AMERICAN UNIVERSITY OF BEIRUT

ASSESSING ECOLOGICALLY SOUND PRACTICES INFLUENCING CLIMATE CHANGE ADAPTATION STRATEGIES AND FOOD SECURITY: A CASE OF SMALLHOLDER FARMERS IN CENTRAL BEKAA, LEBANON

by
ALIAA AHMAD AL DIRANI

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AN ABSTRACT OF THE THESIS OF

Aliaa Ahmad Al Dirani for Master of Science
Major: Food Security

Title: Assessing ecologically sound practices influencing climate change adaptation strategies and food security: A case of smallholder farmers in central Bekaa, Lebanon

Background: Climate change impacts are likely to occur in and are channeled through agriculture, which is the most natural resource-based and climate-sensitive sector. The study examined the local smallholder perceptions, attitudes, and understanding of climate change, identified the climate-smart adaptive measures they undertook, analyzed the determinants that influence their choice of adaptation methods, and classified the barriers that impede adaptation along with evaluating the farming households' food security levels.
Design/methods/approach: The study is based on cross-sectional, quantitative survey. Primary data was collected from 120 randomly-selected households from nine villages in central Bekaa using a structured questionnaire. The study compromised two sets of questionnaires: the first aimed to assess the farming households' resilience to climate change and variability and second intended to evaluate household food security adopting four indexes developed by international agencies (*i.e.*, HFIAS, MIAHFP, FCS and CSI). The analysis used descriptive statistics and a Poisson Regression Model to estimate the number of adaptation strategies the smallholder farmers implemented and the intensity of coping with changes in temperature and rainfall.
Findings: The majority of farmers in central Bekaa believe that climate change is occurring and mostly due to human activities. The severity index (SI) of the farmers' perceptions, attitudes and knowledge are all in the "agree" range. Farmers adopt a combination of practices to meet the challenges posed by climate changes, mainly crop diversification, improved irrigation systems, soil conservation techniques, and chemical fertilizers. Further, the most critical barriers hindering adaptation are water scarcity, limited access to agriculture markets and lack of agricultural policy. The econometric results revealed that different aspects of human, financial, natural/physical and institutional/social capital impact the adoption likelihood. Overall, the results revealed that most households had a low score of food insecurity and used various food and non-food related strategies to cope with food insecurity.
Originality/value: This study provides valuable insights about food security within smallholder households in light of climate variability. Additionally, it paves the way for policymakers to formulate and implement appropriate adaptation responses, policies and programs to overcome all the barriers and tackle the adverse effects of climate change on the Lebanese agriculture sector.

Keywords: *Climate change and variability, Food security, Smallholder farmers, Climate change adaptation strategies, Central Bekaa, Policy implications*

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CHAPTER 1

INTRODUCTION

A. Background to the study

One of the most pressing global threats is how to sustainably feed a growing population while conserving the ecosystem. However, the globe is facing acceleration in climate change that has potentially far-reaching implications (IPCC 2014; Ali and Erenstein 2017). Climate change is associated and experienced with long-term, frequent and extreme weather variations such as the alteration in temperature, precipitation, water vapor pressure in air, radiation, and wind speed (IPCC 2014). Scientific research confirms that climate change is occurring since 1950, where the number of warm days and nights has increased and the pattern, timing and intensity of precipitation has been altered (IPCC 2012).

Climate change impacts are likely to occur in and are channeled through agriculture which is the most natural resource-base and climate-sensitive sector (Georgopoulou, 2017; Pandey *et al.* 2017). Hence, climate change is threatening decades of global agricultural development efforts, particularly in developing countries where the agriculture sector highly relies on rain-fed crops to ensure the nation's economic growth and food security (Okonya, Syndikus and Kroschel 2013; IPCC 2014; Winsemius *et al.* 2014; Niles and Mueller 2016; Pandey *et al.* 2017; Zamasiya, Nyikahadzoi and Mukamuri 2017).

High temperatures and changes in precipitation result in altering the water availability, reducing the desirable crops' yields, increasing the proliferation of weeds and pests, increasing both soil erosion and infertility at critical stages of crop growth, and declining the overall long-term production (Arbuckle *et al.* 2013; Niles and Mueller 2016). Declining agriculture productivity results in a chain of economic stressors such as decreasing farm incomes; hence, increasing poverty and food insecurity levels. (Arbuckle *et al.* 2013; Sultan 2012; Nyakudya and Stroosnijder 2011; Pandey *et al.* 2017; Zamasiya, Nyikahadzoi and Mukamuri 2017). Moreover, scientific projections are expecting an

aggravation and warmer climate in coming decades on most of the land with an increase in the length, frequency, and intensity of heat waves (IPCC 2012; IPCC 2014).

According to United Nations (UN) estimates, close to 815 million people go hungry globally (FAO 2018) where approximately 40% of those are small-scale farmers (IFAD-UNEP 2018). The vast scientific evidence has revealed that climate change presents a major global risk for developed and developing countries since it impacts poor and rich people's socio-economic activities, livelihoods, food security, and health (Romieu *et al.* 2010; Clarke *et al.* 2012; Amjath-Babu *et al.* 2016; Niles and Mueller 2016). However, poor people living in agricultural communities in developing countries are more vulnerable to climate variability as it weakens their social, economic and ecological systems and hence immediately deteriorates their livelihoods and food security (Pandey *et al.* 2017; Ayanlade, Radeny and Morton 2017; Elum, Modise and Marr 2017). Globally, around 2.5 billion people depend on the stability and predictability of the environment since their livelihood partly or fully comes from agricultural production systems (Ali and Erenstein 2017).

B. Statement of the problem

In general, the fluctuations in weather patterns due to change in the climate are going to worsen in the future and will hamper the world's ability to provide sufficient food to feed a burgeoning global population. In order to safeguard the already fragile food security situation, there is a need for natural and human systems to adapt to climate change across various scales such as geography, time and ecology (World Bank 2013; Zamasiya, Nyikahadzoi and Mukamuri 2017). Given these predicted and on-going changes, there is great scope for reducing the adverse impacts of climate change mainly in the agriculture sector by strengthening adaptation strategies and building more resilient farming systems that are vital to rural poverty alleviation (IPCC 2014; Lee *et al.* 2015).

The United Nations Framework Convention on Climate Change UNFCCC (2007) presented adaptation as "adjustments in ecological, social, or economic systems in response to actual or expected climatic stimuli and their effects […] through processes, practices, and structures to moderate potential damages or to benefit from opportunities associated with climate change" (UNFCCC, 2019). Furthermore, climate change

adaptation could be applied at different country levels: regional, national, sub-national and local. But, the most critical adaptation is at the local level since the local stakeholders are the ones who realize the severity of climate change (UNFCCC 2007).

Climate change adaptation practices, programs, and policies have become the subject of intense global discussions among practitioners and in policymakers' agendas in recent years. Despite the fact that climate change is a global phenomenon, yet adaptation strategies are more needed in developing countries since those communities are presumably more vulnerable (Elum, Modise and Marr 2017). According to Tripathi (2017), climate change adaptation is done in two-steps: perceiving climate change and its associated risks and then attempting to reduce the adverse effects. However, sometimes people do not respond to the effects of climate change albeit perceived correctly due to constraints such as lack of resources, capacity and information or because of their orientation or beliefs (Tripathi 2017; Li 2017). Various studies have revealed that before adopting any new climate change adaptation strategy farmers attempt to figure out its benefits and costs (Mulwa *et al.* 2017). Unfortunately, most farmers' decision will not focus on sustaining the environment rather they focus on sustaining their income. For example, although they are aware of the deleterious effect of overusing groundwater, they continue using it (Tripathi 2017).

Many studies have highlighted that the climatic change impact on the agriculture sector relies on the farming community's adaptive capacity. That is, without adopting climate change adaptation strategies the agriculture sector will be damaged (Ali and Erenstein 2017). To reduce the adverse impact of climate change on agriculture, studies revealed that it is vital to understand the farm-level decision-making processes. Eventually, this will aid in estimating the economic impacts of the adaptation strategies along with developing well-targeted policy responses (Wheeler, Zuo and Bjornlund 2013; Below, Schmid and Sieber 2014; Comoé and Siegrist 2013; Menapace, Colson and Raffaelli 2015; Niles and Mueller 2016). Indeed, the existing literature shows that it is instructive to understand from the farmers' and local communities' perspective whether there is a threshold beyond which climate change becomes a more or less prominent issue compared to other political, economic, social stressors operating at multiple

spatiotemporal scales (Elum, Modise and Marr 2017). Finally, understanding people's level of perception and motivation is crucial to apprehend the climate change impact on sustainable livelihoods and food security (Tripathi, 2017).

C. Objectives of the study

This research will focus on challenges to, and opportunities for, achieving decent rural livelihoods, improving food security, and encouraging the agriculture sustainability and climate resilience among farmers in rural Lebanon, particularly in the central Bekaa Valley. This study aims to:

- Explore smallholder farmers' attitudes, perceptions and local knowledge toward climate change vulnerability and their agriculture practices and on-farm innovations
- Identify the common ecologically sound climate change adaptation strategies and their perceived importance among smallholder farmers
- Assess the barriers that hinder smallholder farmers from adopting practices to adapt to the impact of climate change
- Examine the determinants of the main climate change adaptation strategies used by smallholder farmers, to alleviate the adverse impacts of climate change and variability in central Bekaa and,
- Evaluate the vulnerability of smallholder farming households to food insecurity.

D. Rationale and significance of the study

In recent years, there is an upsurge in promoting adaptation of strategies to counter the impacts of climate change. There is a shortage in the literature linking climate change adaptation strategies for reducing rural smallholders' vulnerability to climate change and enhancing their food security and livelihoods. Therefore, this study addressed this gap in the literature by employing the concepts of climate change resilience theory and sustainable livelihoods to holistically examine the linkage between rural smallholder farmers' adoption of environmental sound climate change adaptation strategies in their farming systems and their impact on the food security and livelihoods levels. This

approach contributes to building sustainable food security and livelihoods along with enhancing conservational farming both economically and ecologically.

Understanding the adaption options that smallholders are currently using and examining the extent of the smallholder farmers' resilience to climate change and variability will pave the road for policy makers to formulate and implement appropriate adaptation responses. Thus, these policies and programs will imperatively protect the Lebanese smallholder farmers' livelihoods and sustain their food security and nutrition. Finally, this study contributes to the existing and growing body of knowledge in the field by jointly (1) analyzing the resilience and adaptation of smallholder farmer to climate change; (2) examining the factors affecting smallholder farmers' actual adaptive behaviors to climate change; (3) evaluating farming households' food security in the Lebanese context in particular and arid and semi-arid areas in general.

E. Limitations of the study

Although this study used primary data to achieve the study objectives , there are some limitations mainly attributed to its cross-sectional nature. Accordingly, further research using a panel data may be required to account for time-invariant influences on the outcome variables. The relatively small sample size (120 households), covering merely a defined area of Lebanon, makes the generalization of the findings somehow difficult. This limitation however does not invalidate the study conclusions rather it encourages further research covering the whole of Lebanon. Apart from these limitations, this study advances the knowledge about climate change perception, attitude, understanding, adaptation practices and barriers in Lebanon. It also offers a better understanding of Bekaa smallholder farmers' climate change adaptation which could assist public action and deliberation on climate change adaptation and mitigation policies.

F. Organization of the study

The thesis is organized into seven chapters. Chapter 1 provides the background, specific problem, overall objectives, scope and significance, limitation and organization of the thesis. Chapter 2 presents a scoping of pertinent literature w on several topics, including food security, food insecurity, climate change impacts on agriculture, climate

change adaptation strategies, and climate change effect on food security. Chapter 3 describes the conceptual framework that was developed based on various theories and concepts. Chapter 4 outlines the research approach and methodology of this study; it provides a detailed description of the study design, study setting, population and sampling framework, data collection techniques, empirical models employed in the statistical analysis, household food security indexes and ethical considerations throughout the research process. Chapters 5 and 6 provide the findings and discussions. Chapter 7 summarizes and draws conclusions and policy implications and highlights areas for further research.

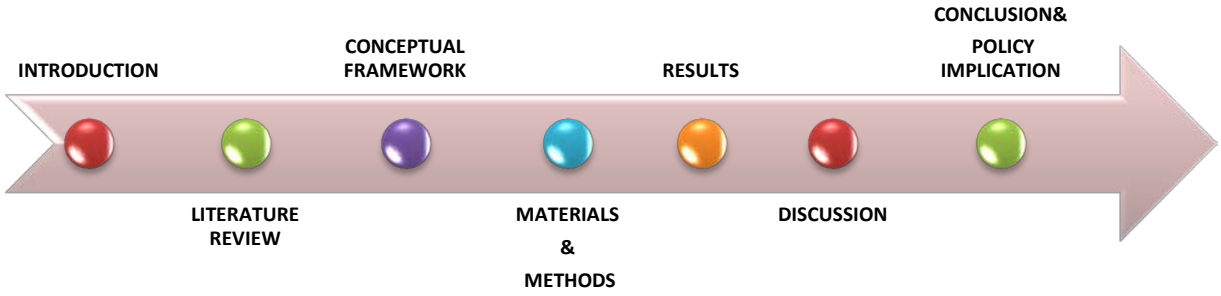


Figure 1: Thesis organization

CHAPTER 2

LITERATURE REVIEW

This chapter will be divided into three main sub-sections: food security and food insecurity, and climate change. A description of the evolution of each concept and their specific relevance to the research context will be presented. First, the history of the food security concept will be presented along with a review of its pillars, causes and measurements. This section concludes with a description of climate change impacts on agriculture, identifying climate smart adaptation strategies, highlighting the drivers and barriers for adopting adaptation strategies and reviewing the impact of climate change on the four pillars of food security.

A. Food security and food insecurity:

1. Historical perspective on food security

According to Maxwell (1996), the food security concept went through three overlapping paradigm shifts:

a) From the global and national level to the household and individual level during the 1972-1974 world oil and food crises.

b) From a food first perspective to a livelihood perspective; this shift was based on the lessons learned from the African famine of 1984-1985. For instance, Oshaug (1985) classified households into three categories in terms of attaining their livelihood sufficiency: enduring households, resilient households, and fragile households. Moreover, the World Bank (1986) report on "poverty and hunger" highlighted the importance of looking at the causes of temporary food insecurity at the household level. Maxwell (1992) determined that a household's food security status is a key indicator in revealing whether the household is poor or not.

c) From objective indicators to subjective perspectives. Food security in conventional approaches was based on objective measurements such as targeting the

consumption level through nutritious and adequate indictors (Staatz 1990). But, this is no more an effective means of accessing food security since it is clear that socio-economic factors (*e.g.*, age, sex, health, work) impact the household status (Payne and Lipton 1994). Furthermore, quantitative technique measurements fail to account for factors such as food quality, cultural acceptability and human dignity (Oshaug 1985).

2. Evolution of the concept food security

Despite the fact that hunger is a timeless phenomenon, the concept of food security was first defined during the initial World Food Conference in 1974. The first food security definition was: "[availability] at all times of adequate world food supplies of basic foodstuffs to sustain a steady expansion of food consumption and to offset fluctuations in production and prices" (UN 1975). Accordingly, the first definition of food security solely emphasized assuring national food availability in economic terms (*i.e.*, global supply problem) where a constant volume or supply of basic foods at stable prices was thought to resolve the issue (Maxwell 1992).

Since its emergence in the 1970s, the term food security has been widely debated and undergone several iterations in both its substance and scale aiming to reflect the complex role food plays within societies (Maxwell 1992, 1996; Carr 2006; Jarosz 2010; Koç 2011; Pritchard 2012; Hinrichs 2013). In the early 1980s, the understanding of the food security term was shifting where the definition paid greater emphasis on food accessibility. The advancement in the entitlement approach goes back to Amartya Sen's book (1981), *Poverty and Famines: An Essay on Entitlement and Deprivation*, in which he anticipated that there is something wrong with the Malthusian approach[1] to food security since in the midst of ample food, famines cannot be deemed a problem of availability but are ratherd rooted in inherent inequalities within societies (Clay, 2002).

During the 1990s, the concept evolved and recognized the utilization aspect of food security (Koç 2011; Hinrichs 2013). This pillar was proposed by Maxwell (1992),

[1] At the turn of the 18th century Thomas Malthus, writing under the alias of Joseph Johnson, published *An Essay on the Principle of Population* (1798) which presents population growth as exponential and the growth in the food supply as arithmetical. Consequently, he foresaw that unchecked population growth would quickly lead to widespread chronic hunger. He proposed a series of population control measures to prevent this perceived catastrophe.

who explained that “enough food” is meant to refer to sufficient caloric intake an individual should meet to supply the daily dietary energy requirements (Carr 2006).

Today, the most common operational definition of food security at all levels – individual, household, national, regional and global – is that of the United Nation’s Food and Agriculture Organization (FAO): "[f]ood security [is] a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy lifestyle" (FAO 1996). This is the most used definition because it encompasses the four-pillars of food security: availability, accessibility, utilization, and stability in addition to taking into account cultural appropriateness.

3. The four pillars of food security

Food security is generally understood as being dependent on three pillars: availability, access, and utilization (Barrett 2010). Food availability refers to having enough and appropriate quality food for consumption. It is provided via domestic production, distribution, imports, exchange or food aid (Clay 2002; Webb and Rogers 2003). Food access relates to the ability of the households or individuals to secure adequate resources/entitlements (*i.e.*, sufficient food and a nutritious diet), be it through purchasing, producing or from any other source (*e.g.*, transfer, gifts). Although sufficient food supply might be available, this does not ensure accessibility since accessing food might be constrained by barriers whether physical or financial (Clay 2002; Webb and Rogers 2003). Food utilization refers to meeting individuals’ physiological needs to reach a sound nutrition well-being and it stresses on the significance of non-food inputs. It combines food safety and quality issues (*i.e.*, clean water, sanitation, health care) with the adequate diet intake to enable the absorption of nutrients (Clay 2002; Webb and Rogers 2003). The food stability dimension was ingrained in the literature after stipulating “all times” in the FAO’s food security definition (1996). Food stability addresses the inherent, impending or conditional risks such as a sudden shock (*e.g.*, economic or climatic crisis) or cyclical events (*e.g.*, seasonal food insecurity) that affect the other food security pillars – availability, access and/or utilization (Clay 2002; Webb and Rogers 2003). Finally, according to Webb and Rogers (2003), the first three pillars follow a certain hierarchy:

"food availability is necessary but not sufficient for access, and access is necessary but not sufficient for utilization". The stability pillar requires understanding the risks an individual's food insecurity might be exposed to.

4. Food security measurements

The measurement of food security is vital since it guides policymaking and development interventions. Historically, the emphasis of policy and development interventions was on the availability dimension. Nevertheless, availability does not guarantee access and access does not guarantee utilization (Webb and Rogers 2003; Pinstrup-Andersen 2009; Barrett 2010). Therefore, in order to have a more holistic picture of the power, distribution, agency, and consumption behavior, food access and utilization pillars must also be measured (Pinstrup-Andersen 2009; Barrett 2010).

Numerous types of quantitative measurements and indicators are utilized to explore the food availability, access and utilization conditions at different levels: national, regional, community, households and individual. For example, national food production and import numbers, months of inadequate household food provisioning (MIAHFP), dietary diversity, caloric intake, coping strategies, food expenditure, and anthropometric measures (Swindale and Bilinsky 2006; Pinstrup-Andersen 2009; Chappell and LaValle 2009; Barrett 2010). Rather than merely aggregating regional and national measurements, such indicators emphasize the individual and household levels; hence, results in development interventions that address "poverty reduction, food price, and social protection policies" (Barrett 2010: 826).

Furthermore, to better understand food security it is also crucial to use qualitative measurements along with the quantitative measurements. Often, qualitative measurements are guided by the target community's subjective perception such as their own definition of food security/insecurity and/or accessing (Maxwell 1996; Kennedy 2002; Morris, Mendez and Olson 2013). Such kinds of measurements data are collected using in-depth interviews, semi-structured interviews, and focus groups. Finally, in order to have a more holistic picture of food security both quantitative and qualitative data should be utilized to complement each other and to triangulate.

5. Definition of food insecurity

Basically, food insecurity is the opposite of food security. Hence, as per the FAO (2002), it is defined as "a situation where individuals at times, have limited availability, lack of physical and economic access to sufficient safe and nutritious food that is needed to maintain an active and healthy life". Furthermore, food insecurity is generally found amongst those who have been victims of wars and conflicts, urban poor and low-income households particularly in developing nations, and women who are more vulnerable to food insecurity especially those residing in low-income households (European Commission 2009; FAO 2011). In addition, food insecurity is a major public health issue, and it is significantly considered an index of health and well-being since it is linked to other fundamental factors such as limited social capital, poverty, illness, and poor dietary intake (Hadley *et al.* 2006).

6. Types of food insecurity

Von Braun *et al.* (1992) differentiated between two types of food insecurity: chronic and transitory food insecurity.

i. Chronic food insecurity occurs when the shortage of food lasts for long periods of time and is a result of poverty where there is lack of productive and financial resources (FAO 2008).
ii. Transitory food insecurity results from a temporal shortfall of food and lasts for short periods of time. It is deeply rooted with factors like short-term shocks and limited food availability attributed to food price fluctuations (FAO 2008).

According to Misselhorn *et al.* (2010), these two types of food insecurity are interrelated since chronic food insecurity is entrenched in one or more transitory shocks. The relationship between the two food insecurity types is indicated by the coping strategies household employ. This is clearly revealed in the poverty trap process where in an attempt to cope with transitory food insecurity a household is more likely to sell off its assets, therefore sacrificing their ability to produce or obtain food or income sequentially and resulting in chronic household food insecurity (Staatz *et al.* 2009).

7. Causes of food insecurity

There are many causes for food insecurity; the major ones are:

i. Population growth and urbanization: Over the past few decades, the world population has been rapidly growing hence increasing the burden of meeting increased food demand (McDonald 2010; Cargill 2012). The United Nations (2012) estimated that by 2050 the global population will reach 9.3 billion with 70% of the world's population living in urban areas. Many researchers and international bodies have been studying the impact of population growth and urbanization on food security (FAO 2006; UNICEF 2010; Ruel *et al.* 1998; Maxwell 1999; Olagunju 2012). Furthermore, urban food insecurity challenges are associated with many factors such as poor sanitation and lack of access to clean water, lack of housing, and increased rates of crime and corruption (Van der Merwe 2011).

ii. Low agricultural production**:** It is well-known that food security is highly associated with the agricultural sector, yet the world agriculture sector is hampered due to many factors such as environmental degradation, climate change, low soil fertility, pre-and post-harvest production loss, etc. (Salih 1994; Maxwell 2001; Clover 2003; FAO 2006; Erickson and Vollrath 2007; Ababa 2011; European Union 2012).

iii. Poverty**:** The link between poverty and food insecurity is complex. Poverty encompasses aspects from various issues such as historical, economic, social, environment, cultural, spatial, psychological, national and international issues (Swift and Hamilton 2000; Bonti-Ankomah 2001; Clover 2003; Burns 2004; the World Bank 2011). Also, poverty increases the likelihoods of and leads to many other problems such as hunger, starvation, malnutrition, reducing life expectancy, and illiteracy (Isliamia 2004).

iv. Income inequality**:** A significant increase in income inequality has been revealed worldwide in the last few decades, especially in developing countries (Jaumotte *et al.* 2008). In low-income countries, a large share of the household income is dedicated to food consumption (European Union 2012), where it is estimated that

almost 70% of the poor household income is spent on food (Staatz *et al.* 2009). As per UNEP (2012), the average food intake per person in developing countries is far lower than in developed countries and has led to malnutrition and chronic hunger mostly among women and children under five years.

v. Health issues**:** The livelihoods of many people around the world is threatened by disease and infections such as HIV/AIDS, malaria and tuberculosis. Diseases and infections negatively influence poor households' income (*i.e.*, fewer working days due to illness) and hence result in long-term vulnerability to food insecurity (De Waal 2003; Haile *et al.* 2005; Mwaniki 2011).

vi. Natural disasters**:** Natural disasters negatively impact the national economy and livelihoods of individuals, and hence their food security (Clover 2003; FAO 2005; De Haen and Hemrich 2006; Abdulla 2007; Zahn 2012).

vii. Food prices**:** Global food prices affect national-level agricultural production and supplies of food, which in turn affect household food security status. For instance, during the 2008 global financial crisis, food prices increased which in turn worsened food insecurity worldwide with particularly negative impacts on developing countries (UN 2009; FAO 2010; Prain 2010; McDonald 2010; Swinnen and Van Herch 2010; Chang and Hsu 2011; Thompson 2012). According to the FAO (2008), more than 1 billion people in 2009 were not able to have enough food globally, which is 85 million more than in 2008 and was the highest number recordedsince the late 1970s.

viii. Political instability and poor management**:** In developing countries, policymakers focus on their best self-interests instead of enhancing the policies, structures and institutions for their societies' benefit (Mwaniki 2011). Therefore, a major challenge in developing countries is the poor governmental management system which results in ineffectiveness of policies and strategies and hence impacts the country's food security and sequentially the household food security status (Rosen and Shapour 2001; Mukherjee 2008). In addition, the correlation between food insecurity and political instability is very complex where food security at the household level is significantly impacted by the conflict within the country

(Maxwell 2012) which is the case of the majority of developing countries that are affected by conflicts (Bakker 2011).

8. Consequences of food insecurity

The three major consequences of food insecurity are: hunger, malnutrition and vulnerability.

i. Hunger: is by definition "the uneasy or painful sensation caused by lack of food or the recurrent and involuntary lack of access to food" (Anderson, 1990, pp. 1575–1576). According to FAO (2010), approximately 800 million people went to bed hungry every day globally during the period of 1950 to 2005.

ii. Malnutrition**:** In order to maintain growth and wellbeing the individual needs to meet a specific intake of calories, protein and sufficient minerals. However, when an individual experiences malnutrition this means there is a general deficiency that is caused by the lack of sufficient minerals like vitamins and iron (Folaranmia 2012). Furthermore, malnutrition is mostly prevalent in developing countries among poor households and chiefly adversely affects children under 5 and women (Nnakwe and Yegammia 2002; Bello 2009). Much research has revealed that there is a strong correlation between food insecurity and malnutrition (Nnakwe and Yegammia 2002; Bello 2009; Osei *et al.* 2010; Folaranmia 2012). It is recognized that malnutrition is deeply rooted in absolute poverty (Bello 2009).

iii. Vulnerability: is the "exposure to contingencies and stress, and difficulty in coping with them" (Chambers 1989, pp. 2). Vulnerability is of two types: an external side of risk, shocks, and stress to which individuals and households are subject, and an internal side which is defenselessness due to the lack of means to cope without damaging loss (Chambers 1989). Vulnerability to food insecurity incorporates both types as it includes the current prevalence of limited food intake along with potential food insecurity future risk (European Commission 2006).

9. Determinants of household food (in) Security: Empirical review

Prior studies found household income, household size, education level, gender and age of the household head as the main determinants of household food security status.

i. Household income: is defined as the total monthly household income from all sources (Jacob, 2009). It is also the most critical determinant of household food security status. Prior research revealed that the likelihood of low-income households to suffer from food insecurity is higher in comparison with middle income and wealthy households (Carter, Taylor and Levenson 2005; Omonona *et al.* 2007; Jacob 2009; Bashir, Schilizzi, and Pandit 2012).

ii. Household size: is measured by the number of members in the house (Feleke, Kilmer and Gladwin 2005). It is expected that the food consumption increases as the number of the household members increases (Feleke, Kilmer and Gladwin 2005; Jacobs 2009; Amaza *et al.* 2009; Aidoo, Osei Mensah and Tuffour 2013).

iii. Education level**:** Many studies showed that the household food security status is positively impacted by the education attainment of the household head (Kidane, Alemu and Kundhlande 2005; Shumiye 2007; Bashir, Schilizzi, and Pandit 2012).

iv. Gender of the household head**:** The literature revealed that the household is more likely to be vulnerable to food insecurity and poverty if the household is female-headed when compared with male counterparts (Franye *et al.* 2009; Carter *et al.* 2010; De Cock *et al.* 2013; De Cock 2012; Olagunji *et al.* 2012; Kassie *et al.* 2013).

v. Age of the household head**:** It has been shown that households with older household heads are more prone to food insecurity since older members are more likely to be retired or cannot adapt as effectively to the ongoing challenges and increasing needs of the labor market as younger household heads (Omonona *et al.* 2007; Heidhues 2009; Pankomera, Houssou and Zeller 2009; Bogale and Shimelis 2009; Bashir, Schilizzi, and Pandit 2012).

B. Climate Change: Impacts on agriculture, adaptation strategies, and effect on food security:

1. Climate change impacts on agriculture

Agriculture plays a key role in many smallholder farmers' livelihoods and economic development. A major determinate of the farm productivity is the climate variability especially in rain-fed farming systems (Arendse and Crane 2011; Branca *et al.* 2012; Mkisi 2014). Many researchers have been claiming that due to the increased concentration of greenhouse gases (GHGs) in the atmosphere the current trends in climate variability will continue to happen in spite of any interventions (Stockholm Environment Institute 2007; Ziervogel *et al.* 2008; Arendse and Crane 2011; Chidanti-Malunga 2011; Branca *et al.* 2012). Climate variability is evident through the frequency and intensity of prolonged floods, droughts, destructive storms and increasing variability and unpredictability of rainy seasons. According to FAO (2004 and 2011b), the most affected communities with these climate variations are smallholder farming ones whose primary source of livelihoods is agriculture.

Research has revealed that in order to meet the growing population's demand for food the agriculture sector is and will continue to struggle (Mkisi 2014). The agriculture community will be facing further stress due to the climate change and its associated variability such as meeting the society's food needs along with food insecurity issues (FAO 2009 a). Moreover, FAO (2011b) highlighted the numerous impacts climate change has on the agriculture sector, emphasizing that the effect varies from one geographical region to another. For example, the predictability of seasonal weather patterns was reduced in some areas resulting in either prolonged droughts and water shortages or increase in the frequency of floods (FAO 2011b). As a result of the varying rainfall patterns and increasing temperatures, a direct negative impact was shown on crop growth (FAO 2011b). Furthermore, the climate variability effects were clearly noticed through the reduced availability of water for irrigated and rain-fed agriculture, as well as increased incidences of disease and pests attack (FAO 2011a, 2011b). Due to the reduced availability of water in both rain-fed and irrigated agriculture the major cereal crop yield productivity will potentially be affected (Schlenker and Lobell 2010; FAO 2011b).

Climate change is also expected to impact livestock. To illustrate, the rainfall amount and distribution variability causes reduction in the water availability that is used to grow healthy forage leading to reduction in the livestock feed quality and quantity. Moreover, the temperature increase is known to create a suitable environment for parasite growth, resulting in increased rate of disease pathogen transmission as well as outbreaks (JotoAfrica 2009; FAO 2011 b). Therefore, the livestock and livestock products would decline due to the increase in parasites and the reduction in forages quality and quantity (Mkisi 2014).

2. Climate change framework

The literature on climate change and climate change adaptation experienced a substantial growth in the last decades where more researchers revealed an interest in studying this critical global issue.

In response to anticipated environmental stimuli agriculture climate change adaptation strategies are adopted. Examples of environmental stimuli that are caused by climate change are increase in temperature, droughts, and erratic rains. Those stimuli affect a given entity that is the exposure units which can be social, human and nonhuman systems derived from regulated/specific climatic conditions (Eisenack and Stecker 2011). Adaptation to climate change is stimulated principally when the exposure units (*i.e.*, systems) are impacted by variation in climatic conditions (Neil Adger, Arnell and Tompkins 2005).

In this case, the operators (e.g. extension service provides) and the individual receptors (i.e. smallholder farmers) may implement climate change adaptive strategies together (Mkisi 2014). The operators' activities are meant to reduce the adverse effects of climate change on the exposure units who are generally allied with the receptors/adaption main target (i.e. farmers) (Mkisi 2014). The operator of adaptation (i.e. institutions) must have access to resources (e.g. information, technical knowledge and skills) to ensure that the information regarding the effective adaptive strategies will reach smallholder farmers (Eisenack and Stecker 2011). According to Ziervogel *et al.* (2008), the significance of these resources is shown when smallholders are influenced to alter their current detrimental farming activities.

Smallholder farmers are failing to adopt climate change adaption strategies mainly because of barriers which are "a set of conditions that hinder the implementation of specific adaptation but are not necessarily absolute limits to adaptation" (Eisenack and Stecker 2011, pp. 11). For example, in this case a principle barrier facing smallholder farmers might be the absence of the operator (i.e. extension services); hence, due to the lack of knowledge, skills and information that the farmer needs s/he will fail to implement effective climate change adaption strategies (Mkisi 2014).

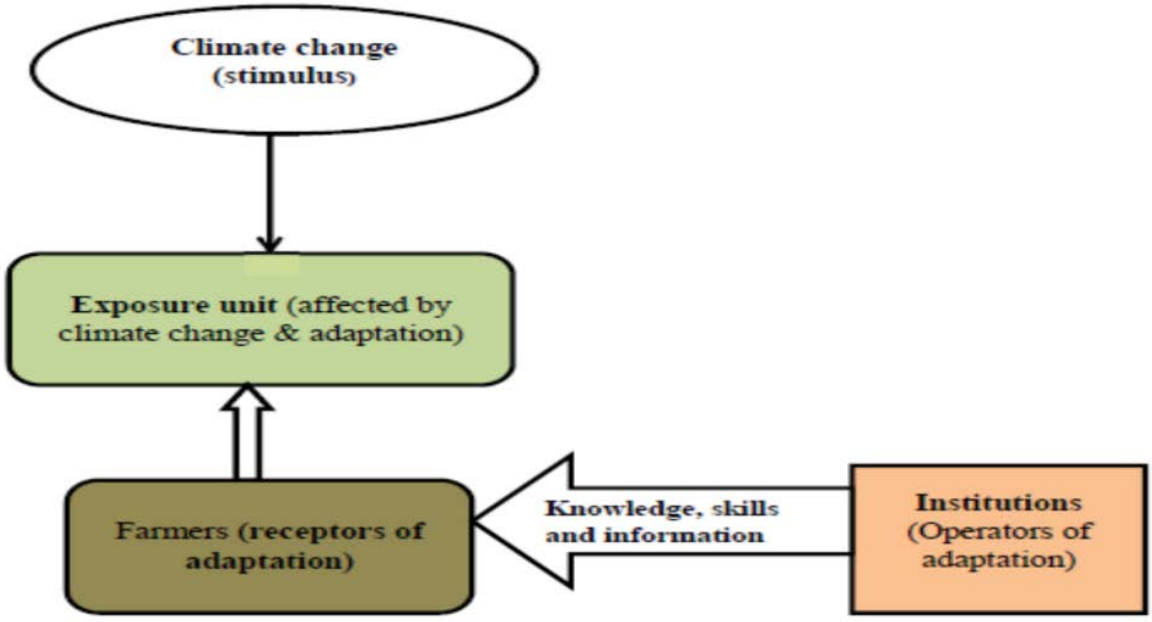


Figure 2: Climate change adaptation framework

Source: Eisenack and Stecker, 2011

In a nutshell, agriculture is very sensitive to climatic conditions which make it the most vulnerable sector to global climate change risks and impacts. Numerous studies have revealed that proper adaptation to climate variation significantly reduces the farming system's vulnerability and increases its benefits (Bradshaw *et al.* 2004; Maddison 2007; Brown and Crawford 2009; FAO 2011b). According to Maddison (2007), Deressa *et al.* (2010) and Mkisi (2014) the agriculture adaptation to climate change is a two staged process, where "the first stage requires that the smallholder farmers recognize and accept that climate change is happening and is having adverse impacts on their economic livelihoods. This would then necessitate the second stage of

the smallholder farmers taking actions in response to the expected negative impacts on their livelihoods." (Mkisi 2014, pp. 20-21).

3. *Agriculture adaptation to climate change - climate-smart strategies*

Since decades ago, smallholder farming communities have been testing and implementing a range of agriculture adaptation strategies to respond to the changing environment being it variability in climate and/or weather conditions (Organisation for Economic Co-operation and Development [OECD] 2012). According to IPCC (2007), climate change adaptation is defined as "initiatives and measures to reduce the vulnerability of natural and human systems against actual or expected climate change effects" (p. 809). Various studies revealed that farmers primarily base their adaptation practices decisions on the strategies familiarity and tangible individual-level benefits (Jackson *et al.* 2010; Arbuckle, Morton and Hobbs 2015). Accordingly, most of the suggested agriculture climate adaptation strategies in the recent literature are not new nevertheless have been evolving from traditional practices (Mortimore and Adams 2001; Neil Adger, Agrawala, and Mirza 2007; Nzeadibe *et al.* 2012; Mkisi 2014; Douxchamps *et al.* 2015). The literature recorded a wide array of farming strategies that smallholder farmers have been practicing to adapt to climate change, mainly adjustments to farm and crop management, soil and water conservation strategies, planting trees/shrubs in agriculture crop and livestock production systems, and diversification of income sources beyond the farm.

i. Adjusting to farm and crop management practices include: crop diversification, inter-planting (mixed cropping), varying crop planting dates, planting early maturing crop cultivars, and planting drought- or disease-resistant crops (Van Noordwijk and Van Andel 1988; Maddison 2006, 2007; Ngigi 2009; Gbetibouo 2009; Deressa *et al.* 2010; Chidanti-Malunga 2011; Nzeadibe *et al.* 2012; Below *et al.* 2012; Tambo and Abdoulaye 2013; Mkisi 2014; Kassie *et al.* 2014; Kihupi *et al.* 2015; Douxchamps *et al.* 2015).
ii. Adopting soil and water conservation practices (i.e. conservation farming) include use of organic manure and inorganic fertilizer, use of shading and

mulching, changing irrigation systems, rain water harvesting, minimum to zero tillage, and planting cover crops (di Falco, Veronesi and Yesuf *et al.* 2011; Below *et al.* 2012; Mkisi 2014; Kassie *et al.* 2015; Kihupi *et al.* 2015). According to Douxchamps *et al.* (2015), soil and water strategies increase soil water content and maintain humidity during dry spells by improving soil structure. Also, when a farmer applies mineral fertilizer the farm yields will increase thus building up financial and food reserves for the household (Douxchamps *et al.* 2015).

iii. Planting/retaining trees and shrubs in agriculture crop and livestock production systems is another widely studied climate change adaptation strategy (Deressa *et al.* 2009). This strategy is crucial due to many reasons: some trees serve as a source of food (Below *et al.* 2012; Faße, Winter and Grote 2014; Mkisi 2014; Kassie *et al.* 2015; Brüssow 2017); trees protect from wind and sun if planted with the field (intercropping) or around the field (Ariga 1997; Branca *et al.* 2011); trees provide shade, biomass and additional source of income (e.g. fuel wood, charcoal, timber or fibre) (Ariga 1997; Akinnifesi *et al.* 2008; Branca *et al.* 2011); trees maintain or increase soil fertility and moisture retention by generating soil organic matter (FAO 2010); and trees function as live fences along with various ecological functions (Ariga 1997; Branca *et al.* 2011; Lasco *et al.* 2014; Douxchamps *et al.* 2015).

iv. Diversifying of household income sources beyond farm activities such as self-employment, off-farm wage, and mixed crop-livestock farming is another form of climate change adaptation strategies that are presented enormously in the literature (Hisali *et al.* 2011; Tibesigwa *et al.* 2015; Douxchamps *et al.* 2015; Brüssow 2017).

4. Climate change/adaptation impact on food security

Although there are few impact studies that relate climate change adaptation to food security (Brüssow 2017) other studies were able to show that climate change worsens the smallholder farmer's food security situation causing higher rates of malnutrition and hunger (Mkisi 2014). Moreover, academic scholars and professionals

affirm that the main reasons behind the challenges of the global agricultural production and the smallholder farmers' food security are attributed to the climate change and its associated variability (Smit and Skinner 2002, FAO 2009, 2011a, Mkisi 2014).

In order to adapt to a changing climate, it is vital to promote behavior changes in agriculture practices. The adoption of climate change adaptation strategies and technologies will limit the impact of climate change on agriculture production henceforth, improving the livelihoods and food security among millions of smallholder farming households in rural areas (van de Giesen *et al.* 2010; Vermeulen *et al.* 2012; Mkisi, 2014). According to a study by di Falco, Veronesi and Yesuf (2011) in Ethiopia, there is a positive impact of adaptation to climate change on food security. In the same study, farmers were asked about the strategies they used to when they perceived changes to climate over the past two decades and most responded that they adopted soil/water conservation strategy, planted trees, or changed their crop variety (di Falco, Veronesi and Yesuf 2011).

CHAPTER 3

CONCEPTUAL FRAMEWORK

This section presents an overview of how various theories and concepts are linked to this specific research. In order to provide evidence-based research, investigate and fulfill the thesis's objectives a conceptual framework based on robust and relevant theories is introduced. When designing this conceptual framework, the researcher surveyed existing frameworks focusing on sustainable livelihoods, food security, climate change, and resilience and vulnerability pathways.

The conceptual framework is presented in Figure 3 below, which is adapted from FAO (2016) theoretical framework on the effects of climate change on food security; Ellis (2000) rural livelihoods diversification framework; TANGO (2012) resistance conceptual framework and Sassi (2015) food security framework. It is challenging and hard to conduct research that encompasses the whole four frameworks. Hence, the conceptual framework applied in this thesis combines a part from each of the four above mentioned frameworks.

The research focuses on the household level, which is the unit of analysis. First, it is crucial to take into account the smallholder farmers' complex and dynamic nature; i.e., in its economic, ecological, socio-cultural and political terms. Farming communities encounter numerous variations in climate change and other factors (e.g., political and market trends) thus influencing the smallholder farmers' household food security status by limiting the food availability, accessibility, utilization, and stability as shown in Figure 3.

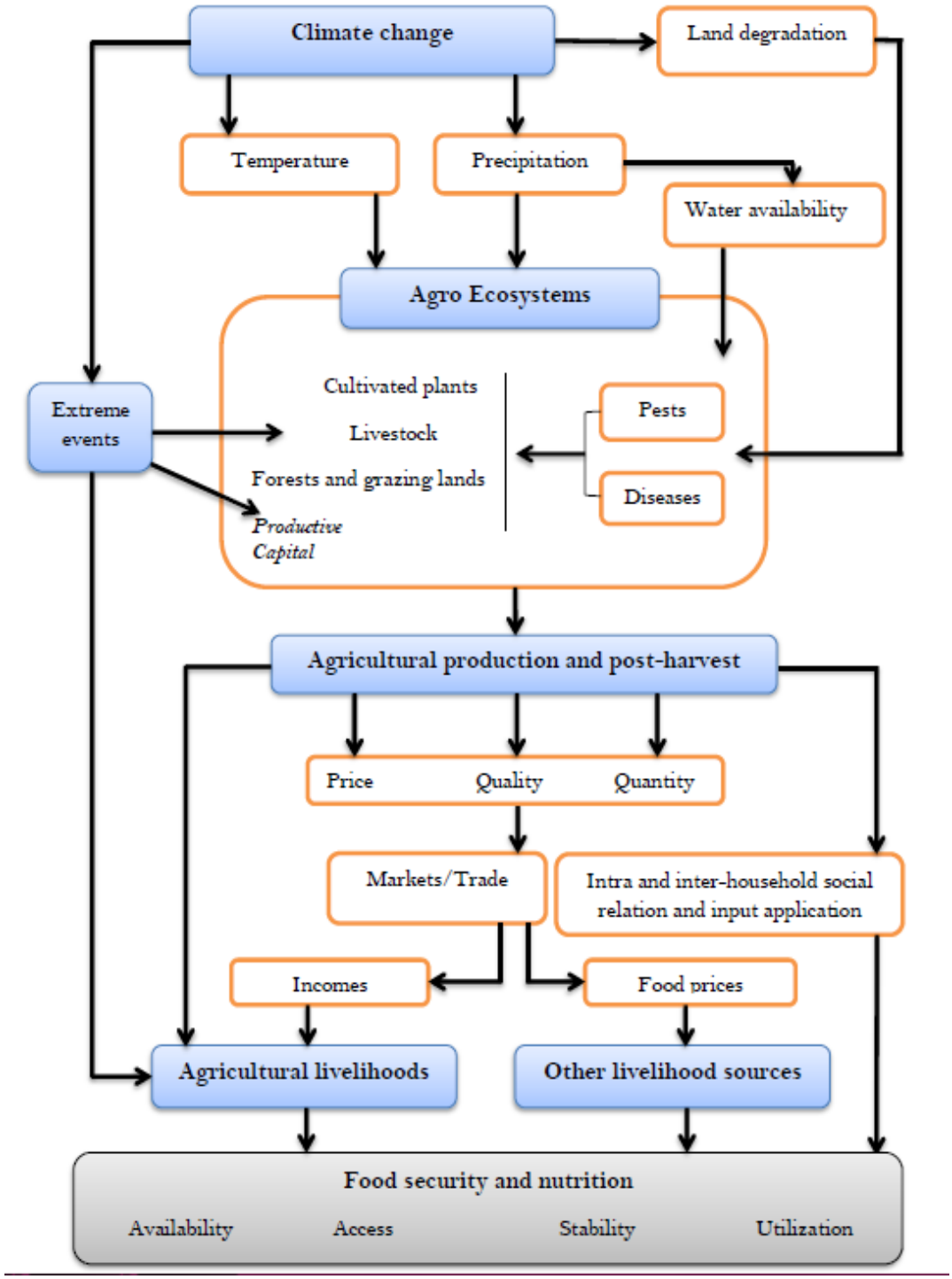


Figure 3: Theoretical framework on the effects of climate change on food security

Source: *Adapted FAO (2016)*

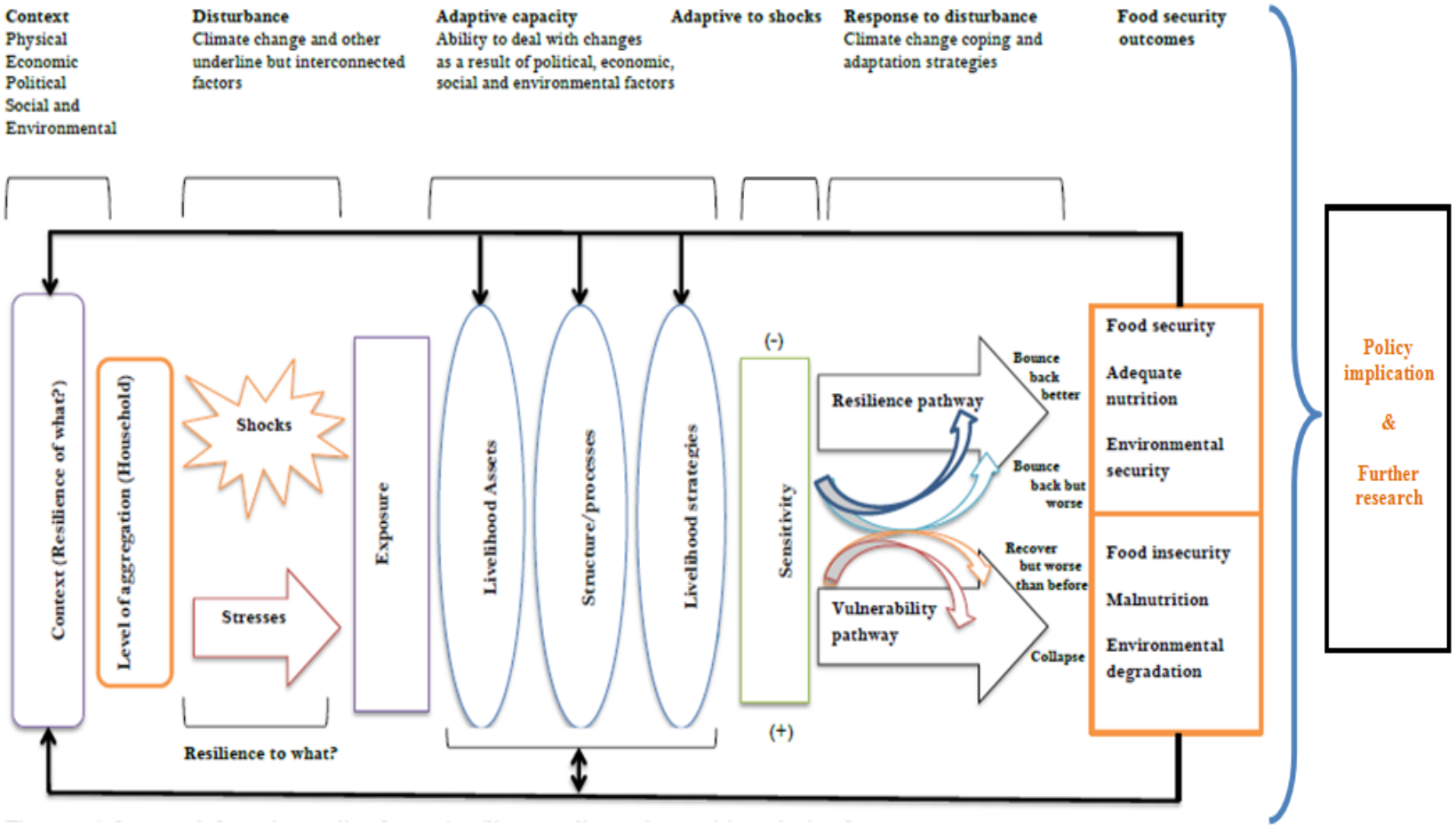


Figure 4: A framework for understanding smallholder farmers' resilience to climate change risks effect on household food security.

Source: Adapted from Abebe, 2017

It is proven that alteration in temperature and rainfall in both intensity and seasonal distribution along with extreme events will adversely impact agriculture production (FAO 2008; OECD 2014; FAO 2016). Also, there is evidence that climate change may increase the effects of weeds, pests and diseases on production (Kilawe *et al.* 2016). Moreover, climate change impacts the economic ability of farmers to buy quality seeds and fertilizers. Rojas-Downing *et al.* (2017) revealed that climate change impacts the grazing and fodder yield and water sources can alter cattle production. As shown in Figure 2, alteration in the production pattern has a negative impact on intra and inter-household reciprocal social networks and in turn affects the farmer's participation in various activities, mainly social ones.

Indeed, climate change is shown to impact the individual's health, livelihood, assets, distribution channels, purchasing power as well as market flows (FAO 2008). Food prices are impacted by climate change where it results in a reduction in the food production and hence availability putting the household and local market at risk of food scarcity. Further, climate change affects agriculture livelihoods as well as other income-generating activities. The effect of climate change on farmers' food security and nutrition is well summarized by FAO (2016):

> *Climate change is profoundly impacting the condition in which agricultural activities are conducted. … The effects of climate change on production are translated into social and economic consequences through a range of different pathways that can result in changes in agricultural incomes, food markets, prices and trade patterns, and investment pattern. They can impact physical capital. They can force farmers to sell productive capital, for instance cattle, to absorb income shocks. They can reduce the capacity to invest. This directly bears social impacts on households, limiting their capacity to face other expenditures, such as health and education. … Ultimately, the impact of climate change risk on agricultural incomes depends on the effects on production, on markets and prices. … These risks can impact directly the four dimensions of food security and nutrition: agricultural production (availability), access to food (sufficient income), utilization (nutrition, quality) and stability.*

In response to the various shocks, stresses and trends, any community faces a dialectical process that occurs and results in a unique household strategies portfolio. This applies to the effect of climate change on community and farmers' household levels. It is expected that the impact will vary from one community to another and among different socio-economic groups.

Household response differs mainly due to its characteristics, access to productive assets and resources, available income sources and opportunities, access to social services and community support traditions (Baptiste and Kinlocke 2016). Besides, various studies revealed that although farmers' food security is highly dependent on the intensity and severity of the shocks and stresses yet, a key driving factor is their vulnerability and adaptive capacity to deal with disturbances (DFID 2012; TANGO 2012; and OECD 2014). FAO (2016) highlighted the social vulnerability dimension:

> *Social vulnerability examines the demographic, social, and economic and other characteristics of the population that affect their exposure to risk and their ability to respond to and cope with negative shocks. [Moreover], a social vulnerability lens is essential to understand why certain individuals, households or communities experience differences in impacts even when they are in the same geographic region.*

The framework represents the households' strategies portfolio components which are adaptive capacity, adaptation to shocks, response to disturbance, and food security outcome. The household strategy portfolio can boost or prohibit the household's ability to cope and adapt to endogenous and exogenous trends, shocks and stresses. On a more profound level, the household vulnerability to the climate change effect is determined by the level of exposure, sensitivity and adaptive capacity. The social dimension of climate change adaptation is clearly summarized by UNFPA *et al.* (2014):

> *Adaptive capacity, exposure and sensitivity are shaped by many non-climatic, socio-economic factors, such as access to and control over economic, social and institutional resources. These resources comprise: human capital, such as good health, skills, knowledge and education; social capital, including the power to influence decision-making …; physical capital, such as shelter, farming tools, but also community infrastructure such as embankment or terraces that protect a watersheds and healthcare facilities …; natural resources, including land and water; and financial capital, such as income, savings or credit. Whether or not people have access to these resources in turn depends greatly on social, political and economic conditions and institutions at both local and global levels … that shape peoples' lives. An enabling institutional environment that empowers people and allows them to gain access to the resources they need for their well-being and the resilience of their livelihoods is therefore crucial for adaptation.*

Many studies affirmed that to pave the road for an appropriate social safety net (Yilma *et al.* 2014) and effective climate change policies (Huang 2014) it is vital to understand the available risks, vulnerabilities, and coping mechanisms the household faces. Also, the household variation in selecting their strategies produces either a diversified or specialized livelihood. Besides, it is critical to distinguish the factors that impact whether the response to shocks, stressors, and trends moves the household into better or worse off position as well as to recognize the influence of those factors on the farmers' agro-system management approach. Ultimately, these factors tremendously affect the household food security outcome.

In a nutshell, this conceptual framework is primarily founded on the resilience theory to comprehensively understand the influence climate change adaptation strategies have on the vulnerability and resilience to food security at the household level. By utilizing this framework an in-depth understanding of the complex and inter-linkage means food secure farmers uses to move away from the vulnerability pathway and hence building and maintaining a resilient path (FAO 2012; ODI 2012).

Context refers to the complex interconnected environmental, economic, social, and physical factors that affect households' adaptive capacity to deal with shocks and stresses.
Level of aggregation refers to the unit of analysis at different sectors or geographical levels. Household is the unit of analysis for this study.
Disturbance can occur in the form of slow onset or rapid onset shocks or long-term stresses (TANGO 2012). The earlier concept refers to sudden events such as droughts with a negative impact on people's means of living. Long–term trends are environmental degradation, loss of production, population growth and climate change. The study of OECD (2014) identifies three types of shocks. First, covariate shocks are frequent events that affect a wider geographical area. Second, idiosyncratic shocks affect only specific groups such as the elderly, children, and people with disabilities and chronically ill who cannot participate in income-generating activities. Third, seasonal or recurring shocks occur at some time of a year. Annual food price rise and flooding following the rainy season are examples.
Exposure is a function of the magnitude, frequency, and duration of shocks. Sensitivity refers to the degree to which farmers will be affected by climate change risks.
Adaptive capacity is determined by farmers' ability to adjust or cope with the impacts of climate change. It is a function of exposure, sensitivity and adaptive capacities to deal with disturbance. The concept of adaptive capacity encompasses two dimensions that play an essential role in resilience (FAO 2016a): recovery from shocks and response to changes. The concept includes three interconnected elements. *Livelihood assets* include the tangible and intangible assets such as financial; physical; political; human; social and natural. *Structures and processes* refer to the formal and informal institutions relevant to manage economic and environmental risks. *Livelihood strategies* represent the distinct or combined strategies that households pursue to make a living and cope with shocks.
Sensitivity is determined by the degree to which ha ousehold will be affected by a certain shock or stress meaning that greater sensitivity implies a lower degree of resilience whereas lower sensitivity implies greater resilience.
Resilience and vulnerability concepts are viewed as processes rather than static states. Farmers who are able to use their adaptive capacity to manage the shocks are less sensitive and are on a resilience pathway. On the other hand, households that are not able to use their adaptive capacity to manage shocks or stresses are sensitive and are on a vulnerability pathway. As Figure 4 shows farmers on the resilience pathway can be divided into two: bounce back better and bounce back worse than before worse. Households on the vulnerability pathway are similarly grouped into two: recover but worse than before or collapse.
Food security outcomes refer to resilient farmers who will be able to meet their food security needs and will have access to adequate nutrition, health security, educate their children and their environment will be protected as well as participate in decisions. Vulnerable households on the other hand experience deficits in each of these aspects.

Table 1: Resilience framework elements

Source: Adapted from Abebe, 2017

CHAPTER 4

MATERIALS AND METHODS

A. Research approach and methodology

The research methodology is defined by Leedy, Ormrod and Johnson (2001) as "the general approach the researcher takes in carrying out the research project." This study uses the quantitative research approach. In quantitative research, the researchers "employ strategies of inquiry (e.g. experiments and surveys) and collect data on predetermined instruments so that information can be quantified and subjected to statistical treatment in order to support or refute alternate knowledge claims" (Creswell 2013).

B. Study design

Study design is vital to any research since it is a safeguard against bias, maximizes the reliability and reduces economic completion of the study (Kothari 2004). When developing the design, the researcher is meant to explore changes over time among the targeted group (Leedy, Ormrod and Johnson 2001).

1. Research Design

This case study is an explanatory one where the researcher closely observes the data to give explanations. To illustrate, household data were examined to reveal the prevalence of food insecurity among smallholder farmers in central Bekaa.

2. Study Settings

Lebanon administrative division is divided into eight governorates; each governorate is subdivided into districts, and then municipalities (consisting of cities, towns, and villages). The largest governorate by physical area is the Bekaa, which is made up of five districts: Hermel, Baalbak, Zahle, the Western Bekaa, and Rashaya. Since ancient times the Bekaa valley has been a domineering agricultural region, referred to as Coele-Syria (Hollow Syria) by Alexander the Great and was known as the breadbasket of Rome during the empire's era (Doyle 2016).

The thesis study area is central Bekaa which in itself is not a distinct administrative area but covers part of two districts: the northern half of Zahle and the southern third of Baalbek. Central Bekaa was selected as the study area due to many considerations. Even though Lebanon has farming in seven of its eight governorates, the agriculture sector's backbone in Lebanon is the Bekaa valley which is the most productive of all governorates. Moreover, comparing to other districts, smallholder farmers in the central Bekaa region produce a wide variety of crops (e.g., wheat, potatoes, fruit trees, vegetables, and grapes), unlike smallholder farmers located in the northern and western Bekaa who grow relatively homogenous crops. Furthermore, central Bekaa is a center of agricultural trading with neighboring countries (Allam 2011).

Notwithstanding the significance of the agriculture sector in the central Bekaa region, it has been facing a lot of obstacles. Central Bekaa's crop is similar to that of the neighbors' countries which makes it in competition with them, unlike other regions in Lebanon where most produced crops (e.g., citrus fruits on the coast) does not compete with what neighboring countries produce. Thus, this puts central Bekaa smallholder farmers at a competitive disadvantage with neighboring countries' farmers who are directly competing with their crops in both domestic and export markets. Briefly, the central Bekaa's smallholder farmers are facing multifaceted systematic problems ranging from limited natural resources mainly water, environmental challenges particularly climate change, changes in the social values, trade liberalization's negative impact. This is provoking those smallholder farmers to price out of the market thus leading the farming sector in this region to collapse (Allam 2011).

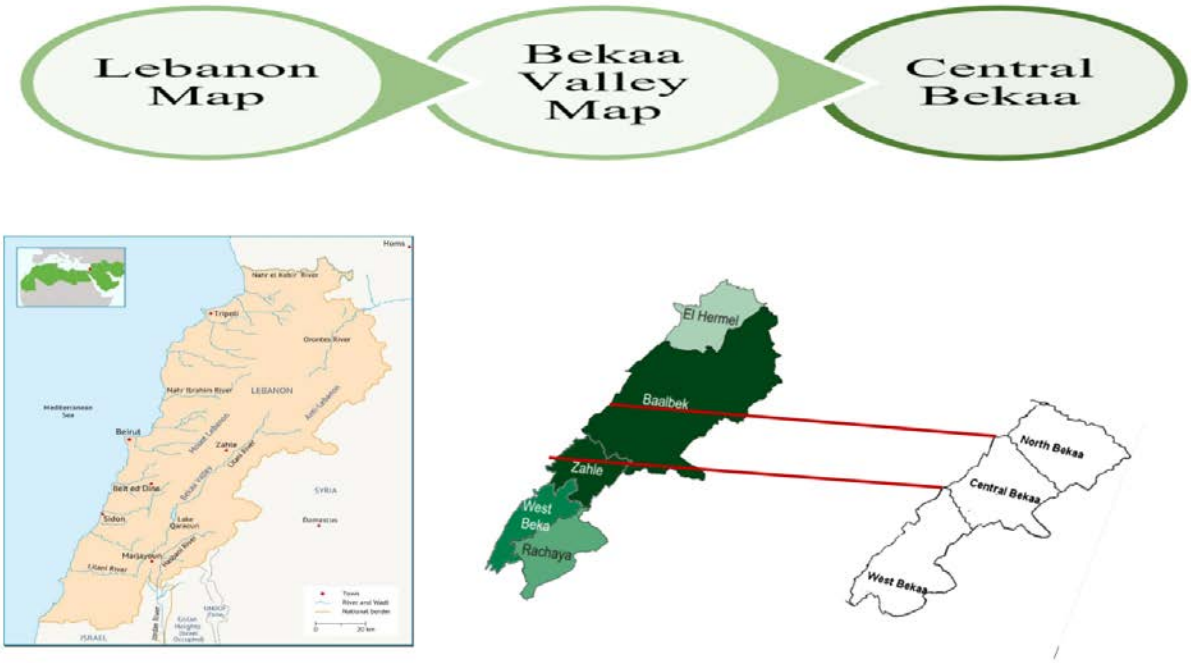


Figure 5: Study area on the map

3. Population and sampling technique

This study is based on a cross-sectional rural household survey. The survey provided data that were used in the quantitative analysis, such as to model smallholder farmers' attitudes, perceptions and knowledge towards adaptation practices to climate change and analyze the impact of those adaptation strategies on food security. Due to time constraints, it was impractical to include every smallholder farmer in this study so the respondents were chosen based on the following criteria: only smallholder farmers were selected, being aged 18 or above, being a tenant or owner of the land. A probability sampling method was applied in the study. First, 9 villages were purposely selected to ensure a degree of cultural (religious) and socio-economic diversity. Then, the researcher directly approached smallholder farmers on site and invited them to participate in the study. A simple random sampling was used to select farming households. From Rayak, Qasarnaba and Khraibeh 20 households were interviewed while from Chmastar, Hosh el Rafika, Temnin el Fawka, Nabi Cheit, Niha Bekaa and Bednayel 10 households were interviewed. In total, 120 smallholder farmers were interviewed during the survey in Fall 2018. This sampling technique was chosen because it is a practical way to consider the heterogeneity aspect of the small-scale farming population in the study area. In random sampling "each

individual has an equal probability of being selected from the population, ensuring that the sample will be representative of the population" (Creswell 2013).

4. Data Collection

Quantitative primary data were collected through a household questionnaire that was administered to 120 randomly-sampled smallholder farmers from 9 villages. These questionnaires were distributed and completed through personal interviews, face to face. A standard questionnaire was used to ask same questions for all respondents in a minimal amount of time (Owens 2002). Questionnaire responses were anonymous and Institutional Review Board (IRB) approval was obtained prior to the commencement of data collection to conduct research in the study area. Data collection took place in Fall 2018.

In each sampled household, respondents were interviewed. The head of the household was eligible to answer to climate change related questions. However, food security related questions including food consumption and coping strategies were only completed by the person in charge of household food preparation. The structured questionnaire was developed in English and then translated to the local language (i.e., Lebanese Arabic dialect) including closed-ended questions. The questionnaire was divided into the main areas of the investigation except for the first part which captured the socio-demographic characteristics of the respondents. The questionnaire was completely anonymous, and no personal identifiers (e.g., name and phone) were collected. To illustrate, the first part of the questionnaire asked about the smallholder farmers' demographic and socio-economic information. Other parts in the questionnaire were soliciting information on smallholder farmers' experience of climate change, farm and household characteristics and the various adaptation practices adopted and their impact on household food security.

After obtaining the approval of IRB at the American University of Beirut, the questionnaire was pilot-tested to ensure its validity. The researcher filled surveys for selected separate respondents who resemble the study's sample. For this study, a sample of 6 respondents was selected for piloting out of the target population. Piloting of the research instrument assisted in increasing its reliability (Mugenda and Mugenda 2003) since it aided in identifying unforeseen limitations that could adversely affect the results of the findings of research. Such limitations and

challenges were addressed before the actual study started in a bid to mitigate their effects on the study outcome.

5. Questionnaire content based on the conceptual framework

The household strategies will be examined through a household questionnaire that assisted in assessing the way smallholder farmers in central Bekaa handle their life to attain food security:

i. Livelihood assets: the household's asset which is made up of natural, physical, economic, social and human capitals where there are interactions and a dynamic relationship between these capitals;
ii. Livelihoods strategy and structure and process: the productivity and income activities are reviewed based on production for direct consumption, production in return for cash to purchase food, and off-farm activities to sustain food availability. It is important to recognize that livelihood diversification and adaptation strategies go hand in hand to manage ecological system diversity and reduce environmental and economic vulnerability (Amekawa 2011).
iii. Food security outcome indicators: A set of various indicators were used to assess the food security pillars (availability, access, utilization, and stability). The used indicators were selected based on a review of the recent studies. All the used indexes and scores (i.e. Household Food Insecurity Access Scale (HFIAS), Months of Inadequate Household Food Provisioning, Food Consumption Score (FCS), and Coping Strategy Index (CSI)) have proven to be reliable proxy indicators across a range of settings.

6. Statistical analysis - empirical models

The quantitative data collected were entered in Excel then analyzed using STATA software (version 14.2) from StataCorp LP. The data were cleaned before data analysis. The quantitative analyses made use of both descriptive and inferential statistical techniques. Descriptive statistics were run to give frequencies, percentages, and graphs of households' socio-demographics, farm characteristics, climate change belief and causes, and information access. Inferences are made using Poisson regression. The study applied Poisson regression to estimate

the number of adaptation strategies the smallholder farmer implemented and to rate the intensity of coping to changes in temperature and rainfall. Findings from the quantitative analysis were used in drawing conclusions and policy implications on climate change awareness interventions in Lebanon generally and in central Bekaa specifically.

i. Severity index (SI) calculation***:***

In order to calculate SI, the researcher applied Masud *et al.* (2017) technique to measure the smallholder farmers' perception of climate change. This method was adapted from other researchers (e.g., Majid and McCaffer 1997; Isa *et al.* 2005; and Longe, Ukpebor and Omole2009) who used the SI in different fields to measure the strength of the respondent's opinion (e.g., solid waste recycling). The respondents were presented with many statements (see Appendix F). They indicated their responses on a 5-point Likert Scale: (1) strongly disagree, (2) disagree, (3) indifferent, (4) agree, and (5) strongly agree.

Severity Index, (*SI)* = $\left(\frac{\sum_{i=0}^{4} p_i q_i}{\sum_{i=0}^{4} q_i}\right)$ (100%) (1)

- pi = index of a class,
- constant = weight assigned to the class
- qi = frequency of response (*i* = 1, 2, 3, 4, 5)
- p_1, p_2, p_3, p_4, p_5 is the response to the corresponding frequency $q_1 = 1$, $q_2 = 2$, $q_3 = 3$, $q_4 = 4$ *and* $q_5 = 5$.

As per, Masud *et al.* (2017), the valuation arrangement is as follows:

q1	Strongly Disagree	$0.00 \leq SI < 12.5$
q2	Disagree	$12.5 \leq SI < 37.5$
q3	Moderate	$37.5 \leq SI < 62.5$
q4	Agree	$62.5 \leq SI < 87.5$
q5	Strongly Agree	$87.5 \leq SI \leq 100$

ii. The importance and barriers of adopting climate change adaptation strategies

Smallholder farmers who showed awareness of climate change were also asked to indicate their adaptation practices and their importance. The adaptations strategies that we examined included: mixed cropping, crop rotation, soil conservation, and water conservation techniques, the use of chemical and organic fertilizers, growing of different crops on the same plot, reduction of farm size, shifting from farming to non-farming practices, the use of early maturing varieties, integration of trees into farming systems, the use of tolernat crop varieties (drought, pest and disease), mixed farming (crop-livestock integration) and change of planting date.

The weighted average index (WAI) was calculated to rank the adaptation practices applied by smallholder farmers. This index was used by Masud *et al.* (2017):

$$\text{WAI} = (Wn * 1 + Wl * 2 + Wi * 3 + Wm * 4 + Wh * 5)/N \quad (2)$$

W_n = not important; W_l = less important; W_i = indifferent; W_m = important; W_h = highly important

iii. Barriers to adopt environmentally sound climate change strategies

Climate change adaptation strategies can be hindered when smallholder farmers face obstacles. The potential barriers of adopting adaptation strategies included water scarcity, shortage of land, unpredictable weather, poor soil fertility, lack of irrigation infrastructure, insecure land tenure, limited access to agriculture markets, lack of resistant seeds/breeds, lack of availability of new technologies, lack of access to credit, lack of fertilizers, lack of policy, high cost of farm inputs, limited farm size, lack of access to timely weather information, limited access to agricultural extension officers, shortage of labor, lack of governance support (e.g. agricultural subsidies), and environmental and diffuse pollution regulations.

To calculate potential barriers of adopting adaptations strategies, the problem confrontation index (PCI) was applied. This index was also used by Masud et. (2017):

$$\text{PCI} = (Pn * 1 + Pl * 2 + Pi * 3 + Pm * 4 + Ph * 5) \quad (3)$$

Pn = no problem; Pl= low problem; Pi= indifferent; Pm= moderate problem; Ph= highly problem

iv. Estimating determinants of adaptation strategies

Due to the recent increase in the occurrence of climate-related incidences smallholder farmers have to make adaptation decisions. Rahm and Huffmann (1984) denoted that farmers maximize utility and conservation practices if the anticipated utility from adoption exceeds that of non-adoption. Further, the farmer may choose a single strategy or may opt to adapt a mix of strategies to deal with a multitude of climate shocks and stresses and moderate their adverse impact. It is anticipated that farmers who combine different adaptation methods are more likely to adhere to the adverse impacts of climate variability compared to those who either adopt a single strategy or do not implement any adaptation strategy. Typically, the adoption decision is modeled as a binary variable where 1 refers to adopters and 0 refers to non-adopters (Jara-Rojas, Bravo-Ureta and Díaz 2012).

There are several climate change adaptation strategies in the literature which are included in this study: change planting dates; crop-livestock integration; integration of trees into farming systems; soil conservation; water conservation (improved irrigation); mixed cropping; crop rotation; tolerant crop varieties (to drought, pest and disease); grow early maturing varieties; grow different varieties on the same plot; reduce farm size; use of chemical/organic fertilizers, and shifting to off-farm jobs.

This study intends to determine the factors that influence the number of adaptation strategies adopted by the smallholder farmer. Given the nature of the outcome variables – the number of climate change adaptation measurement – which is a count data of nonnegative integers best be analyzed using count data models. The most common count data model in the empirical literature is the Poisson Regression Model (PRM), which assumes that the values of the dependent variable are drawn from a Poisson distribution. In this study, (PRM) is used to estimate the number of climate change (temperature/rainfall) adaptation practices (techniques and technologies) adopted. The researcher employed a Poisson regression model adapted from Abebe, Chalak and Abiad (2016), Tambo (2016), Jara-Rojas, Bravo-Ureta and Díaz (2012), Greene (2018) and Hellerstein and Mendelsohn (1993).

Poisson regression is used to fit models with occurrences or counts of an event (i.e., dependent variable), assuming that each y is drawn from Poisson distribution with parameter μ

(Baum 2010). This means the dependent variable y is a random variable indicating the number of times an event has occurred. Hence, its probability density function takes the following form (i.e., the number of practices adopted by famer *i* is expressed as) (Eq. 4):

$$Prob\ (Y_i = j) = \frac{e^{-\lambda_i}\ \lambda^{j_i}}{j!}\ , j = 0,1, \dots, m \quad i = 1,2, \dots, n \qquad (4)$$

where j indicates the number of adaptation options adopted by a smallholder farmer *i*, λ_i is both the conditional mean and the variance of the Poisson distribution, and *m* is the maximum number of adaptation practices adopted.

The Poisson regression model extends Eq. (5) by allowing each observation to have a different value of λ_i such that the observed count for observation i is drawn from a Poisson distribution with mean λ_i. The Poisson regression models the log of the expected mean (λ_i) as a function of independent variables(X_i):

$$\ln(\lambda_i) = \sum_{j=1}^{k} \beta_j X_{ji} \qquad (5)$$

where X_i is a vector of demographic, socio-economic, bio-physical and institutional variables that affect the implementation of the adaptation options; and *where* β is a coefficient for the X_i, and k is the number of observations.

Poisson outcome variables are conceptualized as rates where positive (negative) coefficients indicate a higher (lower) rate. The Poisson regression analysis makes a strong assumption to the effect that the mean and variance of the distribution are equal. Hence, the researcher performed log-likelihood (goodness of fit) tests after all Poisson models initially estimated and confirmed that the required non-dispersion assumption is violated. This means the count data present overdispersion, invalidating the use of Poisson models.

The study applies Poisson regression to estimate the rate of intensity of coping to changes in temperature and rainfall, and the number of adaptation practices. The estimates of Poisson regression are used to interpret the results. In the first model, the dependent variable takes the value of 1 for smallholder farmers who adopt only temperature techniques and zero otherwise; in the second, the dependent variable is equal to 1 for smallholder farmers who adopt only temperature technology and zero otherwise; in the third model, the dependent variable takes the

value of 1 for smallholder farmers who adopt only rainfall techniques and zero otherwise; in the fourth, the dependent variable is equal to 1 for smallholder farmers who adopt only rainfall technology and zero otherwise.

- *Dependent variables*: Based on the smallholder farmer's experience, the researcher asked them to list the climate change (temperature/rainfall) adaptation (technique/technology) strategies they are recently using to reduce risks associated with climate change. The main implemented adaptation strategies were the outcome variables in the Poisson regression analysis.
- *Independent variables:* The selection of the explanatory variables used in the econometric model was based on the academic literature and data availability. The variables were clustered into farm characteristics and household characteristics (i.e., age, gender and education of the smallholder farmer, cattle owned, distance for the output market, land size, total income, off-farm income, food expenditures, credit access, relative connection, and private extensions).

7. Smallholder farmers' household food security

In order to measure the household food security, the researcher referred to Coates (2013) classification. Four indexes on household food security developed and elaborated by international agencies were adopted, with due modification. The used indexes were: Household Food Insecurity and Access Scale (HFIAS), Months of Inadequate Household Food Provisioning (MIAHFP), Food Consumption Score (FCS), and Coping Strategy Index (CSI). It is crucial to mention that the food status of each household member was difficult to assess from the study as a household's food security does not guarantee food security for all its members because of asymmetrical intra-household distribution of the food based on the needs of each member of a household (Andersen 2009).

Level of measurement	*Food sufficiency*	*Nutrient adequacy*	*Certainty and stability*
Household	- Household Food Insecurity Access Scale (HFIAS) - Months of Inadequate Household Food Provisioning (MIAHFP)	Food Consumption Score (FCS)	Coping Strategy Index (CSI)

Table 2: Household food security indexes

Source: Adapted from Coates, 2013

(1) Food sufficiency:

- The Household Food Insecurity Access Scale (HFIAS) designed by Food and Nutrition Technical Assistance Project (FANTA) consists of a set of nine questions (Coates *et al.* 2007) to provide a single measure of a household's ability to access food. The HFIAS index yields information on food insecurity at the household level on the following four types of indicators (Coates *et al.* 2007):
    - Household Food Insecurity Access-related *Conditions*
    - Household Food Insecurity Access-related *Domains*
    - Household Food Insecurity Access Scale *Score*
    - Household Food Insecurity Access *Prevalence*

The index developed by Coates *et al.* (2007) was used to classify the households into four categories of food insecurity based on their continuous HFIAS scores: food secure, mildly, moderately, and severely food insecure.

- The researcher employed the FANTA Months of Inadequate Household Food Provisioning (MIAHFP) prepared by Bilinsky and Swindale (2010) to measure the availability of food in the last 12 months. MAHFP is measured as the number of months over the previous 12 months that a household self-reports having had availability of food for consumption (through household production, purchase, or aid).

(2) Nutrient adequacy:

- The Food Consumption Score (FCS) prepared by the World Food Programme (WFP), Vulnerability Analysis and Mapping Branch (2008) is a specific type of weighted dietary diversity index. The researcher asked the person in charge of preparing the food for the household (i.e., usually females) whether or not specific foods had been prepared and eaten in the household in the last seven days. The FCS is a composite score based on dietary diversity, food frequency, and the weighted nutritional importance of different food groups and is calculated on the basis of standardized survey questions.

(3) Certainty and stability:

- The Coping Strategy Index (CSI) designed by the CARE (Eastern and Central Africa Regional Management Unit) and the Vulnerability Assessment and Mapping unit from WFP was used along with other coping strategies found in the literature. The means the household

adopts to handle food insecurity can have potentially negative or neutral/positive consequences on its members. Besides, questions to assess the household future vulnerability were also included.

8. Ethical Consideration

Ethics is the foundation for conducting effective and meaningful research. The ethical issues which occur during fieldworks are complex (Johnes and Philip 2013). Therefore, the researchers must ensure the appropriateness of their behavior about the rights of research subjects (Saunders *et al.* 2009). In this study, the researcher recognizes the paramount importance to protect the research participants and hence followed the guiding foundation of "do no harm." The researcher explained to the respondents about the research and that the study is for academic purposes only. It was clear that the participation will be voluntary and that the respondents have the right to decline or withdraw any time during the study if they wish to do so. Respondents were not coerced into participating in the study and their participation was on the basis of informed consent. The researcher further guaranteed that the participant's privacy and confidentiality were protected by strict standard of anonymity during the survey; no personal information was included in the questionnaire or results. Moreover, in quantitative research, it is crucial to promote the pursuit of knowledge and truth (Panter and Sterba 2011). Hence, the researcher did not fabricate or falsify the data or even manipulate the results to suit her conclusion.

CHAPTER 5

RESULTS

The study was based on a primary survey of 120 smallholder farmers' households from nine villages from central Bekaa. In 76% of the households, two persons from the same household were interviewed to gather information on the first part (i.e., adaptation strategies) and second part (i.e., food security) of the study. Using a structured questionnaire, data on a number of capital assets, farm and household characteristics were collected. In addition, data relating to the smallholder farmers' experience of climate change, various adaptation practices adopted and their importance, barriers smallholders were facing as well as the household's food security levels were collected. The questionnaires were checked for completeness before data entry commenced. A total of 120 questionnaires were fully completed, and retained for statistical analysis.

A. Climate change questionnaire

Table 3 presents the descriptive statistics for the variables used in this study. The majority of the households (80%) were male-headed with an average family size of five. The mean age of the head of household was 49.3 years (50 for men and 46.7 for women respondents). The majority of the respondents (80%) were married, approximately 12% were widowed, 4% were divorced and 4% were single. Most of the smallholder farmers (45%) had middle school education followed by high school and above education (roughly 40%); 10% had primary level education and 3% of the smallholder farmers had no formal education. On average, the majority (42%) farming male-headed household had more than 25 years of experience in agriculture, followed by (36%) between 16-24 years, and (22%) had less than 15 years. Whereas, the majority (52%) of female-headed household had 16-24 years of experience in agriculture, 32% had less than 15 years and few (16%) had more than 25 years of experience. Overall, the results showed that all of the smallholder farmers had experienced a drought but none of them had experienced floods in the past 5 years.

The study found that most of the smallholder farmers (85%) did not own livestock (e.g. sheep, goat, cattle, cow and poultry). Almost all the respondents have tractors, car, electricity and

cell phones 72.5%, 92.5%, 98%, 95.83% respectively. The majority of the smallholder households monthly income (64%) ranged between 1,000,000 – 2,999,000 L.L.; around 30% of the smallholder farmers' income ranged between 500,000 – 999,000 L.L.; and 3% and <1% of the smallholder farmers' income ranged between ≤ 499,000 L.L. and ≥3,000,000 L.L. respectively. On average, smallholder farmers spend 54% of their income on food items and 46% on non-food items. The majority of respondents considered themselves full-time farmers (60%). Respondents obtain most of their income from off-farm sources (75%), and only 25% of their income from farming activities. Almost half of the respondents stated that they needed credit but either they did not get it or got less than they needed, while 45% of them did not need credit; only 6% of the respondents got what they needed. Smallholder farmers who had access to credit were merely from formal sources (e.g., credit banks and microfinance institutions), with a credit amount ranging between 2,000,000 and 10,000,000 L.L. Almost none of the smallholder farmers received any food aid or farm supports (equipment, inputs, etc.) in the last five years. The majority of the smallholder farmers (95%) hired labor during the harvest season, and most of the respondents did not receive remittances in the last 12 months. The majority of the respondents (80%) were not members of any economic or social group; only 8% of the household heads held an official position in the local authorities. About 75% of the respondents consider connections with relative to be important.

The average size of land holding was about 8.4 dunums (0.84 ha), and the mean of the total current value of all farm tools and equipment was 1,000,000 LL/dunum. Almost 40% of the smallholder farmers own land; 25% of smallholder farmers do not own land (i.e., either borrowed or rented) and the remaining 35% had both owned and not owned land. Approximately 88% of the smallholder farmers reported that they have good quality soil, and the rest (12%) have medium or poor quality soil. Half of the smallholder farmers use only irrigation systems as the source of water for agriculture; 18% of smallholder farmers only rely on rain-fed and the remaining 32% use both irrigation systems and rain fed as a source of water.

Variable	Description	Mean	Std Dev.
Human capital			
Gender	D= 1 if HH is male and 2 otherwise	1.208	0.407
Age	C= Age of the HH in years	49.38	10.68
Family status	Cat= 1 if HH is married; 2 if HH is separated; 3 if HH is single; and 4 widower	1.48	1.0204
Education	D= 1 if the highest education in the Cat= 1 if HH is had no formal education; 2 if HH had primary schooling; 3 if HH had secondary schooling; and 4 if HH had high school and above	3.22	0.769
Household size	Continuous, Number of family members in the household	5.075	1.63
Farming experience	Cat= 1 if HH is had ≤15 years of farming experience; 2 if HH is had 16-24 years of farming experience; and 3 if HH is had ≥25 years of farming experience	2.125	0.773
Drought experience	D= 1 if the household has ever experienced a drought, 2 otherwise	1	0
Flood experience	D= 1 if the household has ever experienced a flood, 2 otherwise	2	0
Temperature increase	D = 1 if smallholder farmer reported temperature increase, 2 otherwise	1	0
Rainfall change	D= 1 if smallholder farmer reported changed rainfall patterns, 2 otherwise	1.017	0.129
Physical capital			
Total Livestock Units	Cat= 1 if HH owns ≤5 livestock; 2 if HH owns 6-20 livestock; 3 if HH is owns ≥20 livestock and 4 if HH is owns no livestock	3.358	1.091
Tractor	Dummy = 1 if smallholder farmer owns tractor, 2 otherwise	1.275	0.4484
Car	D= 1 if smallholder farmer owns car, 2 otherwise	1.075	0.265
Electricity	D= 1 if household has electricity, 2 otherwise	1.016	0.129
Cell phone	D= 1 if smallholder farmer owns cell phone, 2 otherwise	1.042	0.2007
Distance from selling market	C= distance by automobile in Km	13.55	9.77
Distance from purchasing market	C= distance by automobile in Km	204.29	130.07

Financial capital			
Monthly income	Cat= 1 if household income from all sources, ≤499,000LL/month; 2 household income 500,000 to 999,000LL/month; 3 household income 1,000,000 to 2,990,000LL/month; and 4 household income ≥3,000,000LL/month	2.625	0.566
Food expenditure	C= household monthly food expenditure	585416.7	238288.3
Non-food expenditure	C=household monthly non-food expenditure	497208.3	363803.3
Credit access	D=1 if household accessed credit, 2 otherwise	1.9667	0.9696
Credit amount	C= average amount of credit borrowed over the past five year in L.L.	287500	1251323
Formal credit	C= percentage of total amount of credit the farmer got from formal sources	6.667	25.049
Informal credit	C= percentage of total amount of credit the farmer got from informal sources	0	0
Off-farm income	D= 1 if smallholder farmer has off-farm activity, 2 otherwise	1.3	0.460
Farm income	C= percentage of total annual income	25.417	32.278
Off-farm income	C= percentage of total annual income	74.33	32.273
Food aid	D= 1 if household received food aid at least once in the last five years, 2 otherwise	1.992	0.0913
Farm support	D= 1 if household received farm support at least once in the last five years, 2 otherwise	2	0
Remittances	D= 1 if household received remittances in the last 12 months, 2 otherwise	1.917	0.278
Hire labor	D= 1 if smallholder farmer hires labor during the harvest seasons, 2 otherwise	1.05	0.219
Social capital			
Membership	Dummy= 1 if smallholder farmer is member of any organization, 2 otherwise	1.792	0.408
Connection to local authorities	Dummy= 1 if the HH holds an official position in the village or district, 2 otherwise	1.933	0.251
Connection to relatives	Dummy= 1 if a household considers the relationship with relatives very important in times of hardship, 2 otherwise	1.258	0.439

Farm characteristics			
Land tenure	Cat= 1 if HH land is owned; 2 if HH land is leased; and 3 if HH land is mixed arrangement	1.975	0.874
Fertile soil	Dummy = 1 if the plot is highly fertile, 2 otherwise	1.117	0.3224
Land size	C= farm land holding, dunum	8.4	3.785
Farm tools and equipment	C= total capital value, LBP	9330000	8583741
Water source	Cat= 1 if water source is rain fed; 2 if water source is irrigation; and 3 if water source is both	2.142	0.689
Irrigation system	Cat= 1 if irrigation system is sprinkler; 2 if irrigation system is drip; 3 if irrigation is mixed system and 4 if no irrigation system is used	2.367	0.798
Information access			
Access to government extension	Cat= 1 if HH is active member of any agriculture cooperative, 2 if HH is member of any agriculture cooperative with limited activities; and if HH is not member f any agriculture cooperative	4	0
Access to private extension	Cat= 1 if HH had ≥ 5 times per year private extension; 2 if HH had 1 to 5 times per year private extension; and if HH had no access to private extension	1.825	0.443
Cooperative membership	Cat= 1 if HH is active member of any agriculture cooperative, 2 if HH is member of any agriculture cooperative with limited activities; and if HH is not member f any agriculture cooperative	2.858	0.4727
Radio/TV extension	Dummy = 1 if household had extensive access to radio/TV extension, 2 if household had limited access to radio/TV extension; and 3 if household had no access to radio/TV extension	2.342	0.628
Access to climate information	Dummy = 1 if household had extensive access to any information on climate change, 2 if household had limited access to any information on climate change; and 3 if household had no access to any information on climate change	1	0

C: Continuous variable; Cat: Categorical variable; D: Dummy variable *Source: field survey data*

Table 3: Data and description of variables (n = 120)

1. Climate change belief

The questionnaire provided the respondents with five typologies to understand how the smallholder's climate change perceptions are related to climate change beliefs. The smallholder farmer's perspectives of climate change were examined across two dimensions (1) the extent to which the smallholder farmer believes climate change is happening and (2) the extent to which the smallholder farmer believes that humans are contributing to climate change. Figure 4 presents the percentage of smallholder farmers within each typology. Around half of smallholder farmers believed that climate change is occurring, and is caused mostly by human activities (48%). The second largest typology was smallholder farmers who believed that climate change is occurring and is caused equally by natural changes in the environment and human activities (36%). The third typology of smallholder farmers believed that climate change is occurring, and it is caused mostly by natural changes in the environment; this group consisted of 13% of the respondents. Finally, a small number of smallholder farmers (> 2%) fell into the remaining two typologies: climate change is not occurring (> 1%) and there is not sufficient evidence to know with certainty whether climate change is occurring (> 1%).

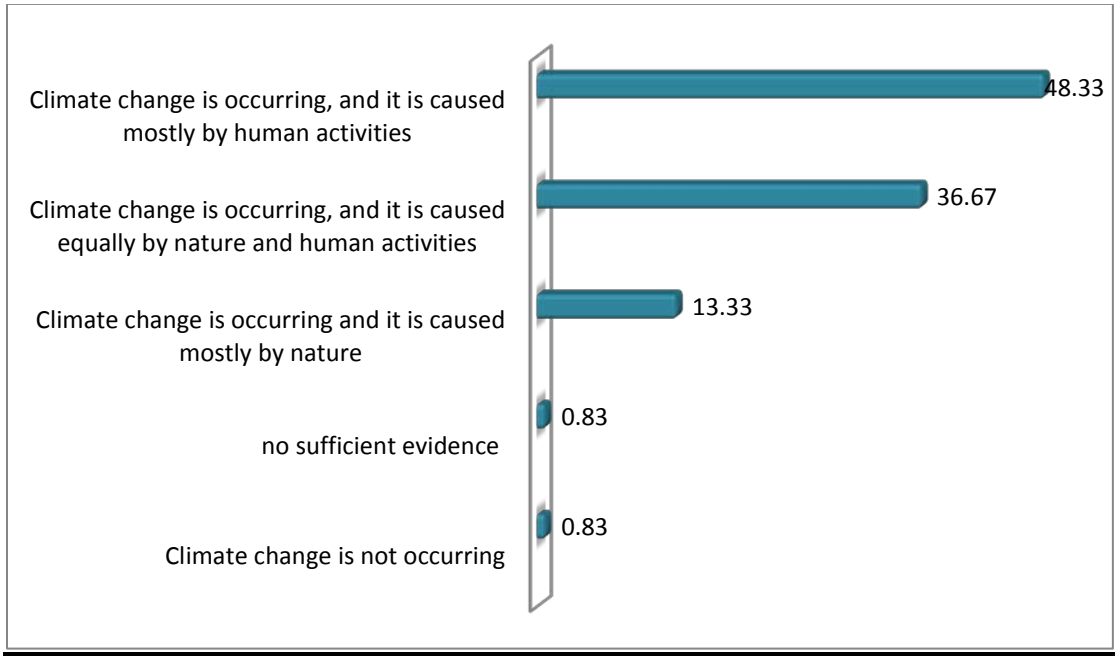


Figure 6 Percentage of smallholder farmers perceived belief on climate change
Source: field survey data

2. Smallholder farmers' perceived causes of climate change on agriculture

Smallholder farmers were subsequently asked to specify what they perceive as causes to changes in the climate (i.e., temperature and rainfall) more than one answer was possible. Their responses are illustrated in figure 5. Most smallholder farmers attributed climate change to human-related causes such as bush burning (23%), deforestation (16%) and pollution (17%). Also, 11% mentioned wars and conflicts that are happening in the region as the cause of climate change. Few smallholder farmers (9%) perceived that desert encroachment (e.g., overgrazing, poor soil management and clearing of bushes for farming) was enhancing the changes in climate. Ten percent of the respondents claimed that God is responsible for the perceived changes in rainfall and temperature trends. Although 13% of the smallholder farmers perceived that the changes in climate incidents in the area were a natural process, but most of them were aware that their land degradation activities are also contributing factors. Finally, 1% of the respondents did not know what was responsible for the changes in the climate.

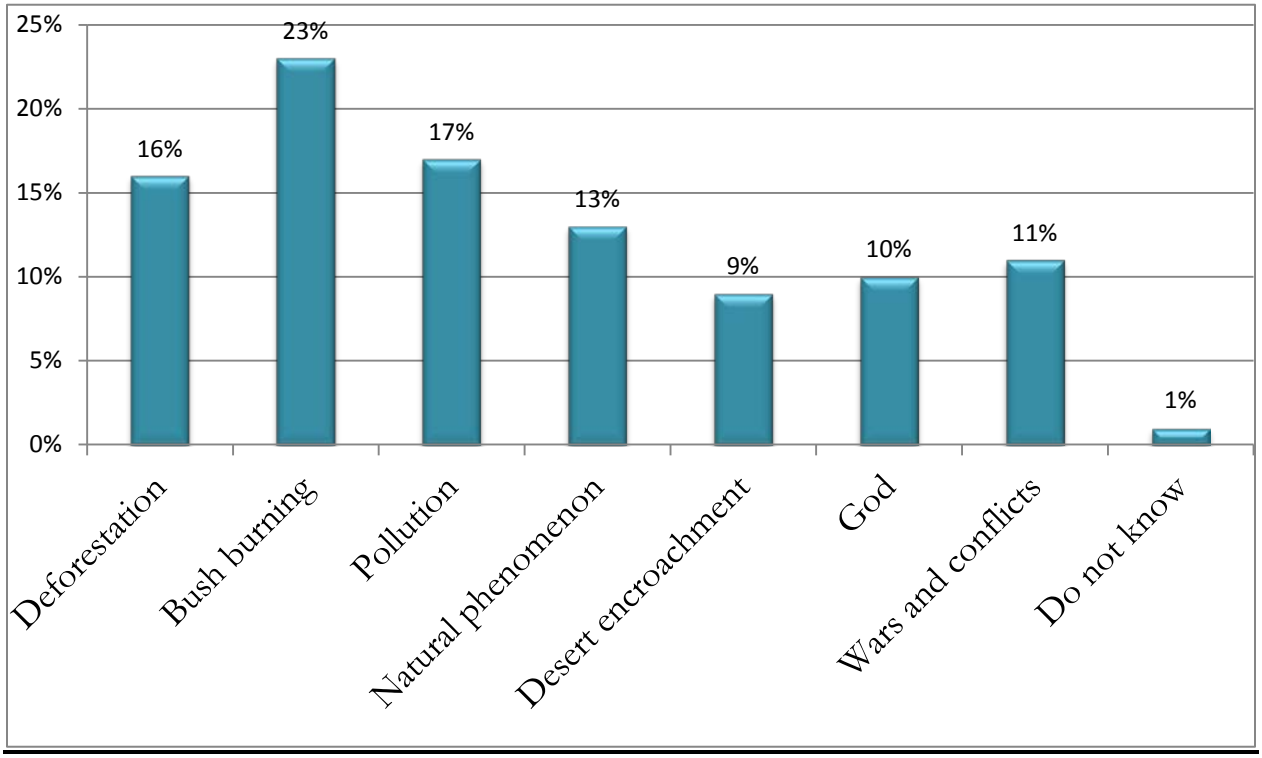


Figure 7: Percentages of causes smallholder farmers think are leading to climate change

Source: field survey data

3. Smallholders' perception of long-term changes in temperature and perception in central Bekaa for the past 20 years

Smallholder farmers were asked whether they had experienced any significant change in temperature, rainfall amount and frequency and length of rainy season over the past 20 years. The majority of the respondents perceived changes in climate factors. A large group of smallholder farmers (97.5%) believed that temperature had increased, around 2% felt a decrease and <1 % mentioned indifferently. With regard to rainfall 98.33% of the smallholder farmers perceived a decrease in precipitation while <1% thought it had increased; also <1% believed that rainfall is unpredictable. 95.83% of the respondents perceived rainfall frequency to be decreasing, with 2.5% indicating that frequency is unpredictable and <1% believed that it is unpredictable and another 1% do not know. Finally, 97.5 % of the respondents perceived a decrease in length of the rainfall seasons over the last 20 years while 1.67% and <1% stated that they do not know and it is unpredictable respectively.

Temperature		**Rainfall amount**	
Description	***%Distribution***	***Description***	***%Distribution***
Increasing	97.5	*Increasing*	0.83
Decreasing	1.67	*Decreasing*	98.33
Indifferent	0.83	*Unpredictable*	0.83
Rainfall frequency		**Length of rainy season**	
Description	***%Distribution***	***Description***	***%Distribution***
Decreasing	95.83	*Decreasing*	97.5
Indifferent	0.83	*Unpredictable*	0.83
Unpredictable	2.5	*Do not know*	1.67
Do not know	0.83		

Table 4: Percentage of smallholder farmers' perception of long-term changes in temperature and precipitation

Source: field survey data

4. Smallholder farmers' perceptions of climate change vulnerability

In this study, the smallholder farmers were asked about their perception of climate change vulnerability. Table 6 shows smallholder farmers' perceptions of climate change vulnerability, in which the SI values related to smallholder farmers' perceptions of climate change vulnerability are also presented. The SI values were calculated based on equation (2). The SI values for the smallholder farmers' perceptions of climate change vulnerability ranged between 65.63% and 98.95%. The calculated value of SI falls under the agreed and strongly agreed opinion ranges; i.e., $62.5 \leq SI < 87.5$ and $87.5 \leq SI \leq 100$, respectively, which is based on the valuation agreement developed by Majid and McCaffer (1997).

The top SI value ranked were 'precipitation is decreasing', 'temperature is increasing,' and water sources are drying with SI = 98.95%, 98.33%, and 91.25%, respectively. Followed by 'government should do more to reduce causes of climate change' (SI= 86.04%), 'I am concerned about the potential impacts of climate change on my farm operation' (SI= 85.63%), 'I am concerned about the potential impacts of climate change on Bekaa's agriculture' (SI= 82.71%), 'Bekaa farmers should take additional steps to protect their land' (SI= 78.33%), 'I believe that extreme weather events will happen more frequently in the future' (SI= 76.04%), 'climate change is not a big issue because human ingenuity will enable us to adapt to changes' (SI= 65.63%) as smallholder farmer's perception of climate change vulnerability.

Items		SD(0)	D(1)	I(2)	A(3)	SA (4)	SI (%)
1. I am concerned about the potential impacts of climate change on Bekaa's agriculture.	NRS	4	1	10	44	61	82.71
	PRS	3.33	0.83	8.33	36.67	50.83	
2. I am concerned about the potential impacts of climate change on my farm operation (i.e. production).	NRS	----	----	8	53	59	85.63
	PRS	----	----	6.67	44.17	49.17	
3. I believe that extreme weather events will happen more frequently in the future.	NRS	----	5	20	60	35	76.04
	PRS	----	4.17	16.67	50	29.17	
4. Water sources is drying	NRS	----	----	3	36	81	91.25
	PRS	----	----	2.5	30	67.5	
5. Temperature is increasing	NRS	----	2	1	----	117	98.33
	PRS	----	1.67	0.83	----	97.5	
6. Precipitation is decreasing	NRS	----	1	1	----	118	98.95
	PRS	----	0.83	0.83	----	98.83	
7. Climate change is not a big issue because human ingenuity will enable us to adapt to changes.	NRS	5	13	23	60	19	65.63
	PRS	4.17	10.83	19.17	50	15.83	
8. Bekaa farmers should take additional steps to protect their land	NRS	5	2	8	62	43	78.33
	PRS	4.17	1.67	6.67	51.67	35.83	
9. Government should do more to reduce the nation's greenhouse gas emissions and other potential causes of climate change (Mitigation)	NRS	----	----	1	65	54	86.04
	PRS	----	----	0.83	54.17	45	

Notes: NRS, PRS, SD, D, I, A, and SA indicate the number of respondents, percentage of respondents, Strongly Disagree, Disagree, Indifferent, Agree, and Strongly Agree.

Table 5: Percentages of smallholder farmers' perception on climate change vulnerability

Source: Author's calculation based on household survey data.

5. Smallholder farmers' attitudes towards climate change issues

In order to evaluate the smallholder farmer's attitude towards climate change vulnerability, they were asked to give their opinion on a few items. Dealing with the predicament of climate change the favorable attitudes of the smallholder farmers were critically measured. The SI values were calculated, and the findings indicated that all the values of the SI were within the agreed opinion range, namely $62.5 \leq SI < 87.5$ (Table 7). The SI value ranked 'climate change is happening' (87.29%) as first followed by 'I feel adaptation has become necessary for all of us' (81.66%), 'we should work together to adapt to climate change' (81.25%) and 'I feel personally obliged to help reduce the impact of climate change in Lebanon' (76.25 %).

Items		**SD(0)**	**D(1)**	**I(2)**	**A(3)**	**SA (4)**	**SI (%)**
1. Climate change is happening	NRS	1	----	3	51	65	87.29
	PRS	0.83	----	2.5	42.5	54.17	
2. I feel personally obliged to help reduce the impact of climate change in Lebanon	NRS	1	6	18	56	39	76.25
	PRS	0.83	5	15	46.67	32.5	
3. I feel adaptation has become necessary for all of us	NRS	4	2	8	50	56	81.66
	PRS	3.33	1.67	6.67	41.67	46.67	
4. We should work together to adapt to climate change	NRS	----	4	8	62	46	81.25
	PRS	----	3.33	6.67	51.67	38.33	

Notes: NRS, PRS, SD, D, I, A, and SA indicate the number of respondents, the percentage of respondents, Strongly Disagree, Disagree, Indifferent, Agree, and Strongly Agree.

Table 6: Percentages of smallholder farmers' attitude towards climate change issues

Source: Author's calculation based on household survey data.

6. Smallholder farmers' understanding of climate change vulnerability

Also, smallholder farmers were also asked about their understanding of climate change. The same SI assessment tool was employed. Overall, most of the SI values fall with the agreed opinion range $62.5 \leq SI < 87.5$, as shown in Table 8. 'climate change is a serious problem' (88.13%) was ranked as number one, based on the SI value, followed by 'climate change is affecting my local climate' (87.29%), 'climate change already affects the Lebanese agricultural sector' (86.88%), 'climate change will have a direct impact on me' (86.04%) and 'I would be doing more things to prevent climate change if I could get some clarity on it' (84.79%).

Items		**SD(0)**	**D(1)**	**I(2)**	**A(3)**	**SA (4)**	**SI (%)**
1. Climate change is a serious problem	NRS	----	----	1	55	64	88.13
	PRS	----	----	0.83	45.83	53.33	
2. Climate change already affects the Lebanese agricultural sector	NRS	----	----	1	61	58	86.88
	PRS	----	----	0.83	50.83	48.33	
3. Climate change is affecting my local climate	NRS	----	----	2	57	61	87.29
	PRS	----	----	1.67	47.5	50.83	
4. Climate change will have a direct impact on me	NRS	----	----	2	63	55	86.04
	PRS	----	----	1.67	52.5	45.83	
5. I would be doing more things to prevent climate change if I could get some clarity on it.	NRS	----	2	3	61	54	84.79
	PRS	----	1.67	2.5	50.83	45	

Notes: NRS, PRS, SD, D, I, A, and SA indicate the number of respondents, the percentage of respondents, Strongly Disagree, Disagree, Indifferent, Agree, and Strongly Agree.

Table 7: Percentage of smallholder farmers' understanding of climate change vulnerability

Source: Author's calculation based on household survey data.

7. Climate change adaptation strategies to adapt to changes in temperature and rainfall

Smallholder farmers who have been aware of climate change were also asked follow up questions about the adaptation practices they are implementing; the results are presented in Figure 6. The results demonstrate that the majority of the smallholder farmers use crop diversification practices including mixed cropping (119), soil conservation techniques (116), crop rotation (114), and chemical fertilizers (110). About 103 grow different crops on the same plot and water conservation (101) followed by a reduction in farm size (87), changing from farming to non-farming (84) and organic fertilizers (83). Other identified adaptation practices being implemented are the use of early maturing varieties (68), integration of trees into farming systems (55), the use of tolerant crop varieties (drought, pest and disease) (42), mixed farming (crop-livestock integration) (34) and change of planting date (27).

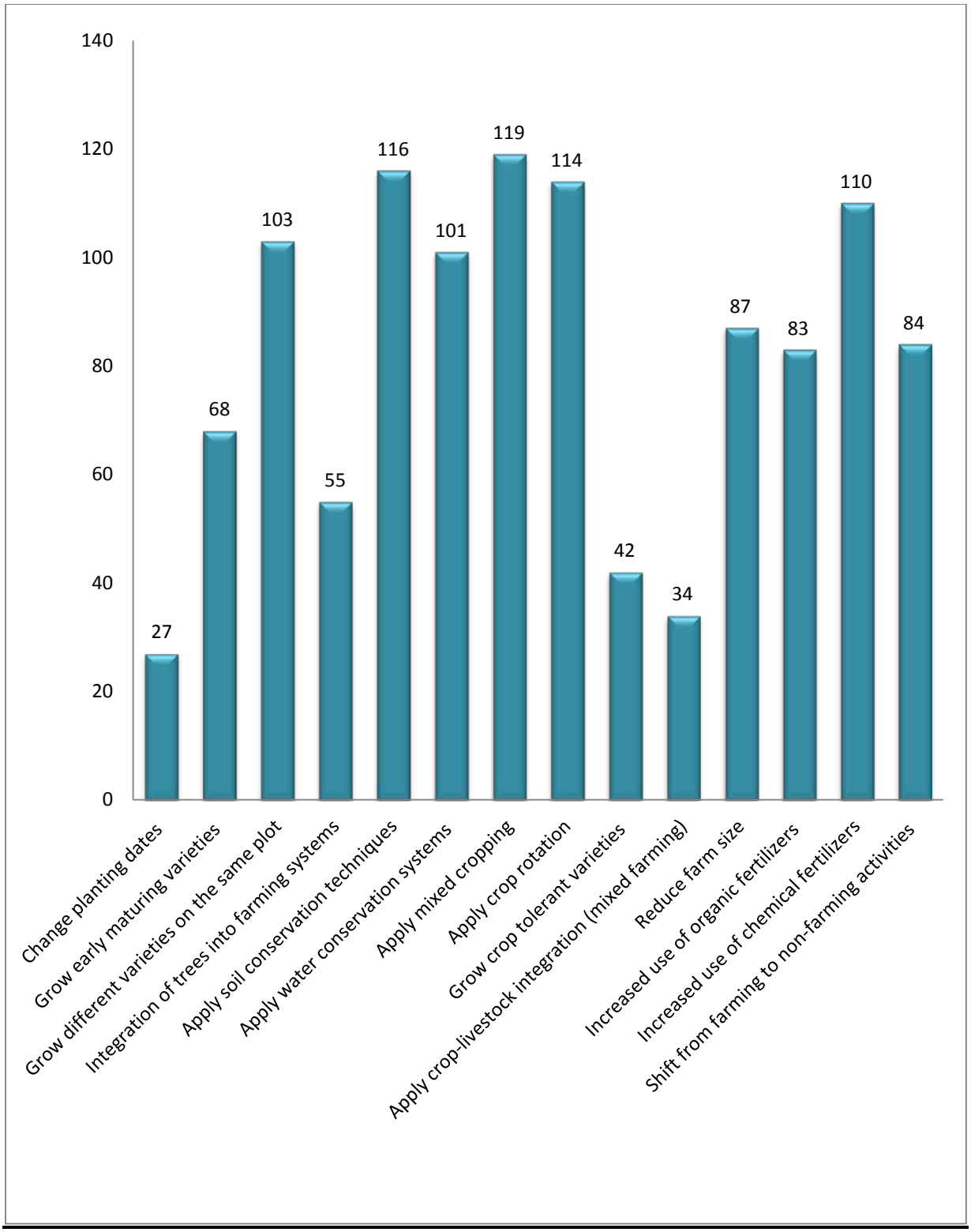


Figure 8: Frequency of climate change adaptation strategies smallholder farmers practice

Source: field survey data

8. Smallholder farmer's perceived importance of climate change adaptation practices

Smallholder farmers were also asked how important they believe each of their common adaptation practices is. Then the weighted average index (WAI) was calculated to rank the adaptation practice based on the smallholder farmers' perceived importance, as shown in Table 9. The study found that among the 14 adaptation practices, mixed cropping, crop rotation, soil conservation techniques, water conservation systems are ranked as the most common practices with a WAI of 3.61, 3.56, 3.35 and 3.35, respectively. Other practices are also perceived as important for adaptation, such as increasing the use of organic fertilizers, different crops on the same plot, crop tolerant varieties, early maturing varieties, and crop-livestock integration were ranked as moderately important. On the other hand, shifting to or engage in off-farm jobs, integration of trees into farming systems, changing of planting dates, reducing farm size and increasing the use of chemical fertilizers were positioned as less important adaptation practices among smallholder farmers, which have WAI of 2.65, 2.56, 2.49, 2.49 and 2.45 respectively.

Adaptation Practice	Frequency by Each Level of Importance					[a]WAI	Rank
	W_n	W_l	W_i	W_m	W_h		
Application of mixed cropping	----	----	2	43	75	3.61	1
Application of crop rotation	----	1	7	36	76	3.56	2
Application of soil conservation techniques	----	1	3	69	47	3.35	3
Application of water conservation systems	8		2	42	68	3.35	3
Increasing the use of organic fertilizers	5	3	4	67	41	3.13	4
Growing of different crops on the same plot	3	6	7	68	36	3.07	5
Growing of crop tolerant varieties	----	4	28	44	44	3.07	5
Growing of early maturing varieties	----	8	20	70	22	2.88	6
Application of crop-livestock integration	1	13	32	38	36	2.79	7
Shifting to or engage in off-farm jobs/activities	16	5	14	55	30	2.65	8
Integration of trees into farming systems	5	17	26	50	22	2.56	9
Reducing of farm size	21	8	12	49	30	2.49	10
Changing of planting dates	1	23	35	43	18	2.49	10
Increasing the use of chemical fertilizers	21	8	6	61	24	2.45	11

Notes: WAI, W_n, W_l, W_i, W_m, and W_h, indicate weighted average index (WAI), the number of respondents who graded the practice as not important, low important, indifferent, moderately important and highly important.

[a] $WAI = (W_n*0 + W_l*1 + W_i*2 + W_m*3 + W_h*4)/N$

Table 8: Smallholder farmers' ranking of adaptation practices importance in central Bekaa, Lebanon

(Number of respondents = 120).

Source: Author's calculation based on household survey data

9. Barriers faced by smallholder farmers to adapt to climate change

Climate change adaptation can be challenging when the smallholder farmer encounters biophysical, economic and social barriers. Table 10 presents the smallholder farmer's barriers. The study found that the most critical obstacles to adaptation practices are water scarcity, which had problem confrontation index (PCI) value of 438, limited access to agriculture markets and lack of policy each with PCI value of 437. Also, in this study, lack of government support, a high cost of farm inputs, lack of access to credit, lack of irrigation infrastructure, unpredictable weather and insecure land tenure were identified as a high problem to adoption. Other factors that smallholder farmers perceive as serious/moderate constraints are shortage of land, poor soil fertility, environmental and diffuse pollution regulations, lack of availability of new technologies, limited farm size, lack of access to timely weather information, lack of resistant seeds/breeds, limited access to agricultural extension officers and lack of fertilizers. The shortage of labor was a minor impediment to adaptation (PCI =51). Interviewed smallholder farmers reported that labor shortage is not a problem mainly due to the presence of refugees who accept low wages.

Barrier to adaptation	Type	Degree of barrier					[a]PCI	Rank
		P_n	P_l	P_i	P_m	P_h		
water scarcity	Biophysical	---	---	3	36	81	438	1
limited access to agriculture markets	Economic	---	4	1	29	86	437	2
lack of policy	Economic	---	2	5	27	86	437	2
lack of government support (e.g. agricultural subsidies)	Social	---	---	---	56	64	424	3
high cost of farm inputs	Economic	1	2	7	38	72	418	4
lack of access to credit	Economic	---	4	8	45	63	407	5
lack of irrigation infrastructure	Economic	1	---	7	58	54	404	6
unpredictable weather	Biophysical	1	1	11	57	51	398	7
insecure land tenure	Economic	---	3	12	53	52	394	8
shortage of land	Biophysical	3	1	7	63	46	388	9
poor soil fertility	Biophysical	3	1	1	78	37	385	10
environmental and diffuse pollution regulations	Social	---	1	4	87	28	382	11
lack of availability of new technologies	Economic	---	2	16	61	41	381	12
limited farm size	Economic	---	3	13	69	35	376	13
lack of access to timely weather information	Social	6	4	6	69	35	363	14
lack of resistant seeds/breeds	Economic	---	10	26	43	41	355	15
limited access to agricultural extension officers	Social	11	3	5	65	35	348	16
lack of fertilizers	Economic	2	16	19	48	35	338	17
shortage of labor	Social	76	37	7	---	---	51	18

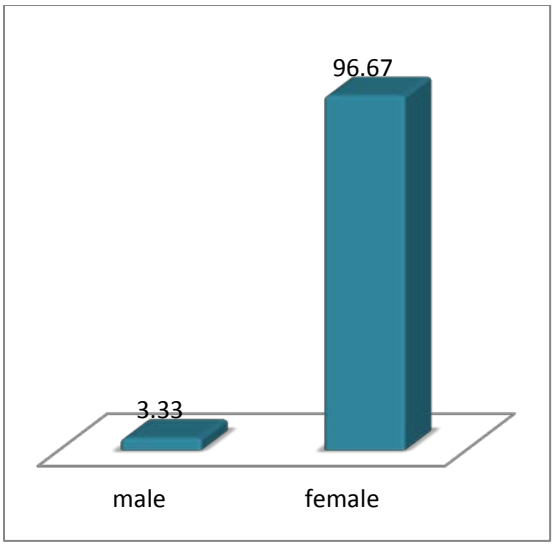
Notes: PCI, P_n, P_l, P_i, P_m, and P_h, indicate Problem Confrontation Index, the number of respondents who graded the barrier as no problem, low problem, indifferent, moderate problem and high problem.
[a] $PCI = (P_n*1 + P_l*2 + P_i*3 + P_m*4 + P_h*5)$

Table 9: Problems affecting implementation of adaptation practices in central Bekaa, Lebanon

(*Number of respondents = 120*)
Source: Author's calculation based on household survey data

B. Food security questionnaire

As for the food security questionnaire, as expected the majority of the people in charge of household food preparation (97%) were female with an average age of 45. More than half of the food security respondents (53%) had middle school education followed by high school and above education (approximately 32%); about 14% had primary level education and < 2% of had no formal education.



Education	Frequency	Percentage (%)
none	2	1.67
primary	17	14.17
middle school	63	52.5
high school and above	38	31.67

Figure 9: Characteristics of the person in charge of household food preparation

Source: field survey data

1. The Household Food Insecurity Access Scale (HFIAS)

The smallholder farmer households' food security was assessed using Coates *et al.* (2007) methodology, as shown in Table 11.Households can report multiple results therefore the total is not 100%. Seventy-five percent of the households in the study were anxious and uncertain about food supply. Most of the households did experience insufficient food quality-food insecurity domain (83.33%), whereas a few households (8%) experienced the third food insecurity domain which is insufficient food intake and its physical consequences.

Household Food Insecurity Access-related Domains	Percentage
Anxiety and uncertainty	75
Households with insufficient food quality	83.33
Insufficient food intake and its physical consequences	8.33

Table 10: Household responses to Household Food Insecurity Access related Domains

(n= 120)
Source: field survey data

The percentage of households experiencing anxiety and uncertainty about household food supply was high (75%). Around 6% of the households consumed poor quality food by eating non-preferred kinds of food more than ten times in a month. Also, around 45% of respondents ate a limited variety of food and non-preferred food at a frequency between 3-10 times in a month. However, few households consumed inadequate quantities of food. About 10% of the households experienced mild coping strategies such as eating smaller meals or fewer meals. None of the respondents employed any of the severe coping strategies such as going the whole day and night without eating anything, as shown in Tables 12 and 13.

Food insecurity conditions	Yes		No	
	Freq	%	Freq	%
Anxiety and uncertainty about food supply	90	75	30	25
Poor quality food consumption coping strategies				
Non-preferred kinds of food	109	90.83	11	9.17
Limited variety of food	88	73.33	32	26.67
Non-preferred food	103	85.83	17	14.17
Inadequate quantity of food coping strategies				
Ate a smaller meal than they needed	11	9.17	109	90.83
Ate fewer meals in a day	9	7.5	111	92.5
Experienced total lack of food due to lack of resources	----	----	120	100
Went to sleep at night hungry due to lack of food	----	----	120	100
Going whole day and night without eating anything due to lack of food	----	----	120	100

Table 11: Household food insecurity access-related to conditions

(n = 120)

Source: field survey data

Food insecurity conditions	Frequency of experience of food insecurity condition in past 4 weeks (%)			
	Once or twice	3 to 10 times	More than 10 times	Total
Anxiety and uncertainty about food supply	54.44	42.22	3.33	100
Poor quality food consumption coping strategies				
Non-preferred kinds of food	60.55	33.03	6.42	100
Limited variety of food	53.41	44.32	2.27	100
Non-preferred food	46.6	46.6	6.8	100
Inadequate quantity of food coping strategies				
Ate a smaller meal than they needed	9.09	63.64	27.27	100
Ate fewer meals in a day	55.56	22.2	22.2	100
Experienced total lack of food due to lack of resources	---	---	---	
Went to sleep at night hungry due to lack of food	---	---	---	
Going whole day and night without eating anything due to lack of food	---	---	---	

Table 12: Household food insecurity access-related to conditions occurrence

(n = 120)

Source: field survey data

Further household food security assessment was demonstrated by calculating the Household Food Insecurity Access Scale Score as displayed in Fig. 9. Household Food Insecurity Access Scale Score "is designed to provide a continuous indicator of food insecurity that captures relative shifts in the situation over time" (Coates, Swindale and Bilinsky 2007).

According to Coates, Swindale and Bilinsky (2007) "The maximum score for a household is 27 (the household response to all nine frequency-of-occurrence questions was "often", coded with response code of 3); the minimum score is 0 (the household responded "no" to all occurrence questions, frequency-of-occurrence questions were skipped by the interviewer, and subsequently coded as 0 by the data analyst.) The higher the score, the more food insecurity the household experienced. The lower the score, the less food insecurity (access) a household experienced." Most households had a low score of food insecurity indicating the low prevalence of moderately and severely food insecurity among households.

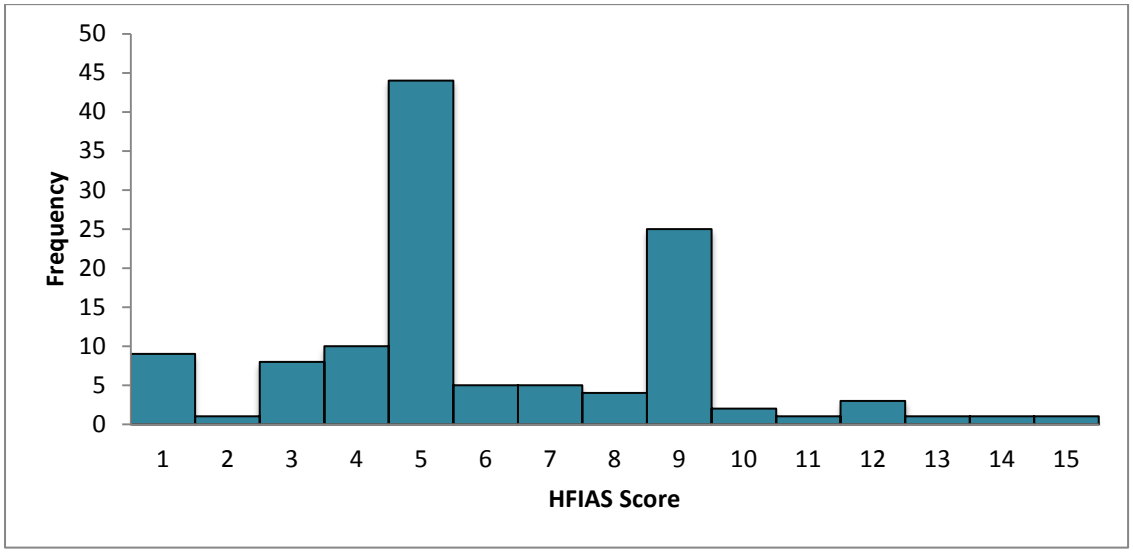


Figure 10: Frequency of Household Food Insecurity Access Scale (HFIAS) scores

(n = 120)
Source: field survey data

Households were grouped based on Coates (2007) methodology. Table 14 presents the distribution of the sampled households across the food security categories. The findings revealed that only nine of the 120 households were food secure, the majority of the households were mildly food insecure (82.5%), and the remaining (10%) were moderately food insecure.

Categories of food insecurity	n	(%)
Food secure	9	7.5
Mildly food insecure	99	82.5
Moderately food insecure	12	10
Severely food insecure	---	---
Total	120	100

Table 13: Percentage of households in each food security category in central Bekaa

(n = 120)
Source: field survey data

2. Months of Adequate Home Food Provisioning (MAHFP)

The second indicator of food security is the Months of Adequate Home Food Provisioning (MAHFP). The MAHFP provides an indication of households' access to food by providing information on the months in which households have food during the year. As per figure 8, 95% of the households felt that they struggled to feed household members adequately (both produced and purchased) over at least five months of the previous year. February and March are the hunger months (i.e., months in which the highest number of households were food insecure) 99.22 % and 93% of respondents respectively stated that they did not have enough food to meet the family's needs, as shown in figure 10. Followed by December, January and April when only 30%, 30%, and 34% of respondents respectively confirmed that they did have enough food to meet the family's needs. In November, half of the respondents and in October more than two-thirds of the respondents had enough food. However, on average, 97% of the respondents reported that they had enough food supply to meet the family's needs in months May, June, July, August, and September.

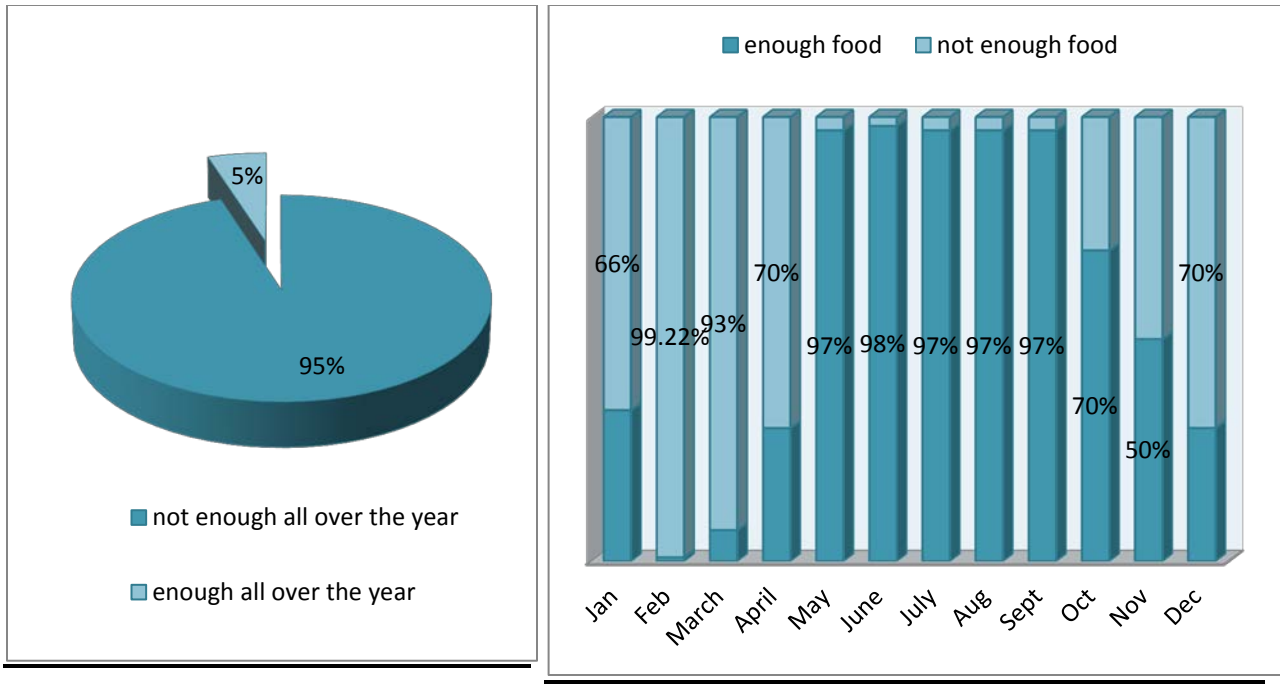


Figure 11: Percentage of households experiencing hunger over a year

Source: field survey data

3. Food Consumption Score (FCS)

The FCS represents the average number of food groups a household consumes in a week and hence measures relative access to a quality diet. The main food groups are cereals, roots and tubers; legumes/pulses/nuts; milk and dairy products; vegetables and leaves; fruits; meat/poultry, eggs, and fish; oil/fats/butter; sugar/sweet; and condiments/spices. Almost all the respondent reported that they were able to eat from all the food groups, as displayed in figure 11.

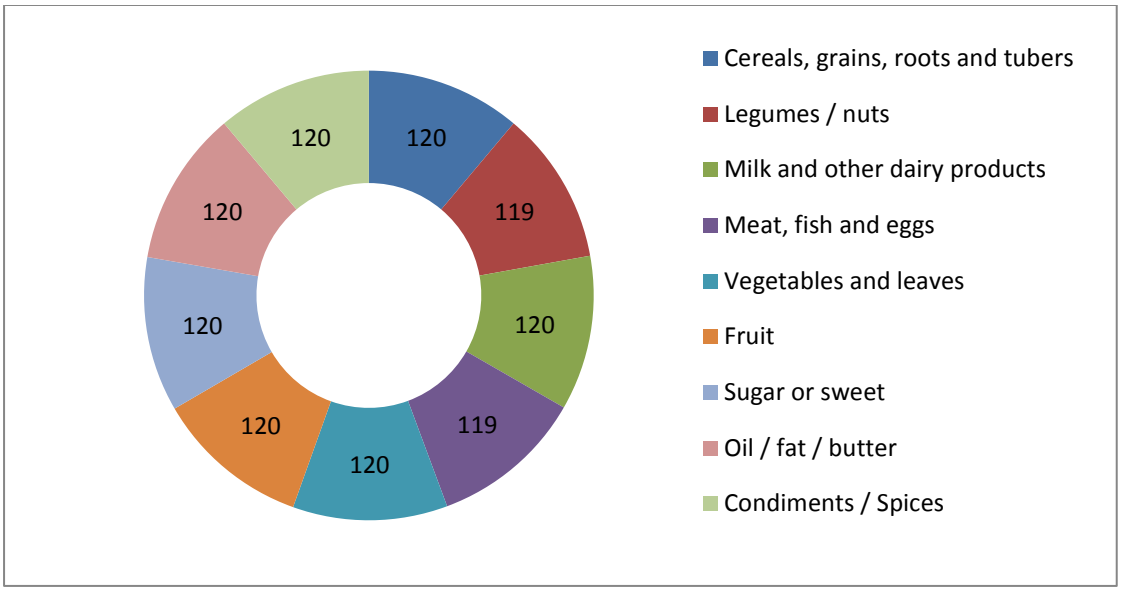


Figure 12: Frequency of respondents' consumption of the different groups

Source: field survey data

The food groups with the highest rate of consumption per week are oil/fat/butter (96%), sugar/sweets (95%), and condiments/spices (95%), followed by cereals, grains, roots, and tubers; vegetables and leaves; legumes and nuts, and fruits being consumed every day 87%, 85%, 80%, and 70% respectively. Almost half the respondents stated that they consume meat, poultry, fish and eggs on average 3-6 times per week, as shown in Fig.12.

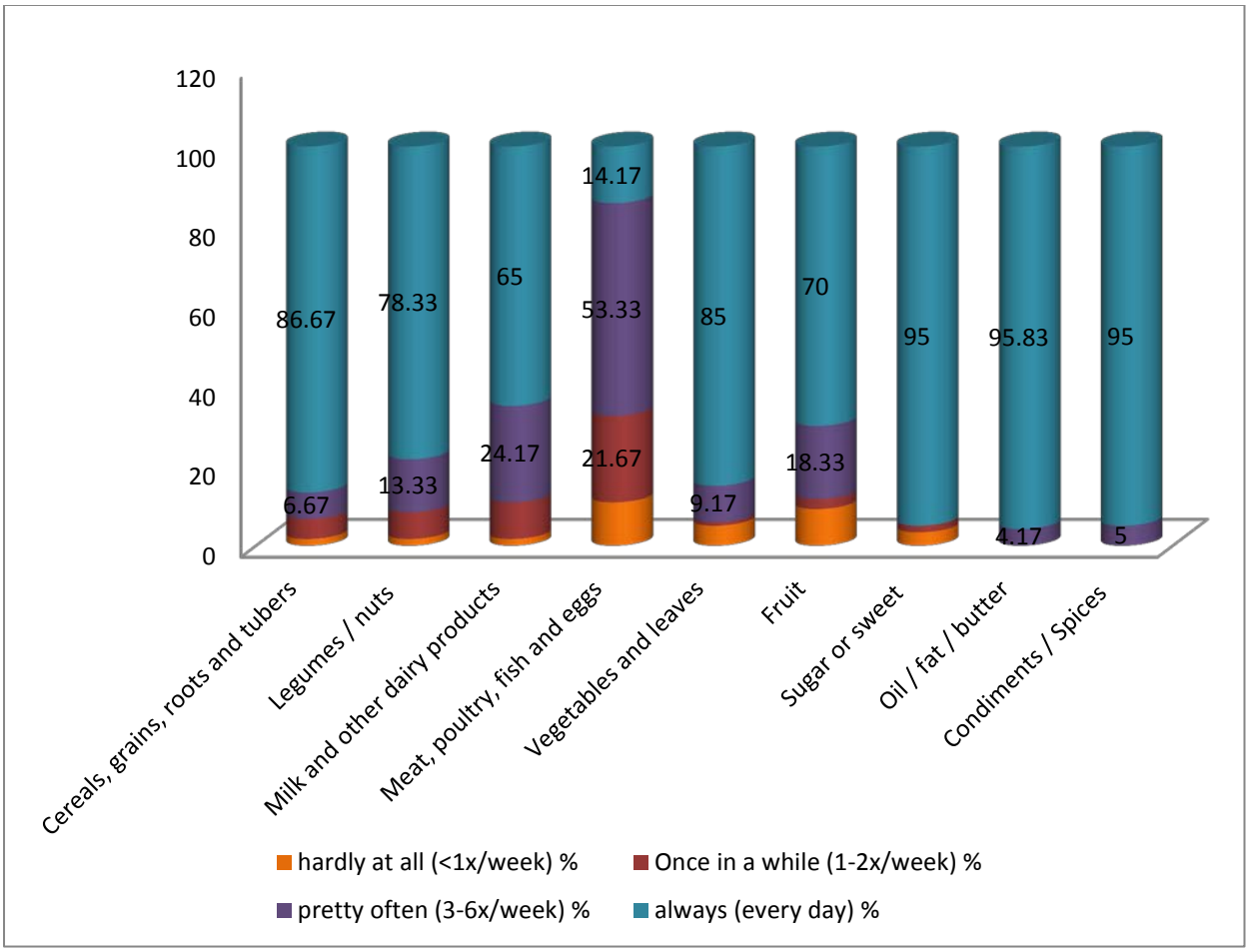


Figure 13: Percentage of consumption of the food groups consumed by a household in the past week

Source: field survey data

Besides, within each food group, the respondents were asked what percentage of the food is sourced from subsistence production versus purchased on the market, a combination of production and purchasing, etc. On average a household purchases most of the food either on debt or in cash. Figure 13 shows that the food groups consumed by households include cereals, grains, roots and tuber (75%); legumes and nuts (78%); milk and dairy products (73%); meat, poultry, fish and eggs (90%); sugar or sweet, oil, fat, butter (95%); and condiments and spices food groups (90%). While the majority of the respondents reported that the vegetables and leaves and fruits food groups are mainly sourced from their own production and to less extent purchased on debt (67%) and in cash (50%).

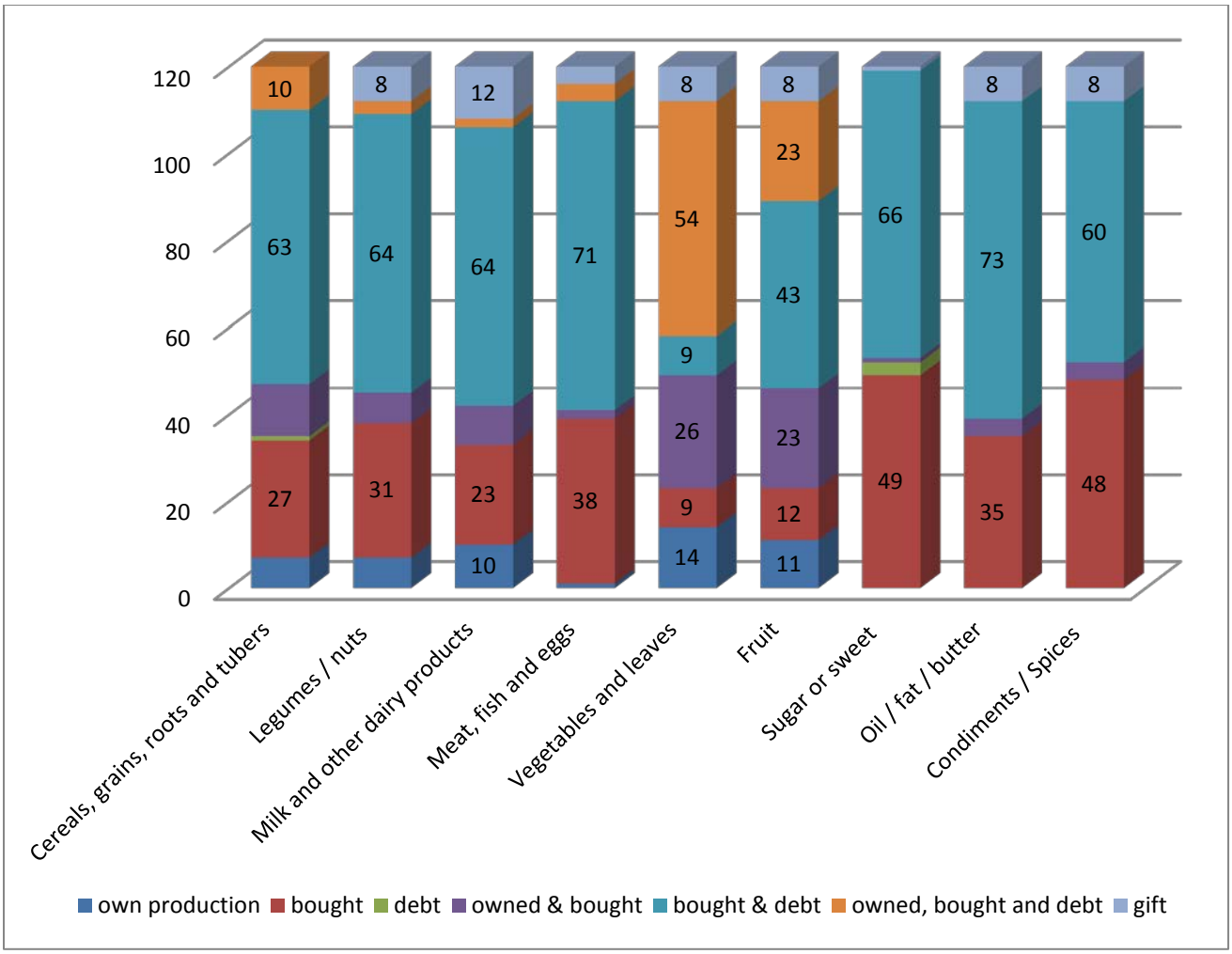


Figure 14: Percentage of the sources of food groups consumed by a household

Source: field survey data

4. Coping strategies

The findings revealed that most of the respondents (96.67%) use various coping strategies to cover the household need from food and other essentials. The most frequently used coping strategies were purchasing food on credit (around 90%). Though most of the respondents (84.48%) ate less expensive and less preferred food, about 82% of the respondents consumed seed stock held for next season and more than two-thirds of the respondents look for additional work or work for longer hours. Other strategies adopted by the respondents included borrowing food (42.24%), rationing the money and buy prepared food (36.21 %), selling household possessions (27.59 %), selling productive goods/assets (31.03%), and using of savings and avoiding health care or education costs (22.41%) to buy food. However, the least commonly employed strategies were gathering wild food, hunt, or harvest immature crops, sending household members to eat elsewhere, limiting portion size at mealtimes, skipping meals, restricting consumption of adults in order for small children to eat, feeding working members of household at the expense of non-working members, reducing number of meals eaten in a day, skipping entire days without eating, migrating elsewhere, reducing spending on fertilizers, pesticides, animal food, asking for aid from NGOs or other group, and asking for remittances.

Coping strategies	Never		Occasionally/Always	
	Freq	%	Freq	%
Purchase food on credit	12	10.34	104	89.66
Rely on less-expensive and less-preferred food substitutes	18	15.52	98	84.48
Consume seed stock held for next season	21	18.1	95	81.9
Looking for additional work, work longer hours	33	28.45	83	71.55
Borrow food	67	57.76	49	42.24
Ration the money you had and buy prepared food	74	63.79	42	36.21
Sold productive goods/assets (sewing machine, tools/machinery, car, livestock, etc.)	80	68.97	36	31.03
Selling household possessions (e.g. TV, jeweler, phone, furniture, etc.)	84	72.41	32	27.59
The use of savings and avoiding health care or education costs in order to buy food	90	77.59	26	22.41
Asked for remittances	101	87.07	15	12.93
Send household members to eat elsewhere	101	87.07	15	12.93
Limit portion size at mealtimes	102	87.93	14	12.07
Reduce spending on fertilizers, pesticides, animal food	102	87.93	14	12.07
Skip meals	103	88.79	13	11.21
Reduce number of meals eaten in a day	104	89.66	12	10.34
Ask for aid from NGOs or other group	105	90.52	11	9.48
Gather wild food, hunt, or harvest immature crops	110	94.43	6	5.17
Restrict consumption of adults in order for small children to eat	112	96.55	4	3.45
Migrate elsewhere	113	97.41	3	2.59
Feed working members of HH at the expense of non-working members	113	97.41	3	2.59
Skip entire days without eating	116	100		

Table 14: Coping strategies used by households

(n = 116)
Source: field survey data

5. Vulnerability

Smallholder farmer's and vulnerability were examined by asking him/her questions related to crisis time, future events and their priorities. The majority of the smallholder farmers (85%) believed that if the needed money someone will help who they claimed will be a friend or relative (92%). Almost two thirds of the smallholder farmers thought that they could not change their future while only 33% believed they could. In order to improve their family's well-being, smallholder farmer's priorities health (57%), stable income and work (40%) and minorities said agriculture (3%).

Certainty and Vulnerability		*Definitely yes*	*Not sure*	*Definitely not*
If suddenly you needed a small amount of money, do you believe that someone would help you to cover these costs?	***Freq.***	102	10	8
	Percent	85	8.33	6.67
Do you think you can change the future of your life?	***Freq.***	33	69	18
	Percent	27.5	57.5	15

Table 15: Smallholder farmers' perceived certainty and vulnerability

Source: field survey data

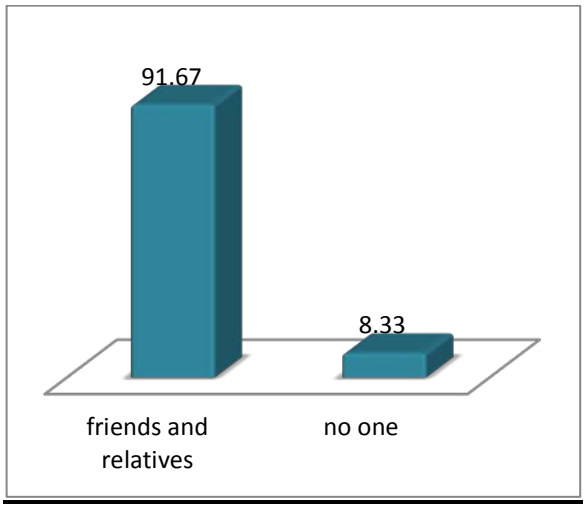


Figure 15: In case of economic loss, who smallholder farmers believed that would help him/her to cover necessities

Source: field survey data

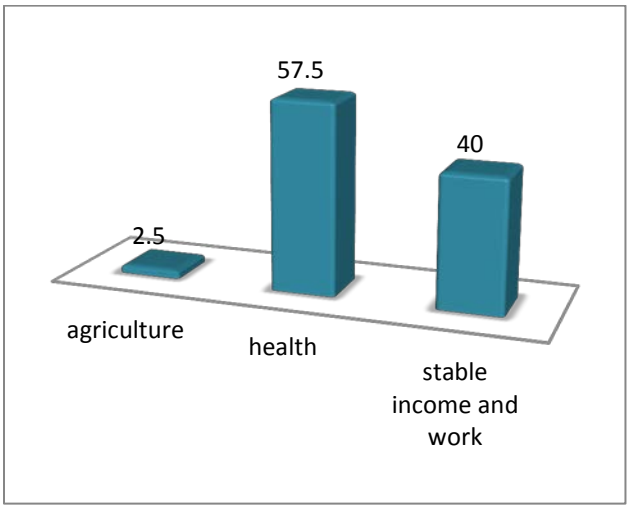


Figure 16: Priority necessities to improve the well-being of smallholder farmers' family

Source: field survey data

C. Econometric model results

The study identified the important determinants of the number of adaptation practices employed by a small-scale farming household to climate changes (i.e., temperature and rainfall), distinguishing between techniques and technologies. Tables 17 and 18 show the various temperature and rainfall adaptation practices respectively and the rate of adoption for each method.

Based on a review of the existing literature on adoption studies and climate change adaptation, and the availability of data, a set of explanatory variables were incorporated in the model. Table 19 presents the description of the dependent and explanatory variables along with their mean values.

The econometric results for the Poisson Regression Model are exhibited in Table 20. In order to better interpret the results the explanatory variables were grouped into: (1) demographics which represents human capital; (2) farm characteristics which mainly include physical and natural capital; (3) financial capital and (4) institutional and social capital.

Temperature adaptation practices	*Adoption*	*Type*
Apply mixed cropping	99.17%	Technique*
Apply crop rotation	95%	Technique*
Grow different varieties on the same plot	85.83%	Technique*
Apply water conservation (improved irrigation) systems	84.17%	Technology**
Shift from farming to non-farming activities	70%	Technique*
Grow early maturing varieties	56.67%	Technology**
Integration of trees into farming systems/shading for animals	45.83%	Technique*
Grow crop tolerant varieties	35%	Technology**
Change planting dates	22%	Technique*
Adopters of two techniques	5%	
Adopters of three techniques	18.33%	
Adopter of four techniques	35%	
Adopters of five techniques	36.67%	
Adopters of six techniques	5%	
Adopters of one technology only	15%	
Adopters of two technologies	54.17%	
Adopters of three technologies	17.5%	
Non-adopters of technologies	13.33%	
Non-adopters of both techniques and technologies	0%	

Table 16: Alternative climate change temperature adaptation practices (technique or technology)

Source: Analysis from household questionnaire interviews

*refers to farming methods specifically tailored to suit the environment that are based on indigenous agricultural knowledge passed from generation to generation through experience and careful observations

**refers to farming methods specifically used to increase productivity and crops that offer greater flexibility in adapting to climate change

Rainfall adaptation practices	*Adoption*	*Type*
Apply mixed cropping	99.17%	Technique*
Apply soil conservation techniques	95.67%	Technique*
Apply crop rotation	95%	Technique*
Increased use of chemical fertilizers	91.67%	Technology**
Grow different varieties on the same plot	85.83%	Technique*
Apply water conservation (improved irrigation) systems	84.17%	Technology**
Reduce farm size	72.5%	Technique*
Engage in non-farm activities	70%	Technique*
Increased use of organic fertilizers	69.17%	Technology**
Grow early maturing varieties	56.67%	Technology**
Integration of trees into farming systems/shading for animals	45.83%	Technique*
Grow crop tolerant varieties	35%	Technology**
Apply crop-livestock integration	28.33%	Technique*
Change planting dates	22.5%	Technique*
Adopters of three techniques	0.83%	
Adopters of four techniques	5.83%	
Adopter of five techniques	9.17%	
Adopters of six techniques	11.67%	
Adopters of seven techniques	28.33%	
Adopters of eight techniques	37.5%	
Adopters of nine techniques	6.67%	
Adopters of one technology only	14.17%	
Adopters of two technologies	27.5%	
Adopters of three technologies	43.33%	
Adopters of four technologies	13.33%	
Non -adopters of technologies	1.67%	
Non-adopters of both techniques and technologies	0%	

Table 17: Alternative climate change rainfall adaptation practices (technique or technology)

Source: Analysis from household questionnaire interviews

Variable	Description	Mean	Std. Dev.	Min.	Max.
Dependent variables					
No. of adaptation strategies to temperature change	Number of current farm adaptation temperature practices	5.94	1.652	2	9
No. of adaptation strategies to rainfall change	Number of current farm adaptation rainfall practices	9.52	2.046	4	13
Explanatory variables					
Gender	D: 1 if HH is male and 2 otherwise	1.21	0.408	1	2
Age	Cat: 1 if HH is age <40; 2 if HH is age 40-59; and 3 otherwise	2.075	0.582	1	3
Education	Cat: 1 if HH education is none; 2 HH education is primary; 3 HH education is secondary and 4 otherwise	3.22	0.769	1	4
Owned livestock	Cat: 1 if smallholder farmer <5 owns livestock, 2 if smallholder farmer owns 6-20, 3 if smallholder farmer >20 owns and 4 otherwise	3.36	1.091	1	4
Distance to selling market	C: distance by automobile in Km	13.55	9.766	3	40
Food expenditure	C: household monthly food expenditure in L.L.	585416	238288	200000	1400000
Total income	Cat: 1 if HH income is ≤499,000 LL, 2 if HH income is 500,000-999,000 LL, 3 if HH income is 1,000,000- 2,990,000 LL and 4 otherwise	2.62	0.566	1	4
Off-farm income	D: 1 if smallholder farmer has off-farm activity, 2 otherwise	1.30	0.460	1	2
Credit access	C: amount of credit, in L.L.	287500	1251323	0	10000000
Relative connection	D: 1 if a household considers the relationship with relatives very important in times of hardship, 2 otherwise	1.258	0.440	1	2
Land size	C: farm land holding, dunum	8.40	3.785	1	20
Private extension	D: 1 if household had access to private extension, 2 otherwise	1.82	0.443	1	3

C: Continuous variable; Cat: Categorical variable; D: Dummy variable *Source: Analysis from household questionnaire interviews*

Table 18: Definition of the variables, and descriptive statistics used in the econometric models (n=120)

Variable	Poisson, Coef. (*Robust SE* [a])		Poisson, Coef. (*Robust SE* [a])	
	Temperature adaptation practice		Rainfall adaptation practice	
	Techniques	*Technologies*	*Techniques*	*Technologies*
Gender	0.0530505 N.S. (*0.0334246*)	0.4222698 *** (*0.1055798*)	0.0393467 * (*0.0243737*)	0.20821*** (*0.0644982*)
Age	-0.0620812 * (*0.0325213*)	-0.1016816 N.S. (*0.0825726*)	-0.0354561 N.S. (*0.0306499*)	-0.0914204 ** (*0.0526759*)
Education	-0.0084709 N.S. (*0.0326041*)	0.1097593 N.S. (*0.0941429*)	0.0226818 N.S. (*0.0273445*)	0.0366835 N.S. (*0.0598354*)
Owned livestock	0.0348609 N.S. (*0.0307027*)	0.1387643 ** (*0.065475*)	0.1037603 *** (*0.0266625*)	0.0256352 N.S. (*0.0573221*)
Land size	-0.0446902 N.S. (*0.0402699*)	-0.0383111 N.S. (*0.0901955*)	-0.031713 N.S. (*0.0371719*)	-0.0730343 N.S. (*0.0319748*)
Food expenditure	-2.20e-07 ** (*7.66e-08*)	-5.58e-07*** (*2.06e-07*)	-2.02e-07 *** (*6.84e-08*)	-4.93e-07 *** (*1.27e-07*)
Total income	0.0533546* (*0.0358841*)	-0.082469 N.S. (*0.081769*)	0.0260387 N.S. (*0.0301538*)	0.0322019 N.S. (*0.0601048*)
Off-farm income	0.256328*** (*0.038927*)	0.138909 * (*0.0753785*)	0.1461531 *** (*0.0310373*)	0.2070862 *** (*0.0587836*)
Credit access	-0.0281222* (*0.0153977*)	-0.0534181 N.S. (*0.042591*)	-0.0325625 ** (*0.0144615*)	-.0730343 ** (*0.0319748*)
Social network- relatives	0.0275676 N.S. (*0.0294112*)	0.1336903 * (*0.0757185*)	-0.0040809 N.S. (*0.0241797*)	.0983882* (*0.0578326*)
Distance to output market	-0.008456*** (*0.0018698*)	-0.0354933 *** (*0.0105568*)	-0.0084607 *** (*0.0017843*)	-0.0194104 *** (*0.0049866*)
Private extension	0.1224565*** (*0.0498323*)	0.0523687 N.S. (*0.1010237*)	0.0845444 ** (*0.0414303*)	0.1229968 * (*0.0678242*)
Constant	1.470175*** (*0.0811163*)	0.7619705 *** (*0.1813084*)	1.996187 *** (*0.0695248*)	1.170803 *** (*0.1366483*)
Log-likelihood	-202.72237	-158.87788	-235.02911	-177.65699
Pseudo-R^2 (*P-value*)	0.0382 (0.0000)	0.0900 (0.0000)	0.0357 (0.0000)	0.0612 (0.0000)

N.S.: not significant ; **P*-value<0.10; ***P*-value<0.05; ****P*-value<0.01.
Robust standard errors (in italics) are computed with STATA 14.2 (commands: poisson, robust).

Table 19: Estimates of the Poisson Regression Model (PRM) for climate change adaptation techniques and technologies (n = 120)

Source: Analysis from household questionnaire interviews

CHAPTER 6

DISCUSSION

A. Socio-demographics- and physical capital-related findings

Undoubtedly, the inflow of remittances from out migrants is a potential source to improve local livelihoods and food security. This is mainly through supporting activities where new technologies are transferred and job opportunities are created for local labor. Certainly, outmigration has a significant impact on livelihoods and food security, yet it adds to the rural development challenge. To illustrate, the increased outmigration and decreased interest of the youth in farming lead to lowering the agricultural production (Hussain *et al.* 2016; Rasul *et al.* 2014). Besides, another interesting finding was the high percentage of smallholder farmers who own tractors (72%); this is not expected in a smallholding land ownership. This, however, is justified by the fact that smallholder farmers in the study area use tractors for a dual purpose – for automobile vehicle and for farming activities.

B. Smallholder farmers' beliefs and perceived causes of climate change

Scientifically, climate change is occurring, and it is chiefly attributed to human activities and posing potentially serious risks to human society and natural systems (NRC 2010). Although the scientific understanding of climate change is firmly established still there is a wide variation in the public understanding of the phenomenon (Arbuckle, Morton and Hobbs, 2015; Weber 2010; Maibach, Roser-Renouf, and Leiserowitz 2009). Howden *et al.* (2007) highlighted that smallholder farmers would not likely undertake climate change adaptive actions if they do not believe that it is happening and/or they do not perceive it as a threat. Moreover, according to the theory of planned behavior[2], there are many factors that influence smallholder farmers' behavioral intentions and shape their attitudes toward responses to climate change (i.e., adaptation); any change at one or more of the factors will result in altering the actual behavior.

[2] As noted by Ajzen (1985 and 1991) in the Theory of Planned Behaviour, it posit that beliefs provide the foundation from which attitudes toward objects and actions are formed, and those attitudes can be highly predictive of behaviors. It is critical to recognize, however, that beliefs may not be scientifically based and may vary substantially between individuals and groups.

From a scientific point of view climate change "[is] due to natural processes or external forcing or to persistent anthropogenic changes in the composition of the atmosphere or land use" (IPCC 2001). In the study, half of the smallholder farmers responded that climate change is due to human activities, and the majority of the smallholder farmers' perceptions about climate change causes are centered on human factors (i.e., bush burning, pollution, deforestation and wars, and conflicts). This entails that the majority of the smallholder farmers were aware of the causes of climate change. The study findings align with other studies (e.g., Ndamani and Watanabe 2015; Farauta *et al.* 2011 and Kusakari *et al.* 2014).

Results, in general, showed that the smallholder farmers in central Bekaa are aware of the significant changes in climatic conditions. All surveyed smallholder farmers responded positively to have been exposed to a climate risk specifically droughts in the past five years. Besides, the findings revealed that a large share of the interviewed smallholder farmers had perceived long-term changes in temperature and precipitation trends over the past 20 years. With regard to climate patterns, the majority of the interviewed smallholder farmers noted an increase in temperature, a decrease in rainfall amount and frequency and decrease in the length of the rainy season. These findings are consistent with the previous studies in Sub-Saharan Africa (Masud *et al.* 2017; Ali and Erenstein 2017; Tesfaye and Seifu 2016; Ndamani and Watanabe 2015; Kusakari *et al.* 2014; Tambo and Abdoulaye 2013; Tessema, Aweke and Endris 2013; Okonya, Syndikus and Kroschel 2013; Gandure, Walker and Botha 2013; Juana, Kahaka and Okurut 2013; Fosu-Mensah, Vlek and MacCarthy *et al.* 2012; Ogalleh *et al.* 2012; Mandleni and Anim 2011; Bryan *et al.* 2011; Sofoluwe, Tijani and Baruwa 2011; Nyanga *et al.* 2011; Acquah-de Graft 2011; Fosu-Mensah, Vlek and MacCarthy 2012; Akponikpe, Johnston and Agbossou 2010; Mertz 2009; Gbetibouo 2009; Apata, Samuel, and Adeola 2009; Yesuf *et al.* 2008; Deressa *et al.* 2008; Nhemachena and Hassan 2007). Central Bekaa smallholder farmers are experiencing a substantial impact on water resources availability due to increase in temperature and prolonged droughts. Hence, it is likely to exacerbate vulnerability of the smallholder farmers in the study area.

C. Smallholder farmers' perceptions, attitudes, and understanding of climate change vulnerability

According to Kim (2008), to provide an appropriate adaptation framework for the smallholder farmers, their perceptions, attitudes, and understanding concerning climate change vulnerability must be first determined.

The results of smallholder farmers' perception on climate change fall in the SI value of the agreed and strongly agreed opinion range of $62.5 \leq SI < 87.5$ and $87.5 \leq SI \leq 100$ respectively. These results corroborate with the findings of Masud *et al.* (2017), Longe, Ukpebor and Omole (2009), Majid and McCaffer (1997) where they found similar SI value ranges in West Selangor-Malaysia, Saudi Arabia, Penang-Malaysia, Nigeria. Most of the sampled smallholder farmers strongly agreed that the increasing temperature, decreasing precipitation and drying sources are the main causes of climate change vulnerability. The findings align with other studies such as Masud *et al.* (2017) and Limantol *et al.* (2016) where they found the same perception on climate change vulnerabilities among the smallholder farmers in West Selangor-Malaysia and Ghana. Furthermore, the majority of the smallholder farmers agreed that they are concerned about the potential impacts of climate change on Bekaa's agriculture and their production. They also believe that climate change is a big issue and the extreme weather events will happen more in the future and thus they should focus on protecting their agriculture land and government should promote mitigation strategies. These findings are consistent with the study of Arbuckle, Morton and Hobbs (2015) which examined smallholder farmers' perceived climate risks to agriculture and their support for adaptive and mitigation responses to climate change in Iowa, USA. Almost all smallholder farmers (99%) agreed to support public action to address the anthropogenic causes of climate change; this was measured through the statement "Government should do more to reduce the nation's greenhouse gas emissions and other potential causes of climate change." As per Arbuckle, Morton and Hobbs (2015), smallholder farmers' support for mitigation entails an acceptance that climate change is driven by human activity and collective action is paramount to incentivize, regulate or at least induce changes in behavior. This indicates that smallholder farmers in Lebanon have expressed their concern about climate change variability (i.e., increasing in temperature, changing rainfall pattern and precipitation); they revealed the perceived climate risks to agriculture as well as they supported adaptation and mitigation responses to climate change.

The literature argues that farmer's attitudes to risk and vulnerabilities are a major determinant of adaptation, implying that farmers with negative attitudes towards adaptation are less likely to adapt. This study finds that smallholder farmers have favorable attitudes towards climate change adaptation. The results of smallholder farmer's attitudes on climate change found that the value of SI falls within the agreed opinion range $62.5 \leq SI < 87.5$. A similar result was obtained by in West Selangor-Malaysia by Masud *et al.* (2017) study where the researchers reported an agreed on an opinion range. This indicates that Lebanese smallholder farmers are aware of climate change vulnerability; they believe that proper adaptation is paramount to handle the threats of climate change and they are pleased to help and work together to minimize climate change impact. This is in line with the finding of Masud *et al.* 2017; Patchen 2006 and Schultz and Oskamp 1996 who argued that awareness about climate change increases the likelihood of smallholder farmers to be willing to act together with government and/or NGOs to preserve the environment.

Scholars and practitioners agree that climate adaptation should be based on the best quality knowledge available. Hence, careful attention must be given to how knowledge is mobilized for decision-making and adaptation initiatives especially among farmers (Haque *et al.* 2017). The SI value of the smallholder farmer's understanding of climate change falls within the agreed opinion range of $62.5 \leq SI < 87.5$. This study found that smallholder farmers have a better understanding of climate change vulnerability and recognize that climate change is a serious problem affecting the Lebanese agricultural sector and has a direct impact on them. These results are in agreement with the previous findings of Masud *et al.* 2017 and Bardsley and Rogers 2011.

D. Adaptation strategies: implementation and importance

Generally, adaptation entails that farmers first notice that climate has changed, and then their understanding of the causes of climate change drives by their responses. Thus, the farmers' identification of the useful adaptation methods they should adopt is directly linked to their perceived climatic changes (Deressa *et al.* 2009; Bryan *et al.* 2009, 2011; Maddison 2006). Farmers adopt different adaptation strategies to improve their resilience and reduce variability on their economic livelihoods and food security (Hussain *et al.* 2016; Tesfaye and Seifu, 2016).

According to the empirical literature, the most common reported climate change adaptation practices among farmers are cultivating different crop types/varieties, soil and water

conservation, changing planting and harvesting dates, planting trees, and off-farm income diversification. The results of this study revealed that the main adaptation strategies used by central Bekaa smallholder farmers are crop management (i.e., mixed cropping/intercropping, growing different crops types/varieties), soil and land management (i.e., soil conservation techniques, crop rotation and use of chemical fertilizers) and water management. These findings are consistent with other studies of Masud *et al.* 2017; Mulwa *et al.* 2017; Li *et al.* 2017; Shikuku *et al.* 2017; Hussain *et al.* 2016; Tesfaye and Seifu 2016; Shisanya and Mafongoya 2016; Ndamani *et al.* 2015; Tambo and Abdoulaye 2013; Juana, Kahaka and Okurut 2013; Tessema, Aweke and Endris 2013; Gandure, Walker and Botha 2013; Belaineh, Yared, and Woldeamlak 2013; Ogalleh *et al.* 2012; Aemro, Mengistu, and Beyene 2012; Acquah-de Graft 2011; Bryan *et al.* 2011; Nyanga *et al.* 2011; Sofoluwe, Tijani and Baruwa 2011; Mandleni and Anim 2011; Fosu-Mensah, Vlek and MacCarthy 2012; Akponikpe, Johnston and Agbossou 2010; Mertz *et al.* 2009; Kang *et al.* 2009; Apata, Samuel, and Adeola 2009; Gbetibouo 2009; Yesuf *et al.* 2008; Deressa *et al.* 2008; Nhemachena and Hassan 2007; and Kurukulasuriya *et al.* 2006.

When looking at the most adopted practices, it is clear that all the smallholder farmers favored the relatively inexpensive financial and time methods such as diversifying crops (i.e., intercropping, crop rotation and growing different crops on the same plot). While improving the irrigation system that is costly and requires more capital was used by around 84% of smallholder farmers. Therefore, the smallholder farmers' financial capabilities significantly influence their choice of adaptation methods.

The results indicated that smallholder farmers' attitudes favor engagement in soil and land management such as intercropping, crop rotation, and growing different types and varieties on the same plot. Smallholder farmers base their choices about what crops to grow on the climate. Thus, crop diversification is considered to be a well-practiced farm-level adaptation to climate change (Smit and Wandel 2006; Speranza 2006). Besides, crop diversification is more related to risk reduction than benefit-maximizing since such practices require little investment to implement or seeking information and training (Tesfaye and Seifu 2016). For instance, the smallholder farmers in central Bekaa grow fruits that are more resilient to water-stress and have higher market value and cultivate vegetables that have shorter growing periods.

The smallholder farmers in this study area were adopting soil and water conservation techniques although such strategies require larger investments in time and money yet they reduce the risks associated with climate change. Such techniques and technologies are considered to be "win-win" adaptation strategies since they serve as social and biophysical goods. These strategies conserve the soil structure and improve water availability thus reducing erosion, preserving essential nutrients and increasing on-farm yields (Dumanski *et al.* 2006).

According to Shikuku *et al.* (2017), land, soil, and water management practices' benefits are often weighted towards the future while entailing current period investment costs. Hence, the returns of implementing these adaptation practices are cumulative and long-term. In central Bekaa case, stallholder farmers' planning horizons are short, and their decision making is influenced by the investment constraints in terms of cash and time, and according to the respondents the few coming year's labor shortage will be added as an obstacle. Furthermore, the high percentage of the smallholder farmers (70%) who are involved in off-farm activities can be attributed to the risk that climate variability has on the agriculture sector.

Diverging from previous studies' findings, changing planting dates (i.e., shifting planting dates by week or month from year to year in response to the variability in rainfall) and integrating trees into farming systems were not shown as common adaptation methods in the studied area. Changing the planting date is considered in the literature to be the most straightforward on-farm climate adaptation strategy (Tesfaye and Seifu 2016). Thus, smallholder farmers in central Bekaa must start implementing it. Although the majority of the interviewed smallholder farmers reported that deforestation is the main cause of climate change, few smallholder farmers (45%) adopted the integration of trees into farming systems. It is vital to mention that planting trees is both adaptation and mitigation method which has diverse ecological and economic benefits (Tessema, Aweke and Endris 2013). Therefore, more smallholder farmers should be integrating trees in their farms.

Interestingly, none of the interviewed smallholder farmers responded "no adaptation" to either changes in temperature or rainfall. This is an encouraging finding and implies that all smallholder farmers were able to adapt to climate change. In contrast, studies in Africa indicated higher percentages of non-adapters; for instance, Tambo and Abdoulaye (2013) reported that 15% of the smallholder farmers in Nigerian savanna are non-adapters, Fosu-Mensah, Vlek and MacCarthy (2012) found that 56% of sub-humid zone of Ghana smallholder farmers are non-

adapters, also Bryan *et al.* (2009) indicated that non-adapter smallholder farmers were 62% and 37% of smallholder farmers in South Africa and Ethiopia, respectively. The full smallholder farmers' adaptation to climate change in this region is attributed to the cumulative farming experience that is mainly a combination of private institutions and farmer-to-farmer extension services.

This study showed that some of the smallholder farmer perceived important adaptation practices were different than the actual practices they have been implementing. On the first hand, some practices were perceived as important and where implemented including mixed cropping, crop rotation, and soil and water conservation. On the other hand, smallholder farmers perceived that important adaptation practices such as the use of fertilizers, farm size, shifting to non-farming jobs, crop tolerant varieties and mixed farming were different from the actual practices being implemented. While smallholder farmers ranked use of organic fertilizers and use of chemical as the fourth most important and least important respectively the actual implementation showed that only 70% use organic and 92% use chemical fertilizers. Besides, reducing farming size and shifting to non-farming activities were not perceived as important practices yet almost 75% of the smallholder farmers implemented both strategies. Moreover, although crop tolerant varieties and mixed farming (crop-livestock integration) were perceived as moderately important practices a few smallholder farmers (35% and 28% respectively) implemented these practices.

Furthermore, studies by Ndamani and Watanabe (2015) in Lawra district of Ghana and Farauta *et al.* (2015) in Northern Nigeria similarly reported that crop diversification activities (i.e., mixed cropping and crop rotation) were perceived as the most important practices among smallholder farmers. In contrast, a study by Masud *et al.* (2017) in West Selangor-Malaysia indicates that smallholder farmers positioned crop diversification activities as less important adaptation practices. Previous studies by Masud *et al.* (2017), Ndamani and Watanabe (2015) and Farauta *et al.* (2015) have reported similar findings regarding soil and water conservation perceived importance. The perceived high importance of organic fertilizers usage is similar to Masud *et al.* (2017) who found the same results. In this study, changing planting date practice is the least important this finding aligns with Ndamani and Watanabe (2015) yet, disagree with Masud *et al.* (2017) who reported that this practice is the positioned as the most important perceived practice among farmers in West Selangor-Malaysia.

E. Perceived smallholder farmers' barriers to climate change adaptation

Traditionally, agriculture in the Bekaa valley was assumed to be the sole contributor to food security and livelihoods of households in the area. Almost all smallholder farmers in the area claimed that the daily living source of livelihoods for the majority of their ancestors was from agriculture and livestock as these activities provided them with diverse foods and contributed to the household income. However, as per the respondents the contribution of agriculture to household income and food security has significantly decreased over time due to many challenges, chiefly climatic hazards .

Adaptation to climate change has many stumbling blocks. The study found that smallholder farmers in Lebanon encounter many barriers to adaptation emanating from different biophysical, economic and social situations. In general, the perspectives of female-smallholder-farmers and male-smallholder-farmers towards the adaptation barriers were fairly similar. Nevertheless, the results revealed that female-farmers were equally concerned about all types of barriers, whereas male-farmers were more concerned about barriers related to financial and economic aspects.

Water scarcity was considered to be the most important barrier from all the three types. In central Bekaa, the inadequate access to water caused severe impacts on farmers' agriculture production thus adversely affecting their livelihoods. The inadequate access to water is a result of the irregular precipitation patterns attributed to climate change along with over-extraction of ground water. This finding is consistent with the previous studies of Masud *et al.* (2017); Jalon *et al.* (2015); Jones and Boyd (2011); Moser and Ekstrom (2010); and Birkmann and von Teichman (2010) who indicated that water scarcity is the main challenge for farmers in various studied countries. Ranking water scarcity as the first barrier in central Bekaa can be explained by the fact that there is clear evidence of depletion of the groundwater sources in this region due to unauthorized over-pumping of water and the increase in the frequency of droughts. As well, a good proportion of the agriculture in this region is rain-fed, making smallholder farmers more sensitive to fluctuations in the annual rainfall distribution.

Beyond water, the second most critical impediments to adoption were economic constraints, limited access to agriculture markets and lack of policy. Furthermore, smallholder farmers identified other main economic barriers including high cost of farm inputs, lack of access to credit, lack of irrigation infrastructure, and insecure land tenure whilst considerably

significant social and biophysical constraints were lack of governance support, unpredictable weather and a shortage of land. In general, these findings are in line with previous studies such as Masud *et al.* 2017; Ndamani and Watanabe 2015; Jalon *et al.* 2015; Tessema, Aweke and Endris 2013; Jones and Boyd 2011; Deressa, Hassan and Ringler 2010; Moser and Ekstrom 2010; Birkmann and von Teichman 2010; Deressa *et al.* 2009; Bryan *et al.* 2009; and Maddison 2007. These findings further denote the significance of financial resources in adaptation to climate change.

Although labor shortage was the least reported barrier, smallholder farmers justified it with the abundance of low wage labor mainly due to the Syrian refugees. Yet, smallholder farmers insisted that certainly in the coming few years there will be an increase in the amounts of fallow agricultural land as a result of labor shortages together with water shortages. Labor shortage will result from refugees going back to Syria, increase outmigration and decreased interest of the Lebanese youth in farming.

F. Determinants of temperature and rainfall adaptation techniques and technologies

The regression analysis results in Table 20 show that small scale farming households' decision to adapt to temperature change are significantly influenced by most of the explanatory variables. Temperature adaptation technique practices are affected by the age of the household head, household income, access to credit and private extension services. On the other hand, temperature adaptation technology practices are influenced by the gender of the household head and livestock ownership. The determinant factors for both practices are off-farm-based income, food expenditure and distance to selling market.

In addition, the results of the outcome model (Table 20) found that most of the explanatory variables significantly affected the probability of adopting rainfall adaptation practices. Rainfall adaptation technology practices are influenced by the age of the household head, livestock ownership, and relative's connections. However, the explanatory variables affecting both rainfall adaptation techniques and technology practices are the gender of the household head, food expenditure, off-farm-based income, access to credit, distance to selling market and private extension services.

1. Demographics/human capital

i. Gender of the household head

Gender of the household head significantly influences the likelihood that a smallholder takes up an adaptation strategy particularly temperature adaptation techniques and rainfall adaptation techniques and technologies. The results indicate that female-headed households are more likely to adapt to climate change than male-headed households. The fact that female-headed households are more likely to take up climate change adaptation may be because women are fully responsible for their households' welfare inside and outside the house. Besides, various studies presented women as risk-averse and thus they are more likely to adopt technologies and techniques that would lower their risk exposure (Arano, Parker and Terry, 2010). As per the literature, the gender of the household head showed mixed results; in some studies, it was significant and in others insignificant. The findings from this study agree with the findings of many studies including Garcı´a de Jalo´n 2015; Grace et al.2015; McCright, Dunlap and Xiao 2013; Silvestri *et al.* 2012; Eurobarometer Survey on Climate Change 2011; Nhemachena and Nhem 2007; Sundblad, Biel and Gärling 2007; and Nhemachena and Hassan 2007. In contrast, various studies in Africa revealed that male-headed households adopt more climate change adaptation technique and technology strategies compared to female-headed households since males are more likely to get information about new technologies and take business risk than female-farmers such as Ali and Erenstein 2017; Zamasiya, Nyikahadzoi and Mukamuri 2017; Opiyo *et al.* 2017; Mulwa *et al.* 2017; Ndiritu, Kassie and Shiferaw 2014; Ragasa *et al.* 2013; Derssa *et al.* 2009; Hassan and Nhemachena 2008; Uaiene 2008 and Asfaw and Admassie 2004.

ii. Age of the household head

Age of the household head turned to be negatively associated with the adoption of temperature techniques and rainfall technologies practices, indicating that younger smallholder farmers are more likely to adapt to climate change compared to their older counterparts. This is plausible since younger smallholder farmers are more aware of climate change and recent innovations which make them keen to try new technology and techniques to combat climate change and improve their agriculture. According to the environmental psychology literature, younger individuals are considered to have a higher environmental commitment that is directly

linked to higher concern about climate change (Davis, Le and Coy 2011; Michel-Guillou and Moser 2006). This finding agrees with numerous previous studies conducted in developed countries which reported that younger farmers were more likely to adapt to climate change, for example, Ali and Erenstein 2017; Tambo 2016; Garcı´a de Jalo´n *et al.* 2013; Islam, Barnes and Toma 2013; Eurobarometer Survey on Climate Change 2011; and Marenya and Barrett 2007. However, previous studies in developing countries revealed that older farmers were more likely to adopt adaptation practices than younger farmers since the age variable is highly correlated with farming experience (de Jalo´n, 2015; Bryan *et al.* 2013; Silvestri *et al.* 2012; and Deressa *et al.* 2009).

iii. Education of the household head

Education of the household head presents a statistically insignificant effect on the adoption of any measures against climate change. This could be explained by the fact that only three percent of the smallholder farmers did not have any schooling and the respondent's education level was not widely diverse. This finding is in contrary to numerous adoption studies that indicate that there is a positive relationship between education level and the adoption of climate change techniques and technology practices. Many studies including Ali and Erenstein 2017; Li *et al.* 2017; Mulwa *et al.* 2017; de Jalo´n, 2015; Huber, Flury and Finger 2015; Islam, Barnes and Toma 2013; Garcı´a de Jalo´n*et al.* 2013; Wheeler, Zuo and Bjornlund 2013; Bryan *et al.* 2013; Eurobarometer Survey on Climate Change 2011; Derssa *et al.* 2009; Czaja *et al.* 2006 asserted that the higher the farmer education level the more likely s/he will be aware of climate change, adaptation practices and benefits of adopting such methods.

2. Farm characteristics/physical and natural capitals

i. Land size

Land is a major agricultural asset variable that reflects natural capital, typically included in adoption models as a proxy for wealth. The findings showed that land parameter does not present a statistically significant effect on any adaptation practice against climate change. The statistical insignificance could be explained by the fact that the land size is relatively small (1-20 dumum); hence farmers with smallholding are unlikely to have the capability to try out and invest in climate risk coping strategies. This result is contrary to the findings of Li *et al.* 2017;

Abid *et al.* 2015; Bryan *et al.* 2013; Wheeler, Zuo and Bjornlund 2013; Tiwari, Wahr and Swenson 2009; Nhemachena and Hassan 2007; Bekele and Drake 2003; Croppenstedt, Demeke and Meschi 2003 who observe that farmers with more land implement more adaptation practices.

ii. Livestock

Livestock ownership is one of the basic assets in the rural economy and wealth indicator where rural households believe that it is a form of saving and insurance (Watson and van Binsbergen, 2008; Doran, Low and Kemp 1979). The result indicates that the number of livestock owned has a positive and significant impact on the likelihood that farming household adapts temperature technology and rainfall techniques. This is in line with the finding of previous studies such as Ali and Erenstein 2017; Opiyo *et al.* 2017; Mulwa *et al.* 2017; de Jalo´n, 2015; Gebrehiwot and van der Veen 2013; Jara-Rojas, Bravo-Ureta and Díaz 2012; Silvestri *et al.* 2012; Deressa *et al.* 2009; Anley, Bogale and Haile-Gabriel 2007.

3. Financial capital

i. *Income*

Income is expected to play a critical role in facilitating adoption of climate change techniques and technologies. The findings designated that income does not seem to explain climate change adaptation much, only increasing the likelihood of temperature adaption technique while diminishing the likelihood of temperature adaption technology and rainfall adaption technique and technology. Wealthy households are likely to have the ability to invest capital in new agricultural methods to adapt to climate risk. Also, it is argued that as income increases the likelihood of the farmer to have access to information, credit and extension services increases (Tessema, Aweke and Endris 2013). Other studies have similarly found a positive correlation between income and adoption of climate change methods such as Ali and Erenstein 2017; Abid *et al.* 2016; Tessema, Aweke and Endris 2013 and Foster and Rosenzweig 2010.

ii. *Off-farm income*

Generally, an important share of the majority of the interviewed smallholder farmer income comes from off-farm activity; in fact, 75% of them have a form of diversification into an

off-farm job. It is crucial to note that the existence of non-farm income serves as an adaptation measure by itself. The results showed that the non-farm income of the households surveyed has a significant impact and positive relationship with temperature and rainfall adaptation. This indicates that as the proportion of total household income emanating from non-farm income increases the likelihood of the smallholder farmers to adopt various techniques and technology measures. Besides, smallholder farmer income diversification is meant to decrease the risk effect of relying merely on agriculture income. This result is in line with the findings of studies by Ali and Erenstein 2017; Mulwa *et al.* 2017; Tambo 2016; Gautam and Andersen 2016; Rahut and Micevska Scharf 2012; Spence *et al.* 2011 Derssa *et al.* 2009; Fernandez-Cornejo 2007; and Tenge, De Graaff and Hella 2004; inconsistent with findings of other studies such as Tessema, Aweke and Endris 2013; Diiro 2009 and Velandia *et al.* 2009.

iii. *Food expenditure*

Food expenditure was found to be significant and negatively related to temperature and rainfall adaptation techniques and technologies. This can be explained by the fact that as the yields of smallholder farmers who employ climate risk adaptation increases the consumption of their own agricultural products increases (i.e. food stock *mounah*); therefore they reduce their expenditure on food. In the literature, we are not aware of previous studies that examined food expenditure as an explanatory parameter of climate risk adaptation measures.

4. Institutional and social capitals

i. Private extension

Agricultural extension agents provide information and advisory services which foster accessing information and knowledge on climate risks, impacts and the possible agricultural practices that can be used in responding to climate variability and change (e.g., old and/or new farming techniques and technologies). Various studies revealed that creating awareness and favorable circumstances will allow smallholder farmers to make rational and suitable adaptation decision; hence, enable them to cope well with changes in climatic conditions (Mulwa *et al.* 2017; Opiyo *et al.* 2017; Ali and Erenstein 2017; Dinku *et al.* 2014; Tessema, Aweke and Endris2013; Falco *et al.* 2011; Nhemachena and Hassan 2007; Baethgen Meinke and Gimenez 2003; Doss 2003; and Kandlikar and Risbey 2000). This study revealed that access to extension services significantly increases the probability of a household to employ more adaptation

techniques and technological measures in line with the growing climate change practices and technological adoption, adaptation and development literature (e.g. Mulwa *et al.* 2017; Ali and Erenstein 2017; Zamasiya, Nyikahadzoi and Mukamuri 2017; Opiyo *et al.* 2017; Abid *et al.* 2016; Tambo 2016; Grace et al.2015; Below *et al.* 2012; Tambo and Abdoulaye 2013; Deressa *et al.* 2009; Maddison 2007; Amsalu and de Graaff 2007; Nhemachena and Nhem 2007).

ii. Market distance

The result revealed that the distance from the output market has a very significant influence on the likelihood of household to adapt to climate change. The negative relationship indicates that the probability of a higher level of adaptation increases with a decrease in the distance from output markets. The implication of this result is that smallholder farmers traveling further to output market are spending more effort, time and money to access the market instead of investing in adaptation techniques and technologies compared to those who access the market in a shorter distance. The negative association between distance to the selling market and climate change adaptation strategies has been similarly found in other studies (Opiyo *et al.* 2017 and Tessema, Aweke and Endris 2013) yet contrary to Tesfaye 2016 and Nhemachena and Hassan 2007.

iii. Credit access

When interpreting the result, the credit constraint variable was categorized into smallholder farmers who needed credit and did not get it or got less than they needed (=1) and those who did not need credit (=0). As per Simtowe and Zeller (2006), credit access relaxes liquidity constraints which in turn increase the use of adaptation practices. Therefore, it is expected to have a negative relationship between credit constraint and the probability of adaptation methods. The study found that access to credit has a significant negative impact on the likelihood of using temperature techniques and rainfall adaptation techniques and technologies. This can be explained by the fact that smallholder farmers who obtain credit are likely to participate in various agricultural investment activities, thereby improving their adaptability and thus delaying their use of adaption techniques and technologies. Similar to the findings of Mulwa *et al.* 2017, Masud *et al.*, 2017 and Tessema, Aweke and Endris 2013; farming households with better access to credit were found to be less probable to adapt.

iv. Social network – connection with relatives

The study findings showed that relative's kinship ties in times of hardship are positively related to the likelihood of adopting temperature and rainfall technology strategies. This result implies that social network in term of relative relationship increases awareness and use of climate change adaptation measures. Further, more kinship ties act as a form of group dynamics facilitating the flow and share of information among relatives which eases and accelerates the process of technology adoption. Studies by Mulwa *et al.* 2017; Li *et al.* 2017; Munasib and Jordan 2011; Deressa *et al.* 2009; and Parthasarathy and Chopde 2001 similarly reported that relationship with relatives has a positive impact on climate change adaptation strategies.

CHAPTER 7

CONCLUSION AND POLICY IMPLICATION

A. Conclusion

The study is based on a primary, cross-sectional survey of 120 smallholder farmers' households from nine villages in central Bekaa. The study compromised two sets of questionnaires: the first aimed to assess the farm households' resilience to climate change and variability, and the second one was intended to evaluate the household food security adopting four indexes developed by international agencies (i.e., HFIAS, MIAHFP, FCS and CSI).

The interviewed smallholder farmers were asked if they have observed any change in temperature and rainfall over the past 20 years. Those who responded to have observed changes were further surveyed to investigate how they responded to climatic conditions variability through adaptation. Hence, the study examined the whole adaptation processes starting from exploring smallholder farmers' level of perception, attitude and understanding of climate change to identifying the types of adaptation measures undertaken, recognizing the barriers that hinder adaptation strategies, analyzing the determinants of the number and choice of climate change adaptation practices, and finally evaluating the household vulnerability to food insecurity.

In a nutshell, the results showed that the smallholder farmers in central Bekaa are aware of the significant changes in climatic conditions. The majority of smallholder farmers believed that climate change is occurring and is caused mostly by human activities such as bush burning, deforestation, and pollution. All the surveyed smallholder farmers responded positively to having been exposed to a climate risk specifically droughts in the past five years. Besides, the findings revealed that a large share of the interviewed smallholder farmers had perceived long-term changes in temperature and precipitation trends over the past 20 years. With regard to climate patterns, the majority of the interviewed smallholder farmers noted an increase in temperature, a decrease in rainfall amount and frequency and decrease in the length of the rainy season.

Most of the sampled smallholder farmers strongly agreed that they are concerned about the potential impacts of climate change on Bekaa's agriculture and their production, and they believed that climate change is a big issue and the extreme weather events will happen more in the future and thus they should focus on protecting their agriculture land and government should

promote mitigation strategies. Almost all the smallholder farmers agreed to support public action to address the anthropogenic causes of climate change. Hence, this indicates that Lebanese smallholder farmers are aware of climate change; they believe that proper adaptation is paramount to handle the threats of climate change, and they are willing to take joint actions to minimize climate change impact.

Smallholder farmers in central Bekaa are implementing a variety of adaptation practices to counter the adverse impacts of climate change. The main adaptation techniques and technologies are diversifying crops (i.e., mixed cropping, crop rotation and growing different crops on the same plot); improving the irrigation system, adopting soil conservation techniques, and using chemical fertilizers. It is crucial to note that none of the interviewed smallholder farmers responded "no adaptation" to either changes in temperature or rainfall. Further, the surveyed smallholder farmers were asked about the most important barriers they face in adapting to climate change. The most frequently identified barriers are: water scarcity, limited access to agriculture markets and lack of policy.

This study analyzes the adoption of climate change practices, separately for techniques and technologies, among small-scale farmers using Poisson Regression Model that aims to assess the determinants of the number of adaptation methods adopted by farming household. In the model, the dependent variables include different rainfall and temperature adaptation techniques and technologies methods, and the explanatory variables include different household characteristics, farm characteristics, and financial, institutional, and social factors. The econometric results reveal that human, financial, natural/physical and institutional/social capitals are important factors in increasing the likelihood of adoption. Temperature adaptation techniques practices are affected by the age of the household head, household income, access to credit and private extension services. Temperature adaptation technology practices are influenced by the gender of the household head and livestock ownership. Both temperature practices are associated with off-farm-based income, food expenditure and distance to selling market. As for the rainfall adaptation technology practices are influenced by the age of the household head, livestock ownership, and relative's connections. Both rainfall adaptation practices are influenced by the gender of the household head, food expenditure, off-farm-based income, access to credit, distance to selling market and private extension services. Finally, the results show that most of

the adaptation measures are complementary where smallholder farmers adopt a combination of practices to meet the various challenges posed by the changes in climate.

Overall, the results of the food security questionnaire revealed that most households had a low score of food insecurity indicating the low prevalence of food insecurity among farming households in central Bekaa. As for HFIAS, only nine of the 120 households were food secure, the majority of the households were mildly food insecure (82.5%), and the remaining (10%) were moderately food insecure. However, MAHFP index showed that February and March are the hunger months and almost all of the households reported that they had enough food supply to meet the family's needs in months May, June, July, August and September. According to the FCS, almost all the interviewed smallholder farmers reported that they were able to eat from all the food groups; as for vegetables/leaves and fruits food groups, the majority of the respondents reported that the sources are a combination of to a larger extent own production and to a less extent purchasing on debt and in cash. Finally, the study findings revealed that most of the respondents use various coping strategies to cover the household need from food and other essentials. The most frequently used coping strategies by the respondents were: purchasing food on credit; eating less expensive and less preferred food; consuming seed stock held for next season and looking for additional work/work for longer hours.

B. Policy implications

The results of this study provided a better understanding of smallholder farmers' decision-making mechanisms. The study has several potential policy implications aiming to build farming households' resilience to climate change and improve the food security and livelihood of smallholder farmers in the study region. There is a need for clearly designed agricultural policies which are anchored in local- and science-based knowledge as well as capitalizing on local potential and opportunities, therefore, assisting in controlling excessive switching to off-farm sector and out-migration.

- Public extension services and training: The study results indicate a failure in the public extension system since none of the interviewed smallholder farmers reported that s/he received any extension services from the public sector (i.e., Ministry of Agriculture). This barrier forces the need for policy interventions, in particular through deepening and

strengthening the network of public extension service offices. Public extension service is meant to be cost free, effectively and competently meet the needs of the agriculture sector, particularly the smallholder farmers. The public extension service should boost the communication of adaptation related information and build smallholder farmers capacity to use innovative practices or technologies. Therefore enhancing the smallholder farmers' beliefs and stimulate actual adaptation to climate change regardless of the smallholder farmer's economic standing.

There is a significant room for the government to combat climate change mainly through establishing a "Climate Change Learning Center" which targets individual farmers or farmer's associations/cooperatives. The center must facilitate the building of knowledge and skills in farmers using field-based teaching methodologies and practices including: conducting awareness and information meetings, disseminating climate information, and exposing the targets to on-farm trials: research experimentation, demonstrations and field days. The extension service messages should be tailored to encourage smallholder farmers to think holistically in terms of adopting optimal combinations of practices. Furthermore, the center should design training programs to build the extension service staff capacity to deliver quality information and strengthen their teaching skills on how to develop and implement field-based learning strategies.

- Stakeholder management: Scaling up climate change adaptation practices (i.e., technologies and techniques) requires a shared vision of all potential stakeholders. Smallholder farmers and the Ministry of Agriculture are not the only actors to be involved in promoting adaptation other stakeholders can be NGOs, local institutions, farmers' associations/cooperatives, the private sector, and the media. All stakeholders must be engaged at different junctures and take part in any climate-resilient project by contributing their ideas, knowledge, expertise, resources, and technologies while ensuring that all perspectives are equally robust and well-connected.

- Government support: The prevailing high cost of farm inputs, shortage in credit facilities and subsidies and lack of market access require the government to include climate change adaptation policies in its development agenda. The agriculture policies, strategies and intervention should augment farm assets and increase the affordability of climate risk coping capacity. For instance, easing liquidity constraints in which agriculture loans with flexible terms are made available to smallholder farmers (i.e., microfinance credits) and provisioning of crop insurance mechanisms to improve their access to farm inputs, market, and finance.

- Research and development: Research and development should be conducted to establish specific adaptation interventions and methodologies that integrate local knowledge to create effective adaptation practices. Government policies should boost the capacity of scientists and agricultural staff via supporting research, development, and diffusion of appropriate and effective technologies to help smallholder farmers adapt to changes in climatic conditions.

- Formation of agriculture cooperatives: In accordance with the findings, kinship ties positively impact some adaptive practices. Thus, policies must generate incentives to encourage the formation of formal and informal farmers and rural community groups. Active participation in such groups increases information dissemination and mutual support. This will aid farmers to acquire information and resources needed for implementing practices that boost the resilience of farming systems and livelihoods.

- Media: Mass media and social media play a crucial role in disseminating climate-change related messages particularly to young smallholder farmers. For instance, the public extension service can develop TV programs and social media platforms focusing on climate change issues and share it with smallholder farmers.

C. Future studies

This study is a situation analysis of local smallholder perceptions, attitude, and understanding of climate change and the local climate-smart adaptive measure they undertook along with evaluating their household food security status in the study area. Previously farmers' behavior towards climate change received very little attention in developing countries. Therefore, it is hoped that this study would provide a good platform for researchers to design and conduct further studies as there are still many unanswered questions for future research on resilience to climate change and means to sustain households' livelihoods and food security.

Based on the findings of this study, several directions for future research can be suggested. First, further empirical study with longitudinal survey data is needed to test causality between climate change adaptation measures and food security levels. Moreover, future research can examine the climate change perceptions and adaptation strategies of small-scale compared to large-scale farmers' resilience. Also, similar studies need to be conducted in other Lebanese districts to discover if farmers' perception, attitude, and understanding are the same or different. In addition, in-depth qualitative research is required to understand the ways in which farmers and other stakeholders analyze their climate risk management to improve climate adaptation decision making in agriculture.

Besides, further research is recommended particularly for semi-arid areas which are aggravated by climate change extreme conditions causing shift/to shorten growing seasons or change the portfolio of feasible crops. As a result, future research is needed to further the understanding of the climate change on semi-arid areas and focus on finding effective strategies, sustainable and resilient agricultural practices or conservation agriculture enabling smallholder farmers to maintain stable yields and further enhance their families' food security. Finally, the findings highlighted the call for research that aims to understand the water agriculture-related issues in this area.

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Appendices

Appendix A

Oral Consent Script to participate in a Questionnaire Pilot testing

Hello. My name is Aliaa Al Dirani. I am a graduate student in the Department of Food Security/Faculty of Agricultural and Food Sciences at AUB. I would like to invite you to participate in a research study about examining the determinants of smallholders' choice of climate change adaptation strategies, and the impact this may have on household food security.

Before we begin, I would like to take a few minutes to explain why I am inviting you to participate and what will be done with the information you provide. You will be asked to participate in the pilot testing of the research project by completing the following questionnaire. You were chosen to be part of the pilot testing because you have experience in farming and you are a resident of a village which is part of the central Bekaa. Please stop me at any time if you have questions about the study.

I am doing this study as part of my studies at AUB. I will be asking 120 smallholder farmers to participant in my study from 9 villages. I will be directly approaching the smallholder farmer on the site and invite him/her to participate in the study. I will use the information as the basis for my thesis. I may also use this information in articles that might be published, as well as in academic presentations. Your individual privacy and confidentiality of the information you provide will be maintained in all published and written data analysis resulting from the study. All questionnaires will be stored and maintained in a locked file cabinet in principal investigator's office. Only researchers will have access to the data.

Your participation should take approximately 30 – 45 minutes. Please understand your participation is entirely on a voluntary basis and you have the right to withdraw your consent or discontinue participation at any time without penalty. There are no known risks, harms or discomforts associated with this study. You will not directly benefit from participation in this study. You will not receive any monetary compensation for your participation. But we hope that this study will aid in future planning to enhance the policies that deals with climate change adaptation and food security.

If at any time and for any reason, you would prefer not to answer any questions, please feel free to skip those questions. If at any time you would like to stop participating, please tell me. We can take a break, stop and continue at a late date, or stop altogether. You will not be penalized for deciding to stop participation at any time. We also assure you that if you decide not to participate in this study this will not affect your relation with the American University of Beirut in any way.

In case the food security related questions were tough on you, I will provide you will a list of Primary Healthcare Centers in the region were you can seek psychological help. Please note that the psychological service will be on your own expenses.

A copy of the consent document will be kept with the participant.

If you have any questions, concerns or complaints, you are free to ask them now. If you have questions later, you may contact my advisor or me at

Investigator's Name	*Phone number*	*Email address*
Dr. Gumataw Abebe	*01-374374 Ext: 4511*	*ga81@aub.edu.lb*
Aliaa Al Dirani	*71-455236*	*aaa136@mail.aub.edu*

If you have any questions about your rights or welfare as a participant in this study, or you want to talk to someone outside the research group, please contact the IRB Office at the AUB.
Phone number: 01-350000 ext: 5445 *Email: irb@aub.edu.lb*
Are you interested in participating in this study? [ ] Yes [ ] No

__ Aliaa Al Dirani_____ _____ _____

Name of Person obtaining Consent *Signature* *Date*

Appendix B

نص شفوي للمشاركة في إختبار تجريبي الاستبيان

مرحبا. انا اسمي علياء الديراني. أنا طالبة ماجستار في قسم الأمن الغذائي / كلية العلوم الزراعية والغذائية في الجامعة الأميركية في بيروت. أود أن أدعوكم للمشاركة في دراسة بحثية عن محددات اختيار أصحاب الحيازات الصغيرة لاستراتيجيات التكيف مع تغير المناخ ، وتأثير ذلك على الأمن الغذائي للأسرة.

قبل أن نبدأ ، أود أن أخذ بضع دقائق لتوضيح سبب دعوك للمشاركة في هذا البحث وماذا سيحصل بالمعلومات التي ستقدمها. سيُطلب منك المشاركة في إختبار تجريبي لمشروع بحث عن طريق إكمال إستبيان. لقد تم اختيارك لتكون جزءًا من الاختبار التجريبي لأن لديك خبرة في الزراعة وأنت مقيم في قرية تعتبر جزءًا من البقاع الأوسط. يرجى إيقافي في أي وقت إذا كانت لديك أسئلة حول الدراسة.

أقوم بهذه الدراسة كجزء من دراستي في الجامعة الأميركية في بيروت. سوف أطلب من 120 مزارع المشاركة في دراستي من 9 قرى. سوف أدعو المزارعين المتواجدون على الارض للمشاركة في الدراسة. وسأستخدم هذه المعلومات كأساس لأطروحتي. قد أستخدم أيضًا هذه المعلومات في المقالات التي قد تنشر ، وكذلك في العروض الأكاديمية. سيتم الحفاظ على خصوصيتك الفردية وسرية المعلومات التي تقدمها في جميع تحليل البيانات المنشورة والمكتوبة الناتجة عن الدراسة. سيتم تخزين جميع الاستبيانات والحفاظ عليها في خزانة الملفات المقفلة في مكتب المحقق الرئيسي. لن يتمكن سوى الباحثين من الوصول إلى البيانات.

مشاركتك ستتراوح 30 إلى 45 دقيقة. و نؤكد أن مشاركتك طوعية و يحق لك التوقف وقتما شئت بدون أي احراج او اي عائق.. لا توجد مخاطر أو أضرار أو مضايقات معروفة مرتبطة بهذه الدراسة. كما أنه لن تستفيد بشكل مباشر من المشاركة في هذه الدراسة. وأود أن أوكد بانه لا يوجد أي تعويض مالي للمشاركة في هذه الدراسة. لكننا نأمل أن تساعد هذه الدراسة في التخطيط المستقبلي لتعزيز السياسات التي تتعامل مع التكيف مع تغير المناخ والأمن الغذائي.

إذا كنت تفضل في أي وقت ولأي سبب عدم الإجابة عن أي أسئلة ، فلا تتردد في تخطي هذه الأسئلة. إذا كنت ترغب في أي وقت في التوقف عن المشاركة ، فالرجاء إخباري بذلك. يمكننا أن نأخذ استراحة أو نتوقف أو نستمر في وقت متأخر أو نتوقف نهائياً. لن يكون هنالك أي تأثير سلبي عليك في حال قررت التوقف و عدم الاستمرار. كما نؤكد لك أن عدم مشاركتك في الدراسة لن تؤثر على علاقتك بالجامعة الأميركية في بيروت بأي شكل كان.

في حال كانت الأسئلة المتعلقة بالأمن الغذائي صعبة عليك ، فسأزودك بقائمة مراكز الرعاية الصحية الأولية في المنطقة ، حيث يمكنك طلب المساعدة النفسية. يرجى ملاحظة أن الخدمة النفسية ستكون على نفقتك الخاصة.

إذا كان لديك أي أسئلة أو مخاوف أو شكاوى ، فيمكنك أن تسألهم الآن. إذا كانت لديك أسئلة في وقت لاحق ، فيمكنك الاتصال بمشرفي أو بي:

إسم الباحث	رقم الهاتف	البريد الالكتروني
الدكتور جوماتاو أبيبي	*01-374374 Ext: 4511*	*ga81@aub.edu.lb*
علياء الديراني	*71-455236*	*aaa136@mail.aub.edu*

إذا كان لديك أي أسئلة حول حقوقك كمشارك في هذه الدراسة ، أو كنت تريد التحدث إلى شخص خارج المجموعة البحثية ، يرجى الاتصال بمكتب لجنة الأخلاقيات في الجامعة الأمريكية في بيروت.

Phone number: 01-350000 ext: 5445 *Email: irb@aub.edu.lb*

هل أنت مهتم بالمشاركة في هذه الدراسة؟ [ ] نعم [ ] لا

علياء الديراني

اسم الشخص الحاصل على الموافقة التوقيع تاريخ

Appendix C

Oral Consent Script to participate in a Questionnaire

Hello. My name is Aliaa Al Dirani. I am a graduate student in the Department of Food Security/Faculty of Agricultural and Food Sciences at AUB. I would like to invite you to participate in a research study about examining the determinants of smallholders' choice of climate change adaptation strategies, and the impact this may have on household food security.

Before we begin, I would like to take a few minutes to explain why I am inviting you to participate and what will be done with the information you provide. You will be asked to participate in a research project by completing the following questionnaire. Please stop me at any time if you have questions about the study.

I am doing this study as part of my studies at AUB. I will be asking 120 smallholder farmers to participant in my study from 9 villages. I will be directly approaching the smallholder farmer on the site and invite him/her to participate in the study. I will use the information as the basis for my thesis. I may also use this information in articles that might be published, as well as in academic presentations. Your individual privacy and confidentiality of the information you provide will be maintained in all published and written data analysis resulting from the study. All questionnaires will be stored and maintained in a locked file cabinet in principal investigator's office. Only researchers will have access to the data.

Your participation should take approximately 30 – 45 minutes. Please understand your participation is entirely on a voluntary basis and you have the right to withdraw your consent or discontinue participation at any time without penalty. You will be questioned about your food security status you are free to skip these questions or any other question. There are no known risks, harms or discomforts associated with this study. You will not directly benefit from participation in this study. You will not receive any monetary compensation for your participation. But we hope that this study will aid in future planning to enhance the policies that deals with climate change adaptation and food security.

If at any time and for any reason, you would prefer not to answer any questions, please feel free to skip those questions. If at any time you would like to stop participating, please tell me. We can take a break, stop and continue at a late date, or stop altogether. You will not be penalized for deciding to stop participation at any time. We also assure you that if you decide not to participate in this study this will not affect your relation with the American University of Beirut in any way.

In case the food security related questions were tough on you, I will provide you will a list of Primary Healthcare Centers in the region were you can seek psychological help. Please note that the psychological service will be on your own expenses.

A copy of the consent document will be kept with the participant.

If you have any questions, concerns or complaints, you are free to ask them now. If you have questions later, you may contact my advisor or me at

Investigator's Name	*Phone number*	*Email address*
Dr. Gumataw Abebe	*01-374374 Ext: 4511*	*ga81@aub.edu.lb*
Aliaa Al Dirani	*71-455236*	*aaa136@mail.aub.edu*

If you have any questions about your rights or welfare as a participant in this study, or you want to talk to someone outside the research group, please contact the Institutional Review Board Office at the American University of Beirut.
Phone number: 01-350000 ext: 5445
Email: irb@aub.edu.lb

Are you interested in participating in this study? [ ] Yes [ ] No

__ Aliaa Al Dirani_____ _____ _____

Name of Person obtaining Consent *Signature* *Date*

Appendix D

نص شفوي للمشاركة في الاستبيان

مرحبا. انا اسمي علياء الديراني. أنا طالبة ماجستار في قسم الأمن الغذائي / كلية العلوم الزراعية والغذائية في الجامعة الأميركية في بيروت. أود أن أدعوكم للمشاركة في دراسة بحثية عن محددات اختيار أصحاب الحيازات الصغيرة لاستراتيجيات التكيف مع تغير المناخ ، وتأثير ذلك على الأمن الغذائي للأسرة.

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مشاركتك ستتراوح 30 إلى 45 دقيقة. و نؤكد أن مشاركتك طوعية و يحق لك التوقف وقتما شئت بدون أي احراج او اي عائق. سيتم استجوابك بشأن حالة الأمن الغذائي الخاصة بك أنت حر في تخطي هذه الأسئلة أو أي سؤال آخر. لا توجد مخاطر أو أضرار أو مضايقات معروفة مرتبطة بهذه الدراسة. كما أنه لن تستفيد بشكل مباشر من المشاركة في هذه الدراسة. وأود أن أوكد بانه لا يوجد أي تعويض مالي للمشاركة في هذه الدراسة. لكننا نأمل أن تساعد هذه الدراسة في التخطيط المستقبلي لتعزيز السياسات التي تتعامل مع التكيف مع تغير المناخ والأمن الغذائي.

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إسم الباحث	رقم الهاتف	البريد الالكتروني
الدكتور جوماتاو أبيبي	*01-374374 Ext: 4511*	*ga81@aub.edu.lb*
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Phone number: 01-350000 ext: 5445 *Email: irb@aub.edu.lb*

هل أنت مهتم بالمشاركة في هذه الدراسة؟ [ ] نعم [ ] لا

علياء الديراني

اسم الشخص الحاصل على الموافقة التوقيع تاريخ

Appendix E

مراكز الرعاية الصحية الأولية

Primary Health Care Centers (PHCs)

إسم المركز	المنطقه	الهاتف
مستوصف الجمعية اللبنانية للرعاية الصحية الاجتماعية - قصرنبا Dispensary of the Lebanese Association - Qsarnaba	قصرنبا	08-912983, 70-540010
مركز تمنين الصحي Tamnin Health Center	تمنين الفوقا	08-911249, 03-747976
مركز الخدمات الانمائية - بدنايل MoSA SDC Bednayel	بدنايل	08-340601, 70-601281
عامل الصحي شمسطار Amel Association- Chmestar PHC	شمسطار	08-330138, 71-552849, 03-570480
شمسطار الصحي Chmestar Helath Center	شمسطار	08-330024, 03-201664
مركز الخدمات الانمائية - نبي شيت MoSA SDC Nabi Chit	نبي شيت	08-335247, 70-820375
مركز علي النهري الصحي Ali Al-Nahri Health Center	علي النهري	08-920944, 70-540010
مركز الخدمات الانمائية – زحلة MoSA SDC - Haouch el Oumara	زحلة	08-815100, 08-815102, 03-238867
الاتحاد الوطني للجمعية المسيحية للشابات Y.W.C.A ABLAH DISPENSARY	زحلة	08-850785
مركز رحاب المحبة Rihab al Mahaba PHC	حوش الزراعنة	08-808991, 71-344013, 03-976054
مركز الصليب الأحمر اللبناني-معلقة Lebanese Red Cross (LRC) - Maallaka	زحلة معلقة	08-806202

Appendix F

Questionnaire

SURVEY IDENTIFICATION

- Questionnaire #: ⟨ | | ⟩
- Date: / / 2018
- Household #: ⟨ | | ⟩
- District: ----------
- Village: ⟨ | ⟩

1. Rayak
2. Qasarnaba
3. Chmastar
4. Hosh el Rafika
5. Temnin el Fawka
6. Nabi Cheit
7. Niha Bekaa
8. Bednayel
9. Khraibeh

Survey Results: (* If 'Refused', write REFUSED in large print on top of this page)

Completed ☐

Postponed ☐

Not fully completed ☐

Not at home ☐

Refused ☐

Survey Entered into STATA ☐

Two surveys will be administered with each household: A) Climate change survey, and B) Food security survey

- The head of the household should preferably answer the climate change questionnaire
- Food security questionnaire will be only completed by the person in charge of household food preparation

Climate Change Questionnaire

Part I- Socio-demographics and household characteristics	
Human capital	
HC1. Gender	[1] Male [2] Female
HC2. Age	……
HC3. Family status	[1] Married [2] Separated [3] Single [4] Widower
HC4. Education	[1] None [2] Primary [3] Secondary [4] High school and above
HC5. Total household members	…….
HC6. Farming experience	[1] Less than 15 years [2] 16 to 24 years [3] 25 or more years
HC7. Experience drought in the last 5 years	[1] Yes [2] No
HC8. Experience flood in the last 5 years	[1] Yes [2] No
HC9. Have you noticed any long-term changes in the mean temperature over the last 20 years?	[1] Yes [2] No
HC10. Have you noticed any long-term changes in the mean rainfall over the last 20 years?	[1] Yes [2] No
Physical capital	
PC1. Number of cattle (cow, sheep, goat, poultry)	[1] ≤ 5 [2] 6 to 20 [3] ≥20 [4] None

PC2. Tractor	[1] Yes [2] No
PC3. Car	[1] Yes [2] No
PC4. Electricity	[1] Yes [2] No
PC5. Cell phone	[1] Yes [2] No
PC6. Distance to the nearest output market	….. in km
PC7. Distance to the nearest input market	….. in km
Financial capital	
FC1. Income (L.L.) per month	[1] ≤499,000 [2] 500,000 to 999,000 [3] 1,000,000 to 2,990,000 [4] ≥3,000,000
FC2. Food expenditure (monthly expenditure on food items)	…….. in L.L.
FC3. Nonfood expenditure (monthly expenditure on nonfood items)	……... in L.L.
FC4. Credit access	[1] needed credit and did not get it or got less than I needed [2] got what I needed [3] did not need credit
FC5. Amount of credit	…… Average amount of credit borrowed over the last one year (in LL)
FC6. Formal credit (receive credit from formal sources such as banks, microfinance institutions, traders, NGOs, etc.) as a percentage of total amount of credit (Q. 22 above)	…….. in percent
FC7. Informal credit (receive credit from informal sources e.g. relatives, neighbors, church, Mosques, etc.) as a percentage of total amount of credit (Q. 22 above)	…….. in percent (note Q. 23 & 24 should add up to 100%)
FC8. Off-farm income1 (e.g. job, trading, etc.)	[1] Yes [2] No

FC9. Farm income as a percentage of total annual income	…….. in percent
FC10. Off-farm income as a percentage of total annual income	…….. in percent
FC11. Received food aid at least once in the last five years	[1] Yes [2] No
FC12. Received farm support (equipment, inputs, etc.) at least once in the last five years	[1] Yes [2] No
FC13. Remittances in the last 12 months	[1] Yes [2] No
FC14. Do you hire labor during the harvest seasons?	[1] Yes [2] No
Social capital	
SC1. Membership in economic or social group	[1] if the household is an active member in at least one economic or social group (cooperatives, producer groups, association, or any other economic or social group) [2] Otherwise
SC2. Connection to local authorities	[1] if the head of household holds an official position in the village or district [2] Otherwise
SC3. Connection to relatives	[1] if a household considers the relationship with relatives (within or outside of the village) very important in times of hardship [2] Otherwise

Part II - Farm characteristics	
F1. Land tenure	[1] owned [2] not owned including borrowed, rented and communal land [3] both owned and not owned
F2. How the smallholder farmers perceive the land soil fertility	[1] fertile [2] lower/medium fertile
F3. Land size (agricultural land)	……. in dunums
F4. Total current value of all farm tools and equipment	……. in L.L.
F5. Source of water for agriculture	[1] Rain fed only (Skip to Next section) [2] Irrigated farm only [3] Both
F6. Irrigation system	[1] Sprinkler irrigation only [2] Drip irrigation only [3] Mixed irrigation system [4] None

Part III- Climate change belief
CCB1. There is increasing discussion about climate change and its potential impacts. Please select the statement that best reflects your beliefs about climate change. [1] Climate change is not occurring [2] There is not sufficient evidence to know with certainty whether climate change is occurring [3] Climate change is occurring and it is caused mostly by natural changes in the environment [4] Climate change is occurring, and it is caused equally by natural changes in the environment and human activities [5] Climate change is occurring, and it is caused mostly by human activities

Adapted from Arbuckle, Morton and Hobbs, 2015

Part IV- Smallholder farmers' perceived causes of climate change on agriculture
FCCP1. Please select the causes you think are due to climate change. (More than one answer is possible) [1] Deforestation [2] Bush burning [3] Pollution [4] Nature/natural phenomenon [5] Desert encroachment [6] God [7] Do not know [8] Wars and conflicts

Adapted from Tambo and Abdoulaye, 2013

Part V- Smallholders farmers' perception of long-term changes in temperature and precipitation in the Bekaa district of Lebanon for the past 20 years					
Statement	Increasing	Decreasing	Indifferent	unpredictable	Do not know
LT1. Temperature	1	2	3	4	5
LT2. Rainfall amount	1	2	3	4	5
LT3. Rainfall frequency	1	2	3	4	5
LT4. Length of rainy season	1	2	3	4	5

Adapted from Opiyo et al., 2016

Part VI- Information access	
IA1. Government extension services	[1] More than 5 times per year [2] 1 to 5 times per year [3] No access or Do not exists
IA2. Private extension services	[1] More than 5 times per year [2] 1 to 5 times per year [3] No access or Do not exists
IA3. Membership to farmers' group (member to his/her organization)	[1] Extensive (3 or more contacts) [2] limited [3] None
IA4. Radio/TV extension	[1] Extensive (Weekly or daily) [2] limited [3] None
IA5. Access to climate information (weather forecast)	[1] Extensive (weekly or daily) [2] limited [3] None

Part VII- Smallholder farmers' perception on climate change vulnerability					
Statement	Strongly Disagree	Disagree	Indifferent	Agree	Strongly Agree
PCCV1. I am concerned about the potential impacts of climate change on Bekaa's agriculture.	1	2	3	4	5
PCCV2. I am concerned about the potential impacts of climate change on my farm operation.	1	2	3	4	5
PCCV3. I believe that extreme weather events will happen more frequently in the future.	1	2	3	4	5
PCCV4. Climate change is not a big issue because human ingenuity will enable us to adapt to changes.	1	2	3	4	5
PCCV5. Bekaa farmers should take additional steps to protect their land from increased precipitation (Protection)	1	2	3	4	5
PCCV6. Government should do more to reduce the nation's greenhouse gas emissions and other potential causes of climate change (Mitigation)	1	2	3	4	5

Adapted from Arbuckle, Morton and Hobbs, 2015

Part VIII- Smallholder farmers' attitude towards climate change vulnerability					
Statement	Strongly Disagree	Disagree	Indifferent	Agree	Strongly Agree
ACCV1. Climate change is happening	1	2	3	4	5
ACCV2. I feel personally obliged to help reduce the impact of climate change in Lebanon	1	2	3	4	5
ACCV3. I feel adaptation has become necessary for all of us	1	2	3	4	5
ACCV4. We should work together to adapt to climate change	1	2	3	4	5

Adapted from Masud et. al, 2017

Part IX- Smallholder farmers' knowledge about climate change vulnerability					
Statement	Strongly Disagree	Disagree	Indifferent	Agree	Strongly Agree
KCCV1. Climate change is a serious problem	1	2	3	4	5
KCCV2. Climate change already affects the Lebanese agricultural sector	1	2	3	4	5
KCCV3. Climate change is affecting my local climate	1	2	3	4	5
KCCV4. Climate change will have a direct impact on me	1	2	3	4	5
KCCV5. I would be doing more things to prevent climate change if I could get some clarity on it.	1	2	3	4	5

Adapted from Masud et. al, 2017

Part X- Smallholder farmers' adopting climate change adaptation strategies	
What have (are) you done (intend to do) to adapt to changes in temperature	
ACCT1. Change planting dates	[1] Yes [2] No
ACCT2. Grow early maturing varieties	[1] Yes [2] No
ACCT3. Grow different varieties on the same plot	[1] Yes [2] No
ACCT4. Integration of trees into farming systems/shading for animals	[1] Yes [2] No
ACCT5. Apply water conservation (improved irrigation) systems	[1] Yes [2] No
ACCT6. Apply mixed cropping	[1] Yes [2] No
ACCT7. Apply crop rotation	[1] Yes [2] No
ACCT8. Grow crop tolerant varieties (drought, pest and disease)	[1] Yes [2] No
ACCT9. Shift from farming to non-farming activities (seeking a job, trading etc.)	[1] Yes [2] No
What have (are) you done (intend to do) to adapt to changes in rainfall	
DCCR1. Change planting dates	[1] Yes [2] No
DCCR2. Grow early maturing varieties	[1] Yes [2] No
DCCR3. Grow different varieties on the same plot	[1] Yes [2] No
DCCR4. Integration of trees into farming systems/shading for animals	[1] Yes [2] No
DCCR5. Apply soil conservation techniques	[1] Yes [2] No
DCCR6. Apply water conservation (harvesting/irrigation) techniques	[1] Yes [2] No
DCCR7. Apply mixed cropping	[1] Yes [2] No
DCCR8. Apply crop rotation	[1] Yes [2] No
DCCR9. Grow crop tolerant varieties (drought, pest and disease)	[1] Yes [2] No
DCCR10. Apply crop-livestock integration (mixed farming)	[1] Yes [2] No
DCCR11. Reduce farm size	[1] Yes [2] No
DCCR12. Increased use of chemical fertilizers	[1] Yes [2] No
DCCR13. Increased use of organic fertilizers	[1] Yes [2] No
DCCR14. Seek for off-farm job or engage in non-farm activities	[1] Yes [2] No
DCCR15. I don't use any of the above adaptation strategies	[99]

Part XI- Smallholder farmers' climate change adaptation strategies importance					
In your opinion, how do you rate the importance of the following strategies to adapt climate change?	**Not important**	**Less important**	**Indifferent**	**Important**	**Highly important**
ACCAS1. Changing of planting dates	1	2	3	4	5
ACCAS 2. Growing of early maturing varieties	1	2	3	4	5
ACCAS 3. Growing of different varieties on the same plot	1	2	3	4	5
ACCAS 4. Integration of trees into farming systems	1	2	3	4	5
ACCAS 5. Application of soil conservation techniques	1	2	3	4	5
ACCAS 6. Application of water conservation (harvesting/ improved irrigation) techniques	1	2	3	4	5
ACCAS 7. Application of mixed cropping	1	2	3	4	5
ACCAS 8. Application of crop rotation	1	2	3	4	5
ACCAS 9. Growing of crop tolerant varieties (drought, pest & disease)	1	2	3	4	5
ACCAS 10. Application of crop-livestock integration	1	2	3	4	5
ACCAS 11. Reducing of farm size	1	2	3	4	5
ACCAS 12. Increasing the use of chemical fertilizers	1	2	3	4	5
ACCAS 13. Increasing the use of organic fertilizers	1	2	3	4	5
ACCAS 14. Shifting to off-farm jobs or engage in non-farm activities	1	2	3	4	5

Adapted from Masud et. al, 2017

Part XII- Smallholder farmers' adaptation barriers to climate change						
Type	**Barriers** **In your opinion, how do you rate the following factors as barriers to adapt to climate change?**	**No problem**	**Low problem**	**Indifferent**	**Problem**	**Highly problem**
Biophysical	**B1**. water scarcity	1	2	3	4	5
	B2. shortage of land	1	2	3	4	5
	B3. unpredictable weather	1	2	3	4	5
	B4. poor soil fertility	1	2	3	4	5
Economic	**E1**. lack of irrigation infrastructure	1	2	3	4	5
	E2. insecure land tenure	1	2	3	4	5
	E3. limited access to agriculture markets	1	2	3	4	5
	E4. lack of resistant seeds/breeds	1	2	3	4	5
	E5. lack of availability of new technologies	1	2	3	4	5
	E6. lack of access to credit	1	2	3	4	5
	E7. lack of fertilizers	1	2	3	4	5
	E8. lack of policy	1	2	3	4	5
	E9. high cost of farm inputs	1	2	3	4	5
	E10. limited farm size	1	2	3	4	5
Social	**S1**. lack of access to timely weather information	1	2	3	4	5
	S2. limited access to agricultural extension officers	1	2	3	4	5
	S3. shortage of labor	1	2	3	4	5
	S4. lack of governance support (e.g. agricultural subsidies)	1	2	3	4	5
	S5. environmental and diffuse pollution regulations	1	2	3	4	5

Adapted from de Jalo´n et al., 2015 and Tessema et al., 2013

Part II. Food Security Questionnaire

Part I- Respondent information (To be filled if the respondent is different from Part I)

Respondent characteristics	
RC1. Gender	[1] Male [2] Female
RC2. Age	……
RC3. Education	[1] None [2] Primary [3] Secondary [4] High school and above

Part II - Food sufficiency

The Household Food Insecurity Access Scale (HFIAS)			
	Question	**Option**	**Code**
HFIAS 1.	In the past four weeks, did you worry that your household would not have enough food?	1= Yes; 2 = No (skip)	
HFIAS1 b.	How often did this happen?	1 = Rarely (1-2 x) 2 = Sometimes (3-10 x) 3 = Often (> 10x)	
HFIAS2.	In the past four weeks, were you or any household member not able to eat the kinds of foods you preferred because of a lack of resources?	1= Yes; 2 = No (skip)	
HFIAS2 b.	How often did this happen?	1 = Rarely (1-2 x) 2 = Sometimes (3-10 x) 3 = Often (> 10x)	
HFIAS3.	In the past four weeks, did you or any household member have to eat a limited variety of foods due to a lack of resources?	1= Yes; 2 = No (skip)	
HFIAS3b.	How often did this happen?	1 = Rarely (1-2 x) 2 = Sometimes (3-10 x) 3 = Often (> 10x)	
HFIAS4.	In the past four weeks, did you or any household member have to eat some foods that you really did not want to eat because of a lack of resources to obtain other types of food?	1= Yes; 2 = No (skip)	

HFIAS4b.	How often did this happen?	1 = Rarely (1-2 x) 2 = Sometimes (3-10 x) 3 = Often (> 10x)	
HFIAS 5.	In the past four weeks, did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food?	1= Yes; 2 = No (skip)	
HFIAS 5b.	How often did this happen?	1 = Rarely (1-2 x) 2 = Sometimes (3-10 x) 3 = Often (> 10x)	
HFIAS 6.	In the past four weeks, did you or any other household member have to eat fewer meals in a day because there was not enough food?	1= Yes; 2 = No (skip)	
HFIAS 6b.	How often did this happen?	1 = Rarely (1-2 x) 2 = Sometimes (3-10 x) 3 = Often (> 10x)	
HFIAS 7	In the past four weeks, was there ever no food to eat of any kind in your household because of a lack of resources to get food?	1= Yes; 2 = No (skip)	
HFIAS 7b.	How often did this happen?	1 = Rarely (1-2 x) 2 = Sometimes (3-10 x) 3 = Often (> 10x)	
HFIAS 8.	In the past four weeks, did you or any household member go to sleep at night hungry because there was not enough food?	1= Yes; 2 = No (skip)	
HFIAS 8 b.	How often did this happen?	1 = Rarely (1-2 x) 2 = Sometimes (3-10 x) 3 = Often (> 10x)	
HFIAS 9.	In the past four weeks, did you or any household member go a whole day and night without eating anything because there was not enough food?	1= Yes; 2 = No (skip)	
HFIAS 9b.	How often did this happen?	1 = Rarely (1-2 x) 2 = Sometimes (3-10 x) 3 = Often (> 10x)	

Adapted from Household Food Insecurity Access Scale (HFIAS) for Measurement of Household Food Access: Indicator Guide, 2007

Months of Adequate Home Food Provisioning (MAHFP)							
MAHFP 1.	In the past 12 months were there months in which you did not have enough food to meet your family's needs? **1 = YES 2 = NO**					**IF ANSWER IS NO, STOP HERE.**	
MAHFP 1. b.	If yes, which were the months (in the past 12 months) in which you did not have enough food to meet your family's needs? **1 = Enough 2= Not enough**						
1.January		2.February		3.March		4. April	
5.May		6.June		7.July		8.August	
9.September		10.October		11.November		12.December	

Adapted from Africare. Guidance: How to Measure Months of Adequate Household Food Provisioning (MAHFP) Based on Participatory Rural Appraisals in Food Security Interventions, 2007

Part III- Nutrient adequacy

Food Consumption Score (FCS)

The frequency of consumption of different food groups consumed by a household in the past 7 days, how often have you eaten:

- Code 1 = Yes and 2 = No
- 0: never; 1: hardly at all (<1x/week); 2: Once in a while (1-2x/week); 3: pretty often (3-6x/week); 4: always (every day)
- Source: 1= own production; 2= Bought; 3= Gifted; 4= trade; 5= debt/lent. If there is more than once source, list them from major to minor.

	Food groups	**Food items**	**Code**	**Freq.**	**Normal source**
FSC1	Cereals, grains, roots and tubers	Rice, maize, wheat, bulgur, other cereals, potatoes			
		Bread, pasta			
FSC2	Legumes / nuts	beans, cowpeas, peanuts, lentils, nut, soy, pigeon pea, chick peas, Groundnut; Ground Bean; green peas, Cow Pea; and / or other nuts			
FSC3	Milk and other dairy products	fresh milk / sour, yogurt, lebneh, cheese, other dairy products (Exclude margarine / butter or small amounts of milk for tea / coffee)			

FSC4	Meat, fish and eggs	goat, beef, chicken, pork, fish, turkey, including canned tuna, escargot, and / or other seafood, eggs (meat and fish consumed in large quantities and not as a condiment).			
FSC5	Vegetables and leaves	spinach, onion, tomatoes, carrots, peppers, lettuce, cucumber, radish, pumpkin, squash, sweet potatoes, broccoli, amaranth and/or other dark green leaves, cassava leaves, wild leaves, chicory, rockets, mulukhiyi, cabbage, etc.			
FSC6	Fruit	banana, apple, lemon, mango, papaya, apricot, peach, waterlemon etc.			
FSC7	Sugar or sweet	sugar, honey, jam, cakes, candy, cookies, pastries, cakes and other sweet (sugary drinks)			
FSC8	Oil / fat / butter	olive oil, other vegetable oil, gee, Butter, margarine, other fats / oil			
FSC9	Condiments / Spices	tea, coffee / cocoa, salt, garlic, spices, yeast / baking powder, lanwin, tomato / sauce, meat or fish as a condiment, ketchup/hot sauce; Maggy cubes, powder; other condiments including small amount of milk / tea coffee			

Adapted from United Nations World Food Programme, 2008

Part IV- Certainty and stability

SV1.	In the last 12 months, have there been moments when the household has not had enough money to buy food or to cover other essentials? 1= Yes 2 = No						
	In the last 12 months, have you had to take one of the following actions to obtain food or satisfy other necessities?						
	SV2. Rely on less-expensive and less-preferred food substitutes		SV9. Skip meals		SV16. Sold productive goods/assets (sewing machine, tools/machinery, car, livestock, etc.)		
	SV3. Borrow food		SV10. Restrict consumption of adults in order for small children to eat		SV17. Looking for additional work, work longer hours		

	SV4. Purchase food on credit		SV11. Feed working members of HH at the expense of non-working members		SV18. Migrate elsewhere	
	SV5. Gather wild food, hunt, or harvest immature crops		SV 12. Ration the money you had and buy prepared food?		SV19. Reduce spending on fertilizers, pesticides, animal food	
	SV6. Consume seed stock held for next season		SV 13. Reduce number of meals eaten in a day?		SV20. Ask for aid from NGOs or other group	
	SV7. Send household members to eat elsewhere		SV 14. Skip entire days without eating?		SV21. Asked for remittances	
	SV8. Limit portion size at mealtimes		SV15. Selling household possessions (e.g. TV, jeweler, phone, furniture, etc.)		SV22. The use of savings and avoiding health care or education costs in order to buy food	
SV 23.	If suddenly you needed a small amount of money, do you believe that someone would help you to cover these costs? 1: Definitely yes; 2: Not sure; 3: Definitely not					
SV 24.	If the household suffered an important economic loss, for example, a harvest loss, who do you believe would help you to fill/cover necessities? 1: government 2: friends and relatives 3: No one 4: others					
SV 25.	Do you think you can change the future of your life? 1: Definitely yes; 2: Not sure; 3: Definitely not; 4: others					
SV 26.	Currently, what are the priority necessities to improve the well-being of your family? 1: agriculture 2: health 3: stable income and work 4: environment					

Adapted from Methot and Bennett, 2018 and CARE/WFP (2003)

What main food and cash crops do you normally grow?

Staples	**Marrow**	**Fruitful trees**
1. Barley	**19.** Pepper (hot and sweat)	**37.** Apples
2. Wheat	**20.** Cucumber/Armenian cucumber	**38.** Pear
3. Maize	**21.** Eggplant	**39.** Grapes
4. Potatoes	**22.** Zucchini	**40.** Cherry
Pulses	**23.** Okra	**41.** Apricot
5. Lentils	**24.** Tomatoes	**42.** Fig
6. Chickpeas	**25.** Pumpkin	**43.** Peach
7. Kidney bean	**26.** Radish	**44.** Peache
8. Pea	**27.** Kale	**45.** Aki Dunya
9. Green beans	**28.** Mushroom	**46.** Avocado
Leafy green	**Edible plant stem**	**47.** Pomegranate
10. Lettuce	**29.** Celery	**48.** Olive trees
11. Spinach	**30.** Asparagus	**49.** Almonds
12. Cabbage	**Allium**	**50.** Nuts
13. Cauliflower	**31.** Carrot	**51.** Pine
14. Artichoke	**32.** Garlic	**Industrial crops**
15. Dandelion	**33.** Onion /Shallot	**52.** Beetroot
16. Molokhia	**Fruits**	**53.** Tobacco
17. Parsley	**34.** Water melon	**54.** Cotton
18. Peppermint	**35.** Melon	**Others**
	36. Strawberry	**55.** Sunflower
		56. Damasks rose
		57. Others (Specify) ----------

Appendix G

الاستبيان

SURVEY IDENTIFICATION

- Questionnaire #: ⟨ | | ⟩
- Date: / / 2018
- Household #: ⟨ | | ⟩
- District: ----------
- Village: ⟨ | ⟩

1. Rayak
2. Qasarnaba
3. Chmastar
4. Hosh el Rafika
5. Temnin el Fawka
6. Nabi Cheit
7. Niha Bekaa
8. Bednayel
9. Khraibeh

Survey Results: (* If 'Refused', write REFUSED in large print on top of this page)

Completed ☐

Postponed ☐

Not fully completed ☐

Not at home ☐

Refused ☐

Survey Entered into STATA ☐

Two surveys will be administered with each household: A) Climate change survey, and B) Food security survey

- The head of the household should preferably answer the climate change questionnaire
- Food security questionnaire will be only completed by the person in charge of household food preparation

إستمارة تغير المناخ

الخصائص الاجتماعية-السكانية والخصائص المنزلية **Part I- Socio-demographics and household characteristics**	
رأس المال البشري	
HC1. الجنس	[1] ذكر [2] الانثى
HC2. العمر	.....
HC3. الوضع العائلي	[1] متزوج [2] منفصل [3] أعزب [4] أرمل
HC4. التحصيل العلمي	[1]لا شيء [2]ابتدائي [3] متوسط [4] ثانوية عامة وما فوق
HC5. مجموع أفراد الأسرة	.....
HC6. عدد السنين في الزراعة	[1] أقل من 15 سنة [2] من 16 إلى 24 سنة [3] 25 سنة أو أكثر
HC7. هل واجهت الجفاف في السنوات الخمس الماضية	[1] نعم [2] لا
HC8. هل واجهت الفيضانات في السنوات الخمس الماضية	[1] نعم [2] لا
HC9. هل لاحظت أي تغيرات طويلة المدى في متوسط درجة الحرارة خلال العشرين سنة الماضية؟	[1] نعم [2] لا
HC10. هل لاحظت أي تغيرات طويلة المدى في متوسط هطول الأمطار على مدى العشرين سنة الماضية؟	[1] نعم [2] لا
رأس المال المادي	
PC1. عدد من الماشية	[1] ≤ 5 [2] 6 الى 19 [3] ≥ 20 [4]لا يوجد

PC2. جرار (Tractor)	[1] نعم [2] لا
PC3. سيارة	[1] نعم [2] لا
PC4. كهرباء	[1] نعم [2] لا
PC5. هاتف خليوي	[1] نعم [2] لا
PC6. المسافة الى أقرب سوق للخارج لتصريف	..... كلم
PC7. المسافة الى أقرب سوق للداخل دكان	..... كلم
رأس المال المالي	
FC1. الدخل الشهري (ل.ل.)	[1] ≤499,000 [2] 500,000 الى 999,000 [3] 1,000,000الى 2,990,000 [4] ≥ 3,000,000
FC2. نفقات الغذاء (الإنفاق الشهري على المواد الغذائية)	..... ل.ل.
FC3. النفقات غير الغذائية (الإنفاق الشهري على السلع غير الغذائية)	..... ل.ل.
FC4. الوصول إلى الائتمان	[1] احتاج إلى الائتمان ولم أحصل عليه أو حصلت على أقل مما أحتاج إليه [2] حصلت على ما أحتاجه [3] لم تكن بحاجة إلى ائتمان
FC5. مبلغ الائتمان	..... متوسط مبلغ القرض المقترض خلال العام الماضي (ل.ل.)
FC6. الائتمان الرسمي (الحصول على ائتمان من مصادر رسمية مثل البنوك ومؤسسات التمويل صغرى والتجار والمنظمات غير الحكومية ، إلخ) كنسبة من إجمالي مبلغ الائتمان (س 22 أعلاه)	..... %
FC7. ائتمان غير رسمي (يتلقى ائتمانا من مصادر غير رسمية ، مثل الأقارب والجيران والكنائس والمساجد ، إلخ) كنسبة مئوية من إجمالي مبلغ الائتمان (س 22 أعلاه)	..... %(ملاحظة Q. 23 و 24 يجب أن تضيف ما يصل إلى 100٪)

FC8. دخل خارج المزرعة 1 (على سبيل المثال ، العمل ، التجارة ، إلخ)	[1] نعم [2] لا
FC9 الدخل خارج المزرعة كنسبة مئوية من إجمالي الدخل السنوي	..... %
FC10. دخل المزرعة كنسبة مئوية من إجمالي الدخل السنوي	..... %
FC11. تلقى المعونة الغذائية مرة واحدة على الأقل في السنوات الخمس الأخيرة	[1] نعم [2] لا
FC12. الدعم الزراعي المستلم (المعدات والمدخلات وما إلى ذلك) مرة واحدة على الأقل في السنوات الخمس الأخيرة	[1] نعم [2] لا
FC13. التحويلات في الأشهر ال 12 الماضية	[1] نعم [2] لا
FC14. هل تستأجر العمالة خلال مواسم الحصاد؟	[1] نعم [2] لا
<u>رأس المال الإجتماعي</u>	
SC1. العضوية في المجموعة إقتصادية أو إجتماعية	[1] إذا كانت الأسرة عضوًا نشطًا في مجموعة اقتصادية أو اجتماعية واحدة على الأقل (التعاونيات أو مجموعات المنتجين أو الجمعيات أو أي مجموعة اقتصادية أو اجتماعية أخرى) [2] خلاف ذلك
SC2. الاتصال بالسلطات المحلية	[1] إذا كان رب الأسرة يحمل منصبًا رسميًا في القرية أو المنطقة [2] خلاف ذلك
SC3. العلاقات مع الأقارب	[1] إذا اعتبرت الأسرة العلاقة مع الأقارب (داخل أو خارج القرية) مهمة جدا في أوقات الشدة [2] خلاف ذلك

خصائص المزرعة **Part II - Farm characteristics**	
F1. حيازة الأراضي	[1] مملوكة [2] غير مملوكة بما في ذلك الأراضي المستعارة والمستأجرة والمشاع [3] مملوكة وغير مملوكة
F2. كيف ينظر المزارعون إلى خصوبة الأرض	[1] خصبة [2] منخفضة / متوسطة الخصوبة
F3. مساحة الأرض (الأراضي الزراعية)	..... في الدونمات
F4. مجموع القيمة الحالية لجميع أدوات ومعدات المزرعة	..... ل.ل.
F5. مصدر المياه للزراعة	[1] مياه أمطار فقط [2] مروية فقط [3] كليهما
F6. نظام الري	[1] الري بالرش فقط [2] الري بالتنقيط فقط [3] نظام ري مختلط

المعتقدات عن التغير المناخي **Part III- Climate change belief**
CCB1. هناك نقاش متزايد حول تغير المناخ وآثاره المحتملة. يرجى تحديد العبارة التي تعكس معتقداتك حول تغير المناخ. [1] ليس هنالك تغير المناخي [2] لا يوجد دليل كافٍ ليعرف على وجه اليقين ما إذا كان تغير المناخي يحدث أم لا [3] يحدث تغير المناخ والسبب الاساس في معظمه التغيرات الطبيعية في البيئة [4] يحدث تغير المناخ ، والسبب هو التغيرات الطبيعية في البيئة والأنشطة البشرية بالتساوي [5] يحدث تغير المناخ ، ويحدث في الغالب بسبب الأنشطة البشرية

Adapted from Arbuckle, Morton and Hobbs, 2015

فهم المزارعين لأسباب التغير المناخي في الزراعة

Part IV- Smallholder farmers' perceived causes of climate change on agriculture

FCCP1. يرجى تحديد الأسباب التي تعتقد أنها سبب تغير المناخ. (أكثر من إجابة واحدة ممكنة)

[1] التصحر

[2]حرق الشجيرات

[3] التلوث

[4] الطبيعة / الظاهرة الطبيعية

[5] زحف الصحراء

[6] الله

[7] الحروب والنزعا

[8] لا أعرف

Adapted from Tambo and Abdoulaye (2013)

تصور أصحاب الحيازات الصغيرة للتغيرات طويلة المدى في درجات الحرارة وهطول الأمطار في منطقة البقاع لبنانية على مدى العشرين سنة الماضية

Part V- Smallholders farmers' perception of long-term changes in temperature and precipitation in the Bekaa district of Lebanon for the past 20 years

التعبير	في ازدياد	متناقصة	غير مختلفة	لا يمكن التنبؤ به	لا أعرف
LT1. درجات الحرارة	1	2	3	4	5
LT2. كمية الأمطار	1	2	3	4	5
LT3. تواتر الأمطار	1	2	3	4	5
LT4. طول موسم الأمطار	1	2	3	4	5

Adapted from Opiyo et al., 2016

الوصول الى المعلومات **Part VI- Information access**	
IA1. خدمات الإرشاد الحكومية	[1] أكثر من 5 مرات في السنة [2] من 1 إلى 5 مرات في السنة [3] لا يمكن الوصول [4] غياب
IA2. خدمات الإرشاد من الشركات الخاصة	[1] أكثر من 5 مرات في السنة [2] من 1 إلى 5 مرات في السنة [3] لا يمكن الوصول
IA3. العضوية في مجموعة المزارعين (عضو في منظمته)	[1] ممتدة (3 مرات أو أكثر) [2] محدودة [3] لا شيء [4] غياب
IA4. برامج على الراديو أو التلفاز	[1] ممتدة (أسبوعية أو يومية) [2] محدودة [3] لا شيء
IA5. الوصول إلى المعلومات المناخية (توقعات الطقس)	[1] ممتدة (أسبوعية أو يومية) [2] محدودة [3] لا شيء

إدراك المزارعين أصحاب الحيازات الصغيرة بشأن مدى تأثير تغير المناخ **Part VII- Smallholder farmers' perception on climate change vulnerability**					
التعبير	لا أوافق بشدة	لا أوافق	محايد	أوافق	أوافق بشدة
PCCV1. أنا قلق بشأن الآثار المحتملة لتغير المناخ على زراعة البقاع.	1	2	3	4	5
PCCV2. أنا قلق بشأن الآثار المحتملة لتغير المناخ على عملي في الارض.	1	2	3	4	5
PCCV3. أعتقد أن أحداث الطقس المتطرفة ستحدث بصورة متكررة في المستقبل.	1	2	3	4	5
PCCV4. إن تغير المناخ ليس مشكلة كبيرة لأن الإبداع البشري سيمكّننا من التكيف مع التغييرات.	1	2	3	4	5
PCCV5. على مزارعي البقاع اتخاذ خطوات إضافية لحماية أراضيهم من زيادة هطول المطر (الحماية).	1	2	3	4	5
PCCV6. ينبغي للحكومة أن تفعل المزيد لتخفيض انبعاثات greenhouse gas وغيرها من الأسباب المحتملة لتغير المناخ (التخفيف).	1	2	3	4	5

Adapted from Arbuckle, Morton and Hobbs, 2015

موقف المزارعين أصحاب الحيازات الصغيرة من مدى تأثير تغير المناخ **Part VIII- Smallholder farmers' attitude towards climate change vulnerability**					
التعبير	لا أوافق بشدة	لا أوافق	محايد	أوافق	أوافق بشدة
ACCV1. يحدث تغير المناخ	1	2	3	4	5
ACCV2. أشعر بأنني مجبر شخصيًا على المساعدة في الحد من تأثير تغير المناخ في لبنان	1	2	3	4	5
ACCV3. أشعر بأن التكيف أصبح ضرورياً لنا جميعاً	1	2	3	4	5
ACCV4. ينبغي أن نعمل معا للتكيف مع تغير المناخ	1	2	3	4	5

Adapted from Masud et. al, 2017

موقف المزارعين أصحاب الحيازات الصغيرة من مدى تأثير تغير المناخ **Part IX- Smallholder farmers' knowledge about climate change vulnerability**					
التعبير	لا أوافق بشدة	لا أوافق	محايد	أوافق	أوافق بشدة
KCCV1. تغير المناخ مشكلة خطيرة	1	2	3	4	5
KCCV2. يؤثر تغير المناخ بالفعل على القطاع الزراعي اللبناني	1	2	3	4	5
KCCV3. تغير المناخ يؤثر على المناخ المحلي	1	2	3	4	5
KCCV4. سيكون لتغير المناخ تأثير مباشر عليّ	1	2	3	4	5
KCCV5. سأبذل المزيد لمنع تغير المناخ إذا حصلت معلومات واضحة بشأنه	1	2	3	4	5

Adapted from Masud et. al, 2017

Part X- Smallholder farmers' adopting climate change adaptation strategies اعتماد المزارعين لاستراتيجيات التكيف مع تغير المناخ الزراعي	
ما الذي قمت به (تنوي القيام به) للتكيف مع التغيرات في درجة الحرارة	
ACCT1. تغيير مواعيد الزراعة	[1] نعم [2] لا
ACCT2. زراعة أصناف النضج المبكر	[1] نعم [2] لا
ACCT3. زراعة أنواع مختلفة على نفس قطعة الأرض	[1] نعم [2] لا
ACCT4. دمج الأشجار في نظم الزراعة / التظليل للحيوانات	[1] نعم [2] لا
ACCT5. تطبيق نظم الحفاظ على المياه (تحسين الري)	[1] نعم [2] لا
ACCT6. تنويع المحاصيل الزارعية المزروعة	[1] نعم [2] لا
ACCT7. تطبيق دوران المحاصيل	[1] نعم [2] لا
ACCT8. زراعة أصناف تتحمل (الجفاف والآفات والأمراض)	[1] نعم [2] لا
ACCT9. التحول من الزراعة إلى الأنشطة غير الزراعية (البحث عن وظيفة ، التجارة ، الخ)	[1] نعم [2] لا
ما الذي قمت به (تنوي القيام به) للتكيف مع التغيرات في هطول الأمطار	
DCCR1. تغيير مواعيد الزراعة	[1] نعم [2] لا
DCCR2. زراعة أصناف النضج المبكر	[1] نعم [2] لا
DCCR3. زراعة أنواع مختلفة على نفس قطعة الأرض	[1] نعم [2] لا
DCCR4. دمج الأشجار في نظم الزراعة / التظليل للحيوانات	[1] نعم [2] لا
DCCR5. تطبيق تقنيات الحفاظ على التربة	[1] نعم [2] لا
DCCR6. تطبيق تقنيات الحفاظ على المياه (الحصاد والري)	[1] نعم [2] لا
DCCR7. تنويع المحاصيل الزارعية المزروعة	[1] نعم [2] لا
DCCR8. تطبيق دوران المحاصيل	[1] نعم [2] لا
DCCR9. زراعة أصناف تتحمل (الجفاف والآفات والأمراض)	[1] نعم [2] لا
DCCR10. تطبيق تكامل المحاصيل والثروة الحيوانية (الزراعة المختلطة)	[1] نعم [2] لا
DCCR11. تقليل مساحة المزرعة	[1] نعم [2] لا
DCCR12. زيادة استخدام الأسمدة الكيماوية	[1] نعم [2] لا
DCCR13. زيادة استخدام الأسمدة العضوية	[1] نعم [2] لا
DCCR14. البحث عن وظيفة خارج المزرعة أو الانخراط في الأنشطة غير الزراعية	[1] نعم [2] لا
DCCR15. لا أستخدم أيًا من استراتيجيات التكيف المذكورة أعلاه	[99]

عوائق المزارعين في التكيف مع تغير المناخ

Part XII- Smallholder farmers' adaptation barriers to climate change

إستراتيجيات التكيف مع تغير المناخ الزارعي والبيئي لدى المزارعين

Part XI- Smallholder farmers' climate change adaptation strategies importance

برأيك ، كيف تقيم أهمية الاستراتيجيات التالية لتكييف تغير المناخ الزراعي؟	لا أوافق بشدة	لا أوافق	محايد	أوافق	أوافق بشدة
ACCAS1. تغيير مواعيد الزراعة	1	2	3	4	5
ACCAS2. زراعة أصناف النضج المبكر	1	2	3	4	5
ACCAS3. زراعة أنواع مختلفة على نفس قطعة الأرض	1	2	3	4	5
ACCAS4. دمج الأشجار في نظم الزراعة	1	2	3	4	5
ACCAS5. تطبيق تقنيات الحفاظ على التربة	1	2	3	4	5
ACCAS6. تطبيق تقنيات الحفاظ على المياه (الحصاد والري)	1	2	3	4	5
ACCAS7. تنويع المحاصيل الزارعية المزروعة	1	2	3	4	5
ACCAS8. تطبيق دوران المحاصيل	1	2	3	4	5
ACCAS9. زراعة أصناف تتحمل (الجفاف والآفات والأمراض)	1	2	3	4	5
ACCAS10. تطبيق تكامل المحاصيل والثروة الحيوانية (الزراعة المختلطة)	1	2	3	4	5
ACCAS11. تقليل مساحة المزرعة	1	2	3	4	5
ACCAS12. زيادة استخدام الأسمدة الكيماوية	1	2	3	4	5
ACCAS13. زيادة استخدام الأسمدة العضوية	1	2	3	4	5
ACCAS14. البحث عن وظيفة خارج المزرعة أو الانخراط في الأنشطة غير الزراعية	1	2	3	4	5

Adapted from Masud et. al, 2017

النوع	العوائق برأيك ، كيف تقيم العوامل التالية كحواجز للتكيف مع تغير المناخ؟	ليست عائق	عائق صغير	محايد	عائق	عائق كبير
بيئية	**B1.** ندرة المياه	1	2	3	4	5
	B2. نقص الأراضي	1	2	3	4	5
	B3. الطقس غير المتوقع	1	2	3	4	5
	B4. ضعف خصوبة التربة	1	2	3	4	5
إقتصادية	**E1.** نقص البيية التحتية للري	1	2	3	4	5
	E2. حيازة الأراضي الغير امنة	1	2	3	4	5
	E3. محدودية الوصول الى الأسواق الزراعية	1	2	3	4	5
	E4. نقص البذور ظ السلالات المقاومة	1	2	3	4	5
	E5. عدم توافر التنكولوجيات الجديدة	1	2	3	4	5
	E6. عدم الوصول الى الائتمان	1	2	3	4	5
	E7. نقص الأسمدة	1	2	3	4	5
	E8. غايب السلطة	1	2	3	4	5
	E9. ارتفاع نكلفة المدخلات الزراعية	1	2	3	4	5
	E10. حجم الحقل محدود	1	2	3	4	5
إجتماعية	**S1.** عدم الوصول الى معلومات عن الطقس في الوقت المناسب	1	2	3	4	5
	S2. محدوية الوصول الى المرشدين الزارعين	1	2	3	4	5
	S3. نقص العمالة	1	2	3	4	5
	S4. عدم توفر الدعم من الدولة (مثل الاعانات الزراعية)	1	2	3	4	5
	S5. نقص في القوانين البيئية والقوانبن المتعلقة بالتلوث المنتشر	1	2	3	4	5

Adapted from de Jalo´n et al., 2015 and Tessema et al.,

الجزء الثاني: إستمارة الأمن الغذائي

معلومات المجيب (يتم تعبئتها إذا كان المجيب مختلفًا عن الجزء الأول) Part I- Respondent information

الخصائص المجيب	
RC1. الجنس	[1] ذكر [2] الانثى
RC2. العمر	.....
RC3. التحصيل العلمي	[1]لا شيء [2] ابتدائي [3] متوسط [4] ثانوية عامة وما فوق

Part II - Food sufficiency

The Household Food Insecurity Access Scale (HFIAS)			
	السؤال	**الخيارات**	**الرمز**
HFIAS 1.	خلال الأسابيع الأربعة الماضية ، هل قلقت أن أسرتك لن يكون لديها ما يكفي من الطعام؟	1 = نعم 2 = لا (تخطي)	
HFIAS 1. b.	كم مرة حدث هذا؟	1 = نادراً (1-2) 2 = أحياناً (3-10) 3 = غالباً (> 10)	
HFIAS 2.	خلال الأسابيع الأربعة الماضية ، هل كنت أنت أو أي فرد من أفراد الأسرة غير قادرين على تناول أنواع الأطعمة التي تفضلها بسبب نقص الموارد؟	1 = نعم 2 = لا (تخطي)	
HFIAS 2. b.	كم مرة حدث هذا؟	1 = نادرا (1-2) 2 = أحياناً (3-10) 3 = غالباً (> 10)	
HFIAS 3.	في الأسابيع الأربعة الماضية ، هل اضطررت أنت أو أي فرد من أفراد الأسرة لتناول مجموعة محدودة من الأغذية بسبب نقص الموارد؟	1 = نعم 2 = لا (تخطي)	
HFIAS 3. b.	كم مرة حدث هذا؟	1 = نادرا 2 = أحياناً (3-10) 3 = غالباً (> 10)	

HFIAS 4.	خلال الأسابيع الأربعة الماضية ، هل اضطررت أنت أو أي فرد من أفراد الأسرة لتناول بعض الأطعمة التي لم ترغب في تناولها بالفعل بسبب نقص الموارد اللازمة للحصول على أنواع أخرى من الطعام؟	1 = نعم 2 = لا (تخطي)	
HFIAS 4. b.	كم مرة حدث هذا؟	1 = نادرا 2 = أحياناً (3-10) 3 = غالباً (> 10)	
HFIAS 5.	في الأسابيع الأربعة الماضية ، هل اضطررت أنت أو أي فرد من أفراد الأسرة لتناول وجبة أصغر مما شعرت أنك بحاجة إليه بسبب عدم وجود ما يكفي من الطعام؟	1 = نعم 2 = لا (تخطي)	
HFIAS 5. b.	كم مرة حدث هذا؟	1 = نادرا 2 = أحياناً (3-10) 3 = غالباً (> 10)	
HFIAS 6.	في الأسابيع الأربعة الماضية ، هل اضطررت أنت أو أي فرد آخر من أفراد الأسرة إلى تناول وجبات أقل في يوم واحد بسبب عدم وجود ما يكفي من الطعام؟	1 = نعم 2 = لا (تخطي)	
HFIAS 6. b.	كم مرة حدث هذا؟	1 = نادرا 2 = أحياناً (3-10) 3 = غالباً (> 10)	
HFIAS 7.	خلال الأسابيع الأربعة الماضية ، هل حصل انه لم يتواجد أي نوع من الطعام في منزلك بسبب نقص الموارد اللازمة للحصول على الطعام؟	1 = نعم 2 = لا (تخطي)	
HFIAS 7. b.	كم مرة حدث هذا؟	1 = نادرا 2 = أحياناً (3-10) 3 = غالباً (> **10**)	
HFIAS 8.	في الأسابيع الأربعة الماضية ، هل ذهبت أنت أو أي فرد من أفراد الأسرة للنوم ليلا جائعا لأنه لم يكن هناك ما يكفي من الطعام؟	1 = نعم 2 = لا (تخطي)	
HFIAS 8. b.	كم مرة حدث هذا؟	1 = نادرا 2 = أحياناً (3-10) 3 = غالباً (> **10**)	
HFIAS 9.	في الأسابيع الأربعة الماضية ، هل ذهبت أنت أو أي فرد من أفراد الأسرة يوما كاملاً ليلاً ونهاراً دون أن تأكل أي شيء لأنه لم يكن هناك ما يكفي من الطعام؟	1 = نعم 2 = لا (تخطي)	

HFIAS 9. b.	كم مرة حدث هذا؟	1 = نادرا 2 = أحياناً (3-10) 3 = غالباً (**10** <)	

Adapted from Household *Food Insecurity Access Scale (HFIAS) for Measurement of Household Food Access: Indicator Guide, 2007*

شهور كافية من التموين الغذائي المنزلي **(MAHFP)**							
MAHFP 1.	خلال الأشهر ال 12 الماضية، هل كانت هناك شهور لم يكن لديك فيها ما يكفي من الطعام لتلبية إحتياجيات أسرتك؟ **1 = نعم 2 = لا**						إذا كانت الإجابة لا ، فتوقف هنا.
	إذا كانت الإجابة بنعم، فما هي الأشهر (خلال الاثني عشر شهراً الماضية) التي لم يكن لديك ما يكفي من الطعام لتلبية إحتياجات أسرتك ؟ **1 = كفى 2 = لا يكفي**						
MAHFP 2. كانون الثاني		**MAHFP 3.**شباط		**MAHFP 4.** أذار		**MAHFP 5.** نيسان	
MAHFP 6. أيار		**MAHFP 7.** حزيران		**MAHFP 8.** تموز		**MAHFP 9.**أب	
MAHFP 10. أيلول		**MAHFP 11.** تشرين الأول		**MAHFP 12.** تشرين الثاني		**MAHFP 13.** كانون الأول	

Adapted from Africare. Guidance: How to Measure Months of Adequate Household Food Provisioning (MAHFP) Based on Participatory Rural Appraisals in Food Security Interventions, 2007

Part III- Nutrient adequacy

Food Consumption Score (FCS)

عدد مرات إستهلاك المجموعات الغذائية المختلفة التي استهلكتها الاسرة خلال 7 الأيام الماضية، كم عدد المرات التي تناولتها:

الرمز **1 = نعم 2 = لا**

0: مطلقًا 1: بالكاد على الإطلاق (أقل من مرة في الاسبوع) ؛ 2: مرة واحدة من حين الى اخر (1-2 مرات في الأسبوع) ؛ 3: في كثير من الأحيان (3-6 مرات في الأسبوع) ؛ 4: دائما (كل يوم)

المصدر: 1 = الإنتاج الخاص ؛ 2 = اشترى ؛ 3 = الموهوبون 4 = التجارة ؛ 5 = الدين

	المجموعات الغذائية	المواد الغذائية	الرمز	التكرار	المصدر
FSC1	النشويات، والدرنيات	الأرز، الذرة، القمح، البرغل ، الفريكة، لبطاطا			
		الخبز والمعكرونة			
FSC2	المكسرات والبقول	الفاصوليا، العدس ، الحمص، الفول السوداني، الفول، البازلاء الخضراء، اللوبيا، وغيرها جوز-لوز-صنوبر /نواة			
FSC3	الحليب ومنتجات الحليب	حليب طازج أو مجفف،اللبن، اللبنة، الجبن، منتجات الحليب الأخرى – بإستثناء السمنة / الزبدة أو كميات صغيرة الحليب لصنع الشاي / القهوة			
FSC4	اللحوم والأسماك والبيض	الماعز واللحم البقري والدجاج ولحم الخنزير والأسماك والديك الرومي ، بما في ذلك التونة المعلبة ، أو قوقعة ، و/ أو غيرها من المأكولات البحرية والبيض (اللحوم والأسماك المستهلكة بكميات كبيرة).			
FSC5	الخضار ذات الأوراق الخضراء	السبانخ ، والبصل ، والطماطم ، والجزر ، والفلفل ، والخس ، والخيار ، والفجل ، والقرع ، والاسكواش ، والبطاطا الحلوة ، والقرنبيط ، وقطيفة القطيفة ، و / أو الأوراق الخضراء الداكنة الأخرى ، أوراق الكاسافا ، الأوراق البرية ، الهندباء ، الصواريخ ، الملوخية ، الملفوف ، إلخ			
FSC6	الفاكهة	الموز، التفاح، الليمون والمانجو والبابايا والمشمش والخوخ والبطيخ وغيرها			
FSC7	السكر / المنتجات السكرية/ العسل	السكر، قصب السكر، العسل، مربى ،جيلي، حلويات / بونبون/ الشوكولاته، وغير ذلك من منتجات السكر والبسكويت والباتيسري *والكعك*			

FSC8	الدهون / الزيوت	زيت الزيتون ،الزيت النباتي ، زبدة، سمن، الدهون أخرى			
FSC9	بهارات / توابل	شاي، قهوة، نسكافيه / كاكاو، ملح، توابل، خميرة / باكنج بودر، كاتشب/ صلصة حارة، مكعبات ماجي، بهارات أخرى - بما في ذلك كميات صغيرة من الحليب لصنع الشاي / القهوة			

Adapted from United Nations World Food Programme, 2008

Part IV- Certainty and stability

SV1.	خلال الاثني عشر شهراً الماضية ، هل كانت هناك لحظات لم يكن لدى الأسرة المال الكافي لشراء الطعام أو لتغطية الضروريات الأخرى؟ 1 = نعم 2 = لا						
	خلال الاثني عشر شهراً الماضية ، هل اضطررت إلى اتخاذ أحد الإجراءات التالية للحصول على الطعام أو تلبية احتياجات أخرى؟						
	SV2. إعتمدت على الأطعمة الغير محبذة ، والأرخص ثمناً		SV9. خفضت عدد الوجبات المتناولة يوميا		SV 16. بيع الممتلكات المنزلية (على سبيل المثال التلفاز ، الجواهري ، الهاتف ، الأثاث ، إلخ)		
	SV3. اقتراضت الغذاء		SV10. قللت استهلاك البالغين ليتسنى للأطفال الصغار تناول الطعام		SV17. تبحث عن عمل إضافي ، والعمل لساعات أطول		
	SV4. شراء الطعام بالدين		SV11. تغذية العاملين في الأسرة على حساب الأعضاء غير العاملين		SV 18. هاجرت الى مكان أخر		
	SV5. جمع الطعام البري ، أو الصيد ، أو جني المحاصيل غير الناضجة		SV12. جمعت المال الذي كان لديك واشترايت الطعام الجاهز؟		SV19 خفض الإنفاق على الأسمدة والمبيدات الحشرية والأغذية الحيوانية		
	SV6. تستهلك مخزون البذور للموسم المقبل		SV13. تقليل عدد الوجبات التي يتم تناولها في يوم		SV20. اطلب المساعدة من المنظمات غير الحكومية أو مجموعة أخرى		
	SV7. أرسلت أفراد الأسرة لتناول الطعام في مكان آخر		SV14. تخطي أيام كاملة دون تناول الطعام		SV21. طلب للتحويلات		
	SV8. قللت حجم وجبات الطعام		SV 15. بيع السلع / الأصول الإنتاجية (ماكينة الخياطة ، والأدوات / الآلات ، والسيارات ، والثروة الحيوانية ، وما إلى ذلك)		SV22. استخدام المدخرات وتجنب تكاليف الرعاية الصحية أو التعليم من أجل شراء الطعام		

SV 20.	إذا كنت فجأة بحاجة الى مبلغ صغير من المال، فهل تعتقد أن شخصاً ما سيساعدك في تغطية هذه التكاليف؟ 1: نعم بالتأكيد. ؛ 2: غير متأكد ؛ 3: بالتأكيد لا
SV 21.	إذا عانت الأسرة من خسارة إقتصادية مهمة، على سبيل المثال، خسارة محصول، من تعتقد أنك سيساعدك على ملْ\ تغطية الضروريات؟ 1: الدولة 2: الأصدقاء والأقارب 3: لا أحد 4: الآخرين
SV 22.	هل تعتقد أنك تستطيع تغيير مستقبل حياتك؟ 1: نعم بالتأكيد. ؛ 2: غير متأكد؛ 3: لا ؛ 4: غيره
SV 23.	حالياً، ما هي الضروارات ذات الأولوية لتحسين رفاه عائلتك؟ 1: الزراعة 2: الصحة 3: الدخل المستقر والعمل 4: البيئة

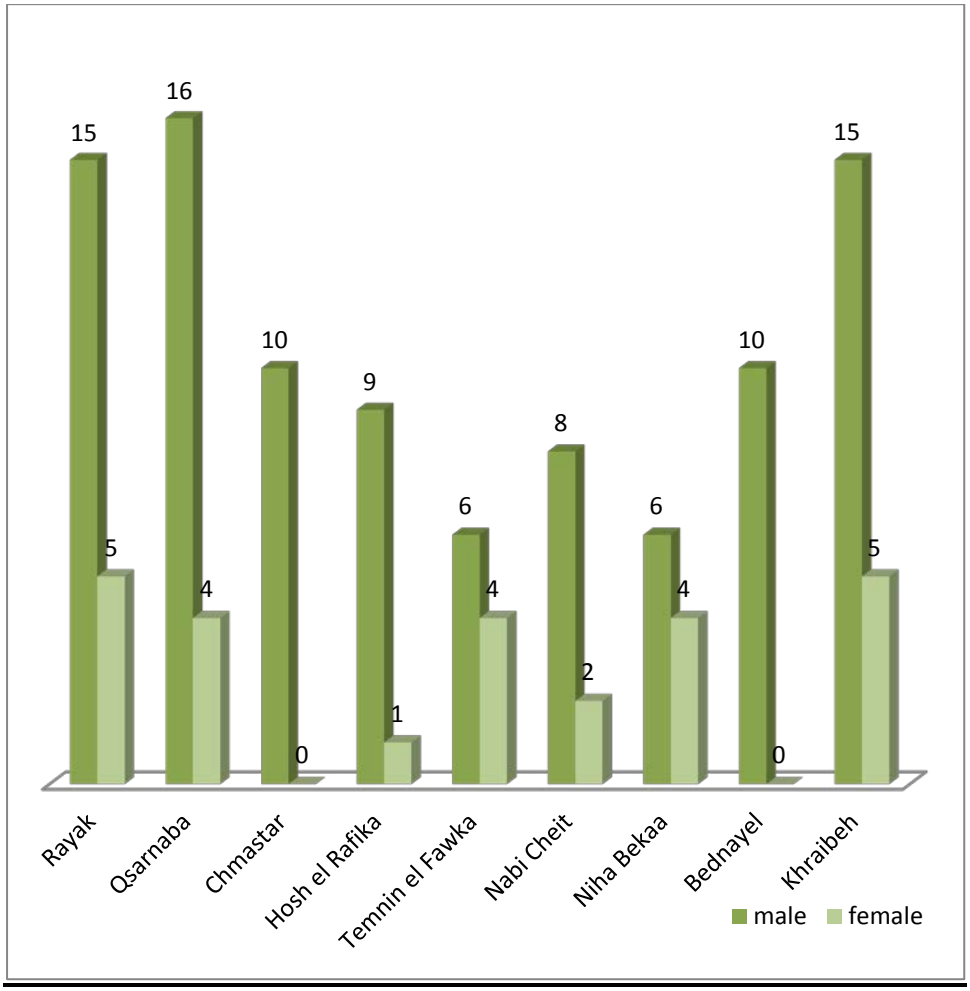
Adapted from Methot and Bennett, 2018 and CARE/WFP (2003)

ما هي المحاصيل الرئيسية التي تزرعها عادة؟

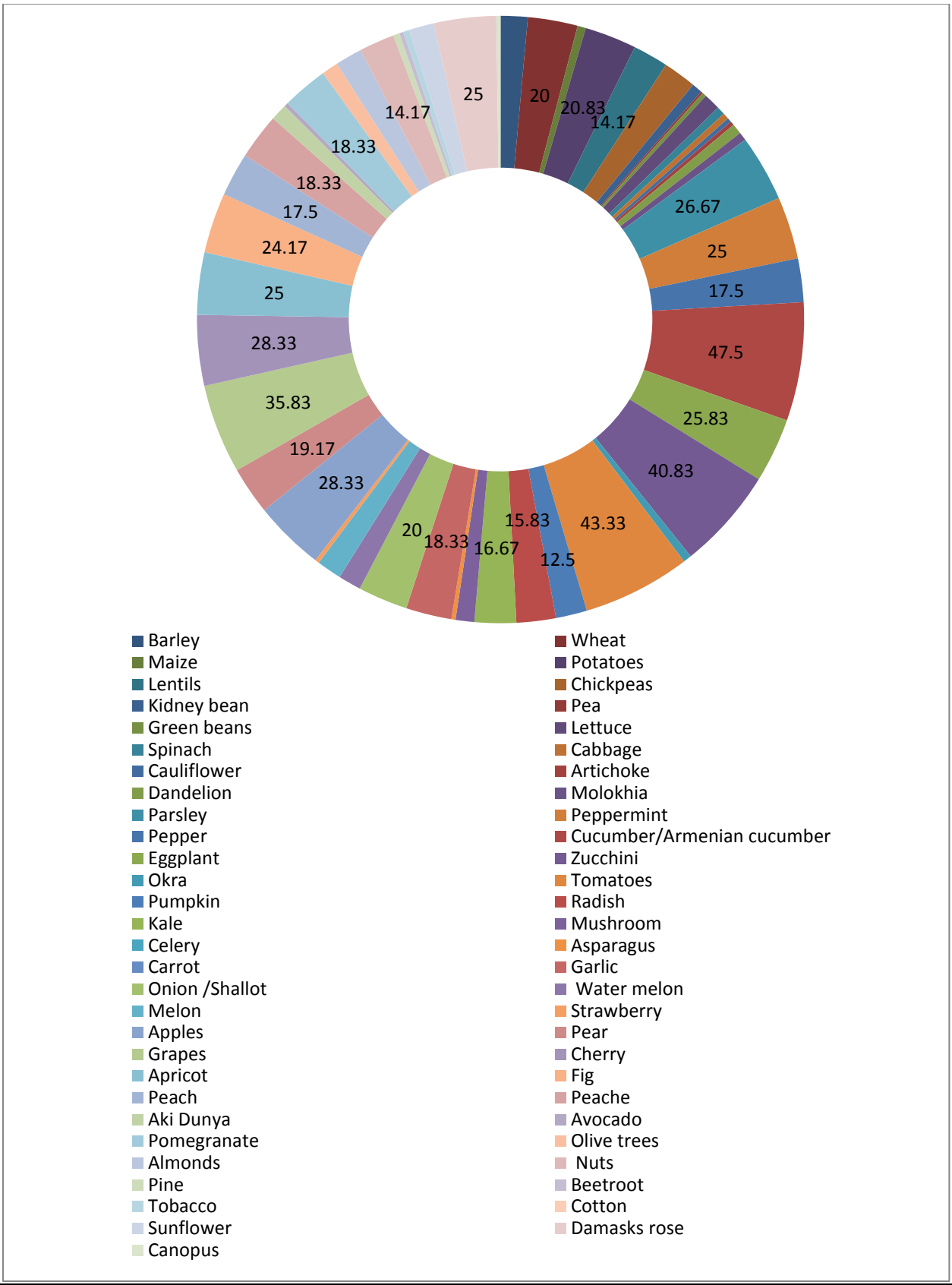
النجليات	**خضار ذات ثمار**	**أشجار مثمرة**
1. شعير	**19.** الفلفل (حار وعرق)	**37.** التفاح
2. قمح	**20.** الخيار / المقة	**38.** الاجاص
3. ذرة	**21.** الباذنجان	**39.** العنب
4. بطاطا	**22.** كوسة	**40.** الكرز
الحبوب	**23.** البامية	**41.** مشمش
5. العدس	**24.** الطماطم	**42.** التين
6. الحمص	**25.** القرع	**43.** الخوخ
7. الفاصوليا	**26.** الفجل	**44.** الدراق
8. البازلاء	**27.** لفت	**45.** اكي دنيا
9. الفول	**28.** الفطر	**46.** الأفوكادو
الخضار ذات أوراق	**جذع نبات صالح للأكل**	**47.** الرمان
10. الخس	**29.** كرفس	**48.** أشجار الزيتون
11. السبانخ	**30.** الهليون	**49.** اللوز
12. الملفوف	**نباتات ذرية**	**50.** جوز
13. القرنبيط	**31.** الجزر	**51.** الصنوبر
14. ارضي شوكة	**32.** الثوم	**المحاصيل الصناعية**
15. الهندباء	**33.** البصل / الكراث	**52.** الشمندر
16. ملوخية	**الفواكة**	**53.** التبغ
17. البقدونس	**34.** البطيخ المياه	**54.** القطن
18. النعناع	**35.** البطيخ	**الآخرئ**
	36. الفراولة	**55.** عباد الشمس
57. غير (حدد) ----------		**56.** ورد جوري

Appendix H

Questionnaire Data



Distribution of gender per village



Smallholder farmers' grown crops