I. INTRODUCTION

Whilst farming is the predominant profession for many Palestinians and Jordanians in the Jordan Valley region, the agricultural system still lacks proper planning and management. Along the region, most water and land resources are utilized for agricultural uses, and therefore, agricultural planning is more challenging under the existing conditions and limitations. Just like any other arid regions, groundwater is the main water source for drinking, agriculture, and industrial uses, in particular in the Palestinian side where Palestinians have no access to surface water and very limited access to ground water resources. In addition, land degradation is becoming increasingly clear due to both natural and anthropogenic implications. As a result, lights will be shed on the related literature for the targeted areas in the Jordan Valley given the current socio-economic status, water resources, crop production and climate change and food security.

This paper presents an overview of the main factors affecting agriculture in the Jordan Valley. It is constructed of two sections, one offering an overview about Jericho and Al-'Auja in the West Bank and the other about Al-Shouneh Al-Janoubeyeh in Jordan. The information presented in this paper offers a summary of the data found in the available literature concerning three main fields: Socio-economic status, natural resources and agricultural sector, and climatic change.

Most of the reviewed literature provided data on the governorate level, detailed information on the micro farm level was mainly collected through filed survey, focus group meetings and in person interviews with experts. The mentioned methods were used to bridge the gap existing in the reviewed literature such as: pricing, marketing, seasonal crop calendar, obstacles and limitations concerning water resources and land ownership.

The research conducted in this project provides detailed data that contributes to enriching the available official existing data for the target area of Jordan Valley. Moreover, the Decision Support System that will be built over this combination of official data and resulted data will be used to serve one of the major needs of the agricultural sector which is proper planning. This will lead to an increasing economic benefit on the household level and consequently contributing to self sufficiency on the household level and food security on the national level.

II. TARGET AREA – WEST BANK

1. The Socioeconomic Status of Jericho and Al 'Auja

1.1 Demography

1.1.1 Population

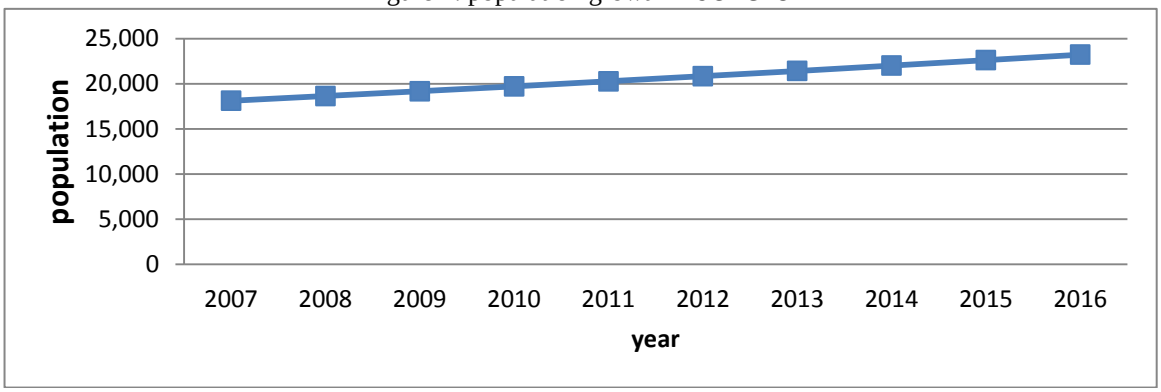
According to the Palestinian Central Bureau of Statistics (PCBS), the total population of Al 'Auja in 2007 was 3,934; of whom 1,965 were male and 1,969, female. There were additionally registered 674 households to be living in 721 housing units. While the total population of Jericho in 2007 was 17,515; of whom 8,731 were male and 8,784, female. There were additionally registered to be 3,510 households living in 4,549 housing units.

1.1.2 Age group and Gender

The General Census of Population and Housing carried out by PCBS in 2007 showed the distribution of age groups in Jericho was as follows: 37% were less than 15 years, 55.5% between 15 - 64 years, whilst 3.2% fell in the 65 years and older category. Data additionally showed that the sex ratio of males to females in the city was 99.4:100, meaning that males and females constituted 49.8% and 50.2% of the population, respectively.

The estimated population of Jericho city by 2012 was 20,826 and it's estimated to reach 23,220 by 2016.

Figure 1: population growth in Jericho

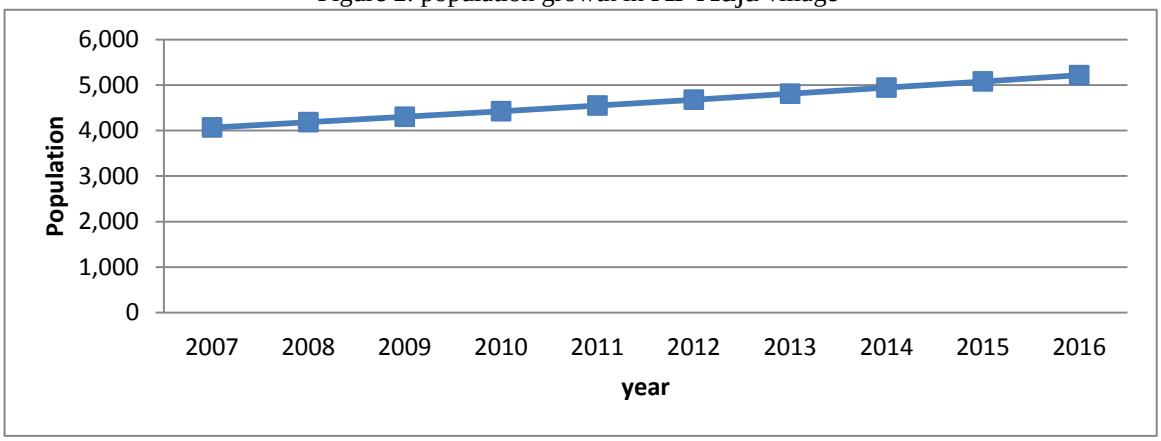


While in Al 'Auja, the General Census of Population and Housing carried out by PCBS in 2007 showed the distribution of age groups was as follows: 44.2% were less than 15 years, 51% between 15 - 64 years, whilst 2.5% fell in the 65 years and older category. Data additionally showed that the sex ratio of males to females in the town was 99.8:100,

meaning that males and females constituted 49.9% and 50.1% of the population, respectively.

The estimated population of Al 'Auja village by 2012 was 4,677 and it's estimated to reach 5,214 by 2016.

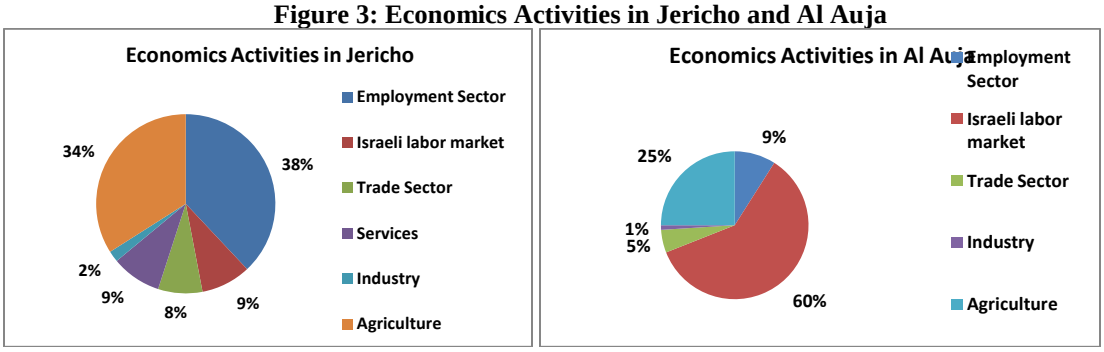
Figure 2: population growth in Al 'Auja village



1.1.3 Economic Activities

The economy in Jericho and Al Auja depends on several economic sectors, mainly: the Israeli labor market in Al Auja and employees sector in Jericho. The distribution of labor by economic activities in Jericho and Al Auja are as follows:

Figure 3: Economics Activities in Jericho and Al Auja



2. <u>Natural Resource and Agricultural Sector</u>

Sovereignty over natural resources is one of the key elements for any nation to achieve sustainable development and sound environmental management. The case of the occupied Palestinian territory (oPt) is different than other nations as it suffers from the Israeli occupation over 40 years. The intrusive route of the West Bank segregation wall through the West Bank governorates isolates number of farms, forests, rangelands and water resources of local Palestinian communities. Due to such policies and military regulations, there has been an increased rate of destruction, loss of green areas and

reduced biodiversity in the Palestinian ecosystems. The plans of the Israeli authority, the controlling power in the area, have systematically hindered the development of the Palestinians and damaged the natural resources in the process. The Palestinians had no ability to regulate land use over a contiguous piece of land causing land fragmentation, which made the management and conservation of natural resources a very difficult task especially in the Jericho and Al 'Auja in the Jordan Valley, in addition to climate, water resources, and soil types and fertility.

The targeted areas Jericho and Al Auja lie on a total area of around 165098 dunums, of which 57515 dunums (35% of the total area) are considered arable land, and 5321 dunums (3.2 % of the total area) are registered as residential (see table 1).

Table 1: Land Use and Land Cover in Jericho and Al Auja localities, 2010 (area in dunum)

Locality	***Total area***	***Built up area***	***Agricultural area = 57515***				**Inland water**	**Forests**	**Open Space**	**Area of Industrial, Commercial & Transport Unit**	**Area of Settlements & Military Bases**
			Permanent Crops	***Greenhouses***	***Rangelands***	***Arable lands***					
Jericho	*58701*	4195	6577	580	4926	19400	69	0	22130	741	83
Al Auja	*106397*	1126	2457	846	9951	12778	96	0	74625	109	4409
Total	***165098***	***5321***	***9034***	***1426***	***14877***	***32178***	***165***	***0***	***96755***	***850***	***4492***

Source: (ARIJ, 2012b, ARIJ, 2012a)

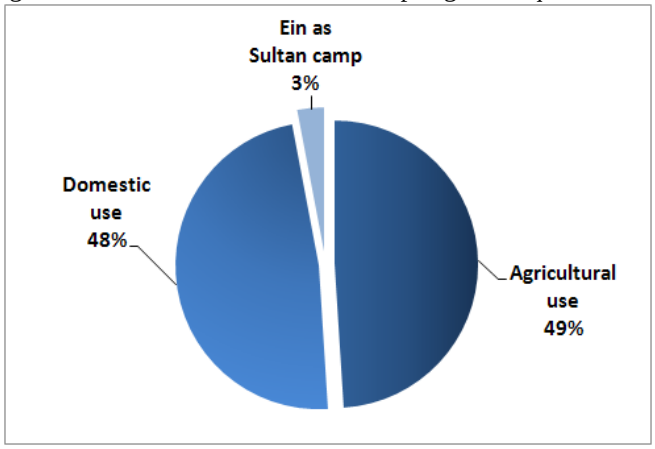
Agriculture production in Jericho and Al Auja depends mostly springs, artesian walls and ground water wells. The city residents' cultivate citrus fruits, bananas and different kinds of vegetables using these methods.

2.1 Water Resources

Water resources are a vital element of Palestinian ecosystems. Sources consist mainly of surface and groundwater resources (springs and wells). The most stable surface water resource is the Jordan River, however, a central feature of the Israeli occupation of the Palestinian territories is the denial of access to water and over extraction of sources like the Jordan River, this has left Palestinians dependant on groundwater resources. This paper will mainly focus on the two main springs in Jericho governorate, 'Ein as Sultan and Al 'Auja.

'Ein as Sultan water spring is currently the main source of water for Jericho. Jericho Municipality provides residents with spring water through the public water network established in 1955 (Jericho Municipal Council, 2011). The average rate of water discharged from 'Ein as Sultan spring is approximately 650 cubic meters/ hour; the spring water is being distributed in specific quantities among the public water network, the agricultural channels and 'Ein as Sultan camp water network (Fig. 4). In 2009, the public water network was supplied with 310.7 cubic meters/ hour of the spring's water, which is equivalent to 48% of the spring's rate of discharge. The percentage of water loss through the network reaches about 23.7% (Palestinian Hydrology Group, 2011).

Figure 4: Allocation of 'Ein as Sultan spring water quotas, 2009



Source: Palestinian Hydrology Group, 2011

The amount of water consumed in Jericho city in 2009 was approximately 2,031,363 cubic meters/ year; equivalent to 169,280 cubic meters/ month (Palestinian Hydrology Group, 2011). Thus, the rate of water consumption per capita in Jericho was estimated at 225 liters per day. Moreover, the price of water in Jericho is the lowest across the Palestinian territories, as the cost of pumping the water from 'Ein as Sultan spring is as low as 1.4 NIS per cubic meter (Jericho Municipal Council, 2011).

However, the water used in agriculture, which was estimated (in 2009) at 229,680 cubic meters/ month, reaches farmers through agricultural channels during specific time periods. A farmer can irrigate his land directly with the amount of water he receives through channels, or he can keep it all or part of it in the ponds. The irrigation network consists of five channels; each of which receives a certain amount of water. In addition, Jericho city has 99 private artesian wells used for agricultural purposes (ARIJ, 2010). Furthermore, there are 4 public harvesting reservoirs in the city; the combined capacity of which reach 4,500 cubic meters (Jericho Municipal Council, 2011).

'Ein as Sultan spring is publically owned by all residents of the city. It is not therefore limited to certain people, a fact which distinguishes this source from any other private agricultural wells (Photo 1).

Photo 1: 'Ein as Sultan Spring

According to what is inherited; 'Ein as Sultan spring water is divided into two categories: The Bustani (Garden) and Felha (Agricultural) waters. The Bustani water is used primarily for gardens and domestic use. It comprises one third of the spring's water with 15 dunums; with time share identical with real time, i.e. 1 hour for 1 hour. The felha water is inherited and can be sold but not attached to land. However, the Bustani water is linked to the land. Here the water time-share is sold or rented with the land. The Felha water comprises two thirds of the spring's water. One hour of the Felha water comprises only 23 minutes of real time and can be sold or rented (Barghouthi, 2008).

While ***Al 'Auja spring*** is one of the main springs in Palestine; the discharged water reaches more than 2,000 cubic meters per hour in some years, with the estimated rate of discharge being considered more than 10 million cubic meters per year. Notably in 2005, the spring's annual discharge reached around 14 million cubic meters (PWA, 2007). The spring's discharge predominantly depends on the quantity of rainwater, meaning the discharge declines if the amount of rains decreases. The spring is also susceptible to 'drying out', which used to happen infrequently but has in recent years become a more frequent phenomenon. In 2012, the flow of the spring began earlier than the year before, starting on Feb 1st and lasting for just 20 days. The spring then dried up as a result of Mekerot Company over extracting water from the aquifer once the spring water started flowing.

Al 'Auja town receives water from the privately owned Israeli company 'Mekerot'. The water is provided through the public water network established in 1986. The whole town is connected to this existing network (GVC & FAO, 2011). The average rate of water supply per capita in Al 'Auja town is around 174 liters per day, with the quantity of water supplied to Al 'Auja in 2011 being estimated at 18,250 cubic meters/ month. However no Al 'Auja citizen consumes this quantity of water due to an estimated 30% of water losses which occur at the main source, through the piping, through the distribution network and within the household due to faulty and old networks which require rehabilitation. All of these factors make the household rate of water consumption per capita in Al 'Auja an estimated 120 liters per day (GVC & FAO, 2011).

It is worth mentioning that Al 'Auja town has been suffering from a severe shortage of water for many years especially during the period of 2000-2011. The areas of Badu al 'Auja and Ras 'Ein al Auja face further problems as they are in area C and face severe restrictions on their access to water. This occurs simultaneously with illegal Israeli settlers draining water resources in areas of building development throughout the West Bank. In addition, the water quality in these areas is considered a source of growing concern for the local Palestinian citizens due to contamination and pollution of local sources.

2.2 Soil Type and Fertility

The soil resources of an area are one of the most important elements of the natural resources base. Soils like other agro-biodiversity components in the occupied Palestinian territory are distinguished for the high range of variety in type and nature (Isaac, et al.,

2007). The major soil associations in the oPt are Terra Rosa and Brown Rendzinas; dominating the Central Highlands of the West Bank, Brown Rendzinas and Pale Rendzinas are found to the north and south of the mountain ridge, in Tubas, Qalqilyia and Hebron Governorates, and also in regions of the Eastern Slopes. Grumosols are also found in the far north and far west of the West Bank, coinciding with low-lying areas that enjoy a more temperature climate than other parts of the highlands (Isaac, et al., 2011).

The project targeted areas Jericho and Al ‘Auja located in Jericho and Al-Aghwar Governorate in the West Bank. They located in one agro-ecosystem the Jordan valley agro-ecological zone. The Jordan Valley is a narrow strip between the Eastern Slopes and the Jordan River. It is 70 km long and drops to about 400 m below sea level near the Dead Sea. Rainfall is low (100 – 200) mm/year, winters are mild and summers hot. Soils are sandy and calcareous. This zone is the most important irrigated area in the West Bank. However without access to water this region would be a desert (Dudeen, 2001).

Figures 5 and 6 show the main soil associations in the targeted localities Jericho and Al Auja, while map 1 and 2 shows the distribution of each soil association in Jericho and Al 'Auja (ARIJ, 2013).

Figure 5: main soil types (%) in Jericho locality

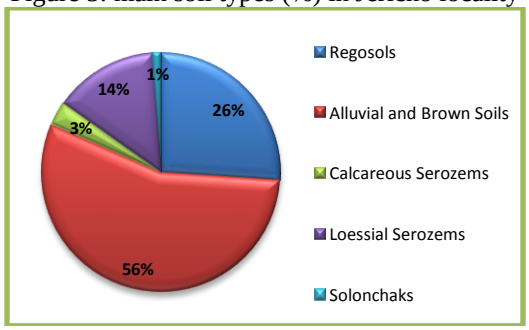
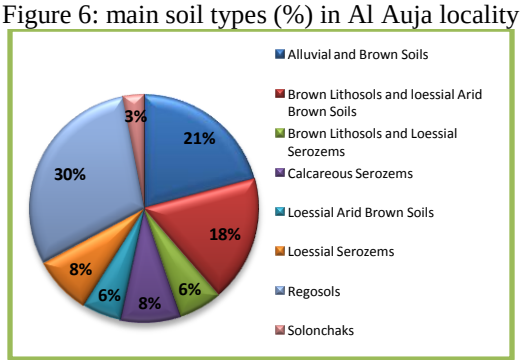


Figure 6: main soil types (%) in Al Auja locality

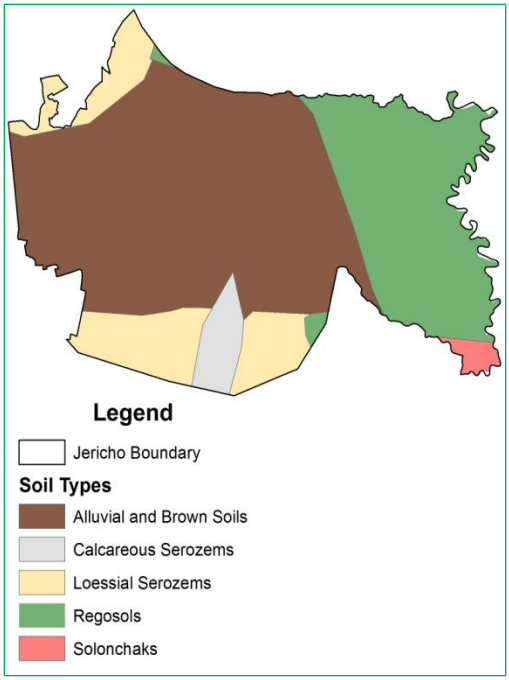


The figures show that nine soil associations can be distinguished in the targeted area, a brief description of each type, as the following:

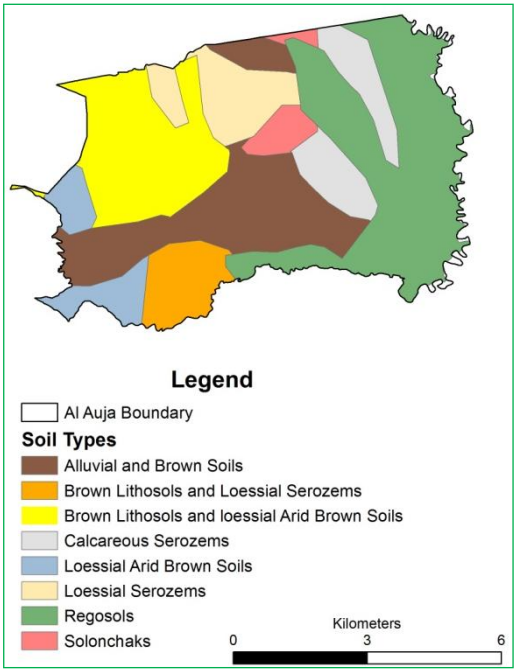
1. *Calcareous Serozems;*
2. *Regosols;*
3. *Alluvial and Brown Soils;*

4. *Loessial Serozems;*
5. *Solonchalks;*
6. *Brown Lithosols and Loessial Arid Brown Soils;*
7. *Brown Lithosols and Loessial Serozems;*
8. *Loessial Arid Brown Soils.*

Map 1: Jericho Soil Map



Map 2: Al- Auja Soil Map



Soils are degraded in Jericho and Al 'Auja as a result of many factors, including soil erosion and salinization. Two categories of soil deterioration process are in Jericho and Al 'Auja; these are displacement of soil material (e.g., soil erosion by water and wind), and in-situ soil deterioration, covering chemical and physical soil degradation. These causes can be divided into anthropogenic (man-made) and non-anthropogenic (natural causes). The natural causes include climatic change (rainfall and temperature); it is necessary to mention here that the amount of land under the effect of aridity on the vegetation density for the period (2000-2010) was 32% of Jericho area (19 km2) and 31% of Al-Auja area (33 km2) (Urban & Rural Physical Planning Department, 2013).

Incorrect agriculture management, such as scarcity of water, uncontrolled domestic and industrial dumping sites, and the heavy usage of fertilizers are the main in-situ soil deterioration causes in the Jericho and Al-Auja.

In general the most prominent issues facing soil in Palestine is the extensive use of fertilizers and pesticides. Because of the large increase in population and the narrow of agriculture area, people have to use fertilizers and pesticides to increase the productivity of agriculture land; in the West Bank the annual rate of use agriculture fertilizers reached

30,000 tons of chemical fertilizers and manures, and the annual rate of use of pesticides reached to 502.7 tons, consisting of about 123 types; 14 of them are internationally banned for health reasons (PCBS, 2010). Also, it is necessary to mention here that in the Agriculture Season (2007/2008) in Jericho and Al-Aghwar the total costs of fertilizers was 4,569 (1000 USD$), and for pesticides was 2,997 (1000 USD$), which represents 28% and 18.5% from the total costs of plants intermediate consumption in Jericho and Al-Aghwar governorate (PCBS, 2009). Fertilizers and pesticides accumulated in the soil filter downwards and may reach the groundwater table (ARIJ, 1997).

The soil in Jericho and Al Auja is sandy, high in salinity, and low in clay and organic matter (SWITCH, 2006). The concentration of salts in the Jordan River has reached 5,000 ppm; while it did not exceed 600 ppm in 1925. The concentration of chloride has increased from 24 mg/l to 1,365 mg/l in Jericho and Al-Aghwar Governorate during the past 20 years (PCBS, 2010).

Jericho and Al-Auja as a part of the Jordan valley is intensive-production agriculture area, and its witnessing diversification in agriculture production from citrus and banana to date palm, grapes, herbs and vegetables (EQA & UNCCD, 2012).The production of fruits and vegetables, which is heavily dependent on irrigation in the Jordan Valley due to the arid climate conditions. However, poor water quality, insufficient or lack of soil leaching and drainage and inappropriate nutrient management such as: overuse and abuse of fertilizers, have resulted in the accumulation of some nutrients in the root zones (Ammari, 2011).

Water and soil salinity are continuously increasing due to the fact that soil leaching treatments are not often enough applied. Intensive agriculture techniques, while increasing short term production have negatively affected environment, the intensive usage of pesticides, especially methyl bromide for soil fumigation, has had negative effects on human, the environment in general, the ecological balance of soil profile and groundwater. Also, the increasing quantities of general solid wastes resulting from the extensive usage of soil plastic mulches, tunnels and plastic houses, have negative effects on the environment and livestock. Residues of plastic left in the fields may also hinder soil quality (Isaac, et al., 1995).

The outcome or symptom of desertification in Arid area such as Jericho and Al-Aghwar is land degradation, and its driving forces are climate variation and human activities (del Barrio, et al., 2010). According to the previous Jericho and Al-Aghwar lands suffer from desertification consequences, and the major impacts of desertification, land degradation and drought in the Jericho and Al-Auja in general are the following:

- Increased soil erosion and loss.
- Decrease in soil fertility and productivity.
- Less food and feed production and increased food insecurity mainly in marginal areas and among vulnerable groups.
- Less income and more costs of economic activities mainly livestock and agriculture.

2.3 Production

The agro-production calendar in the oPt is diverse, based on the variety of cropping patterns (rain-fed or irrigated), planting systems (open or protected), location, season, availability of water resources, availability of agricultural lands, and other existing economic activities (ARIJ-ACF, Integrated Report, 2008). Several parameters have led to the insecurity of the Palestinian agro-production system as more than 86% of the produced agro-commodities are dependant on levels of precipitation and are affected by limited access to the technology, land and water due to the current political circumstances. The Palestinian agro-production system produces more than 100 crops throughout the year and achieves surpluses in some commodities during the peak-production seasons. The oPt has the demonstrated the ability to export surpluses of tomato, cucumber, squash, eggplant, beans, cabbage, cauliflower, olives, grapes, plums and citrus, while still meeting the demands of the Palestinian market.

However, there remains a shortage within local production of potatoes, onions, watermelons, and garlic, which creates an imbalance in the agro-commodities demand-supply chain in the oPt. Due to the water shortage and poor soil fertility there is a general inability to meet the local consumers' fruit production demand. Yet local production of olives, grapes and citrus have achieved self-sufficiency and produced surpluses which are usually marketed to Israel and/or other countries. The Palestinian agricultural production system (especially in the Jordan Valley) is mainly based on cultivating during certain periods of the year, which creates peaks of production in some periods and shortages in others (ARIJ-ACF, Integrated Report, 2010). The production calendar in Jericho and Al 'Auja will be summarized according to their type of agriculture.

Jericho lies on a total area of around 58,701 dunums, of which 31,483 dunums are considered 'arable' land as shown in Table 2.

Table 2: Division of the agricultural area in Jericho (area in dunum)

Agricultural area [31,483 dunums]			
Permanent Crops	Green-houses	Range-lands	Arable lands
6,577	580	4,926	19,400

Agricultural production in Jericho depends mostly on springs and artesian wells. The city residents cultivate citrus fruits and bananas (Jericho & Al Aghwar Directorate of Agriculture – Jericho, 2011).

While Al 'Auja lies on a total area of around 106,398 dunums, of which 26,032 dunums are considered arable land as shown in Table 3.

Table 3: Division of the agricultural area in Al 'Auja (area in dunum)

Agricultural area (26,032 dunums)			
Permanent Crops	Green-houses	Range-lands	Arable lands
2,457	846	9,951	12,778

Source: ARIJ - GIS Unit, 2011.

Agricultural production in Al 'Auja depends mostly on springs and groundwater wells. The town residents cultivate different kinds of vegetables; mainly tomatoes and cucumbers

Figure 7: Agriculture Practices.

- **Open Field Agriculture**

Farmers in the targeted areas (Jericho and Al 'Auja) are cultivating almost 14 vegetable crops under open field irrigated conditions. The main open field irrigated vegetable is squash, which constitutes the highest produced quantity from the irrigated open field crops, followed by cucumber, eggplant, tomato, and potato. The remaining production

consists of: broad beans, beans, corn, radishes, cauliflower, spinach, parsley and coriander. For the open field irrigated vegetables there are two peaks of production: the first peak, February through to May, is the largest. The second peak of production is during October through December; whilst the remaining months produce a smaller yield.

Figure 8: Open Field Agriculture

- **Greenhouse Agriculture**

The highest quantity of greenhouse agriculture in Jericho and Al 'Auja are cucumbers, closely followed by tomato, fresh beans, peppers, eggplant and Molekhia (Jews Mallow) all form smaller yields. Greenhouses also have two main peaks of production per annum. The first peak is seen in January, February, March and April; while the second peak occurs during October, November and December. Comparing the production of both greenhouses and open field irrigated crops, we noticed that both cropping systems operate in parallel; this means that during the peaks of production marketing crises might occur. We found that both production systems have the highest production interval during the months of October, November and December and during February, March, and April they have the second interval.

Figure 9: Greenhouse Agriculture

3. Climate Change and Food Security

In the oPt; specially the Jericho and Al 'Auja; many agricultural ventures, such as vegetables and fruit production is a significant commercial and, to a large extent, a primary source of revenue for agricultural areas (FAO, 2008). This however is extremely vulnerable to damage from climate change extreme events such as:

1. Increase of temperature and frequency of extreme events will reduce crop yield (some crops are more tolerant than others).
2. Modification of mean temperature will induce changes of the agricultural distribution of crops.
3. Increase of temperature will negatively affect marginal land and its farmers.
4. Scarcity of water resources will force farmers to abandon marginal land, and will increase desertification.
5. Socio-economic impacts associated with loss of agricultural and other related jobs, resulting in the increase of unemployment, loss of income, and political disorder.

Drought and land degradation which are the major threaten affecting the study area show are attacking the agricultural lands. Jericho and Al 'Auja show the highest severity of land degradation and drought, and the main reason for this is steep slopes, saline soils, water over pumping and poor farming techniques (ARIJ & WFP, 2010).

Referring to our field visits in the targeted communities (Jericho and Al 'Auja); several risks are noticed and identified due to the changing in climate on areas, crops, drought, and irrigation requirements such as:

1. Crop area changes due to decreases in optimal farming conditions;
2. Decreased crop productivity;
3. Increased risk of drought and water scarcity;
4. Increased irrigation requirements;
5. Decreased groundwater recharges rates;

Agriculture remains an important source of livelihood for the Palestinian people in Jericho and Al 'Auja. A large share of the agricultural land area is used to produce crops and vegetables, but the characteristics of the land and the limited supply of freshwater results in extreme year-to-year changes in the production of food and agricultural products. The limited supply and high cost of water restrict the expansion of irrigated areas and these water costs can only be covered by relatively high value crops which are able to reach markets. Cereals, legumes and oilseeds are not high value crops. Production of these crops represents a relatively small share of the consumption requirement and so the only short term solution to instability is to ensure adequate imported stocks to cover shortfalls.

Recent droughts, combined with a poor access to water, mobility restrictions to grazing land and lack of diversified livelihoods have collectively put at risk the very

sustainability of the herding livelihood in West Bank communities. Moreover, a steep increase of fodder, cereals and water prices in 2007 has pushed herders into a deeper cycle of indebtedness, resulting in a reduction in families' ability to buy food hence justifying the need to deliver immediate food aid to the affected communities and develop mid-term activities geared at ameliorating the households' food security.

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