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Institute of Environmental and Water Studies

Socio-Economic Aspects of Climate Change Impacts on Rainfed Agriculture in the Jenin District, Palestine

الجوانب الاجتماعية والاقتصادية لتأثيرات تغير المناخ على الزراعة البعلية في محافظة جنين، فلسطين

M.Sc. Thesis By

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The findings, interpretations and the conclusions expressed in this study do not necessarily express the views of Birzeit University, the views of the individual members of the M.Sc. Committee or the views of their respective employers.

Dedication

Every hard work needs self-effort as well as guidance of people who are very close to our heart.

I dedicate my humble effort to gentle souls, to my sweet and loving

Father, Mother, husband, mother in law, sisters, and brothers

For their affection, love, encouragement, prayers and support in achieving this success and honor.

And to my respected teachers

Abstract

Agriculture is a crucial sector in Palestine, yet it is vulnerable to climate change. This is particularly the case for rainfed agriculture. Since Jenin is one of the largest agricultural cities in the West Bank, it has been chosen as the study area. Jenin includes the largest variety of rain-fed crops and the high amount of agricultural production imply that families in Jenin can depend on farming to live especially on rainfed, since it provides family needs of food all the year. They can also sell part of the production to provide cash for other needs.

The social and economic effects of climate change on rainfed farming in Jenin are examined in this thesis. Earlier studies have shown that rainfed farming in Jenin faces great challenges due to climate change. This is reflected in the amounts and variety of agricultural production and the income generated from agriculture. Recently, it was noticed that some agricultural varieties decreased and other crops' prices increased.

Data was collected using multiple methods such as surveys, interviews, meetings, and field visits. A questionnaire was distributed to a random sample of 120 rainfed farmers in Jenin covering diverse backgrounds.

Data from the questionnaire was analyzed using SPSS20. The results indicate that about 95.5% of the rainfed farmers realize that there is a change in the climate and they have already adapted to this change by supplementary irrigation, changing the type of crops or the planting date.

The study revealed that the majority of farmers are university degree holders, and agriculture is the only livelihood source for 65% of farmers. Agriculture is also considered a social standing for 44.3% of farmers. Therefore, it is concluded that climate change significantly affects the rainfed farmers both socially and economically.

Based on the findings from the questionnaire, there is also a need to improve the information about climate systems and more support for adaptation of agriculture and farmers to climate change.

Farmers recommend that the policy-makers of the agricultural sector should increase their support for rainfed agriculture. Besides, they also recommend developing new varieties that can bear varying climate conditions, improve water management and adjust insurance programs to help the farmers adapt to climate change.

There was a meeting in Gaba'a and Anza resulted in giving farmers some suggestions to avoid climate change effects and how to adapt with. This is what specialists with climate change indicated during the meetings.

ملخص

تعد الزراعة قطاعا مهما في فلسطين و لكنه حساس تجاه التغير المناخي وخاصة الزراعة البعلية. بما ان جنين هي واحدة من اكبر المدن الزراعية في الضفة الغربية لقد تم اختيارها لتكون منطقة الدراسة حيث انها تتضمن اكبر تنوع من المحاصيل البعلية و اكبر كمية للانتاج الزراعي. بالاضافة الى ان العائلات في مدينة جنين تستطيع الاعتماد على الزراعة و خصوصا البعلية للحصول على الدخل, حيث ان الزراعة البعلية توفر احتياجات الاسرة من الطعام على مدى العام و يتم بيع جزء من المحصول للحصول على النقود لاحتياجات اخرى .

لقد تم دراسة الاثار الاجتماعية و الاقتصادية للتغير المناخي على الزراعة البعلة في مدينة جنين في هذه الاطروحة. فقد بينت الدراسات السابقة ان الزراعة البعلية في مدينة جنين تواجه العديد من التحديات نتيجة لتغير المناخ, وهذا ينعكس على كمية و نوعية الانتاج الزراعي والدخل الذي توفره هذه الزراعة, فقد لوحظ مؤخرا بان بعض الاصناف الزراعية تناقصت و اسعار محاصيل اخرى ارتفعت.

لقد تم جمع المعلومات باستخدام طرق متعددة كالبحوث و اللقاءات و الزيارات الميدانية. لقد تم توزيع استبيان على عينة عشوائية تتكون من 120 مزارع يقومون بزراعة المحاصيل البعلية في مدينة جنين يشمل خلفيات متعددة.

لقد تم تحليل المعلومات التي تم جمعها من خلال الاستبيان باستخدتم برنامج SPSS 20 .اشارت النتائج الى ان حوالي 95.5% من المزارعين البعليين ادركوا بان هناك تغير في المناخ وقد تكيفوا مسبقا مع هذا التغير عن طريق الري التكميلي و تغيير نوع المحاصيل او موعد الزراعة.

كشفت الدراسة بان اغلبية المزارعين هم حاملي شهادات جامعية وان الزراعة هي المصدر الرئيسي للعيش بالنسبة ل 65% من المزارعين. و تعتبر الزراعة ايضا مكانة اجتماعية بالنسبة ل 44.3% من المزارعين. لخصت الدراسة ايضا بان التغير المناخي يؤثر بشكل كبير على المزارعين البعليين اجتماعيا و اقتصاديا.

بناء على نتائج الاستبيان, كان هناك حاجة لتحسين المعلومات عن النظام المناخي و دعم اكثر لتكيف الزراعة و المزارعين للتغير المناخي.

يوصي المزارعون بان يزيد صناع القرار دعمهم للزراعة البعلية و ان يطوروا محاصيل تستطيع تحمل ظروف المناخ المتنوعة و تطوير ادارة المياه و تعديل نظام التامين لمساعدة المزارعين على التكيف مع التغير المناخي.

اما بالنسبة للاجماعات التي تمت في قرية جبع و عنزة , فقد اسفرت عن اعطاء المزارعين بعض النصائح لتجنب اثار التغير المناخي و كيفية التكيف معه. و هذا ما اوصى به الخبراء في التغير المناخي خلال اللقاء.

Acknowledgment

This work has been done as a requirement for the master thesis which was funded by the Netherlands Representative Office through the Palestinian-Dutch Academic Cooperation Program on Water (PADUCO). I extend my sincere thanks and appreciations to PADUCO researchers, the Ministry of Agriculture and everyone that helped me to achieve this work, especially my supervisors Dr. Maher Abu-Madi and Dr. Gül Özerol. Thanks are also extended to Dr. Margôt Kuttschreuter from the University of Twente for her support in designing the questionnaire. Special thanks to the members of the examination committee Dr. Rashed Al-Sa'ed and Dr. Ziad Mimi for the valuable remarks and comments they made to improve the quality of my thesis.

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List of Abbreviations

AEZ: Agro-ecological zones

BCPs: Palestinian Central Bureau for Statistics

BLS: Basic linked system

CWR: crop water requirement

EQA: Environmental Quality Authority

FAO: Food and Agriculture Organization

IEA: International Energy Agency

ILS: Israeli Shekel

IPCC: Intergovernmental Panel on Climate Change

IWR: irrigation water requirements

JD: Jordanian Dinar

PNA: The Palestinian National Authority's

PRDP: Palestinian Reform and Development Plan

SRES: Special report on emissions scenarios

SSA: Sub-Saharan Africa

WHO: World Health Organization

Chapter One: Introduction

1.1 Background

Climate change is one of the threats that face humanity in the 21st century. This is because of the damages in the natural environment, which affect the ecosystem of earth and water, and the irreparable production capacity. Besides, climate change affects social and political systems by threatening food security, which includes availability and accessibility of food. Climate change also has economic implications through its impacts on livelihoods, markets, and purchasing powers (Rosenzweig et al., 2007).

The impacts of climate change can be short-term like changes in weather patterns and some can be long-term which are caused by temperature changes, rainfall dates and seasonal shifts.

Some impacts can be direct like temperature increase, air pollution, spread of diseases, environmental disasters, effects on crops, and water availability. Some impacts can be indirect like poverty, immigration, conflict over resources and post-disaster mental health problems (ARIJ, 2010).

In the past few years, climate change led to great damages to the economy and social stability all around the world. These damages: food shortages (Vidal, 2013), loss of biodiversity (Sahney et al., 2010), the spread of infectious diseases and thus a high mortality (Moore, 1996). The World Health Organization (WHO) has estimated the occurrence of 160,000 deaths since 1950 directly linked to climate change (Mc Michael et al., 2006).

Climate change threatens particularly the poor countries, especially the areas that depend on natural resources to survive. As a result, these areas suffer from drought and starvation. Since the ability of these countries to adapt or face the effects do not or barely exists due to poverty, the people are forced to leave their homes and search for new ones. So, this is both a great social loss, since families are displaced, and also an economic damage, since they have lost their incomes and homes.

Therefore, we have to adapt to climate change in order to achieve sustainable development. Adaptation has been defined in several ways, but it can be summarized in the following definition which means finding measures to reduce the negative effects and potential risks and use the positives resulting from climate change, VCCCar, 2017. As well as commitment

to environmental treaties like Kyoto protocol. Scientists most concerns today are to find solutions of agriculture affected by climate change to achieve sustainability to produce food for more people. In order to achieve that, sustainability must be done in agriculture sector. By crop rotation and soil amendments for example or by enhance the quality of life for farmers and society as a whole.

Climate change has many effects on agriculture, which mainly include rainfall dates, rainfall amounts, water accumulation in the soil, plants response to temperature and CO_2 concentration. In Jenin, for example, according to the Palestinian Meteorological Department, the amount of rain did not detract too much but erratic rainfall has led to lack of availability and overused properly (Abo Asa'd, 2015).

About 25% of world's economies depend on agriculture. When this sector is affected by climate change, it immediately affects global economy (ARIJ, 2007).

Agriculture sector is also a major source of livelihood for Palestinians. It is considered the traditional way for living in Palestine, since it provides food and money, especially the rain-fed agriculture.

Climate change which is represented by drought, frost and high temperature nearly in the last 15 years (The World bank, 2011), played a major role in reducing the amounts of some kinds of agricultural crops affected by frost waves and crops that were burned from the heat that hit the country, as well reducing production of pastures. As a result, the prices of food have increased and the prices of livestock have declined.

The drought in 2008 made the situation even worse, since the rainfall decreased during 2007-2008 winter, and 55,000 families that depend on rainfall were affected which led to a great economic loss (ARIJ, 2010).

1.2 Research Problem

Agriculture preserves a special place in the environment in terms of water and land management, and it is threatened in many countries due to land degradation, water scarcity, deforestation and biodiversity loss. Climate change in the past few years affected agriculture, especially the rainfed agriculture, which directly depends on climatic conditions.

There are clear signs of global temperature increase, which affects rainfed and irrigated crops due to water shortages and droughts. However, rainfed agriculture is more affected than irrigated agriculture, since it depends entirely on the climate. Therefore, farmers and specialists were interested in rainfed farming to meet the increasing demands of food due to population increase. Recent estimates show that the world population will grow from 7.2 billion in 2010 to 9.6 billion by 2050 (United Nations, 2013).

Historically, agriculture was the basis of social and economic progress. Therefore, the challenge of the agriculture sector requires the integration of environmental, social and economic aspects to meet the needs of the present without sacrificing the livelihood of future generations. The sustainability of agriculture is essential for achieving economic progress through eliminating hunger, poverty and creating work opportunities and trade. When agriculture is affected by climate change, this reflects on economy and causes losses up to billions of dollars globally. Therefore, the economic impacts of climate change on agriculture should be considered (Fischer et al.2002).

Since Jenin is one of the biggest and important agricultural cities in Palestine, the idea of the study emerged to search the social and economic impacts of climate change on rain-fed farming.

It was noticed lately in Jenin the increase of prices of some crops significantly. Besides, some crops are rarely planted and other crops are not even planted in Jenin anymore. This led to import of these crops and therefore increase of their prices. So, this confused the agricultural economy of all people in Jenin, especially the poor (Amarnieh, 2015).

1.4 Aim and Objectives

The main goal of this research is to study the social and economic impacts of climate change on rainfed agriculture in Jenin area. The specific objectives are:

- To assess the level of farmers' knowledge on climate change and their practices to cope with these changes.
- To assess the social and economic impacts of climate change on rainfed farmers.
- To assess the governmental and non-governmental support to rainfed farming.
- To develop recommendations for improving farmers' adaptation to climate change.

1.5 Thesis Outline

Chapter one is an introduction, chapter two reviews previous literature; chapter three describes the study area; chapter four describes the approach and methodology; chapter five presents and discusses the results, and finally chapter six presents the conclusions and recommendations.

Chapter Two: Literature Review

2.1 Climate Change

There are clear signs of climate change. For example, the Earth's average temperature has risen by about 0.3-0.6°C since the late nineteenth century. In addition, the sea level has risen by 10-25 cm, the ice area has shrunk as a result of melting ice in some areas, and with the repetition of heat the Earth is going through warmer period during the last 600 years. Therefore, it is expected to rise from 1-5.3 °C by 2100 (Karas, 2000).

Studies are no longer searching in climate change, and scientists are also no longer discussing the existence or not of climate change. Besides, every country in the world had a change in the climate regardless the change was for better or worse (United Nations, 2017). Therefore the issue is to answer the following questions: How to adapt with climate change? What are the solutions to its effects? What are the methods to adapt with it? What are the solutions to preserve the remaining earth resources?

Climate change is an environmental, social, economic and global challenge, the crisis has exacerbated due to what human does like:

1. Using lands widely in building, which caused reducing the green areas and elimination of forests.
2. Resources drain, like using fossil fuel and organic fuel heavily which causes the green house effects.

Hecht, 2014 shows how the world understanding of climate change was developed through the local and international procedures taken over the past decades, dividing the history of climate change understanding into 10 levels:

1. 1960s-1970s: concern of climate change and the unusual weather fluctuation began in this level. Scientists warned of greenhouse gas risks and developed climate change predicts. Therefore, this level is the beginning of understanding the science of climate change and how humans can affect climate.
2. 1978: Creating the National Climate Program Act and US Global Change Research Program. This law called for plans to evaluate climate effects on the environment,

agricultural production, power supplies, land, water, and transportation resources, human health and national security.

3. 1980s: Stage of climate and power assessment.
4. 1988: The Intergovernmental Panel on Climate Change IPCC was established. In this year, the first assessment was published about climate change effects. This report led to the first climate change international agreement.
5. 1990: IPCC meeting report was made in 1988. It was agreed to establish groups to do scientific evaluation of climate change effects economically and socially, and Policies responded to that.
6. 1992: it was negotiated on UN agreement of climate change.
7. 1997: it negotiated on Kyoto Protocol which obliges the states the necessity to reduce greenhouse emissions and use renewable power as an alternative. However, USA didn't commit this protocol despite president Clinton signed Kyoto protocol under the pretense that this leads to extensive damages on economy in the USA.
8. 2000-2010: politicians start using climate in their presidential campaign since most people are more aware to climate change.
9. 2007: a resolution which considers CO_2 as pollutant and the main reason for global warming was issued from Supreme Court.
10. 2010s: IPCC issued a report which evaluates unnatural phenomena in the world, in 2014; climate report was issued in the USA.
11. 2015: United Nations Climate Change conference was held in Paris and the results was an agreement to set a goal of limiting global warming to less than 2 degrees Celsius compared to pre-industrial levels. The agreement calls for zero net green gas emissions to be reached during the second half of the 21^{st} century (the Paris agreement summary, 2015).
12. 2016: The Conference of the Parties (COP)-22, climate change conference was held in Marrakech. The agreement recommended to foster sustainable development and 2018 will be the dead line for developing. It also aimed to achieve carbon-reducing growth (Gehring and Phillips, 2016).

The figure below shows a brief of climate change understanding and how CO_2 concentration change from 1970 to 2013.

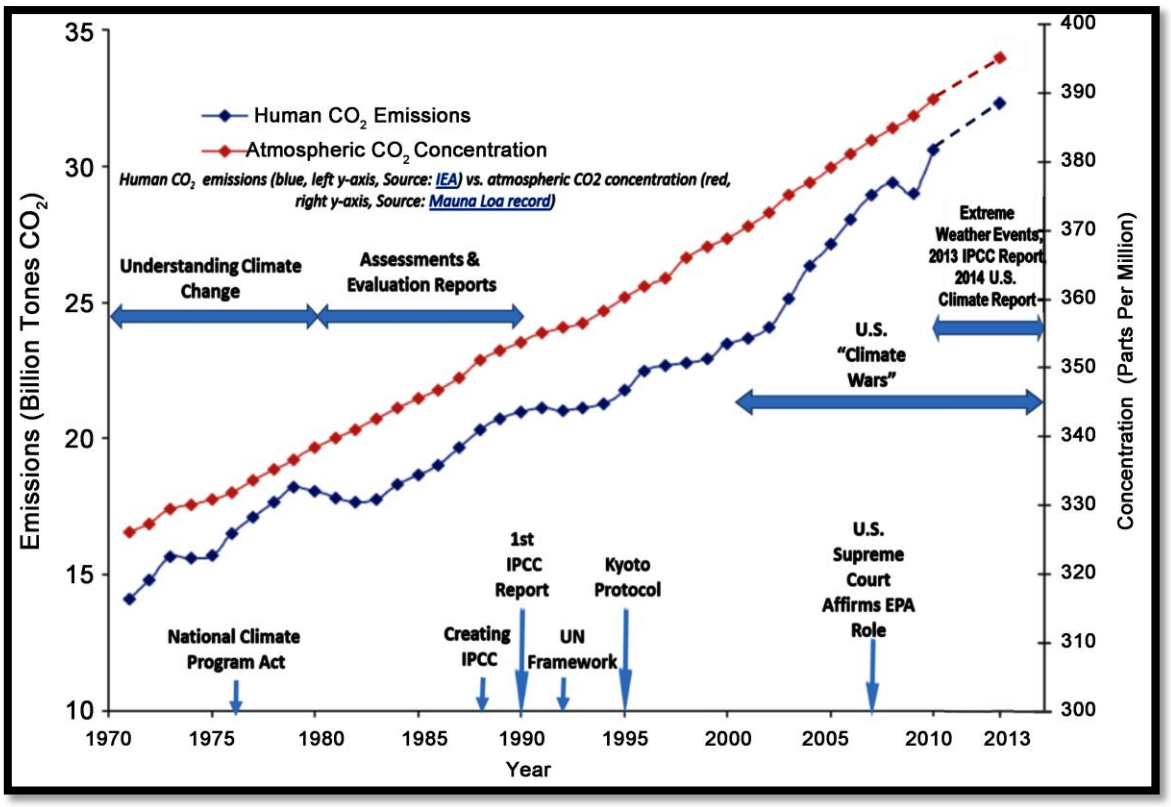

Figure 1: How CO2 concentration change from 1970 to 2013, (The source is: IEA, and Mauna Loa record).

Nunez and Blazquez, 2014 studied the possible scenarios of climate change on La Plata basin which is one of the important areas in North America due to its economic and population. The results shown that temperature change in the near future on this area will be about 0.5-1.5 °C. While in the far future, at the end of the twenty first century, the increase will almost be1.5-2.5 °C especially in the North West basin. The results also showed there's an increase of rainfall soon of 0.5 mm/day and 2 mm/ day by the end of this century. Despite the increase of rainfall could increase the flow of rivers in the area which is used to generate electricity, the increase effect on agriculture lands will be negative.

Studies revealed that climate change affected many aspects like health, food supplies, biodiversity, the availability of wood fuel, businesses and the dangers of environmental disasters occurrence.

The global negative effects of climate change include (Ishaya and Abaje, 2008):

Environmental impacts:

- Drought, increasing the damage on the environment,
- Increasing vulnerability of crops to pests and diseases, the loss of biodiversity and changes in wildlife and other resources.
- Reduction in the soil condition (such as soil moisture and nutrients).
- Erratic rainfall pattern.
- Increase in temperature.
- An increase in evaporation.
- Changes in vegetation type.
- Decrease in forest resources.
- Dwindling pasture and water.

Social and economic impacts

- Increasing migration from the countryside to the cities,
- Increasing social conflicts between communities.
- Lifestyle change in some communities.
- Increased health risks and the spread of infectious diseases.

Arnell, 2004 presented assessment of climate change and population growth effects on global water resources in the future by using the private report of SRES socio-economic which was published by IPCC in 2000. This report included new scenarios of greenhouse gas emissions in the future. These models were about four scenarios describe how the world developed in respect of populations, economics, political and life styles in the few coming decades. The four scenarios are the following:

1- A1 scenario: this expresses a rapid increase in the economic growth in line with an increase in globalization, general wealth, material consumption and rapid technological change, with regions close and reduce individuals' income in one region.

This scenario included three changes causing three assumptions about power resources, and they are:

a) A1F1 fossil intensive
b) A1T non-fossil fuels

c) A1B balance across all sources

2- B1: population growth as in A1, but development takes more environmentally sustainable pathway with globally coordination, more effective technology and focus on finding global solutions to achieve social, economic and environmental sustainability.
3- A2: less growth speed than A1, but more population growth. This scenario included income increase and various changes in technology.
3- B2: population increase less than A2, but higher than A1 and B1 with an economic, social and environmental development.

The results of the climate side in the scenarios were as the following:

1. Climate change increases pressure on water resources in some regions and reduce it in others.
2. Generally, some scenarios impose the presence of many people who will have their own pressures on water resources by 2020 and 2050.
3. The regions that will suffer from water resources pressure are all around the Mediterranean, middle and South Africa, Europe and middle and South America. The areas that will have less pressure on water resources are concentrated in south and East Asia.

Parry et al. 2004conducted a similar study to Arnell's. However, this study aimed to predict climate change effects on crop production, starvation dangers and connect them to the economic and social scenarios of climate.

Basic Linked System BLS was used to evaluate subsequent changes on global grain production, grains prices and the people who are endangered of starvation.

The report shows a great increase in grains prices and the danger of starvation among the poor countries especially within A1 and A1F1 scenarios.

Fischer et al. 2005, this study made a whole evaluation of climate change effects on agriculture globally in this century. It included the scenarios used to predict climate change effects on agriculture, environment and the social and economic aspects.

The study put scenarios until 2080, and they are:

1) AEZ model: This calculates arable and unfit lands. It also classifies lands into lands with severe restrictions like too cold, too wet, too steep or having soil quality. Or lands with moderate restricts.

It also classifies lands into rain-fed and irrigated based on information about water shortage.

AEZ model is used to evaluate resources and workers in many of agriculture studies regionally and globally.

This model used in the study to concentrate on grain production (wheat, maize and others)

2) World agricultural trade and economic modeling: this model is used to estimate the actual value of production and consumption. This provides a frame to analyze the global food system and a show of national agricultural components.

3) Socio-economic scenario generation: this model develops a hypothesis about how economic and social aspects will develop in line with diets for the same period.

4) SRES scenarios: is a special report about emissions scenarios which is for intergovernmental panel on climate change IPCC published in 2000. This special report was canceled in 2014.

The scenarios described in the report about greenhouse gas emissions were used to do reports about the predicted climate change.

5) Climate change scenario generation: this model forms man-made future climatic characteristics (resulted from greenhouse emissions which cause global worming).

In the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, the IPCC predicts that the southern and eastern Mediterranean warming over the 21st century will be larger than global annual mean warming between 2.2 and 5.1ºC. According to an optimistic emissions scenario (A1B), rapid economic growth and technological change have reduced reliance on fossil-intensive energy sources. Annual precipitation is very likely to fall in the eastern Mediterranean of 10% by 2020 and 20% by 2050 with an increased risk of summer drought (UNDP, 2010).

Abu-Jamous, 2009 evaluated the agricultural water demand under different suggested climate change scenarios for Palestine, Jericho and Al Aghwar district. She also evaluated the potential impact of climate change on agricultural water demand for the irrigated open-field crops. The results showed that crop water requirement (CWR) is very sensitive to temperature increase. Besides, it increases by an average of 2.7%, 5.4% and 8% as temperature increases by 1°C, 2°C and 3°C, respectively. The precipitation Chang doesn't affect crop water requirements, but it affects the amount of irrigation water requirements (IWR) as the effective rain provides part of the crop water requirement. Changing precipitation scenarios show an increase in IWR by an average of 1.47 % and 5.53% for a decrease in precipitation by 10% and 20% respectively. The other scenario of increasing precipitation shows a decrease by an average of 1.44% and 2.84% in the IWR for an increase by 10% and 20% in precipitation respectively. When combining the scenario of increasing temperature with the scenario of decreasing precipitation, the total amount of required irrigation water will get greater.

Badolo and Somlanare, 2014 searched in climate fluctuations on two indicators of food security. These are food supplies and population, who suffer from malnutrition. The study conducted that climate fluctuations reduce food supplies and increase the number of people that suffer from malnutrition in the developing countries, which the most affected is African sub-Saharan.

Mendoza and Servin, 2014 studied climate change effects on pests and insects in Mexico. An increase in desert locust numbers and other agriculture pests was noted like the pink mealy bug, mites and other insects in Mexico. The study showed that the development in insects and pests numbers was due to climate factors change. Rainfall differences could cause drought and the increase in temperature are both of the environmental factors that affect insect's evolution and increase of their numbers.

2.2 Adaptation to Climate Change

Adger et al. 2003 presented clarification of the nature of the predicted risks of climate change. Besides, it presented proofs of adaptation occurrence at the present time within change in the developing countries. Adaptation can be done by the individuals themselves in

response of extreme events, or by the government on behalf of the whole society. However, most adaptations are at the individual level.

Adger et al. 2003 gave an example of adaptation which says that agricultural societies in north Nigeria showed flexibility through increase per capita of agricultural production. This was fixed during 1970 -2000, which witnessed an increase in drought and population. Bangladesh is another example, in which the government helped build shelters for people to protect them from hurricanes. Here, the study confirmed on the necessity of teamwork to find solutions of adaptation especially in the developing countries which are less able to adapt. Indeed, there was contributions from advanced countries of 400 million US$ to support the developing countries to adapt. Support was on stages: The first stage supported studies and planning. This has already been implemented. The second stage supported detailed planning and ability building. This has been done in some countries like Bangladesh. The third stage supported actual amendments.

Ishaya and Abaje, 2008 examined how climate change affects the natives and their activities in Jema'a region in Kaduna state in Nigeria, and they studied how to adapt with climate change. The study revealed that the people of this area think and believe that, the climate has already changed in the past few years, and the farmers were the most affected of climate change.

The oldest farmers and the most experienced adapted with climate change more than the youngest and the less experienced did. Adaptation took many forms like growing types of crops that bear harsh conditions, shorten the growing period; use fertilizes and uses water and moisture maintenance techniques in soil. Yet, improved seeds prices increase and sometimes its absence and the lack of water are all obstacles to effective adaptation.

Mongi et al. 2010 evaluated the vulnerability and adaptation of agriculture to climate change in the semi-arid areas of Tabora, Tanzania. The data about rain fall and temperature during the 35 past growing seasons has been analyzed. The rain fall quantities in general were declining, while rain fall distribution was various in terms of time, place and intensity. The results also showed that temperature is increasing, but minimum temperature increased faster than maximum temperature which increased gradually. Besides, inter-seasonal dry spells showed an increase in duration and frequency.

The study also explained that climate change differed according to activity type and its influence by change. Most the negative effects were on the rainfed agriculture, such as growing season shrinking, insects and pests increase, heat stress, low income and food insecurity.

Gbetibouo, 2009 investigated farmers' understanding of climate change, such as temperature increase, drought and lack of rain, in South Africa, in the Limpopo River Basin area. The study included 794 families in this area within planting season in 2004-2005. It compared the farmer's concepts of climate and his realization of the occurred fluctuations with the recorded climate data in meteorological station.

It also studied the farmer's response of climate fluctuations, and the determining factors of adaptation. Moreover, it confirmed that temperature increased and rainfall decreased in the past three years of the study time.

The study results showed that the farmer's perceptions are aligned with the recorded climate data. Yet, almost half of the farmers adjusted their farming practices to the changing climate.

It also showed that lack of government support for adaptation was the main reason of adaptation process discouragement.

2.2.1 Climate adaptation in the agricultural sector

Agricultural sector is the most affected by climate change especially in developing countries, which suffer from poverty, hunger, malnutrition, low education, low economic strength and low technology knowledge.

Studies showed that the poor are the most affected of climate change since they depend on natural resources like farming and ranching.

Agriculture is in the interface between the ecosystems and society, since the driving force of agriculture is global increase of food demand. This is due to population growth and demand increase on food production.

The result is an increasing pressure by agriculture on water and land resources globally. This leads to land degradation, land pollution, soil erosion and increase soil salinity.

The results of climate change differ from one area to another as the soil type, resources availability, infrastructure to deal with the change in every area and economical and political conditions (Bazzaz and Sombroek, 1996).

Smit et al. 2000 presented several definitions for adaptation in the agricultural sector. One of which adaptation with climate change is the process by which people reduce the negative effects of climate on health, living and get benefit as possible as of this climate change's favors.

Adaptation also includes control the social and economic changes to reduce its effect.

The study also presented a plan of agricultural adaptation which is as the following:

1. Adaptation with what? (Is it with an occurred natural phenomenon, the time in which you must adapt the required time to adapt and the place in which to adapt)?
2. Who are going to adapt (stakeholders and those affected)?
3. How will adaptation be (the steps, the processes and results)?
4. Evaluate adaptation (did it achieve the goals in reducing the expected results).

Wang et al. 2009 studied the expected effects of climate change on farming in China, and the effects of temperature and rainfall change.

The results showed that global warming and temperature increase could be harmful to rain-fed farming. Yet, this could be useful on the short-term to irrigated farming. But the effects will generally be harmful to both on the long-term.

The study also showed the effects will be few at the beginning, but they will increase if the necessary measures haven't been taken.

Besides, the study show the Chinese crop productivity as the rest of the world will be affected due climate change. Yet, this change could be useful if handled well, adaptation done right and farmers were well educated by modern technology and techniques.

Cooper et al. 2008 suggested promoting the rural communities' ability and agriculture interest's owners in African south desert Sub-Saharan Africa (SSA) to deal better with climate change, especially in the regions depending on rain as an only source of water to irrigate crops and pastures.

The government also calls to present and facilitate all the tools and means which make that easy to accomplish. It also calls to draw maps of effects by climate change on agriculture, and to develop strategies to manage its risks.

The study found that the solution to climate change crisis is to concentrate on rain-fed agriculture, since water scarceness threatens irrigated farming and food security. However, demand for food will continue to increase. So, rain-fed farming is the alternative solution in order to meet the increasing demand.

The study also cleared that farmers already do adapt since they use techniques like early farming, change the type of crops and use crops suitable to climate change conditions.

Smit and Skinner, 2002 studied the Canadian agriculture adaptation options with climate change. This study showed that for adaptation to take place, first there must be intention and determination. Then, time adaptation and the needed duration. Third, determine the adaptation size whether it's field, farm or area level. Besides, determining this adaptation is the responsibility of (individuals, farmers or government). Fourth, determine adaptation form based on type of the required crop, available money, available technology and the help presented by institutions or governments.

This paper indicated that the adaptation patterns are the results of farmer's experience or the information gained through workshops or courses.

The study also confirmed the necessity to spread information about climate change, the expected results and the possible adaptation options to fulfill its patterns.

It also assured that in order to get the required adaptation, the government has to provide money and the needed technology. The government has also to support farmers and provide compensations of the damaged crops due to climate change.

In 2010, FAO launched the concept of "climate-smart agriculture", which is an approach to re-orient agricultural systems to sustainably support food security and it includes crop, livestock production and forest management (FAO, 2010). In another study,

Arslan et al. 2014 focus on climate-smart agriculture to achieve the food security to be in line with the population growth. This approach aimed sustainable food security by increasing the agricultural productivity, adaptation to climate change, and reduction of greenhouse gas emissions.

Dhehibi, 2014 studied the possibility to improve production through more efficient use of inputs. A sample of 100 rainfed farms was taken in Jenin and Tubas. According to the results of the study, farms' production can be increased in Jenin ad Tubas of 28% through more efficient use of inputs.

It was also found that the relationship between efficient use of inputs and education and experience of the farmers. The more experienced and educated the farmer is, the more he was experienced to more effective use of inputs of fertilizers, labor, expenses and others.

2.2.2 Farmer adaptation to climate change

It is doubtful that the farmer knows immediately what he/she has to do to adapt and respond to climate change, since adaptation requires experience and farmers, especially the younger generation, have no experience.

Maddison, 2007 studied the farmer's ability in Africa to deal with climate change and to adapt to it. The study included 11 African countries and revealed that the oldest, the most experienced farmers that had access to free advice dealt well with climate change. The study also showed that many of the farmers believe that the temperature has already increased and rainfall decreased.

Besides, some of the farmers perceived no obstacles to adapt with climate change, whereas others had obstacles to adapt, such as unavailability of seeds.

Their adjustments as a response to climate change included growing different varieties of the same crop, shifting to another crop, changing the planting date in line with rainfall, use of shading, use of crop covering techniques or water maintenance.

Reidsma et al. 2010 studied the farmer's adaptation to climate change in different regions of the European Union and the prevailing climate in the past decades (1990-2003).

The study concluded that good management and adaptation can largely reduce potential impacts of climate change on crops.

The results also explained that farmers work regarding to production of crops was higher in the temperate climate region that has a better social and economic level.

At the beginning, temperature increase effect was positive on agriculture in Europe. However, through long term calculations the results were negative.

The study also found that the Mediterranean regions have less ability to adapt than North Europe regions.

The study also confirmed that the land productivity doesn't necessarily reflect the harvest productivity. Some of the Mediterranean areas have high land productivity, but less harvest productivity.

This assumes that the farmers in low harvest productivity may get better prices by growing more profitable crops to increase land productivity. More profitable crops like corn on which temperature and rainfall changes effects was slight.

Osbahr et al. 2011 studied the Ugandan farmers' knowledge of climate change. The study also measured rain fall and daily temperature from 1960 to 2011. The comparison also included daily rainfall, temperature and season change.

The results show that farmers noticed that, during the recent drought at the latest of 1990s and 2000s, the transformation in climate caused less production, there was also irregular rainfall, which caused drought and crops failure, also the heavy rainfall led to floods and soil erosion.

Farmers made progress in responding to these changes depending on the oldest experience and adopt ways which help achieve that.

2.3 Social Impacts of Climate Change

Rapid population growth, poverty, hunger, bad health, low education, low equality between women and men, inequality and lack of access to knowledge, services and technology are all affect the social side as the following.

Population is expected in the 50 coming years to increase of about 3 billion, especially in the developing countries. Agriculture provides the increase food and work.

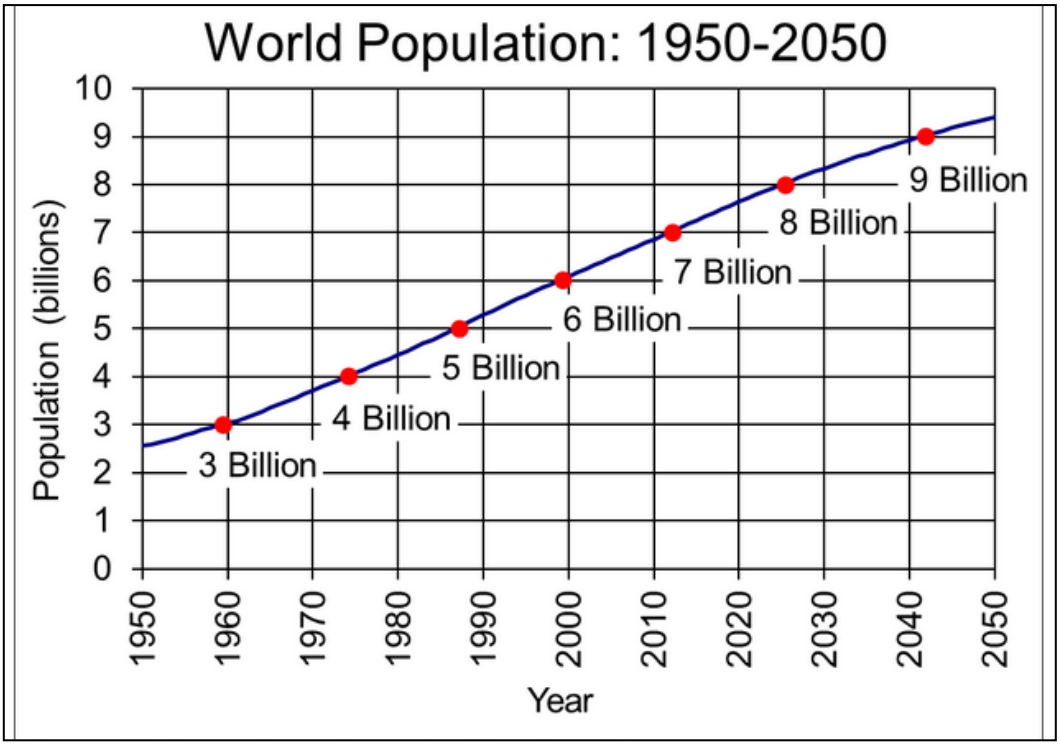

Figure 2: World Population:1950-2050 (Source: U.S. Census Bureau, 2016)

Currently, almost half of the man powers in the world work in agriculture. Besides, agriculture dominates 25% of the world's economies.

Hunger and poverty are one of human weakness factors. The lack of enough money for food and lack of enough food lead to food insecurity.

More than 780 million people suffer from malnutrition. Those live in about 84 of the poor developing countries which are about 4 billion people and are expected to increase to 7 billion in 2050. Food shortage is about 25million ton of grains yearly. This is about 2.5% of production in these countries.

These endangered countries have limited abilities to protect themselves of natural and economic risks. Agriculture in these countries is threatened of climate change risk. Climate change hasn't stopped since then, but became more intensity. This led to more economic shocks.

Therefore, there had to be a solution of climate change to maintain food security, and prevent starvation all over the world especially in the developing countries. This requires intensify agricultural research especially rain-fed, use genetics to get resistant crops and develop technology and others to serve adaptation with climate change (ARIJ, 2010).

2.4 Economic Impacts of Climate Change

Climate change most affects agriculture, Moreover, when agriculture is affected, it affects economy. Economic losses connected to weather in the developing countries in 1998 were about 42 billion US$ (ARIJ, 2010). Farmers are the most affected economically, since they lose the crop for a year or two by the climate change. And the Agriculture contributes of 13% of total domestic products in the developing countries compared to 2% in the advanced ones.

The farmer sometimes has to introduce a new crop on his land due to temperature increase for example. Therefore, he starts searching for crops bear the heat and so he pays the costs of the new crop of seeds, growth, tools and others.

The results show that climate changes like temperature and rainfall have greater effects on the agriculture revenues, weather irrigated or rain-fed.

Agriculture revenues are affected negatively by temperature increase and rainfall decrease. However, if rainfall increases, it affects positively in some areas and some crops.

Studies unanimously that rain-fed farming revenues are more affected than the irrigated revenues. Since the latter is more resistant to temperature change and low rainfall.

The studies indicate that trained farmers to adapt with climate change, secured fertilizers, improved seeds and supplementary irrigation water can contribute improve farming revenues (Turral, 2011).

Olesen et al. (2011) studied the expected effects of climate change on harvest productivity in Europe and the way to adapt with. The study was on all Europe which was divided into 13 environmental zones that the study included.

The results of the study indicate a high rate of negative expectations about climate change effects on harvest and productivity even in the northern region of Europe.

Europe witnessed an increase in the surface air temperature during 1901-2005 of (0.9°C) in the average of the whole continent. This temperature increase caused decline in grain output.

There is damage in the crops as well due to late frost in the spring or early frost during autumn. Beyond that, drought minimizes growing season period and there for shorten crop growth. Yet, the results show that farmers now do adapt with climate change either by changing planting time or by changing the crop kind. A significant decrease in the irrigated

areas which turned into rain-fed areas was monitored as a type of adaptation. The results also show the negative effects can be exceeded by studied and effective adaptation.

Kurukulasuriya and Mendelsohn (2006) studied the economic losses that result from climate change in Africa. This was one of the biggest studies, since it included a whole continent. It included 11 countries in Africa. These cover all the major climate zones and agriculture systems. The results indicated that rain-fed agriculture is more affected of the change than the irrigated one. It also found that temperature increase of 10%, will lead to decrease the revenues of the crops by 13%. And temperature increase of 2.5 °C, will reduce the revenues by 23 billion US $. Temperature increase of 5 °C, will decrease the revenues by 38 billion US $. As for rainfall, the study showed that rainfall decrease of 7% will decrease the revenues of the crops by 4 billion US $. Moreover, rainfall decrease of 14% will decrease the revenues of 9 billion US $.

Deressa (2007) studied climate change effects economically on farming in Ethiopia. The study included more than 74% of Ethiopia. Analysis showed the Ethiopian farming was harmed due to climate change, temperature increase and rainfall decrease through the four seasons. This negatively affected the agriculture revenues. Analysis also cleared that temperature increase in summer and winter will decrease agriculture revenues of 464.71 US$ of one hectare in winter.

In case rainfall increased during spring, revenues of each hectare will increase of 225.09 US$. If rainfall decreased of 14%, revenues will decrease of 0.39US$ for each hectare.

Mano and Nhemachena (2007) studied the economic effect of climate change on agriculture in Zimbabwe. The study included simple scenarios of how the agriculture production will be affected. The scenarios showed that temperature increase of 2.5°C will decrease the farmer's total production by 0.4 billion US $. Besides, there's an increase in irrigated farming revenues of 0.3 billion US $. Moreover, if the temperature increases of 5 °C, the total farming production will decrease by 0.4 billion US$. Production decrease of rain-fed will be 0.5 billion US $ while the irrigated will be 0.003 billion US$. Mano and Nhemachena, 2007, also found that if rainfall decreased of 7-14%, total farming revenues will decrease of 0.3 billion US$. By 2100, there will be decrease in total farming revenues by 0.8 billion US$, rain-fed by 1.3 billion US$ and irrigated 1.4 billion US$. The study also showed that farmers implement some strategies to adapt, such as early farming of rainfed crops, growing drought-resistant crops and using supplementary irrigation. The study also concluded that increased

training of farmers to adapt, securing the use of fertilizers and improved seeds will contribute improve the revenues.

Tol (2009) showed that greenhouse gas emissions are the effects of global power system and the food production. Economy, goods production and food production are all only produced by greenhouse gases presence like CH_4 and CO_2. However, these gases are the cause of climate change which affects agriculture, power use, health and others. Therefore, the study investigated the marginal cost of greenhouse gas emissions, and found that the taxes imposed on carbon emissions are much less than the losses it causes. Besides, the effort on economic effects of climate change research doesn't equal the problem size and the expected costs. So, the suggestion was to reduce global warming gas emissions.

Tol (2009) also cleared that governments impose tax of 25$ per metric ton of carbon which the study prefer to raise to 50$ per metric ton of carbon, since higher tax means higher level of danger. Moreover, carbon tax varies from one area to another. For example, in the European Union the tax is 78$ per metric ton of carbon in 2009 while in the USA there's no such imposed tax. Generally, high income countries don't impose carbon tax despite they are the most polluting.

Kurukulasuriya et al. (2006) measured the economic effects of climate change on agriculture in Africa. The study included 11 countries and more than 9000 farmers. First the authors found after studying the revenues of each hectare that dry and irrigated crops and livestock are generally affected by climate change, since they change by temperature and rainfall change.

Second, dry crops' revenues decreased with temperature increase, while irrigated crops' revenues in moderate regions in Africa increased. Yet, the study predicted that in the long-term, losses would be higher than the increases in revenues. Finally, the study concluded that dry crops are more affected by climate change than irrigated ones.

Ighbareyeh et al. (2014) studied in this article and analyzed crop production like olive, grape and fig in some of the Palestinian areas, and studied the relationship between production and climate. He also studied bioclimatic features in the area. Climate factors the study had are: temperature average, evaporation, rainfall, water reserves, soil, transpiration and water deficit.

The data was taken from five of the Palestinian metrological stations over five years. These stations exist in five areas of the West Bank: Hebron, Ramallah, Nablus, Jenin and Tulkarem.

The purpose of the article is to study the biological basis and bioclimatic to improve crop production and increase the Palestinian economy. The results of the analysis found that olive and fig production were clearly affected by climate change while grape production affected by climate change was low.

Besides, Jenin and Tulkarem areas were more affected by climate factors than Nablus, Hebron and Ramallah, since Jenin and Tulkarem are affected by thermicity index and water deficit, which affect production. However, production in Nablus, Ramallah and Hebron depend on rainfall and reserved water in soil.

2.5 Role of policy-making in Climate Change

Olesen (2002) studied climate change effect on agriculture in Europe and added this to the current agriculture policy. This study also discussed interaction between agriculture and other sectors of the European society. The study confirms the necessity to considering the multi-role of agriculture which achieves balance in economic, environmental and social aspects. The study also shows that climate change has temporary positive effects on the north regions of Europe, since the increase in temperature and CO_2 concentration will motivate some crops; growth in these areas and therefore; the areas of the land appropriate for agriculture will increase.

As for the southern areas of Europe, which includes the Mediterranean region, the effects will be negative. Probably, there will be shortage in water and bad weather which may cause decrease in crop production.

The study also affirms the role of policies to support agricultural adaptation through encouraging land use, crops production, farming systems and to be more flexible.

Olesen (2002) also affirms that politics has to concern about setting agricultural strategies to face climate change effects, to reduce Methane emissions and Nitrous oxide. As well as, encourages and setting plans to support the environmental farming.

Hodgson et al. (2010) summarized the Palestinian National Authority's PNA steps to face the climate crisis. It was urgent to focus on addressing adaptation measures within the context of the occupation rather than focusing exclusively on the difficulties of implementation. That is because of the political situation which makes the implementation of climate change policy a difficult task. There was a room to implement low-technological solutions such as the more widespread implementation of grey water systems and conservation education programs. Moreover, addressing the more immediate public health and disaster management issues was outlined in the EQA report. The fact that climate change has emerged in the most recent Palestinian Reform and Development Plan (PRDP) is a positive sign. This can support development outcomes and may assist the PNA in achieving other development goals.

Mimi et al. (2009) confirmed that the governmental departments (such as ministry of finance) need to be involved in the development of adaptation strategies to achieve a real progress on adaptation. Furthermore, environmental institutions sectors should be strengthened to be able to implement the adaptation actions. It assured that there are some actions which can help facilitate adaptation and integration of adaptation into policy. For example, climate change risks are combined in projects of regional development agencies and the creation of intersectoral committees to be engaged in the formulation of adaptation plans at the regional level.

Mason et al. (2009) explained the necessity to have cooperation between the Ministry of Agriculture and the Environmental Quality Authority and the Palestinian Water Authority. Each of the authorities performs its duties and puts strategic climate change adaptation planning.

2.6 Researcher's Comments on Previous Studies

The suggested adaptation methods

1) It is obvious and known that farm lands and its production differ from land to land, Crop production and farmer's income in one hectare also differ from one area to another. The

ability to adaptation differs from one area to another according to the following indicators:

a) Farm size (area and the economics)
b) Use of suitable farming lands
c) Agriculture intensity
d) Use of fertilizers
e) Crop yield and protection
f) Irrigated areas and others

2) In order to find solutions to climate change and find adaptation methods, first some changes must be understood, like:
   a) How crop production responds to climate change
   b) How the income of the farmer responds to climate change
   c) How to respond in the short and long terms
   d) Developing scenarios of the possible climate effects
   e) Study the actual impact which happens in reality which differs from one area to another, since it depends on agricultural features like (the intensity and size of agriculture, lands use and on management)

3) Adaptation methods of climate change could be either by depending on the traditional knowledge of the oldest and the most experienced farmers, or depending on modern technology.

The previous studies showed the oldest and the most experienced farmers are the most observant of the change in climate, since they noticed the increase in temperature and rainfall decline. Besides, they were the most capable to deal with climate change effects, and they had solutions to handle and exceed these effects.

4) Despite some farmers do adapt due to their or their relatives experience or guidance or other ways, many of them are still vulnerable due to their ignorance of adaptation ways, lack of experience, lack of guidance, lack of technological knowledge and lack of resources or money.

The following are the suggested ways the farmers used to make to adapt with climate change:

1. Change agriculture patterns which include, change tillage practices, change sowing dates, introduce new crops and crop rotation.
2. Use soil and water maintenance techniques to reduce drought effects.
3. Shift from irrigated farming into rainfed farming.
4. Introduce farming techniques to reduce soil erosion in order to avoid high frequency of rainfall which may lead to soil erosion.
5. Use field drainage system to avoid change in rainfall type.

To achieve the Short-term respond the farmer should do the following:

1. Change farming date to avoid heat and drought periods and exploit as much rain as possible in winter. For example spring crops could grow earlier, since early farming increases growing season.
2. Tillage to maintain water and soil.
3. Use natural fertilizer to reduce nitrogen dangers and phosphor transpiration, to increase the harvest, and to reduce the potential losses which may happen during or between the seasons.
4. Use new kinds of crops, which capable to adapt, endurance, and get great yields.
5. Use pesticides to protect crops from pests and diseases.
6. Seasonal weather forecasting which is the meteorological station job. Predicting the unusual weather types is an adaptation mean which helps using the appropriate type of adaptation.
7. Improve awareness on climate change adaptation through:

a) National strategies of adaptation suggested by ministry of agriculture.
b) Increase the farmer's awareness of climate change through workshops, lectures and give training courses.
c) Increase the advisers and the decision-makers awareness of climate change.
d) Increase the government awareness to climate change, to make the appropriate measures.

Long-term patterns of adaptation must be major changes in the agriculture system. This includes increase irrigation patterns efficiency, use new techniques and develop new kinds of crops and here we can use genetics to find these kinds (Olesen et al., 2011)

Long-term adaptation can be achieved through the following:

Farm level:

1. Change the use of land. In Europe for example, there are studies that indicate that the lands used to grow wheat, corn and vegetables in winter have increased. Moreover, the lands used to grow wheat, barley and potatoes in spring has decreased. This change in using lands lead to production stability.
2. Search for resistance and preserver of moisture crops.
3. Exploit the development in genetics to produce heat, disease and lack of water resistance kinds.
4. Use new techniques to manage the land (the minimum of tillage, the stubble mulching), manage irrigation schedule to improve irrigation efficiency in farming.
5. Use techniques which may be useful to improve water use efficiency like: inter-cropping, multi cropping and rely cropping.
6. Use organic fertilizers instead of industrial fertilizers.
7. Apply fertilizers in time, crop rotation periodically and use cover crops.

Local and national level:

Monitoring of measures and programs implemented at the local and national level, projections at the local and national level, implementation of risk assessments, sharing of information with citizens, formulation of adaptation measures (including incorporation into existing plans, programs and policies) and implementation, promotion of research and development, awareness-raising to contribute to higher awareness among the public, development of fundamental information, risk assessment tools, and assessing progress.

International level:

1. Reduce gas emissions which cause global warming directly by reduce using power, methane emissions and nitrous oxide. And indirectly through substitute the use of fossil energy of a cleaner one harmless to the environment like wind energy, water energy, solar energy and others.

2. Publish agriculture technology information and researches. Besides, information exchange system among farmers must be fast and efficient by using modern techniques like the internet.
3. Encourage research in adaptation (Olesen, 2002).

Chapter Three: Description of the Study Area

3.1 Geographical Location

Historical Palestine lies in the western part of Asia between the Mediterranean Sea in the west and Jordan River and the Dead Sea in the east.

It's bordered by Lebanon from the north, Syria and Jordan from the east, the Mediterranean Sea from the west and Egypt, Gulf of Aqaba from the south.

Historical Palestine was divided into the West Bank and Gaza strip. Besides, what is called now of Israel which occupies the lands of 1948.

The West Bank is located in the central highlands in Palestine. It's surrounded by Jordan River and the Dead Sea from the east and by 1948 lands from the north, west and south (ARIJ, 1996).

Jenin which is the study area is located north the historical Palestine and north the West Bank. It's bordered by Nablus from the south and by Tulkarm from the south west, it's location between 90-750m above sea level (ARIJ, 2010).

Jenin's governorate is about 10.25% of the West Bank area (Saqer, 2005). In 1945 the area of Jenin city was of 835.214 km² and after the 1948 war the area reduced to 592 km². The Israelis took a total of 243.214 km² of the city lands (Al-Dabbagh, 1991).

The name of Jenin is derived from the large number of gardens and orchards surrounding the city. Jenin occupies the largest planted area among the Palestinian provinces of about 185,426 Donums which is about 19.4% of planted lands in Palestine (PCBS, 2011). It also has many large plains which rely on planting such as Marj bin Amer and Sanur Plain (ARIJ, 2010).

Figure 3: Jenin city in palestine, (source: https://desertpeace.wordpress.com/2008/01/page/2)

Figure 4 : Jenin city in the West Bank (source: wikipedia,Jenin_Governorate, 2017)

3.3 Water Resources

Groundwater is the main source of water for the Palestinians in the West Bank. Besides, Jordan River which is the only surface water in the region. However, the Palestinians don't have the ability to reach it as they want since Israel controls the flowing water in the river. The Palestinians moreover, depend on the rain as an extra source of water.

The water issue in the West Bank is complicated due to the political situation in the region. In 1967, when Israel occupied the West Bank, it occupied water sources and made it under the Israeli military orders control which imposed restricts on water use by the Palestinians. Besides, it prevented the Palestinians use of Jordan River water.

Besides all of that, it makes unfair distribution of water sources in the region between the Palestinians and the Israelis. The Israeli's per capita of water is six times the Palestinian's (ARIJ, 2010).

The Palestinian per capita of water for all uses is 50 m^3 / capita / year, compared with a 350 m^3/ capita / year for the Israelis.

The West Bank is considered a water-scarce region. The people now can barely meet their needs of water, and the situation will get worse in the near future due to the increase in population and industrial and commercial developments.

Groundwater represents 95% of total water consumption of the Palestinians (Al-Nazer, 2009). Groundwater in the West Bank flows in three main aquifers (see also figure5):

1. The western aquifer, which is shared between the West Bank and Israel.
2. The northeastern aquifer which is also shared between the West Bank and Israel.
3. The eastern aquifer which is completely inside the West Bank.

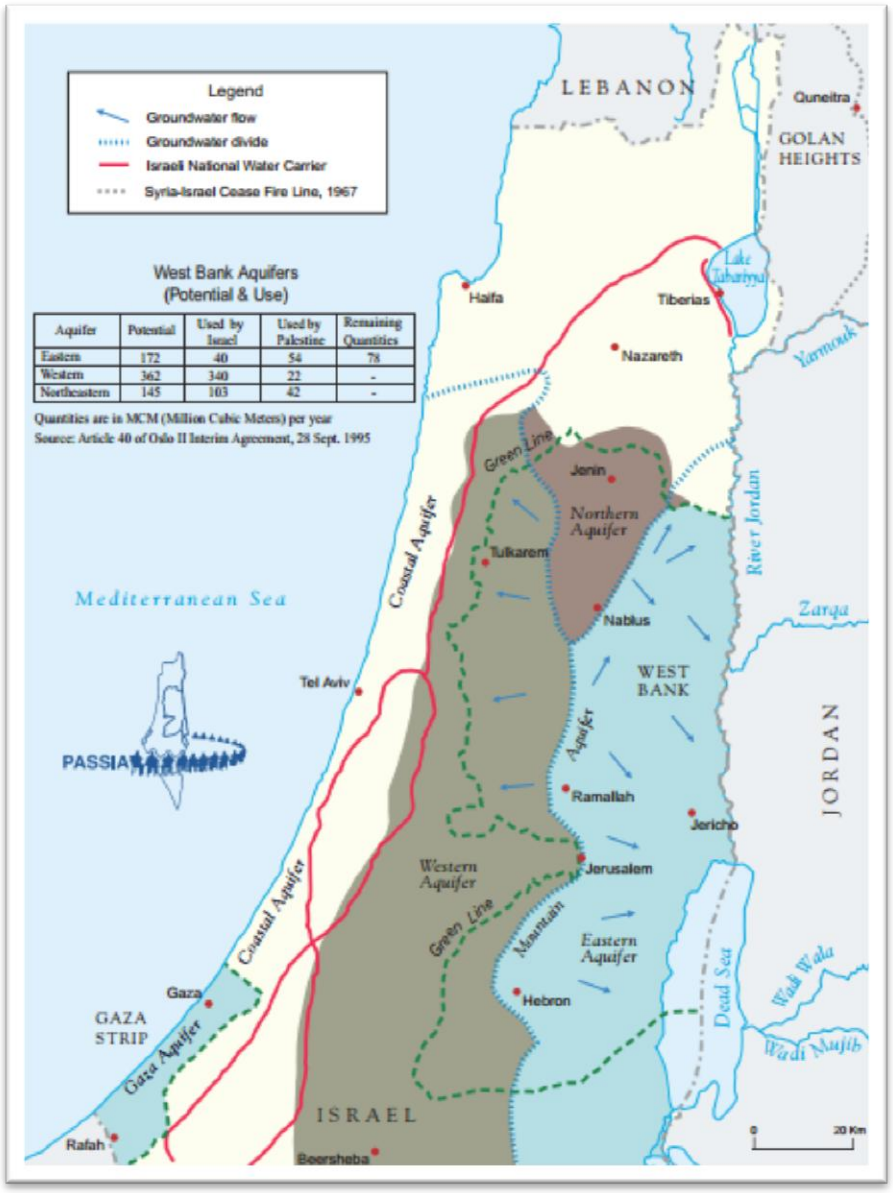

Figure 5: Water sources in Palestine (source: from 'Water and War in the Middle East' Info Paper No.5, July 1996, Center for Policy Analysis on Palestine/ The Jerusalem Fund, Washington D.C.)

3.3.2 Available water resources and water use

Water issue in Palestine is one of the complicated cases due to the political situation since groundwater is being controlled by the Israelis. Therefore, most Palestinians turn to rainwater which is used for drinking and daily life use and for irrigation by farmers.

The West Bank receives average rainfall of 540 mm/year which equals 2970 millionm^3 /year.

- 77 million m^3/year flow as runoff,

- 7 million m^3/year is being harvested by rainwater harvesting systems,
- 2207 million m^3/year is collected by total evapotranspiration,
- 679 million m^3/year is filtrated into the groundwater aquifers (Nazer et al.2010).

Jenin, as the rest of the Bank's cities, depend mainly on groundwater, which exists on the form of wells and springs. There are 63 artesian wells in Jenin used for irrigation, drinking and daily uses (ARIJ, 1996).

58 of these wells are for the private sector and mostly used for irrigation. The five remaining wells are general owned by municipalities like (Jenin and Ya'bad) or owned by the Israeli company Mekorot like (Arabba', Qabatiya and Sanour wells) which are used for daily uses.

Most groundwater wells in Jenin are under the Israeli control which prevents the people to dig except for few meters, which means limited amounts of water. Therefore, after the 2000 Intifada, people had to dig few meters without a license from the water authority. This led to inability to count these wells.

According to Oslo agreement (13 Sep, 1993), Israel supplied Jenin of 104 million of cubic meters of water yearly for daily uses (Saqer, 2005).

The Israeli company Mekorot began building a deep new well 4km away from Jenin to the North West. This well is with 933 m depth and 150-200 m under the surface.

But after the digging, Israel claimed that the well isn't enough to cover the expenses. Yet, there was confirmed news that the well produces 18m^3/hour. This could have helped to solve the problem of water spatially in summer.

Negotiations between the Palestinian Water Authority and Israel are still on, to clarify the reasons behind the project failure and the possibility to improve the well or prepare alternatives to supply the people of Jenin of extra amounts of water.

It should be noted here that the closing official report of the well hasn't been presented yet and Israel decision is still unknown.

There are 42 springs in Jenin, but most lose water through run-off and they are seasonal, drought-prone and used for daily uses and few for agriculture.

Moreover, rainwater harvesting wells during winter forms an extra source of water for the people (Saqer, 2005).

Rainy season in the Jenin area normally starts in mid-October and lasts until April. Almost 3.2% of the annual rainfall falls in October, while almost 80% of the annual rainfall falls in November to February. The rain fall usually begins to decline in March to 12% of the annual rain while it's almost rare in June to September (ARIJ, 1996).

3.3.1 Agricultural water use in Palestine

Palestine and especially the West Bank is one of the regions suffer from water scarcity as many of the Middle East countries. The average per capita of water in the West Bank is 50m³/person/year, used for home, industry and farming purposes.

Farming consumes 155 MCM/yr (millions of cubic meters) which represents 66% of the withdrawn water by the Palestinians in the West Bank (Lautze and Kirshen 2009). Therefore, introducing improvements to farming water management was a must to achieve the highest benefits. Besides, water must be used with high efficiency and make every drop of water more productive.

Nazer et al. 2010, made a study to find the perfect solution of irrigation water distribution. The study included five farming areas one of which was Jenin and five vegetables and fruits crops (tomatoes, cucumber, eggplant, squash and citrus).

The result was the following suggestions:

1. Increase water production through reduce losses.
2. Seek for other water options which may be hypothetical.
3. Improve rainwater use and widen rain-fed faming.

The study concluded that the perfect solution of irrigation water is to change crops pattern by widen rain-fed farming, and therefore water scarcity will be solved and the water used in farming will be reduced.

3.4 Environmental Situation

Palestine in general and Jenin in particular are subjected to the Mediterranean Sea climate which is mild and rainy in winter and hot and dry in summer (ARIJ 1996).

Rainfall in the West Bank ranges between 700-850 mm in the western slopes, 500-800 mm in the mountainous and 100-150 mm in the eastern regions. This rain is the only source that

feeds the groundwater and Because of high temperatures, the rate of evaporation has increased and the lack of rains led to lack of water percolating into groundwater.

One of the expected environmental effects of the east Mediterranean Sea areas including Palestine in general and the Jenin area in particular that there will be a decrease in the rain. In the fourth report of the IPCC, the heat over the 21st century is expected to be greater than global annual mean warming by 2.2-5.1 °C according to the scenarios realistic emissions of the southern and eastern Mediterranean. Rainfall is also expected to drop by 10% by 2020 and 20% by 2050 in addition to the risk of drought in summer.

In Palestine, drought is caused by low rainfall in some years and poor distribution of rainfall on days and regions in other years and this significantly affected the cultivation of crops and pastoral plants season during the past few years. The amount of rain fall during the agricultural season in the West Bank in 2007/2008 and 2008/2009 amounted to 354 mm and 428 mm, compared to the historical average annual precipitation rain in the West Bank which is 537.5 mm. Besides, the amount of rainfall in south Hebron and east Bethlehem is less than normal precipitation by 20 % (ARIJ, 2010).

Jenin, like other Mediterranean regions, is exposed to the effects of climate change that have been mentioned. There have been significant changes in rainfall pattern in Jenin district over the last ten years. (Froukh, 2010) found that the changes in rainfall in the main recharge areas which are Jerusalem, Hebron and Jenin areas [these areas where the aquifer is exposed to it and high rainfall occurs], it is found that the rainfall in the last 10 years is below the average and continues to drop with time around 20% (average rainfall is around 450 mm/year). Winter season is shifted a little bit toward November in the beginning of the season and toward April in the end of the season. Jenin is considered the largest agricultural areas in West Bank and it has large agricultural activities. Therefore, the impact of climate change on the agricultural sector specially the rainfed agriculture was studied by Hamarsheh, 2010. It showed that when temperature increased by 1 °C ,T+2 °C and T+3 °C, wheat production, for example, reduced changes by 35.7%, 36.6 % and 37.3 % respectively and there were no changes in the precipitation. However, if all the climate parameters have changed, it will be more significant. For example, if the increase in temperature +3 °C was combined with reduction in precipitation -30%, the changes will be 41.7 %. The losses occurred in wheat crops during the last ten year was expected to be about 1,461,606 $. If the temperature was expected to increase by 1°C with no decrease in precipitation, losses in wheat crops would

be about 1,495,110 $. If temperature didn't change and the amount of precipitation decreased by 10 %, losses would be 1,557,930 $. Thus, the impact would be doubled or tripled if combined with changes in temperature and precipitation.

3.4.1 Bio-Climate

In order to improve agricultural production in Palestine, we need to know and study the environmental and bio-climate factors despite the political situation and its negative effects that hinder agricultural production.

We always seek to achieve the max output economically with less environmental costs. Agriculture is affected by climate instability due to the relationship between the biological features of some crops and climate. For example, some kinds of olive trees roots don't penetrate soil to great depth and this makes it more affected to climate.

Ighbareyeh et al. (2014) studied temperature along the past few decades. They took monthly, seasonal and yearly results of temperature and analyzed physical factors of bio climate after taking the results from the Palestinian meteorological station.

The data was taken from six weather stations of the Palestinian meteorological station within two periods: the first from 1969-1981 and the second period from 1975-1995. This means they took the data over than32 years. The results of analysis showed a clear trend towards climate change and especially there're temperature increase and disparity in rainfall rate and dates.

According to ARIJ (2010), woods or forestry in Palestine contribute significantly in the Palestinian economy through non-wood products like fruits, nuts, honey, wax and dye and woods used in industry and heating. Forestry trees protect the soil and keep biodiversity, since it's a home for many plants and animals. Besides, it helps keep water and forms a natural area for picnic and entertainment, Jenin's area joins the biggest part of natural woods which is about 18,637.1 hectares of woods and forestry, (Ghattaset al., 2010).

Ighbareyeh et al. (2015) studied the effect of biology, bioclimatology (study the relationship between climates and living organisms) and climatology applied on apple to establish the variables that had the greatest influence on apple production in Jenin in Palestine. It has been observed, that Jenin during 1993-2000 was affected by the bioclimatic factors and climate factors as temperature, deficit water, and soil water reserve. Whereas Jenin was affected by

precipitation during 2000-2005 and during 2005-2010 it was affected by temperature. Nevertheless, precipitation was positively correlated to production and growth of plant while negatively affecting the rest of climate and bioclimatic factors.

3.5 Socio-Economic situation in Palestine

Generally, most of the Middle East countries are featured of low income per capita, high poverty and absence of food security. Palestine has exactly the same features.

These features are clear in rural areas. They suffer from high population which presses on the renewable and nonrenewable resources with a high pressure on food security.

There are many economic activities in Palestine in general and in Jenin in particular. In Jenin, there are industries began to play an important role as a source of income such as the plastics industry, feed, food, vegetables, paper, cardboard, concrete-block, brick and cut the stone which is famous in Qabatiya town and the coal industry deployed in Ya'bad town.

Agriculture is dominating the Palestinian economy, since it represents the main element of the gross domestic products of economy. Agriculture represents 8.1% of gross domestic products and 15.2% of the total exports (PCBS, 2009).

Agriculture's contribution in the Palestinian gross local output in 2014 was lower than in 2013 by 7%. It represented about 3.8% of the total production (PCBS, 2014).

Although Palestine has significant agricultural production, the contribution of the agriculture sector in the local output is low. This is due to farmers stopped farming because production costs are high compared to the imported ones, and absence of farmer unions which can protect them from production prices decrease, exposes them to loss.

Additionally, occupation plays a major role in seizure of farming lands. The apartheid wall, for example, seizes thousands of fertile farming land (PCB, 2010).

Agriculture has a significant share in employment. In 2013, the number of Palestinians working in farming was about 64000, which corresponds to 10.4% of labor. However, in 2014, the percentage decreased by 5% compared with 2013 (PCBs, 2014).

Thus, agriculture for the Palestinians in particular is not just an economic sector, income or an activity for profit, but it is a tool to protect their land of being seized. Moreover, it provides food security and job opportunity for the imprisoned Palestinian in his own country.

Rainfed agriculture forms 86% of total farming areas. This percentage is high compared to other countries like Jordan, which is also considered scarce water, but the share of rain-fed farming is 77% (Dhehibi, 2014).

In Jenin, rain-fed agriculture is the prevailing one, as the water available for agriculture does not reflect the actual needs of the agricultural sector because Israel controls wells water extracts. The irrigated area in Jenin is 11779 hectares and the current use of water is 4.16 million m^3 / year and this is not enough to irrigate the existing agricultural areas.

The unit of Water Research at the research center ARIJ calculated the amount of water needed to irrigate the irrigated areas and it was 7 million m^3 / year, So, farmers in the region depends on rain water to irrigate their crops (Saqer, 2005).

Table 1: Water demand and amount in Jenin area (Saqer, 2005).

Year	Population	Irrigated area /Donums	Agricultural Need / million m^3
1990	180400	13100	9
2000	311340	108700	74.7
2010	426610	158600	101.4
2020	546100	208500	128.1

Taking into account the amount of annual rainfall in Jenin city, it was divided into the following four zones:

1) Eastern areas: the amount of rain in these areas is limited almost 300 mm and rain-fed agriculture is the dominant where summer and winter field crops are cultivated and summer vegetables alternately. This section includes Arr'ana, Deir-Ghazzala, Bet Qad, Der Abu-Daif and Um Et-Tut.
2) South Eastern areas: rain average is greater than the eastern areas which range from 350-500 mm. The dominant crops here are grains and field crops in addition to olive trees. This part includes El-Zababdah, Maythalun, Sanur, Siris, Jadeida and Qabatya. In some

of these villages there are a number of Agricultural wells such as Sanur area and Qabatiya.

3) North and northwestern areas: the average annual rainfall ranges between 300-400 mm. These plant rain-fed crops in addition to irrigated vegetables in open fields or greenhouses. These areas include the following villages, Jalama, KafrDan, El-Yamun, Burqin, Rummana and Silat El-Harithiya.
4) West and west southern regions: rain averages range in this segment between 600-700 mm. The dominant vegetation here is the cultivation of olives, vegetables, rain-fed farming of stone fruits, field crops and Tobacco. There are few and limited number of agricultural wells and greenhouses in some villages here. This part includes A'rraba, Silat El-Daher, El-Fandaqumia, Ya'abad, A'jja, El-Ramah (ARIJ, 1996).

For the previously mentioned reasons, farming is important to the Palestinians, especially the rainfed agriculture. So, developing this sector is a must since production in Palestine is low compared to the high population. And the ability to import food is restricted due to occupation. Besides, climate change in Palestine was in the form of drought, frost and change in the intensity and timing of rainfall, which has reduced the crops and pastures in recent years. For example, rainfed crops losses were estimated as a result of frost and drought in the Palestinian territories during the agricultural season 2007/2008 to be more than 113.5 million US$ see Table 3 (ARIJ, 2010).

Table 2: *Estimated losses of the main rainfed crops in the years 2007/2008 (Ministry of Agriculture, 2008*)

Crops	Area (Donums)	Total production(Ton)	Yield of reduction (%)	Losses value(million US$)
Wheat	207542	38395.27	40	6.9
Fodder crops	66686	22673	35	4.5
Fruits	90207	30743	35	10.7
Olives	866917	134372	40	60.7
Grape	67216	48395	35	14.1

Chapter Four: Methodology

Previous studies were collected from international journals, conferences, M.Sc. theses, project reports, etc. Data related to the study area were collected from the archives of the PCBS, MOA, ARIJ, and other institutions that publish periodic reports about Palestine in general.

A questionnaire has been prepared and distributed to 120 farmers who grow rain-fed crops in four different climatic zones, the Eastern areas, South Eastern areas, North and northwestern areas and the West and west southern regions) in Jenin area. These areas have been divided to include all possible climates in this region and the sample was randomly selected.

The data collected through the questionnaire were analyzed with the help of SPSS, common software used in statistical analysis.

4.1 Data sources and data collection methods

- The data was collected from different sources. The previous studies about the subject were collected from the internet and global scientific magazines from which the current and expected climatic data were taken at global, Palestinian and the West Bank level.
- Agriculture ministry gave information about kinds of crops in Jenin, climate change effects on rain-fed farming, adaptation patterns farmer's do and the ministry accomplishments to help farmers in adaptation.
- All the statistics and numbers were taken from the Palestinian Central Bureau of Statistics of different volumes have been issued.
- Reports issued by The Applied Research Institute-Jerusalem (ARIJ) were drawn upon.
- The study also adapted to its results on a questionnaire about whole Jenin area of its different climate patterns. It covers the four climatic areas: the eastern, east-south, north-west and west-south areas. The questionnaire was distributed on farmers who planted rain-fed crops whether gardening trees, rain-fed vegetables, field crops or medical plants.

- The study also relied on interviews with officials in the ministry of agriculture and agriculture department of Jenin to ask about the achievements of the ministry of agriculture in Jenin to face the effects of climate change, and benefit their experience in dealing with farmers.

  Interviews were done to get information about Jenin's climate with the engineer Mustafa Amarnieh from Jenin agriculture department, the engineers Imad Ghanmeh and Ebtisam Abo-AlHeja from the ministry of agriculture, Mr. Sa'ad Dagher, the manager of adaptation project and Mr. Yusuf Abo Asa'd the general manager of the Palestinian Meteorological Department.

  Mustafa Amarnieh who represents agriculture department in Jenin, was interviewed many times, each meeting lasted 2-3 hours.

  Besides, I visited Mr. Sa'ad Dagher projects and tree planting sites, in Jaba' and Anza on 12/11/2015.

  The meeting included many questions about agricultural conditions in Jenin, and about the on-going and suggested projects.

  Mustafa Amarnieh explained some ways farmers use to adapt with climate change.

  Moreover, there was a meeting with Imad Ghanmeh and Ebtisam Abo-AlHeja from the ministry of agriculture in 24/3/2014. The meeting with both engineers lasted 2 hours, and they gave the needed information about crops planted in Jenin, and the ways farmers use to adapt with climate change.

  As for Mr. Yusuf Abo Asa'd, the general manager of the Palestinian Meteorological Department meeting , he answered the questions about climate elements in Jenin, and how these changed within the last 15 years. And he confirmed that there are a seasonal shifting, rainfall frequency and temperature rises.

- Workshops of adaptation projects were attended, in coordination with the ministry of agriculture in Jaba' and Anza in 12/11/2015, in order to teach farmers how to adapt with climate change and take their suggestions.

4.2 Data analysis

Most the social information of the farmers were taken from the questionnaire like age, gender, marital status, scientific qualifications, if farming is the main job, if it is the family

only living, the main purpose of farming, family members participating in farming and the non-profit benefits on the farmer.

The economic data were taken from the questionnaire by asking the farmers about: the farmer's usufruct of the land, the planted land area, production quantity, profits of crops, is the output annual, seasonal or quarterly, the costs of agriculture and the costs payments.

The questions of the questionnaire also aimed to inquire if the farmer realizes the existence of climate change or not, and what are the changes he noticed, whether negative or positive.

The farmer was also asked if he has done any kind of adaptation or no, what are the costs, the source of climatic information, whether governmental organizations support the adaptation or not, and if the initiatives are meaningful or not.

The questionnaire was analyzed by (SPSS20) which is one of the programs used in statistical analysis. This analyzes text and digital data and shows the analysis with statistical graphics. The results were arranged in Excel then in schedules after being analyzed to show in the form of graphs.

Chapter Five: Results and Discussion

This chapter presents the finding on the social and economic impacts of climate change on rain-fed farming in Jenin.

The study covered the four climatic areas which are divided according to rainfall in Jenin district. The results from the questionnaire, interviews with specialists and courses were as the following:

Questionnaires were distributed on rain-fed farmers in the eastern, south -east, north-west and south- west parts of Jenin, and response was as the Schedule shows:

Table 3: *The area according to location in Jenin*

The area according to location in Jenin					
Valid		Frequency	Percent	Valid Percent	Cumulative Percent
	The eastern part (Arranah, Dayr Ghazzala and Umm at-Tut …)	14	15.9	15.9	15.9
	South-east part (Qabatiya, Meithalun, Sanur, Zababdeh…)	19	21.6	21.6	37.5
	Northwest (Jalamah,Kafr Dan, Rummanah, Al-Yamun and Silat al Hariyhiya…)	23	26.1	26.1	63.6
	South-west (Silat ad-Dahr, Arrabah, Ya'bad, Ajja and Jaba'…)	32	36.4	36.4	100.0
	Total	88	100.0	100.0	

5.1 Social Results

In this section, farmers were asked questions like age, social status, qualification, family member's number and whether farming is the main job on which the family depends as a main source of living.

The respondents in the age group 20-30 and 30-40 were the dominant categories, with 30.7% and 43.2% respectively. This shows that the young dominates farming, which needs working hands, effort, attention and constant monitoring that are usually done by the young. Then, ages groups 40-50 and 50-60 were the second category, with 11.4% and 12.5% respectively. The percentages of farmers older than 60 were 2.3%, which is relatively low and this confirms what is mentioned before that agriculture needs young people. The following figure shows the percentages for each age group:

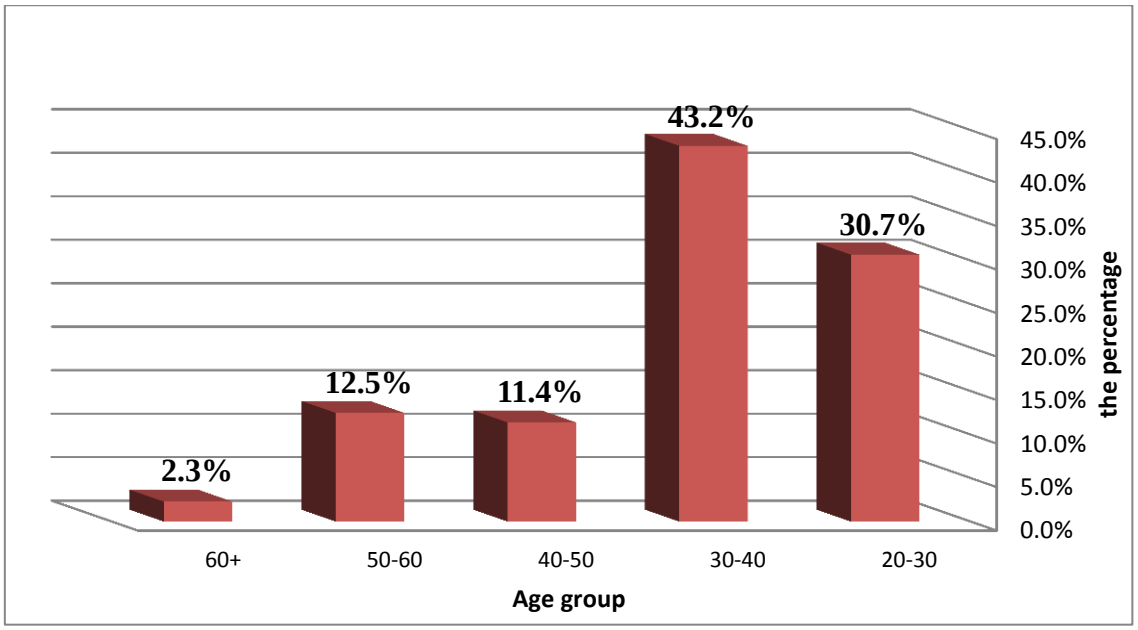

Chart 1: The age distribution of farmers

As for gender, males were the dominant by 94.3% while females were 5.7%, since they worked as house wives taking care of children, prepare the food or work in government departments or schools. Besides, men are more capable of working in farming.

The following figure shows the gender distribution:

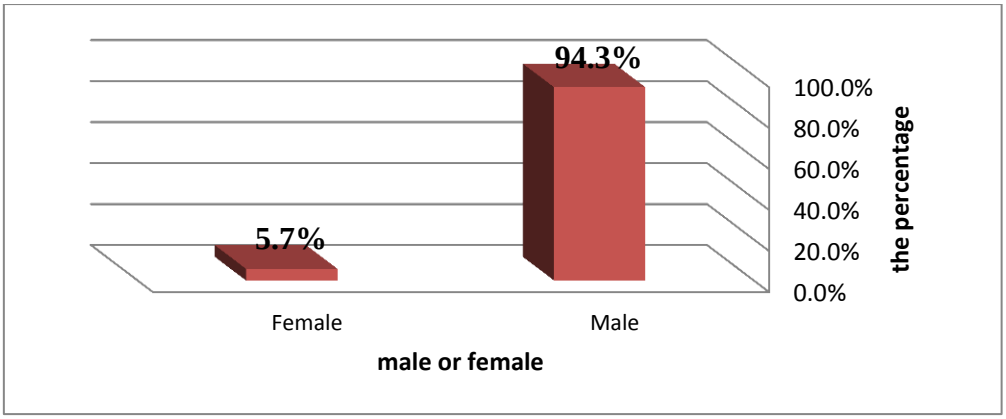

Chart 2: The gender distribution farmers

As for the marital status, the number of married was higher than that of non-married as the drawing show. The percentage of the married was 65.9% which is almost double the non-married which was 34.1%. This is reasonable since the married needs to work in farming to meet all his family and children needs of food, money and others.

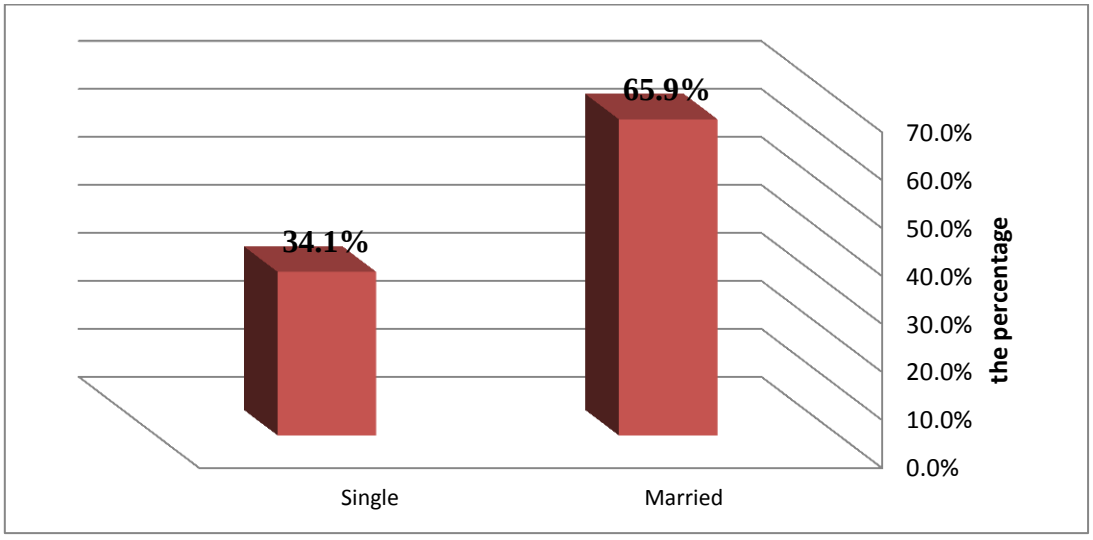

Chart 3: The marital status of farmers

As for education, most farmers were educated with BA degrees or higher of 29.5%. This shows the farmer doesn't only depend on the parents and grandparents experience, but also what he has learned. Yet, the degree is not necessarily to be in agriculture. Moreover, this percentage shows high unemployment among the educated youth. This led them to work in farming. Some educated youth work in farming since there's no other job. Some inherit the land and there is no one else to take care of. Those with Tawjihi degree (high school degree) were 14.8%. People in Palestine think Tawjihi degree is the dividing line between studying

and work. Most people prevent their children to work unless they get Tawjihi even if they don't want to study at college. Most the Palestinian families consider it sufficient and the minimum of education. The following figure shows the education levels of respondents and the distribution in terms of percentages.

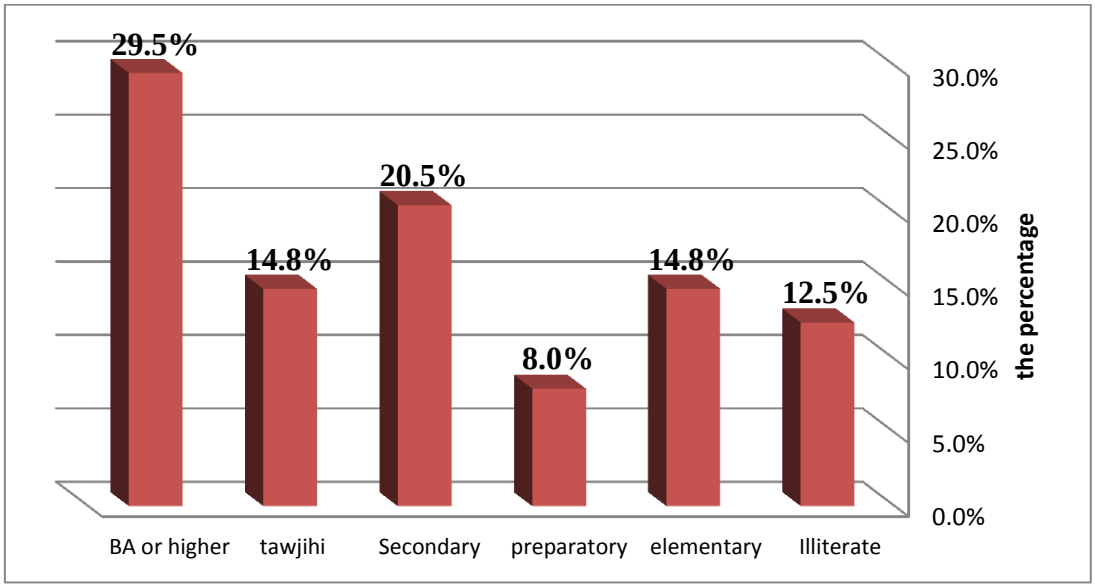

Chart 4: The education levels of farmers.

Regarding their income source, 65.9% of farmers depend mainly on farming as a living since it provides food, money for descent life, clothes, education, medicine and others of daily life needs and there's no other income.

Those who don't depend on farming as a main job were 34.1% and work in government departments so farming will be an extra work, or have a farming land with labors who get paid, or they work in trade as a main job and farming as a secondary or farming for them is just a land planted with olive or almonds trees which are seasonal.

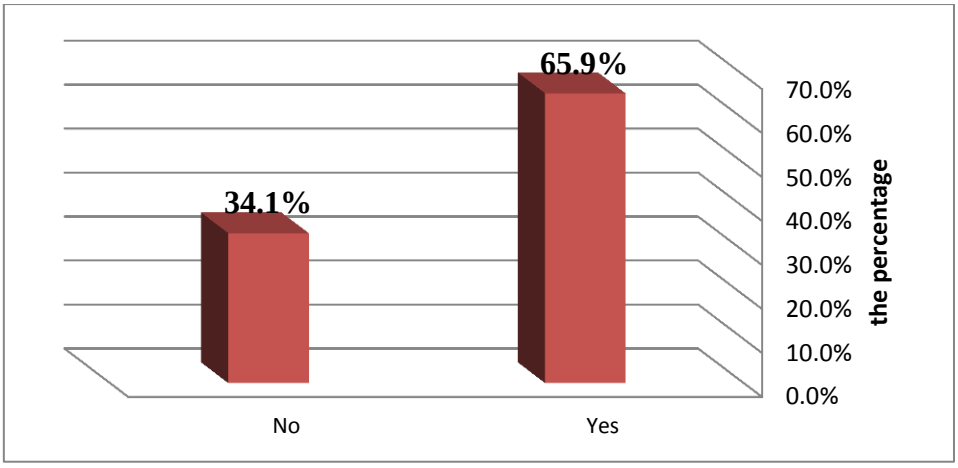

Chart 5: Whether farming is the main job for the farmer or not

As for the family members participating in farming, some families for which farming is a main living source had higher number of participating members than those who don't depend mainly on farming. The families whose 2-3 or 4-5 of the members work in farming were 44.3% and 25% respectively. For those with more than 6 of the family members work in farming, the percentage was slight of 5.7% and 1.1% for those with more than 10 members. 23.9% of the respondents, the number of family members that participate in farming was one person. The following figure shows the percentages:

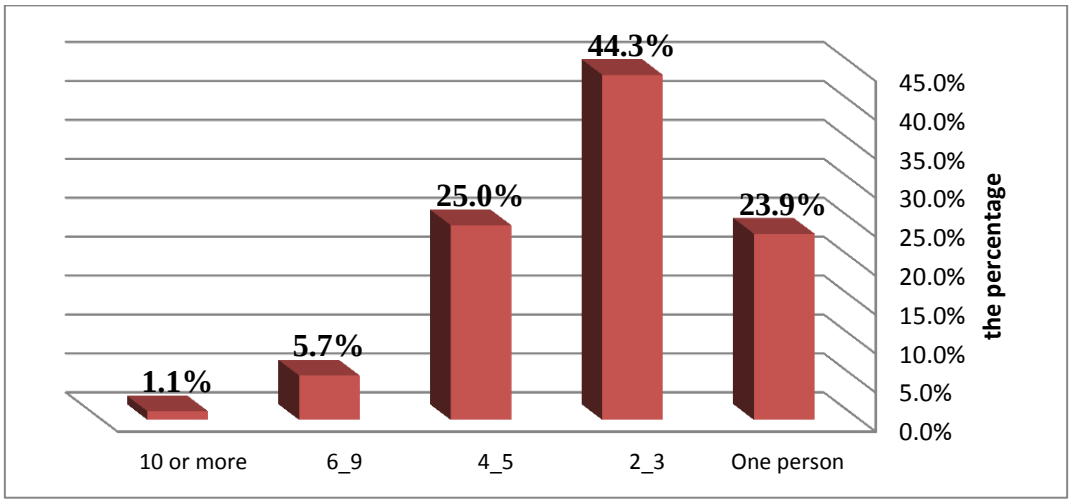

Chart 6: Number of family members that participate in farming

The farmers in Jenin grow on the land which they own through inheritance, purchase, rented or others like using *waqf* lands, from which part of the production is taken by the country. Farmers who own the land they grow were 53.4%, but those who rent the land were 46.6%.

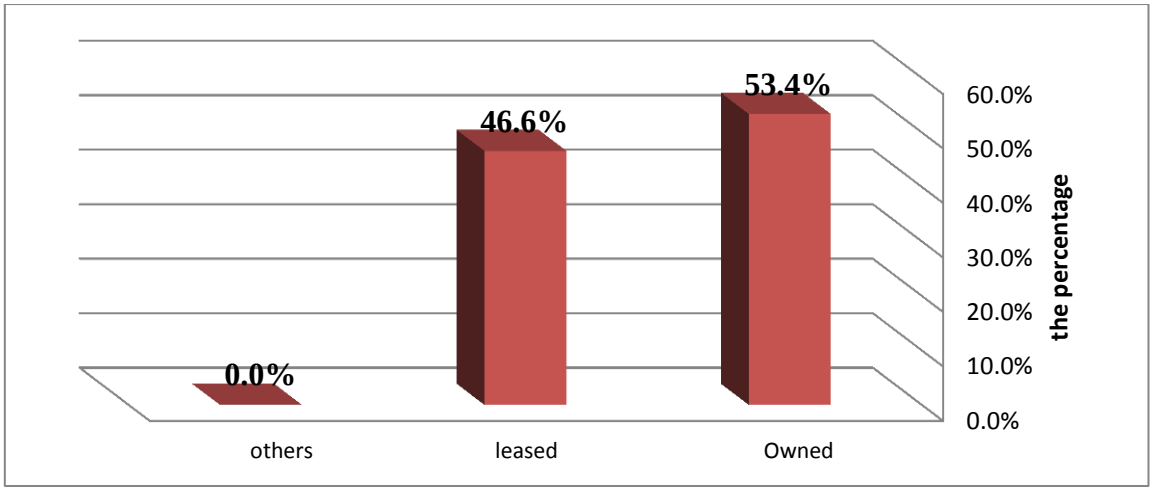

Chart 7: Land ownership status

Rainfed crops grown in Jenin vary as mentioned before, and the percentages of farmers who grow them vary as well. There are:

1. Perennial plants: which include citrus, olive, almonds and grape.
2. Vegetables and fruits: like Jew's mallow, squash, tomato, okra, potato, water melon and musk melon.
3. Field crops: like wheat, barley, lentil, chickpeas and tobacco which are grown in wide areas.
4. Medical plants: like sage, thyme, chamomile and anise.

The following figure shows each type grown in percentages:

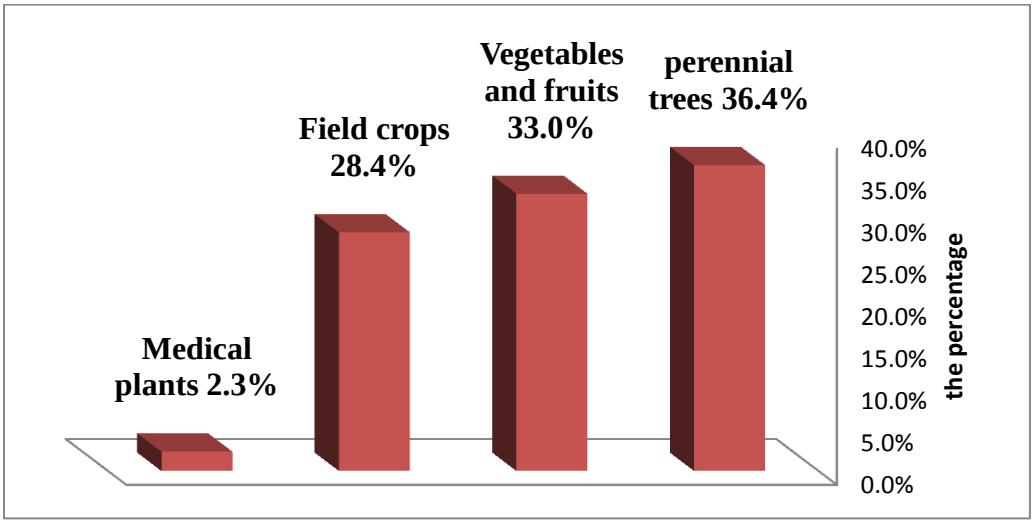

Chart 8: Types of crops cultivated in Jenin

5.2 Economic Results

Farmers who depend only on farming for living (food, clothes, education, medicine and others) were 83%, whereas the percentage of those who has another source of living was 17%.

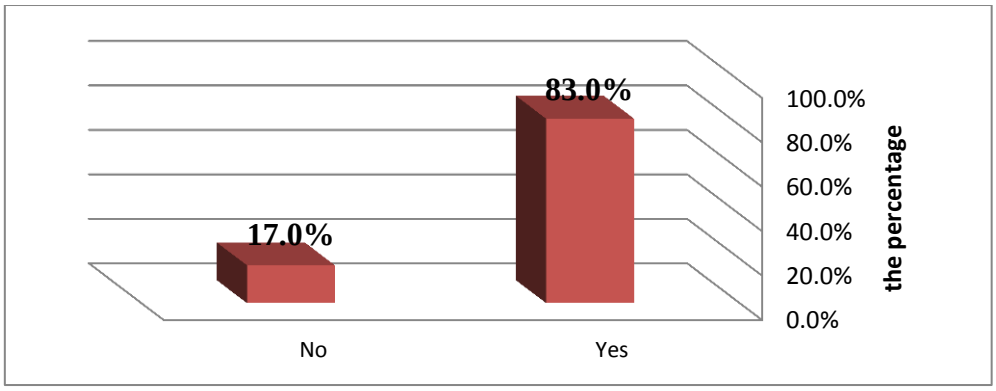

Chart 9: If farming is the main source of living or not

For 36.4% of the respondents, farming's main purpose is household consumption. This shows that families in Jenin depend on the crops they grow to get food. For 52.3% of the respondents, sale was the main purpose of farming. These percentages show that the farmers depend on farming to get money to provide other family needs like clothes, medicine, education and others.

The Palestinian families in general store olive and olive oil and most families in Jenin have lands planted with olive trees, which is a rain-fed tree. Wheat and groats which considered as supplies (stored for the rest of the year), are also some of rain-fed crops which are collected from wheat. There are many other rainfed crops classified as supplies which every house in Jenin have, like lentil, chickpeas, broad bean, bean, onion and garlic which can be stored for the whole year, other than seasonal rain-fed vegetables which are planted, available and vary all the year. The huge amount of crops production means that the family in Jenin can depend on farming to live especially on rainfed, since it provides family needs of food all the year. They can also sell part of the production to provide other needs that need money. Besides, 11.4% of farmers grow crops for serenity.

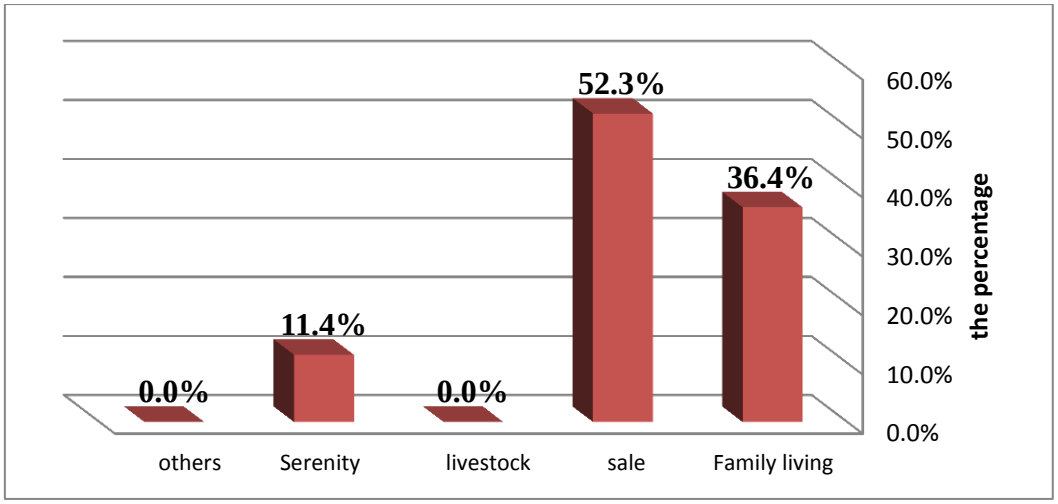

Chart 10: The main purpose of farming

Some farmers depend only on rainfed farming, some on a mix of rain-fed and irrigated and some on a mix of rain-fed agriculture and animal husbandry.

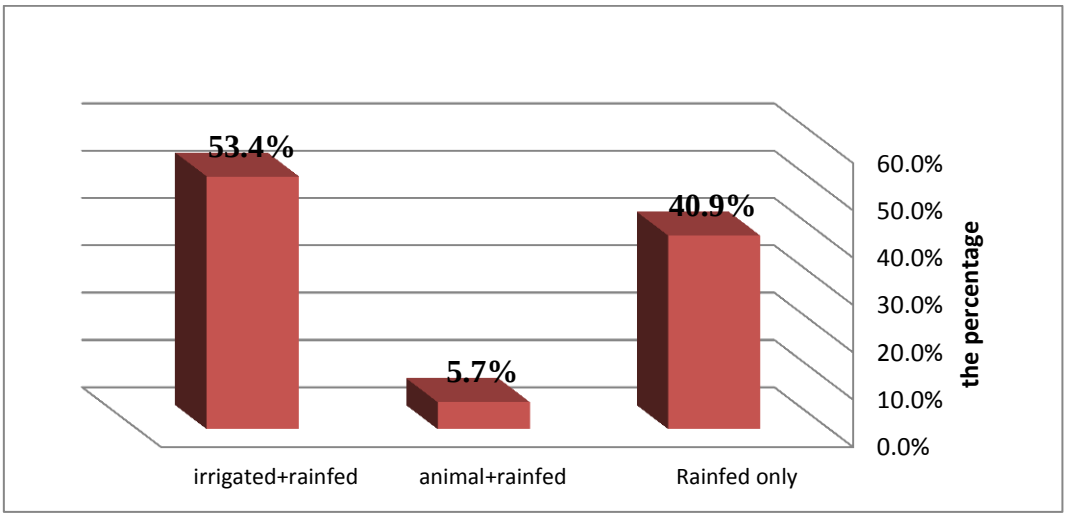

Chart 6: The types of farming in Jenin

Farmers in Jenin depend on farming either totally or partly since they might be an employee or a dealer and consider farming as supplementary income.

The areas of the lands planted with rain-fed crops vary. Some farmers grow few areas (less than 3 Donums, 3-6 Donums or 6-10 Donums) and others grow more than that (10-20, 20-30 and more than 40 Donums).

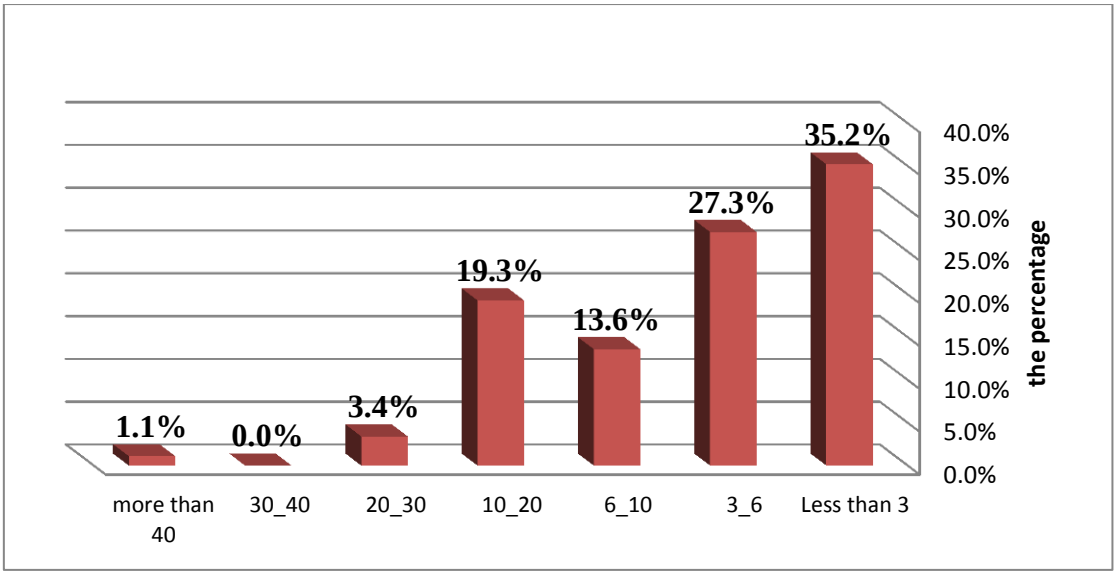

Chart 7: Land area planted with rainfed crops

Depending on the planted area, production quantity varies from one farmer to another according to the area he plants, type of the land, climate, type of the soil, water availability and maintenance. Production quantity also depends on the type of the crop, since some crops weigh heavier than others.

The questionnaire shows that rain-fed farming in Jenin produces big quantities. The percentage of farmers who produces more than 500 kg/Donums was 29.5%. Those who produce 100-200 and 200-300 were 23.9% and 21.6% respectively.

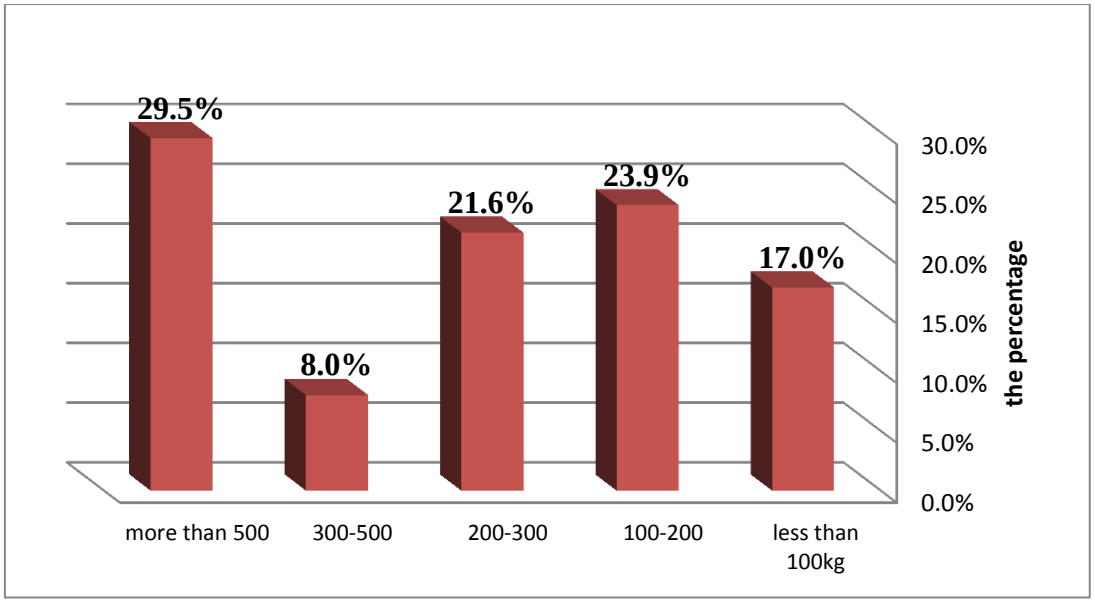

Chart 8: The amount of rainfed farming products(Kg/Donums)

This shows that Jenin area which is 19.4% of the planted areas in Palestine is productive one and is the biggest planted land among the Palestinian provinces (PCBS, 2011). The monthly spending average per capita in JD in the West Bank is 188.1 JD which is about 1034.5 ILS (PCBS, 2011). The monthly spending average per household in JD of family of six members in the West Bank is 1058.4JD which is about 5821.2 ILS (PCBS, 2011). 5821.2 ILS/month is the household spending average. Notice (the amount was calculated in ILS by multiplying with dinar which is 5.5 ILS).

If we calculate the household spending average per year, it would be 69854.4 ILS/year. Here, choices of revenues which the farmer get of farming were set. 8%of farmers get 46000-70000 as household spending average. Those who get 34000-46000 ILS/year were 78.4% which is the highest and equals spending average of 2500-4000 ILS/month. 13.6% of farmers get more than 70000 ILS and their monthly spending average is more than 6000 ILS. Those are considered luxurious families.

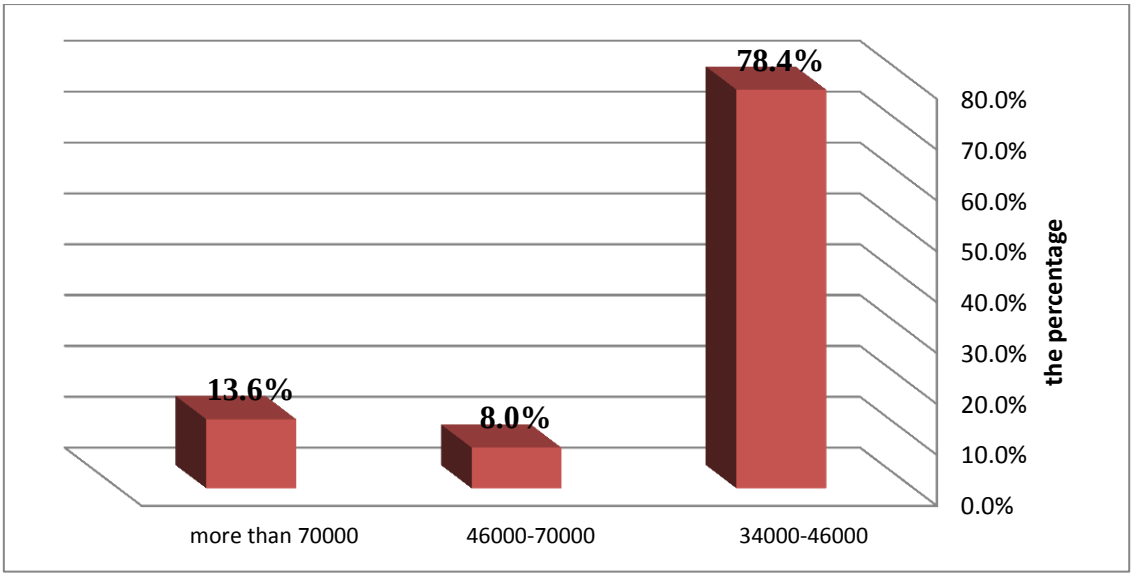

Chart 9: Revenues of rainfed crops in Jenin (ILS/year)

Yet, most farmers in Jenin get low revenues of farming less than public spending average. The farmer doesn't live in luxury as much as he works since the revenue he gets barely enough to provide family needs of food, clothes, medicine, education and others.

The Palestinian society in general suffers every day from many difficulties due to the occupations which put restrictions on their lives. Therefore, farming isn't just about revenues, but also has other calculations for the Palestinians in general and Jenin in Particular.

Farming is serenity of life's pressure, expenses and daily life problems for 23.9% of farmers. Besides, farming is physical comfort since it strengthens muscles, prevents laziness and increases activity for 27.3% of farmers.

Farming forms social importance for 44.3% of people. So, farming is a social status since it shows that an owner of a land is a man with money, one of the feudal and has a reason to boast among the Palestinian families.

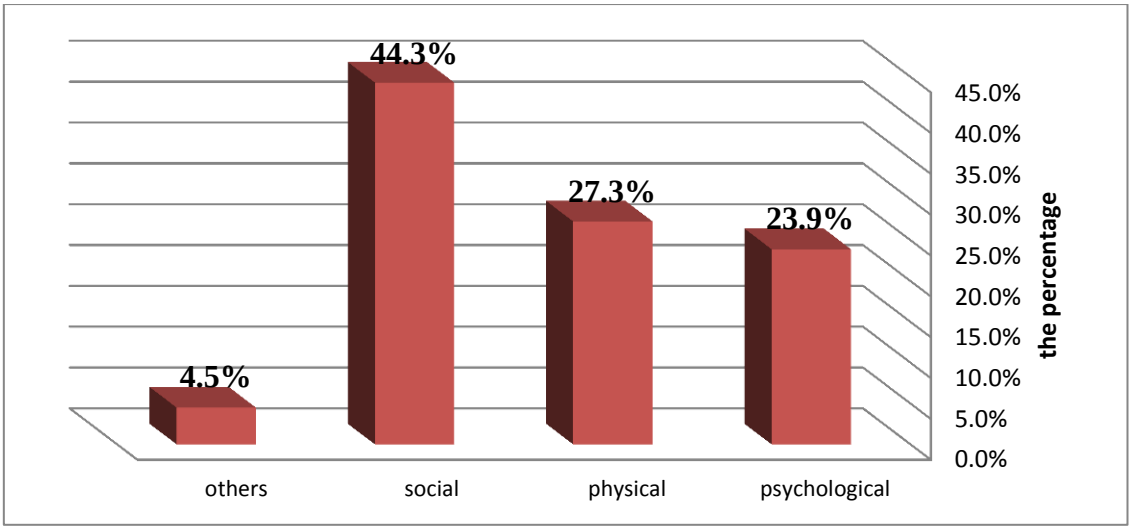

Chart 10: The benefits of farming excluding revenues

54.5% of farmers get yearly revenues. 31.8% of farmers depend on seasonal farming like olive, cucumber and other rain-fed crops. 13.6% of farmers depend on seasons (summer, autumn, winter and spring).

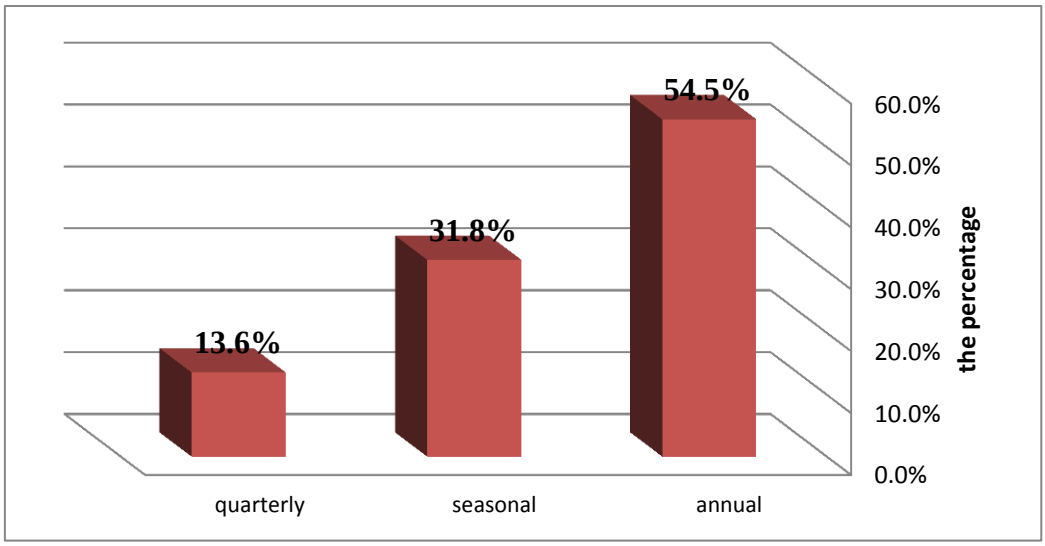

Chart 11: Dependence on rainfed crops

Despite farming gives good financial returns supports the Palestinian families, it needs attention and costs in order to produce. 85.2% of farmers pay less than 10000 ILS/Donums/year for rain-fed farming. However, rain-fed farming costs 4.5% of farmers 10000-15000 ILS/Donums/year and it costs 10.2% of farmers more than 15000 ILS/Donums/year.

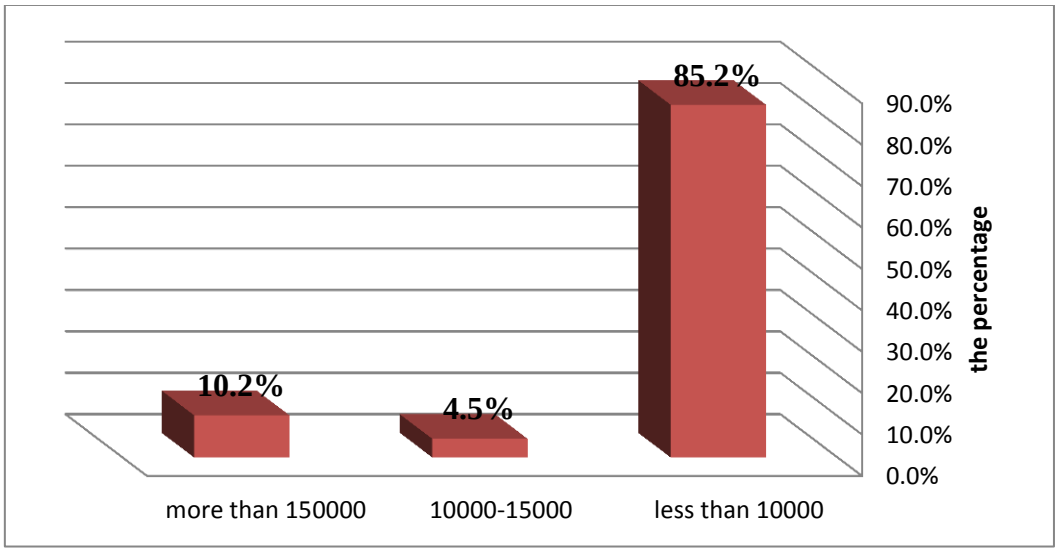

Chart 12: Costs of rainfed farming in Jenin (ILS/Donums/year)

The costs were estimated depending on the existing information in agriculture census in 2010 of the ministry of agriculture. Costs vary according to land, farming and costs types. There could be different expenses like 28.4% for fertilizers, 19.3% for supplementary irrigation, 13.6% for labor, 3.4% for pesticides and 35.2% of farmers pay for all of these expenses.

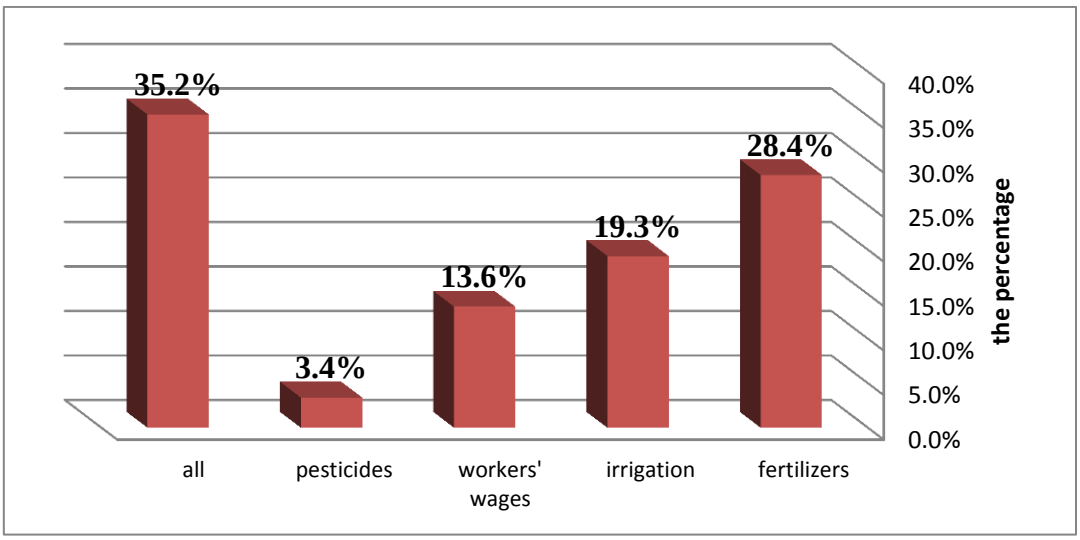

Chart 13: The cost payment destination of rainfed farming

Besides, rain-fed farming costs financially and costs indirectly of other aspects. Sometimes, it could be psychological stressful for the farmer since he stays stressed and worried if the crop would be successful or not and if there would be good returns or not. These keep 29.5% of

farmers confused and exhausted. Moreover, sometimes it needs big effort specially the farmer who works manually and doesn't hire labors to save money. This farmer will be one day exhausted psychologically and healthy which 45.5% of farmers feel. 17% of farmers in Jenin spend long time in their lands at the expense of his life.

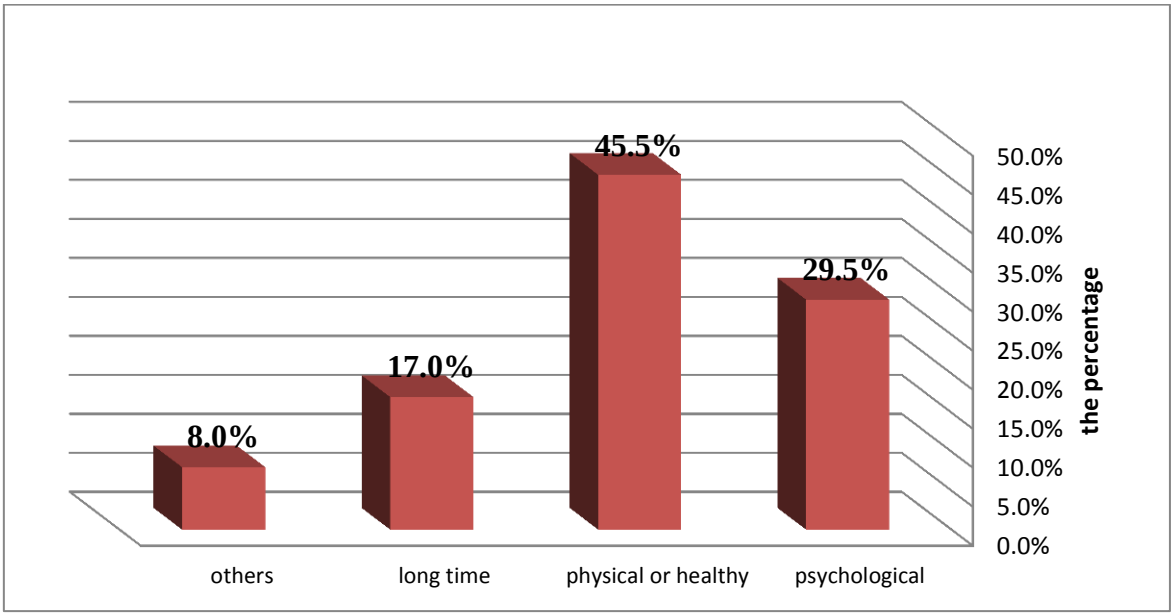

Chart 14: Indirect costs of rainfed farming.

5.3 Individual perceptions on the impacts of climate change

The study shows that 95.5% of farmers in Jenin realize and believe there's noticeable change in the climate during the past 15 years while 4.5% don't.

Table 4: Do you believe there is climate change during the past 15 years?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	84	95.5	95.5	95.5
	No	4	4.5	4.5	100.0
	Total	88	100.0	100.0	

Besides, because the change in weather differs from climate change, the farmer must be asked if he knows the difference. 86.4% of framers distinguish between weather change and climate change while 13.6% don't.

Table 5: Do you distinguish between weather change and climate change?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	76	86.4	86.4	86.4
	No	12	13.6	13.6	100.0
	Total	88	100.0	100.0	

Weather is the atmosphere we live day after day and since it's changeable we can't predict the change more than 10 days. Besides, climate is the weather average which is calculated on terms of 1-30 years, which can give predictions like temperature average between day and night for specific month during the year and rainfall average for the month.

This high percentage of farmers who distinguish between climate change and weather change shows how much the Palestinians are educated in general. This clearly shows that 45.5% of farmers noticed an increase in temperature, 40.9% noticed decrease in rainfall, 9.1%noticed drought and 4.5% noticed delay in seasons.

Table 6: what are the changes that occurred?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Temperature increase	40	45.5	45.5	45.5
	Rain fall decrease	36	40.9	40.9	86.4
	Season late	4	4.5	4.5	90.9
	Drought	8	9.1	9.1	100.0
	Total	88	100.0	100.0	

Jenin as the rest of the world is affected by global warming and suffer from climate change represented by temperature, heat and drought increase. They also notice rainfall decrease and irregular distribution of rain and this reduces benefit of them.

5.4 Negative effects of climate change

These changes have negative effects on farming in general and rain-fed in particular since it depends on climate conditions and weather fluctuations. One of the negative effects of the change on rain-fed farming is that plants are more susceptible to disease and that's what 84.1% of farmers showed. 6.8% of farmers showed that this change causes fatigue while 9.1% showed this change needs extra time which the farmer spends to take care of the crop.

Table 7: What are the negative effects of climate change on health and daily life?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	More susceptible to disease	74	84.1	84.1	84.1
	fatigue	6	6.8	6.8	90.9
	Extra time	8	9.1	9.1	100.0
	Total	88	100.0	100.0	

Negative effects of climate change on agricultural activities were as the following:

39.8% of farmers said they used extra amounts of pesticides, 4.5% changed the date of using pesticides, 35.2% changed the date of farming, 2.3% changed the type of farming, 18.2% paid extra costs because of the change and 70.5% changed the type of the crop according to climate change while 29.5% didn't. Besides, 40.9% turned to grow tobacco while 59.1% didn't.

Table 8: What are the negative effects of climate change on farming activities?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	use pesticides	35	39.8	39.8	39.8
	change pesticides date	4	4.5	4.5	44.3
	change farming dates	31	35.2	35.2	79.5
	change farming type	2	2.3	2.3	81.8
	cost increase	16	18.2	18.2	100.0
	Total	88	100.0	100.0	

Table 9: Have you changed any of the rain-fed crops due to climate change?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	62	70.5	70.5	70.5
	No	26	29.5	29.5	100.0
	Total	88	100.0	100.0	

Table 10: Have you changed into tobacco farming?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	36	40.9	40.9	40.9
	No	52	59.1	59.1	100.0
	Total	88	100.0	100.0	

Mustafa Amarneh from the Ministry of Agriculture confirmed this during an interview. He confirmed that tobacco before 2010 was planted in almost 7,000dunums while in 2015 it was planted in 37,000-40,000 Donums.

This change was due to the following:

According to the particular condition the Palestinians live, most of the Palestinian workers work in 1948 lands. Lately, the Israelis increased workers restrictions, closures and prevent their access except with a permit which isn't given to any on with the pretext of security rejection. Therefore, they turned to tobacco farming since it is profitable financially and that equals what they earn when working in 1948 lands. Besides, increase taxes on foreign tobacco increased its prices for the Palestinians. On the other hand, tobacco farming flourished the Palestinian families since women work in rolling cigarettes which means extra income. Moreover, the demand on Arabic cigarettes increased in large amounts in Gaza and 1948 lands. However, the increase demand on cigarettes was at the cost of field crops like wheat and barley and vegetables like okra and others of rainfed crops.

53.4% of farmers noticed the existing of water crisis due to the change, 22.7% noticed soil fertility decrease and 23.9% noticed disease spread increase among crops.

Table 11: What are the negative effects of climate change on the surrounding environment?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	water crisis	47	53.4	53.4	53.4
	lack of soil fertility	20	22.7	22.7	76.1
	disease spread among plants	21	23.9	23.9	100.0
	Total	88	100.0	100.0	

The negative effects of climate change included the revenues of the crop production since 94.3% of farmers said the revenues decreased and this indicates that production quantity is affected of the change while 5.7% said it didn't.

Table 12: Are there negative effects on revenues due to climate change?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	83	94.3	94.3	94.3
	No	5	5.7	5.7	100.0
	Total	88	100.0	100.0	

26.1% of farmers lost 10-20% of the revenue, 45.5% lost 30-20% and 27.3% lost 30-50 and these affect significantly the farmer income which is already limited.

Table 13: Reduction in revenues

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	10%-20%	23	26.1	26.1	26.1
	20%-30%	40	45.5	45.5	71.6
	30%-50%	24	27.3	27.3	98.9
	More than 50%	1	1.1	1.1	100.0
	Total	88	100.0	100.0	

As shown in Table 15, 25% of farmers abandoned their lands. 31.8% abandoned their land due to climate change and what it requires of attention, effort and more money, while 40.9% abandoned the land due to leaving the village to the city for social or other reasons like work site and others. 27.3% abandoned the land for other reasons either the need for money to marry his sons or teach them, or social problems or others.

Table 14: Have you abandoned your farmland?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	22	25.0	25.0	25.0
	No	66	75.0	75.0	100.0
	Total	88	100.0	100.0	

Table 15: If yes, why?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Climate change	7	8.0	31.8	31.8
	leave the village to the city	9	10.2	40.9	72.7
	Inheritance and others	6	6.8	27.3	100.0
	Total	22	25.0	100.0	
Missing	System	66	75.0		
Total		88	100.0		

5.5 Climate change benefits

Despite climate change has negative effects for some farmers, it had positive effects for others. 47.7% of farmers noticed that plants are less exposed to diseases, 5.7% noticed it takes less time and tired, 13.6% noticed that social communication increased, 30.7% noticed other benefits on farming activities, 27.3% reduced pesticides use and 17% reduced farming costs.

Table 16: What are the benefits of climate change on health and daily life?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	less susceptible to disease	42	47.7	47.7	47.7
	less fatigue	5	5.7	5.7	53.4
	less time	2	2.3	2.3	55.7
	increase social communications	12	13.6	13.6	69.3
	others	27	30.7	30.7	100.0
	Total	88	100.0	100.0	

Table 17: What are the benefits on your own farming activities?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	use less pesticides	24	27.3	27.3	27.3
	change pesticides using time	9	10.2	10.2	37.5
	less costs	15	17.0	17.0	54.5
	others	40	45.5	45.5	100.0
	Total	88	100.0	100.0	

Some farmers noticed climate change benefits on the environment. Some noticed that air pollution decreased, soil fertility increased and crops are more resistant to diseases. The following table shows this:

Table 18: The benefits of climate change on the environment

The benefits of climate change on the environment				
Valid	Frequency	Percent	Valid Percent	Cumulative Percent
Reducing air pollution	11	12.5	12.5	12.5
Increase soil fertility	10	11.4	11.4	23.9
The spread of disease-resistant crops	27	30.7	30.7	54.5
Other	40	45.5	45.5	100.0
Total	88	100.0	100.0	

As for the revenue of the production, 72.7% of farmers who believe in climate change benefits showed an increase in the production. Moreover, 27.3% showed an increase in profits and this depend if the farmer changed the crop type or not.

Table 19: What are the benefits of climate change on revenues?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	increase some crops production	64	72.7	72.7	72.7
	increase profits	24	27.3	27.3	100.0
	Total	88	100.0	100.0	

Farmers who see climate change benefits which aren't only on the revenue, but also reflected on other sides of their personal lives as shown in the table:

Table 20: The benefits of climate change on other aspects of the personal life of farmers

The benefits of climate change on other aspects of the personal life of farmers				
Valid	Frequency	Percent	Valid Percent	Cumulative Percent
Social	9	10.2	10.2	10.2
Economic	41	46.6	46.6	56.8
Otherwise	38	43.2	43.2	100.0
Total	88	100.0	100.0	

On the other hand, in order to find the correlation between variables by the SPSS, mean 1 was found which represents Individual perception of the risks and benefits and mean 2 represents the benefits and costs of climate change.

Table 21: Group Statistics

	Gender	N	Mean	Std. Deviation	Std. Error Mean
Individual perception of the risks and benefits	male	83	1.5809	.18356	.02015
	Female	5	1.5000	.04545	.02033
The benefits and costs of climate change	male	83	1.6983	.17099	.01877
	Female	5	1.7333	.04082	.01826

Independent sample T-test analyzed the variable gender to find variable difference of two levels: male and female. It was found that gender does affect Individual perception of the risks and benefits. The results show that p- value>0.05 which is 0.013. Besides, there is no effect of gender variable on the benefits and costs of climate change based on the previous table 23.

Table 22: Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Individual perception of the risks and benefits	Equal variances assumed	4.740	.032	.978	86	.331	.08087	.08266	-.08346	.24520
	Equal variances not assumed			2.825	15.013	.013	.08087	.02862	.01987	.14187
The benefits and costs of climate change	Equal variances assumed	4.998	.028	-.455	86	.651	-.03500	.07699	-.18806	.11805
	Equal variances not assumed			-1.337	16.047	.200	-.03500	.02618	-.09050	.02049

Table 23: Group Statistics

	Marital status	N	Mean	Std. Deviation	Std. Error Mean
Individual perception of the risks and benefits	Married	58	1.5536	.20011	.02628
	Not married	30	1.6202	.12201	.02227
The benefits and costs of climate change	married	58	1.7401	.14891	.01955
	Not married	30	1.6235	.17392	.03175

Table24: Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Individual perception of the risks and benefits	Equal variances assumed	12.041	.001	-1.668	86	.099	-.06665	.03995	-.14607	.01277
	Equal variances not assumed			-1.935	83.551	.056	-.06665	.03445	-.13516	.00186
The benefits and costs of climate change	Equal variances assumed	1.500	.224	3.286	86	.001	.11660	.03548	.04606	.18714
	Equal variances not assumed			3.127	51.403	.003	.11660	.03729	.04175	.19145

Independent Sample T-test was used to know the effect of the marital status variable to find variable differences of two levels: married and not married. The results show that there is no effect of the marital status on Individual perception of the risks and benefits. Yet, marital status affects the benefits and costs of climate change where the result is p- value>0.05 which is 0.003 according to Table 25.

Table 25: ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Region based on geographical area	Between Groups	71.068	13	5.467	12.121	.000
	Within Groups	33.376	74	.451		
	Total	104.443	87			
Age	Between Groups	58.364	13	4.490	8.462	.000
	Within Groups	39.261	74	.531		
	Total	97.625	87			
Educational qualification	Between Groups	88.114	13	6.778	2.684	.004
	Within Groups	186.875	74	2.525		
	Total	274.989	87			
The main purpose of agriculture	Between Groups	20.307	13	1.562	7.138	.000
	Within Groups	16.193	74	.219		
	Total	36.500	87			
Family members participating in farming	Between Groups	23.937	13	1.841	2.973	.002
	Within Groups	45.836	74	.619		
	Total	69.773	87			
Right of usufruct	Between Groups	8.510	13	.655	3.618	.000
	Within Groups	13.388	74	.181		
	Total	21.898	87			
Planted rainfed crops	Between Groups	37.819	13	2.909	7.950	.000
	Within Groups	27.079	74	.366		
	Total	64.898	87			
Farming type	Between Groups	39.014	13	3.001	5.212	.000
	Within Groups	42.611	74	.576		
	Total	81.625	87			
Area planted with rainfed crops (dunum)	Between Groups	78.500	13	6.038	5.962	.000
	Within Groups	74.943	74	1.013		
	Total	153.443	87			
Production quantity Kg/dunum	Between Groups	111.204	13	8.554	7.906	.000
	Within Groups	80.069	74	1.082		
	Total	191.273	87			
Crop revenues (shekel/year)	Between Groups	24.155	13	1.858	6.901	.000
	Within Groups	19.925	74	.269		
	Total	44.080	87			
Benefits of crops revenues	Between Groups	40.640	13	3.126	8.358	.000
	Within Groups	27.678	74	.374		
	Total	68.318	87			
Dependence on rainfed production in terms of	Between Groups	19.986	13	1.537	4.499	.000
	Within Groups	25.286	74	.342		

revenues	Total	45.273	87			
Rainfed agriculture costs (shekel/dunum/year)	Between Groups	18.944	13	1.457	6.932	.000
	Within Groups	15.556	74	.210		
	Total	34.500	87			
Costs expenses	Between Groups	103.944	13	7.996	4.226	.000
	Within Groups	140.010	74	1.892		
	Total	243.955	87			
Indirect expenses	Between Groups	34.931	13	2.687	5.854	.000
	Within Groups	33.967	74	.459		
	Total	68.898	87			

One Way AOVA was used to find the variables in table 26 effects on Individual perception of the risks and benefits. Results show that these variables affect Individual perception of the risks and benefits with p- value<0.05.

5.6Farmers strategies for climate change adaptation

Farmers in Jenin implement varying strategies for climate change adaptation, 48.9% of farmers changed the type of crop to accommodate with the change, and 3.4% changed the date of farming in line with seasons shifting. 47.7% used supplementary irrigation to face heat and drought which dry crops and reduce soil maintenance of water.

Table 26: What are your strategies to adapt to climate change?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	change crop type	43	48.9	48.9	48.9
	change farming date	3	3.4	3.4	52.3
	use supplementary irrigation	42	47.7	47.7	100.0
	Total	88	100.0	100.0	

80.7% said they used additional amounts of irrigation water, 79.5% of these depended on rain water and 75% of those who used rain water said it's effective. When we asked them if they

accept to use treated water for supplementary irrigation, 81.8% said they would and 18.2% said they wouldn't.

Table 27: Do you use extra irrigation water?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	71	80.7	80.7	80.7
	No	17	19.3	19.3	100.0
	Total	88	100.0	100.0	

Table 28: Do you agree using treated water in supplementary irrigation to all or some of the rain-fed crops?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	72	81.8	81.8	81.8
	No	16	18.2	18.2	100.0
	Total	88	100.0	100.0	

Table 29: Do you collect rainwater?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	70	79.5	79.5	79.5
	No	18	20.5	20.5	100.0
	Total	88	100.0	100.0	

Besides, 86.4% of farmers flipped the harmed crops which is either replanted or changed because of seasons delay or fluctuations like heat, frost and sometimes heavy rain which destroy crops, so the farmer has to replant or change the crop.

Table 30: Have you changed rain-fed crop types?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	76	86.4	86.4	86.4
	No	12	13.6	13.6	100.0
	Total	88	100.0	100.0	

When we asked if these ways of adaptation worked or not, 43.2% said they reduced the financial losses, 6.8% said they increased production, 6.8% noticed the spread of diseases decreased and 43.2% noticed other effects of adaptation some which could be negative.

Table 31: What are the effects of climate change adaptation?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	reduce material losses	38	43.2	43.2	43.2
	reduce disease spread	6	6.8	6.8	50.0
	increase production	6	6.8	6.8	56.8
	Others	38	43.2	43.2	100.0
	Total	88	100.0	100.0	

Despite adaptation benefits the farmer, it may be costly as well. For example, 19.3% paid for new seeds, 22.7% paid for supplementary irrigation water and 58% said the costs were loss in production and perhaps these are the negative effects of adaptation the farmers noticed.

Table 32:What are the direct costs to adaptation?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	new seeds price	17	19.3	19.3	19.3
	irrigation water price	20	22.7	22.7	42.0
	production lose	51	58.0	58.0	100.0
	Total	88	100.0	100.0	

As for non-financial costs, 23.9% had to work harder for the same results while 10.2% had to search for resistant crops of the change. 65.9% planted in different dates of the usual.

Table 33: What are the indirect costs of adaptation?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	grow in different dates	58	65.9	65.9	65.9
	the need to work hard for the same results	21	23.9	23.9	89.8
	use resistant plants	9	10.2	10.2	100.0
	Total	88	100.0	100.0	

This concerned the farmer and kept him worried about the success of the crop since he is used to specific pattern as the following:

- In August : tillage and prepare the land for winter crops
- First of September : add composts organic fertilizer and tillage the land in order to mix the fertilizer with soil

- October : continue preparing the land for those who didn't
- November : start growing winter crops like wheat and barley and add nitrogen fertilizer as basic for the seeds
- December : continue growing and adding the fertilizer and start growing legumes and add fertilizer
- January : add fertilizer to wheat and barley with the rain and grow chickpeas with fertilizer
- February: continue adding fertilizer to the wheat and barley and start weed control in winter crops and some diseases which began to spread
- March: continue weed control to some diseases using pesticides
- April: grow maize
- May: harvest the legumes
- June: harvest wheat and barley
- July: harvest maize

70.5% of farmers thought there're more suitable adjustments for adaptation, but they didn't do with for the following reasons:

1. 65.6% thought it's expensive.
2. 26.6% said the profits don't cover the costs the suitable adaptation.
3. 7.8% found this adaptation needs bigger space than they owned.

Table 34: Do you think there're other effective adjustments in your situation?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	62	70.5	70.5	70.5
	No	26	29.5	29.5	100.0
	Total	88	100.0	100.0	

Table 35: If yes, why don't you work with them?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	it's expensive	42	47.7	65.6	65.6
	profits don't cover the expenses	17	19.3	26.6	92.2
	useless to the area of land	5	5.7	7.8	100.0
	Total	64	72.7	100.0	
Missing	System	24	27.3		
Total		88	100.0		

The results of the questionnaire shows that 92% of the farmers communicate and discuss with each other about climate change like temperature increase, rainfall decrease, seasons delay and drought.

Table 36: Do you contact with other farmers about adaptation?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	81	92.0	92.0	92.0
	No	7	8.0	8.0	100.0
	Total	88	100.0	100.0	

Table 37: Do you discuss climate change with other farmers?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	79	89.8	89.8	89.8
	No	9	10.2	10.2	100.0
	Total	88	100.0	100.0	

Besides, they discuss methods of adaptation and benefit the elderly experience. Moreover, 96.6% showed they follow and depend on the forecast.

Table 38: Do you follow weather forecast?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	85	96.6	96.6	96.6
	No	3	3.4	3.4	100.0
	Total	88	100.0	100.0	

5.7 Governmental and non-governmental support

44.3% confirmed that government organizations like ministry of agriculture, Environment Quality Authority (EQA) and the Palestinian water authority support adaptation with climate change.

Table 39: Do governmental organizations like (ministry of agriculture, EQA and Palestinian water authority) help in climate change adaptation?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	39	44.3	44.3	44.3
	No	49	55.7	55.7	100.0
	Total	88	100.0	100.0	

42% of farmers benefit as a financial compensation for damaged crops due to climate change. 7.2% of them were provided with alternative seeds, 7.2% of the farmers take the support in the form of supplementary irrigation water and the rest of farmers with a percentage of 43.5% take the offered tips about farming dates.

Table 40: What are the measures taken?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	material compensation	29	33.0	42.0	42.0
	provide alternative seeds	5	5.7	7.2	49.3
	supplementary irrigation water	5	5.7	7.2	56.5
	provide tips about farming dates	30	34.1	43.5	100.0
	Total	69	78.4	100.0	
Missing	System	19	21.6		
Total		88	100.0		

Despite these government organizations help take the appropriate measures to help the farmers, but 76.6% of benefits is from the ministry of agriculture, 10.4% benefit from EQA and 10.4% benefit from Palestinian Water Authority.

Table 41: Which ctors are taking these measures?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	ministry of agriculture	59	67.0	76.6	76.6
	EQA	8	9.1	10.4	87.0
	Palestinian water authority	8	9.1	10.4	97.4
	Others	2	2.3	2.6	100.0
	Total	77	87.5	100.0	
Missing	System	11	12.5		
Total		88	100.0		

Moreover, 61.4% of the farmers said these measures and aids worked, but some think government organizations have to do more.

Table 42: Are there benefits of these measures?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	54	61.4	61.4	61.4
	No	34	38.6	38.6	100.0
	Total	88	100.0	100.0	

43.2% of the farmers see that the organizations should contribute to pay more financial compensations, 18.2% of them see that organizations should provide more alternative seeds, 25% of the farmers need to provided more irrigation water and 12.5% see they should offer more tips about farming date.

Table 43: In your opinion, what should governmental organizations do to adapt?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	material compensation	38	43.2	43.2	43.2
	provide alternative seeds	16	18.2	18.2	61.4
	provide supplementary irrigation water	22	25.0	25.0	86.4
	provide tips about farming dates	11	12.5	12.5	98.9
	Others	1	1.1	1.1	100.0
	Total	88	100.0	100.0	

25% of farmers were totally confidence in the governments while 60.2% were partially and 14.8% didn't trust at all.

Table 44: How much can you trust governmental organizations?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	totally	22	25.0	25.0	25.0
	partially	53	60.2	60.2	85.2
	no trust	13	14.8	14.8	100.0
	Total	88	100.0	100.0	

93.2% said there are other measures to adaptation with the change either by citizens, farmers, environment organizations or farmer union. For example, they offered financial aids and the more presented were awareness sessions of climate change and how to adapt with. 86.4% said these measures and especially the sessions really worked.

Table 45: Are there initiatives from (citizens, farmers, environmental organizations or farmers' union) to adapt?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	82	93.2	93.2	93.2
	No	6	6.8	6.8	100.0
	Total	88	100.0	100.0	

Table 46: Do you think these initiatives are effective?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	76	86.4	86.4	86.4
	No	12	13.6	13.6	100.0
	Total	88	100.0	100.0	

Farmers' interest in farming lands increased especially after the Intifada which encouraged citizens to return to and invest their farming lands. After the Palestinian leaders of Intifada had called to boycott Zionism products, there was a desire to produce the products which prevented to be imported.

5.7.1 External initiatives

Engineer Saad Dagher who is the manager of an adaptation project which is done for the ministry of agriculture by GFA and supported by GIZ in Palestine, did one of the sessions that were set to help farmers understand climate change and methods of adaptation. He presented two, the first was in Jab'a and the second was in Anzah near Jenin in 12/11/2015.

The sessions included objects like methods of maintaining water and soil within small waterfall (khellat or khor) within specific project (Masseen wadi) as kind of adaptation with climate change. Saad Dagher presented the farmers definition and shapes of climate change and showed them some simple techniques to maintain soil and moisture as the following:

1- He encouraged making strings to prevent soil erosion in the planted land , since it existed over years even before climate change, but ancient farmers were interested in strings, Yet, farmers today don't take care of their lands since they work in government departments, so they negligent string rebuilding for 40 years. One of climate change problems is heavy rainfall, so it increases soil erosion and neglect strings increases the danger.
2- Make sand berms, which are mean incision the ground, raise the dirt and make canals to reserve and direct water to maintain moisture in the soil and prevent soil erosion. This is done by adaptation project in Bayt-Qad east Jenin.
3- Use straw or carton (mulching) to keep the soil moisture and prevent harmful plants. When it is analyzed, it richness trees. This way is done by putting carton or straw and a stone over or the rest of tree pruner could be used under the trees especially olives. We keep it until it's dried and start breaking down into organic materials. When using this way, there is no need to tillage or use pesticides. It also provides permanent moisture for the soil and this reduces the effect of drought and heat. It helps to find useful, harmless insects for trees and soil as well.
4- Add a little of organic material from the natural manure by applying on the surface of the soil. Natural manure works like sponge and maintain four times its size of water and this keeps the soil moisture.

5- Grow cactus to avoid soil erosion on the surface.
6- Make small sequent dams (water traps) in the slanting areas to break water flow and stimulate the absorption. The benefits of this way appear after 4-5 years since it creates springs in the surroundings.
7- Make half-moons around the trees on the slanting surfaces and fill it with stones or straw to prevent soil erosion.
8- Tillage reverses to direction to prevent soil erosion.
9- Cut the grass twice a year and leave it on surface since it keeps the soil moisture and forms organic materials richness the soil. Besides, its roots decompose and forms water paths.

Figure 6: Jab'a session with Saad Dagher and the farmers

Farmers participated in the discussions at the end of the sessions. One of the suggestions farmers agreed was to make dam to collect rainwater in specific valley and the people of the area donated 10 Donums. Therefore, it was agreed that the owners of this land sell water and use the money, but the project needed support.

Despite farmers make suggestions, but the project and the Ministry don't work with but take what's the best for all.

5.7.2 Achievements of the ministry of agriculture as kind of adaptation with climate change in Jenin

It was asked about the achievements of the ministry of agriculture during interviews with the workers of the ministry of agriculture, and was as the following:

1- Direct the farmer to do high terrace in home gardens through field schools of home gardens of which six families implemented and benefit in Jab'a and 16 in Atara'. They gave every home garden a water tank with a capacity of 1/2 cup and drip irrigation system to save water.

Figure 7: The water tanks for the Afforestation in Anzah

2- afforestation of 40 Donums, fence them, put 4 water tanks and rehabilitation the farming road in Anzah in cooperation with municipality of the village.

Figure 8: Afforestation in Anzah

Figure **9***: Afforestation in Anzah*

3- 192 Donums are being studied to be afforested in Jab'a.

4- 16 Donums were afforested in Jab'a during November of 2015.

5- Do workshops for farmers and crews that work with adaptation.

6- Do workshops to study the way to benefit from concentrated rainwater in specific valley (Masseen wadi). This is done by making workshops, so that farmers can present their

suggestions and initiatives about the subject. Specific valley (Masseen wadi) passes through Deir al-Ghusun in Tulkarem, Selat al-daher, al Fandaqaumiya, Ajja, al-Rama, KafrRa'I and Anzah in Jenin). This means that rainwater which flows in this valley is huge amounts.

7- An existing spring in Jaba' and Anza is being studied to be used in supplementary irrigation.

Chapter Six: Conclusions and Recommendations

The main goal of the research has been achieved, which is to study the social and economic impacts of climate change or rain-fed agriculture in Jenin area. The research had two specific objectives to achieve this goal.

The first objective was to assess the level of farmers' knowledge on climate change and their practices to cope with these changes. Findings of the thesis reveal that farmers in Jenin district know enough about climate change.

The study shows that 95.5% of farmers in Jenin realize and believe that there is noticeable change in climate during the last 15 years.

The study also shows that those farmers adapted with the current climate change through implementing the following three strategies:

1. Farmers shift farming dates of crops that are sensitive to climate change. For instance, the crops which were usually planted in October are now planted in November and December. This is because of seasonal shifting, which means that winter, which used to be experienced with rain and cold that appeared in October, is now being experienced in November.
2. Because of temperature increase and drought in summer, farmers use supplementary irrigation for some crops.
3. Farmers use organic fertilizers to keep the soil fertilized and to give it texture. Besides, fertilizers which save four times water of its size, work as sponge.

The total size of the cultivated land area varies from year to year based on climate. Besides, the amount of production is always heavily influenced by the size of cultivated land and also affected by climate change since most crops and most areas are planted with rainfed crops as shown in the research.

The amount of water used to irrigate the irrigated crops is lost either by evaporation (because of temperature increase), seepage or deep percolation, and this increase the costs on farmers. But modern irrigation methods save a lot of lost water. Therefore, this reduces water costs, increases productivity and improves the quality of products. The farmer can also set up new irrigated land by using the quantity that has saved.

The second objective was to assess the social and economic impacts of climate change on rain-fed farmers; this objective was achieved since the study shows that 43.2% of farmers are youth between the ages of 30-40. 94.3% of these are males, 65.9% of them are married and need to work in farming to meet their family's needs. Moreover, 29.5% of farmers are Bachelor's degree BA holder or higher.

These results show how farmers adapted to climate change. Since the need to work and to meet their families' needs were a motive to face the risks and negative effects of climate change. In addition, farmers' awareness and education help them create organized solutions to adapt to climate change. Besides, farming is a main job for 65.9% of farmers. Therefore, they cannot just leave farming easily. This is about the social aspect.

Economically, the results show that 29.5% of farmers produce more than 500 Kg/Donums. Therefore, any change of this product due to climate change will lead to financial differences. The results also show that 78.4% of farmers make 34000-46000 ILS/year, to be 2500-4000 ILS monthly average income. This shows that most farmers in Jenin receive low revenues from farming less than public spending average which is 6000. those farmers cannot bear any financial losses due to climate change, since 54.5% get annual profits and therefore, any lose will be huge.

The third objective was to assess the governmental and non-governmental support of rainfed farming. It was referred to in the section the achievements of the ministry of agriculture as kind of adaptation with climate change in Jenin and in section the external initiatives

The fourth objective of the thesis which was to develop recommendations to improve farmers' adaptation to climate change. These recommendations are:

1. Technological developments by: crop development, through developing new varieties that can bear moisture, drought and other changing climate conditions.

2. Improve information about climate systems by developing early alarm system to predict daily and seasonal weather.

3. Improve resources management by developing water management innovations to face drought or increased moisture.

4. Agriculture support programs such as crop insurance program

5. Modify agricultural production practices by growing different kinds of crops and breeding different kinds of livestock.

6. Modifying land use by changing crop production site, using alternative practices of tillage for example to maintain moisture in the soil, changing planting time to handle change in growing season and the changes in temperature and rainfall, using supplementary irrigation and diversifying the sources of family income.

It is recognized that social features of a community – such as internal cohesion and group knowledge – may decrease the overall vulnerability of that community to environmental risks (e.g. by increasing adaptive capacity). Similarly, a community that enjoys rich and diverse economic base would be considered less (socially) vulnerable than a community whose economy is weak and dependent on external factors. (UNDP, 2010)

Finally, rainfed farming in Jenin is clearly affected by climate. Yet, the results show that farmers have overcome and adapted with the effects on the economic and social aspects. Governmental and non-governmental institutions also help overcoming climate change effects. Through the results, I recommend to have more efforts in helping farmers.

During the study, economic and social aspects have been studied. Yet, other aspects weren't studied despite their affection of the change. Especially, water sector which other sectors depend on and the mostly affected by the amount of water, the way to keep it and occupation control of the biggest large of it.

Moreover, there are some important issues to search about. For example, I recommend researchers to widen the study of the advantages of climate change and widen the study of disadvantages to find the cheapest and easiest solutions for farmers. Researchers can also study the costs of adaptation and develop its ways which will be affected by population growth. Besides, they can study special kinds of crops which will be greatly affected by climate change and find solutions that able these crops survive the change.

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Annex

Farmer's questionnaire about climate change effects on rainfed farming in Jenin

The area according to location in Jenin	☐The eastern part (Arranah, DayrGhazzala and Umm at-Tut …) ☐South-east part (Qabatiya, Meithalun, Sanur, Zababdeh…) ☐Northwest (Jalamah,Kafr Dan, Rummanah, Al-Yamun and Silat al Hariyhiya…) ☐South-west (Silat ad-Dahr, Arrabah, Ya'bad, Ajja and Jaba'…)

Social information

Age	☐20-30 ☐30-40 ☐ 40-50 50-60 ☐60+
Gender (male female)	☐Male ☐ female
Social status (marriage)	☐Married ☐ single
Qualification	☐Illiterate ☐ elementary ☐ preparatory ☐Secondary ☐tawjihi☐ BA or higher
Is farming the main job for you**?**	☐Yes ☐ No
Does the family depend on farming to live**?**	☐Yes ☐ No
The main purpose of farming	☐Family living ☐ sale ☐ livestock ☐Serenity ☐ others
Family members participate in farming	☐One person ☐ 2-3 ☐4-5 ☐6-9 ☐10 or more

Information connected to agriculture

Usufruct	☐Owned ☐leased ☐others
Rainfed crops you grow	☐Garden trees (citrus, olives, almonds, grapes and apples…) ☐Vegetables (corchorus, squash, tomato, okra and potato…) ☐Field crops (wheat, barley and tobacco…) ☐Medical plants (thyme and salvia officinalis (Merimee)
Type of farming	☐Rainfed only ☐

	animal+rainfedirrigated+rainfed
Land area planted with rainfed crops (dunums)	☐Less than 3 ☐3-6 ☐6-10 ☐10-20 ☐20-30 ☐30-40 ☐more than 40
Production Kg/dunums	☐less than 100kg ☐100-200 ☐200-300 ☐300-500 ☐more than 500
Revenues of the crop (ILS/year)	☐34000-46000 ☐46000-70000 ☐ more than 70000
Benefits of farming excluding revenues	☐psychological ☐physical ☐social ☐others
Dependence on rainfed of revenues side	☐annual ☐seasonal ☐quarterly
Rainfed cost (almost ILS/dunums/year)	☐less than 10000 ☐10000-15000 ☐ more than 150000
Cost payments	☐fertilizers ☐irrigation ☐workers' wages ☐pesticides
Indirect costs	☐psychological ☐physical or healthy ☐long time ☐others

Individual perception of the risks and benefits

Do you believe there's climate change during the past 15 years	☐yes ☐no
Do you distinguish between weather change and climate change	☐yes ☐no
In your opinion, what are the changes that occurred	☐temperature increase ☐rainfall decrease ☐season late ☐drought
What are the negative effects of climate change on health and daily life	☐more susceptible to disease ☐fatigue ☐extra time ☐lack of social communication ☐ others
What are negative effects of climate change on farming activities	☐use pesticides ☐change farming dates ☐change farming type ☐cost increase ☐others
Have you changed any of the rainfed crops due to climate change	☐yes ☐no
Have changed into tobacco farming	☐yes ☐no
What are the negative effects of climate change on the surrounding environment	☐water crisis ☐lack of soil fertility ☐disease spread among plants ☐insects spread ☐others
Is there negative effects on revenues due to climate change	☐yes ☐no
Revenues low amount	☐10-20% ☐20-30% ☐30-50% ☐more than 50%
Have you abandoned your farmland	☐yes ☐no
If yes, why	☐Climate change ☐leave the village to the city ☐inheritance ☐others

The benefits and costs of climate change:

What are the benefits of climate change on health and daily life?	☐less susceptible to disease ☐less fatigue ☐less time ☐increase social communications ☐others
What are the benefits on your own farming activities?	☐use less pesticides ☐change pesticides using time ☐less costs ☐others
What are the benefits of climate change on the surrounding environment?	☐reduce air pollution ☐increase soil fertility ☐disease resistant crops spread ☐others
What are the benefits of climate change on revenues	☐increase some crops production ☐ increase profits
What are the benefits of climate change on other sides of your personal life	☐social ☐economic ☐others
What are your strategies for climate change adaptation?	☐change crop type ☐change farming date ☐use supplementary irrigation ☐ others
Have you changed rainfed crop types?	☐yes ☐no
What are the effects of climate change adaptation?	☐reduce material losses ☐reduce disease spread ☐increase production ☐ others
What are the direct costs to adaptation?	☐new seeds price ☐irrigation water price ☐production lose
What are the indirect costs of adaptation?	☐grow in different dates ☐the need to work hard for the same result ☐use resistant plants
Do you think there're other effective adjustments in your situation?	☐yes ☐no
If yes, why don't you work with?	☐it's expensive ☐profits don't cover the expenses ☐ useless to the area of land ☐others
Do you contact with other farmers about adaptation?	☐yes ☐no
Do you discuss climate change with other farmers?	☐yes ☐no
What are the main subjects of these discussions?	☐temperature increase ☐rainfall decrease ☐season late ☐drought
Do you follow weather forecast?	☐yes ☐no
Do you use extra irrigation water?	☐yes ☐no
Do you agree using treated water in supplementary irrigation to all or some of the rain-fed crops?	☐yes ☐no
Do you collect rainwater?	☐yes ☐no
Is rainwater collecting effective	☐yes ☐no
Do governmental organizations like (Ministry of Agriculture, EQA and Palestinian Water Authority) help in climate change adaptation?	☐yes ☐no
What are the measures taken?	☐material compensation ☐provide

	alternative seeds ☐provide supplementary irrigation water ☐provide tips about farming dates
Which actors are taking these measures?	☐ministry of agriculture ☐EQA ☐ Palestinian water authority ☐others
Are there benefits of these measures?	☐yes ☐no
In your opinion, what should governmental organizations do to adapt?	☐material compensation ☐provide alternative seeds ☐provide supplementary irrigation water ☐provide tips about farming dates ☐others
How much can you trust governmental organizations?	☐totally ☐partially ☐no trust
Are there initiatives from (citizens, farmers, environmental organizations or farmers' union) to adapt?	☐yes ☐no
What are these initiatives?	☐provide advice ☐provide material help ☐make awareness courses about climate change
Who are the actors of the initiatives?	☐citizens ☐farmers ☐environmental organizations ☐farmer union ☐others
Do you think these initiatives are effective?	☐yes ☐no

Thanks for your cooperation