	386
apricot	742	742
bananas	42	42
musk melon	133	133
strawberries	204	204
mulberries	**212**	**233**
plums	255	255

almonds	148	148
unsalted peanuts	**0**	**1075**
mixed nuts	**620**	**0**
kicheck	1558	1558
burghol (cracked wheat)	**11**	**30**
chickpeas	11	11
chicken	1102	1102
red meat	4896	4896
white rice	**168**	**0**
natural juice	**1307**	**2812**
sodas	**833**	**0**
chocolate	**574**	**0**
driedfruits (apricots)	**0**	**138**
sugar	**92**	**56**
coffee	**483**	**159**
tea	**286**	**101**
Total cost	**28576**	**30297**

*Bolded items are those with a change in cost

Reference: Hunter's thesis, Food security in rural Lebanon - Links with diet and agriculture, Université Laval, 2008.

Appendix 4: Consent form for participation in the study.

INFORMED CONSENT

TITLE OF THE STUDY:

Food and Health in Rural Lebanon: Options to Improve Dietary Diversity, Food Security, Livelihoods and Ecosystem Management

INVESTIGATORS:

Dr. Malek Batal; Dr. Michael Robidoux; & Dr. François Haman, University of Ottawa, Ottawa, Ontario

RESEARCH PARTNERS: Nature Conservation Center for Sustainable Futures (IBSAR) at the American University of Beirut

COMMUNITY PARTNERS: Community Councils in Aarsal, Batloun, and Kuakh (Lebanon)

PURPOSE OF THE RESEARCH

After extensive consultation meetings with community leaders and community health practitioners, we have assembled a research program to examine the potential health risks and health benefits of traditional Lebanese food consumption as it relates to the prevalence of Type II Diabetes

DESCRIPTION OF THE PROPOSAL

Examine the potential health risks and health benefits of wild consumption as they relate to the prevalence of Type II Diabetes (insulin resistance) and Inflammation (auto-immune response).

PRE-SCREENING

1) Through consultation with community research coordinators in your community we will identify potential research participants who self identify as High-Traditional-Food consumers and Low-Traditional- Food consumers.

2) Potential participants will be interviewed to discern dietary intake by Batal and Research Assistants. 30 minute personal tape-recorded interviews will be conducted. Individuals will be interviewed once.

3) Based on the information acquired through interviews, 2 groups of research participants will be selected in each community made up of High-Traditional-Food consumers and Low-Traditional- Food consumers. Each group will consist of 30 people made up of men and women 20-40 years of age, totaling 180 participants in total. Exclusionary criteria, in addition to age, would be pregnant women and those with Type I Diabetes.

4) Results from the pre-screening will then be analyzed in order to determine if participants correspond to the inclusion criteria of this present study. If you are selected for this study, you will be asked to come to the health centre for one *Half-Day* of measurements described in detail below.

EXPERIMENTAL SESSION (All research to be performed within the health centre is in compliance with Regulated Health Professions Act)

HALF-DAY measurements

A. Arrival at the laboratory at 9 AM: You will be asked to report at the health centre located in each community between 9:00 and 9:30 AM, following 24-h without heavy physical activity and after a 12-14h fast. The following procedures will be done during the experimental session:

B. Anthropometric measurements. Your weight, height and hip/waist circumferences will be taken.

C. Insertion of a cathether and fasting blood samples. You will rest comfortably in a reclining bed. An intravenous catheter (small plastic tube) will be placed in a vein of your forearm by a qualified nurse. Four samples of 5 ml will be taken for a total of 20 ml.

D. Resting Metabolic Rate. We will establish your resting energy expenditure, using your oxygen consumption and carbon dioxide production. You will be asked to breathe through a scuba diving type mouthpiece for approximately 30 minutes. While wearing this mouthpiece, you will be freely breathing in room air. We will be measuring the air you breathe out. There are no risks associated with this procedure.

E. Oral glucose tolerance test. The oral glucose tolerance test consists of drinking a sweetened drink (340ml containing 75g of glucose) and to measure the changes in blood glucose and insulin through blood samples taken during the 2 hours following the ingestion (3 samples of 5ml every 15 minutes during the first hour and every 30 minutes for the second hour for a total of 105 ml). Oxygen consumption and carbon dioxide production will be measured as described above for 5 minutes after each blood sample. During this measurement, 80-ml samples of expired gases will be collected in order to measure the amount of ^{13}carbon dioxide produced by oxidation of 1-^{13}C-glucose. The catherter will be removed after the 120 min measurements. There are no risks involved in this procedure.

F. Snack. A breakfast type snack consisting of toast with the topping of your choice and a beverage of your choice will be served.

G. Follow-up Interview. You will meet with the research assistant or nurse. You will be interviewed on your medical history and physical activity levels. This is in fact an informal conversation based on a Medical History questionnaire.

FORESEEABLE RISKS

The risks and discomforts associated with the study are as follows: The indwelling catheter for blood samples poses potential risks ranging in severity from simple redness of the skin to a local inflammation of the vein. On the psychological level, it is possible that certain individuals may feel distressed and anxious with regards to some measurements such as blood sampling, the indwelling catheters.

The following measures will be taken to reduce the above mentioned risks:

- In the pre-screening, the procedure and measurement techniques will be reviewed with me to ensure that I am comfortable with the protocol.

- To ensure that there are no risks associated with the use of indwelling catheters, the skin area will first be sterilized with alcohol. A nurse will place the catheter, ensure its correct operation and collect the blood samples. All blood samples will be taken with sterilized instruments. The

nurse will also withdraw the catheter at the end of the experiment. **The use of a catheter will provide less discomfort compared to repeated sampling with a needle. No pain will be experienced when the catheter is put in place or when blood is being extracted.** Once the catheter is removed, the wound is cleaned with alcohol and peroxide. A sterile bandage is then applied. You will be asked to report any unusual discomfort or discolouration of the skin.

BENEFITS

This research will establish formal mechanisms to inform community leaders and community members about the cost-benefits of Traditional-Food consumption on the incidence/prevalence of Type II diabetes.

MONETARY COMPENSATION

I will receive a compensation of $50.00 which will be paid at the conclusion of experimental session. **I will receive financial compensation if I choose to withdraw from the experimental session once it is undergoing.** However I will not be compensated for a session for which I did not show up.

CONFIDENTIALITY AND ANONYMITY

In order to guarantee the confidentiality and anonymity of participants, all precautions and necessary measures will be taken to ensure that results and personal information of participants is kept under the strictest of confidentiality.

- My name will not appear on any reports. A number code will be used to identify me on all research documents.
- All material and information which can be linked to myself will not be made public and will be kept under the strictest confidentiality.
- The data collected will be kept in a locked filing cabinet and data will only be accessible to the research investigators at the Behavioural and Metabolic Unit in the Montfort hospital. In addition, the computer files will be protected by a password. **The data will be destroyed after ten years**.
- If I choose to withdraw from the experiment all the data collected is no longer viable and will be destroyed.
- I am aware that only the above mentioned investigators will have access to the data from my sessions

VOLUNTARY PARTICIPATION

- My participation in this study is entirely voluntary.
- I will be made aware of new findings that might influence my decision to take part in the present study.

RIGHTS OF THE PARTICIPANTS

The researchers guaranty that:

- I can withdraw from the project at any time.

- The confidentiality of the information gathered as well as the anonymity of all participants will be rigorously protected as indicated above.

Any information about my rights as a research participant may be addressed to the Protocol Officer for Ethics in Research, 550 Cumberland Street, Room 159, Ottawa, ON, CANADA, K1N 6N5. Tel. +1 (613) 562-5841 or email: ethics@uottawa.ca .

There are two copies of the consent form, one of which I may keep.

If I have any questions about the conduct of the research project, I may contact: Malek Batal at +1 (613) 562-5800 ext. 8997. Collect charges accepted.

CONSENT:

I the undersigned, agree to participate in the above research study. The study has been explained to me, I have had the opportunity to ask questions about my involvement and to receive additional details that I wanted to know about the study. I understand that by accepting to participate, I am in no way waiving my right to withdraw from the study at any time.

I have been given a copy of this form.

Research participant's signature: _____ Date: _____

Signature of Researcher: _____ Date: _____

Appendix 5: Ethics approval on the project by the comité d'éthique de la recherche en santé de l'université de Montréal

Université de Montréal

Comité d'éthique de la recherche en santé

19 octobre 2015

Objet: Approbation éthique – « La relation entre la production locale d'aliments et la qualité de l'alimentation des populations rurales libanaises »

Mme Hiba Al-Masri,

Le Comité d'éthique de la recherche en santé (CERES) a étudié le projet de recherche susmentionné et a délivré le certificat d'éthique demandé suite à la satisfaction des exigences précédemment émises. Vous trouverez ci-joint une copie numérisée de votre certificat; copie également envoyée à votre directeur/directrice de recherche et à la technicienne en gestion de dossiers étudiants (TGDE) de votre département.

Notez qu'il y apparaît une mention relative à un suivi annuel et que le certificat comporte une date de fin de validité. En effet, afin de répondre aux exigences éthiques en vigueur au Canada et à l'Université de Montréal, nous devons exercer un suivi annuel auprès des chercheurs et étudiants-chercheurs.

De manière à rendre ce processus le plus simple possible et afin d'en tirer pour tous le plus grand profit, nous avons élaboré un court questionnaire qui vous permettra à la fois de satisfaire aux exigences du suivi et de nous faire part de vos commentaires et de vos besoins en matière d'éthique en cours de recherche. Ce questionnaire de suivi devra être rempli annuellement jusqu'à la fin du projet et pourra nous être retourné par courriel. La validité de l'approbation éthique est conditionnelle à ce suivi. Sur réception du dernier rapport de suivi en fin de projet, votre dossier sera clos.

Il est entendu que cela ne modifie en rien l'obligation pour le chercheur, tel qu'indiqué sur le certificat d'éthique, de signaler au CERES tout incident grave dès qu'il survient ou de lui faire part de tout changement anticipé au protocole de recherche.

Nous vous prions d'agréer, Monsieur, l'expression de nos sentiments les meilleurs,

Dominique Langelier, présidente
Comité d'éthique de la recherche en santé (CERES)
Université de Montréal

DL/GP/gp
c.c. Gestion des certificats, BRDV
Olivier Receveur, professeur titulaire, Faculté de médecine - Département de nutrition
Malek Batal, professeur agrégé, Faculté de médecine - Département de nutrition
Jean-Pierre Lefebvre (nutrition)
p.j. Certificat #14-065-CERES-D

adresse postale
C.P. 6128, succ. Centre-ville
Montréal QC H3C 3J7

3744 Jean-Brillant
4e étage, bur. 430-11
Montréal QC H3T 1P1

Téléphone : 514-343-6111 poste 2604
ceres@umontreal.ca
www.ceres.umontreal.ca

Université de Montréal

N° de certificat
14-065-CERES-D

Comité d'éthique de la recherche en santé

CERTIFICAT D'APPROBATION ÉTHIQUE

Le Comité d'éthique de la recherche en santé (CERES), selon les procédures en vigueur, en vertu des documents qui lui ont été fournis, a examiné le projet de recherche suivant et conclu qu'il respecte les règles d'éthique énoncées dans la Politique sur la recherche avec des êtres humains *de l'Université de Montréal.*

Projet	
Titre du projet	**La relation entre la production locale d'aliments et la qualité de l'alimentation des populations rurales libanaises**
Étudiant requérant	**Hiba Al-Masri** [redacted], Candidate à la M. Sc. en nutrition, Faculté de médecine - Département de nutrition
Sous la direction de	Olivier Receveur, professeur titulaire, Faculté de médecine - Département de nutrition, Université de Montréal & Malek Batal, professeur agrégé, Faculté de médecine - Département de nutrition, Université de Montréal.

Financement	
Organisme	Non financé
Programme	
Titre de l'octroi si différent	
Numéro d'octroi	
Chercheur principal	
No de compte	

MODALITÉS D'APPLICATION

Tout changement anticipé au protocole de recherche doit être communiqué au CERES qui en évaluera l'impact au chapitre de l'éthique.

Toute interruption prématurée du projet ou tout incident grave doit être immédiatement signalé au CERES

Selon les règles universitaires en vigueur, un suivi annuel est minimalement exigé pour maintenir la validité de la présente approbation éthique, et ce, jusqu'à la fin du projet. Le questionnaire de suivi est disponible sur la page web du CERES.

[redacted]

Dominique Langelier, présidente
Comité d'éthique de la recherche en santé
Université de Montréal

19 octobre 2015
Date de délivrance

1er novembre 2016
Date de fin de validité

adresse postale
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Appendix 6: Consent form approval by the institutional review board of the faculty of medicine- American University of Beirut.

لجنة الأخلاقيات
كلية الطب
INSTITUTIONAL REVIEW BOARD
FACULTY OF MEDICINE

AUB American University of Beirut
الجامعة الأميركية في بيروت

To: Dr. Salma Talhouk
Date: March 15, 2010

Principal Investigator:	Dr. Salma Talhouk American University of Beirut
Protocol Number:	FAFS.ST.01(b)
Protocol Name:	Food and health in rural Lebanon: options to improve dietary Diversity, food Security, Livelihoods and Ecosystem Management

Thank you for submitting to the IRB your response received on December 21, 2009 and a copy of the Material Transfer Agreement (MTA) received on March 12, 2010 for review.

The IRB reviewed in an expedited manner your reply, the amended English and Arabic versions of the informed consent forms for Dietary and Metabolic benefits (version date November 17,2009), the amended English and Arabic versions of the informed consent forms for the Cultural benefits /viability(version date November 17,2009), the amended English and Arabic versions of the oral script for food safety(version date November 17,2009), the English and Arabic versions of the metabolic medical history questions, the English and Arabic versions of the cultural semi-structured interviews and the English and Arabic versions of food safety semi-structured interviews and the MTA (received on March 12,2010).

This is to grant you approval for the study, the amended English and Arabic versions of the informed consent forms for Dietary and Metabolic benefits (version date November 17,2009), amended the English and Arabic versions of the informed consent forms for the Cultural benefits /viability(version date November 17,2009), the amended English and Arabic versions of the oral script for food safety(version date November 17,2009), the English and Arabic versions of the metabolic medical history questions, the English and Arabic versions of the cultural semi-structured interviews and the English and Arabic versions of food safety semi-structured interviews, the English and Arabic versions of the questionnaires, the English and Arabic versions of the recruitment flyers: cultural benefits/viability, and the English and Arabic versions of the recruitment flyers :dietary Benefits for a period of one year ending March 15,2011; at which time a progress report is kindly requested from you.

The American University of Beirut and its Institutional Review Board, under the Institution's Federal Wide Assurance with OHRP, comply with the Department of Health and Human Services (DHHS) Code of Federal Regulations for the Protection of Human Subjects ("The Common Rule") 45CFR46, subparts A, B, C, and D, with 21CFR56; and operate in a manner consistent with the Belmont report, FDA guidance, Good Clinical Practices under the ICH guidelines, and applicable national/local regulations.

Sincerely,

[redacted]

Michael Clinton, PhD
IRB Vice Chairperson
Social & Behavioral Research

Cc: Ibrahim Salti, MD, PhD
Chairperson of the IRB

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