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FUTURE PROJECTION FOR SYRIAN FOOD INDUSTRY

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Abstract

In this study, the food and nutritional energy requirements in Syria for the years of 2020, 2030, 2040 and 2050 were calculated by assessing the demand and capacity of the country. The food requirement (ton/year) based on the various food sectors was calculated, which was used to determine the amount of food to feed Syria. For the enhancement of the food productivity, the shortcomings in the sector were identified. It was also aimed to provide a guidance on which basic steps should be taken during the rehabilitation period by assessing the agricultural and food self-sufficiency of Syria and help to develop a food policy for Syria's future. According to the results, after the crisis/war in the future, the population of Syria will increase and reach to about 34 million in 2050. Syria will face with difficulties in feeding this expanding population, which is two-folds the current number. Additionally, climatic change will cause more arid region in Syria due to its geographical position, therefore it will depress the growth of food. Food security will also be another problem for Syria after the crisis/war.
Key Words: Syria; food; future: foresign; economy
JEL Codes: C53, E23, E27, E60, H50, L66, O13

1.Introduction

The Syrian Arab Republic is a Middle East country situated on the eastern end of the Mediterranean Sea with an 185,180 km^2 total area and bordered in the north by Turkey, in the west by Lebanon, in the east by Iraq and in the south by Jordan and Israel (FAO, 2005).

The Syrian Arab Republic geographically has been divided into four regions, which are the coastal, the mountainous, the interior and the desert regions (Almadani, 2014). Additionally, for administrative purposes, Syria is divided into fourteen provinces, one of which is the capital Damascus and the others are Aleppo, Al-Hasakah, Al-Suwayda, Daraa, Deir Ez-Zor, Quneitra, Homs, Idleb, Hama, Lattakia, Rif Dimashq, Ar-Rakkah and Tartous (Frenken, 2009).

In the country, pastures, steppe land and forests cover 48% of the total land, cultivable lands constitute 32%, where the remainder is rocky mountain and desert. Cultivable land is split into cultivated (92%) and uncultivated lands (8%) (Shhaideh et al., 2000). The desert areas of the country are used for grazing when there is an adequate precipitate (Hassan & Krepl, 2014).

1.1. Climate

In the Syrian Arab Republic, the climate type is the Mediterranean with four seasons: cool rainy winters, warm dry summers, relatively short spring and autumn (FAO, 2008). The coastland regions are characterized by a mild Mediterranean climate, while the interior parts are considerably continental with hot summers above 40 °C and cold winters below 0 °C (Masri, 2006). The annual precipitation in the country is approximately 252 mm (FAO, 2008).

1.2. Population

Syria, in the history, was a homeland for many civilizations such as Sumerians, Egyptians, Hittites, Assyrians, Babylonians, Persians, Turks, Arabics and the Seleucid Empire and the country had a significant role for trade and industry in the ancient ages due to its location.

In the first years of the country, the population was around 3.5 million (Commins, 2004). According to the World Bank records, one year before the crisis/war, in 2010, the population of the country increased to 21,018,834 (The World Bank, 2018).

While Syria is entering its seventh year with the crisis/war, more than 500,000 Syrians died, half of the population left their homes and migrated to neighbouring countries, mostly Turkey, Egypt, Jordan, Iraq and Lebanon, with some fled for Europe (Amnesty International, 2013; Reuters, 2018). As of October 7, 2018, the population of the country estimated as 18,430,453 based on the latest World Bank records (The World Bank, 2018).

1.3. Economy

Syria used to be a middle-income developing country with an economy mainly dominated by the oil and the agricultural sector, which together accounted for half of Gross Domestic Product (GDP), where the contribution of agriculture used to be nearly 30 percent, employing 25 percent of the total labor force with another 50 percent dependent on it in the manufacturing sector (IBP, 2015; The World Bank, 2001).

In 2000, the economy of Syria attempted to pass liberal economy and innovations were performed such as opening up the market to foreign investors, licensing foreign banks to operate within the country (Raphaeli, 2007). In the recovery process of the economy, the government implemented many innovations including allowing new private-sector banks to operate, policies for the reduction of borrowing interests and government subsidies in agricultural and industrial sectors (Çakmak & Ustaoğlu, 2015). Moreover, the first stock exchange of Syria, Damascus Securities Exchange was opened in 2009 for upgrading Syria's financial system and encouraging foreign investments (Rafei, 2009).

In addition to the global financial crisis and the sanctions, the macroeconomic performance of Syria was affected by long-term droughts, which dropped the agricultural output (Feldman, 2007). The poor climatic conditions caused the share of the agricultural sector to decline to about 17% of 2008 GDP, which was 20.4% in 2007 (IBP, 2015). Even though Syria was showing an improvement towards economic reforms and succeeding access to universal primary education, reducing the gender gap in education, decreasing the mortality and enhancing immunization coverage among children, poverty, which was falling between 1997 and 2004, had shown a rise in the second half of 2000s (Gobat & Kostial, 2016).

Even the impacts of the global crisis in 2009 had been relatively moderate and the slight impact was mostly because of the decrease in exports to trade partners in Europe and the Middle East and resulted in 1 percent reduction in GDP, about 4 percent decrease in the exports of commodities and services, and the increase of unemployment to 11% from 9% (Bloomsbury

Publishing, 2010). However, the effects of the global crisis were temporary and the trade flows rose again in 2010 (Mohsen et al., 2016). Consequently, before the long-term effects of the economic recovery were observed, the war began in 2011 and the economic balance of the country was devastated inevitably (Çakmak & Ustaoğlu, 2015).

Before the conflict, the major trading partners of Syria were the European Union (EU) and Arab countries (Al-Hamwi, 2005). The EU represented a significant export market for oil, in addition to some other Syrian commodities. The Arab countries were the second largest export destination for mainly food products such as cereals, vegetables and fruits (Abbas & Procházka, 2010).

Syria also used to be a transit route for agricultural and food exports from Jordan, Lebanon and Iraq to the black sea markets and the EU, and from Lebanon and Turkey to Jordan and the Gulf. However, the trade dynamics in the Middle East have been affected by the crisis/war and as new export routes have been emerging, trade volumes and flows have changed, significantly (RFSAN, 2016).

The especially conflict-related disruptions and international sanctions imposed on Syria had a very significant impact on the economic recession of the country, as exports decreased by 92 percent between 2011 and 2015. Also, the account deficit in 2016 widened sharply to 28 percent of GDP from 0.7 percent of GDP in 2010. Moreover, the number of foreign reserves fell to US$1 million in 2015 from about US$21 billion in 2010 (World Bank Group, 2017).

According to a report of Business Monitor International (BMI) Research, it is forecasted that the economy of Syria, annually will decline by 3.9 percent from 2016 to 2019, which will bring its economy back in the 1990s and will make the country dependent on investments from Iran and Russia (Holodny, 2016).

1.4. Food Exports and Imports in Syria

Agricultural exports lead foreign currency earner in Syria and the sector has a significant contribution to industrial growth since agricultural raw materials are the source of many manufacturing activities (FAO, 2003). For the years from 1980 to 2010, the raw material export share was about 68%, while the share of the total Syrian export for finished products and semi-finished products was 24% and 8%, respectively (Mohsen, 2015).

It is estimated that exports decreased about 38.4 percent at the beginning of 2012 and this decline reached up to 70 percent by 2015 as a result of the international embargo, the breakdown of border-cross trading and impact of the civil war on economic activities of the country (Gobat & Kostial, 2016; Nasser et al., 2013). The decreases in export volume have resulted in an ascend in the trade balance deficit, which has been one of the reasons of depreciation in the SYP (Nasser et al., 2013; Dost et al., 2015).

Before the war, the main imported goods in Syria used to be industrial and agricultural equipment, vehicles and heavy machines, where manufactured products were accounting for 87 percent of total imports in 2009 (IBP, 2015; Sleman & Farfour, 2012). The share of the agricultural products was around 11% and with sugar, maize and tea were comprising the bulk (Abbas & Procházka, 2010; Sleman & Farfour, 2012).

Currently, for the opposition-controlled areas of northern Syria, Turkey has the largest import share, where Iraq comes second for manufactured foodstuffs such as rice, sugar, tea, lentils, bulgur, margarine and frozen chicken. Moreover, agricultural inputs (fungicides, pesticides and fertilizers) are also provided via the port of Mersin, Turkey. The most of the cross-border trade between Turkey and Syria is carried out through Bab al-Hawa and Bab es-Salam borders, which are only one-way trades as they are under a ban for exports from Syria to Turkey for the last two years (SIM Team, 2018).

1.5. Agriculture in Syria Before Crisis

Agriculture has been the mainstay of the Syrian economy with 6,025 million ha agricultural land, which represents 22.34% of the total area (Erian et al., 2010; SEF & Syrian Economic Task Force, 2017).

Agriculture has also a vital role in providing raw materials for the food manufacturing sector of the food industry as well as generating employment opportunities (Hassan & Krepl, 2014). While almost half of the population lives in rural areas, in 2008 the labor force in agriculture was 20-25% of the country's total population, which is more than any country in the Middle East and North Africa region except Yemen (The World Bank, 2008).

The main crops of the country are wheat, barley, lentil, chickpea and cotton (Omar, 2002). Also for the arid and semi-arid areas, where irrigation water and rainfall is insufficient, the rearing of livestock, especially sheep, goat and camel is the most important agricultural activity (Khoury, 2011).

1.6. Effects of the Crisis on Agriculture and Food Industry

The agricultural sector of Syria has experienced many severe crises because of droughts, increasing urbanization of arable lands, the salinization of irrigated lands (Euphrates region), desertification in the desert and the marginal areas, misadministration of water resources, retarded implementation of important projects, such as the adoption of neo-liberalization policies in prices of energy and fertilizers and modern irrigation systems (Nasser et al., 2013; SEF & Syrian Economic Task Force, 2017). In addition to these problems, the ongoing crisis has caused losses and enormous damage to the agricultural production (FAO, 2017a). It also affected job creation, prices of goods and food safety, and eventually the economy of the country (Nasser et al., 2013).

The FAO Report published in 2013 states that while the conflict is continuing, the agricultural production of the country also keeps dropping, where wheat and barley production has shown a drop; fruit trees 55% and olive oil production 40% and vegetables 60% drop (Jaafar et al., 2015).

The effects of the conflict include not only the decrease of crop production, disruption in the supply of agriculture inputs and reduction in livestock numbers, but also the irrevocable destruction of properties, such as farm machinery and storage, irrigation systems and processing facilities (FAO, 2016). Assessments also demonstrate that the increased transportation costs as a consequence of increased fuel prices and insecure roads have resulted in higher prices in agricultural inputs and marketing (ACAPS & MapAction, 2013).

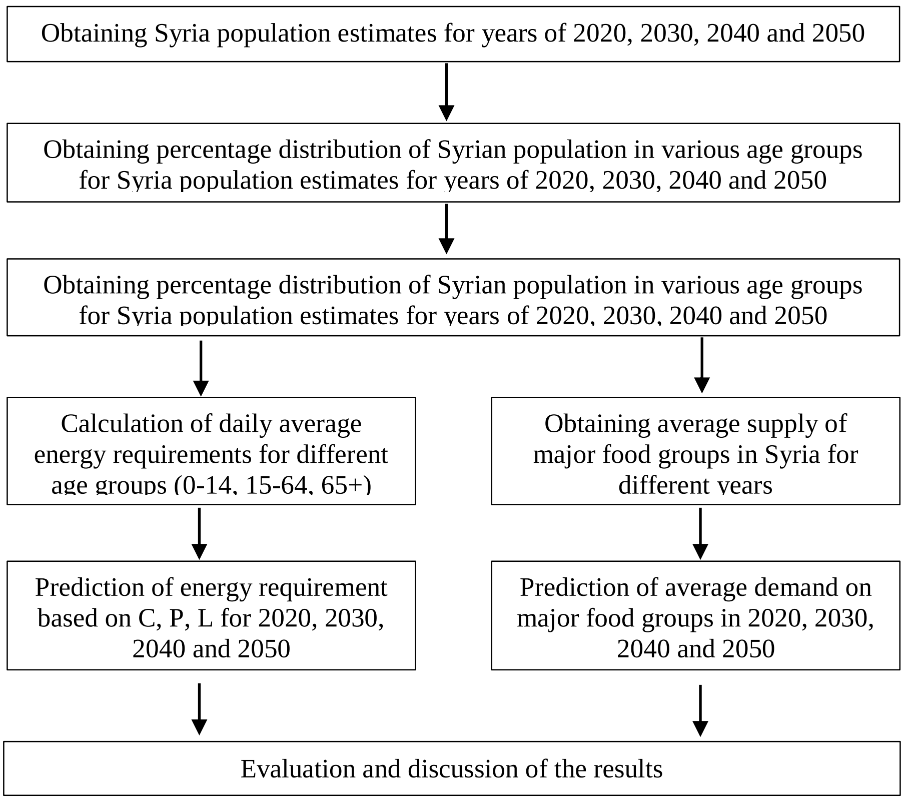
The conducted research by FAO shows that the ongoing crisis has caused more than $16 billion total bill damage to farming assets, crops and livestock sector. While the estimated loss in the crop production is about $6.3 billion of the total, it is calculated at around $5.5 billion for the livestock sector and $80 million for the fisheries sector. The report states that dependently on how the conflict develops, rebuilding the agricultural sector would cost between $10.7 and $17.1 billion over the first three years (FAO, 2017b).

Syria has still big potential about the food and agricultural sectors. After the crisis/war, these sectors will also be locomotive for the economy of Syria. Especially, cereals, vegetables, fruits, meat, dairy and fishery sectors are critical for the country. During this crisis/war, a lot of establishment, company, plant, industry and economical chain have collapsed. Important industrial zones in the conflict areas nearly collapsed. Additionally, professional human power related to food industry left from Syria. Therefore, there are a lot of gap for the future. But, food is critical for Syria similar to other countries due to its importance to feed peoples.

During the crisis/war, local productions at different sectors continued to feed the local peoples. A restricted trading was also made with other countries. As soon as possible, a new food policy for the future of Syria should be made. Therefore, this study was aimed to determine the food requirements for the next 30 years (as near future) for Syria. It was estimated that the agricultural production growth studies will be the key aspect and it was aimed to accelerate the process by providing extensive research over the primary requirement of the country and actions to be taken for development of the agriculture and food industries. In the study, the food and nutritional based energy requirements of Syria in 2020, 2030, 2040 and 2050 were determined as foresight to predict demands in the food industry. By using these results, the future of Syrian agricultural and food industries was evaluated. Additionally, a foresignt was given for planning the food sector investment in Syria after the crisis/war.

2.Materials and Method

In the study, according to recent situation related to Syria in the international area, it does implicity accept the conflict will be ended, Syria will remain a single country and agricultural infrastructure is fully developed.



2.1 Calculation of Food and Nutritional Energy Requirements for Syria in the Future

The food and nutritional energy requirements in Syria for the years of 2020, 2030, 2040 and 2050 were calculated by using the following method (Figure 1).

Figure 1. Calculation Methodology of Food Requirements of Syria

Table 1. Total Population Estimates of Syria and Estimated Percentage Distribution of Syrian Population in Various Age Groups for 2020, 2030, 2040 And 2050 (The World Bank, 2018)

	Years			
	2020	2030	2040	2050
Number of the estimated population	18,924,000	26,608,000	30,799,000	34,021,000
Age Groups				
0-14	34.2	28.1	25.0	21.9
15-64	60.9	65.5	66.7	66.5
65+	4.9	6.3	8.3	11.6

Syria's population estimations (Table 1) for 2020, 2030, 2040 and 2050 were obtained from the World Bank data (The World Bank, 2018). The future age and gender group distributions (percentages as estimated) in the Syria population (Table 1) were also used to determine their food and nutritional energy requirements, individually. Then, these values were used to calculate the total food and nutritional energy requirements for Syria in the future. In order to calculate the energy requirement for each age and gender group (Table 2) due to their different activities and energy usages; the individual energy requirement for each group was calculated. The estimated energy requirements per day, by age and gender for moderately active individuals were taken from Britten et al. (2006) and Michaelsen et al. (2000). Equation 1 was used for the calculation of nutritional energy requirements for each age and gender group. The results are given in Table 2, separately. The average values were calculated as 1560.5, 2254.2 and 2000 kcal/day per capita for 0-14, 15-64 and 65+ years old, respectively.

$$TER = PT\ x\ AGGP\ x\ AER \quad (1)$$

where TER (kcal/day) is total energy requirement, PT (number) is population in the future, AGGP (%) is age/gender group percentage, AER (kcal/day) average energy requirement of age/group per capita.

To determine the quantity of carbohydrate (M_C), protein (M_P) and lipid (M_L), which are used in the regular diet, the overall energy requirement calculated values were converted by using the conversion factors such as 4, 4 and 9 kcal/g for carbohydrate, protein and lipid, respectively. In a regular daily diet, humans generally consume 70% carbohydrate, 20% protein and 10% lipid (Gökırmaklı, 2017). In that study (Gökırmaklı, 2017), different diet formulations were generated (0-100% for carbohydrate, protein and lipids), then these ratios were analysed according to world people diets. It was found that 70%, 20% and 10% of carbohydrate, protein and lipids were consumed in regular diets overall the world. Therefore, these percentages were used to calculate the required quantities of carbohydrate, protein and lipid.

Table 2. Average Energy Requirement for Moderately Active Women and Men with Different Age Groups (Britten et al., 2006; Michaelsen et al., 2000).

Age group (0-14 years old)	Energy req. (kcal/day) per capita	Age group (15-64 years old)	Energy req. (kcal/day) per capita	Age group (65+ years old)	Energy req. (kcal/day) per capita
0-12 months (boy)	745.0	15-20 (Male)	2760.0	65+ (Male)	2200.0
0-12 months (girl)	697.5	15-20 (Female)	2040.0	65+ (Female)	1800.0
2-9 (boy)	1475.0	21-60 (Male)	2550.0		
2-9 (girl)	1400.0	21-60 (Female)	1975.0		
10-12 (boy)	2000.0	61-64 (Male)	2400.0		
10-12 (girl)	1866.7	61-64 (Female)	1800.0		
13-14 (boy)	2300.0				
13-14 (girl)	2000.0				
Average energy requirements (kcal/day) per capita based on age and gender	**1560.5**		**2254.2**		**2000.0**

Table 3. Daily Average Supply (Quantity as Weight) of Major Food Groups in Syria (G/(Dayxcapita)) and Their Shares (FAO, 2005)

Major food groups	1965-1967	1972-1974	1979-1981	1986-1988	1993-1995	2000-2002	Mean (g/(dayxcapita))	Percentage of product in diet based on the quantity(%)
Cereals	423	469	478	503	478	465	469.33	28.13
Starchy roots	20	38	69	66	52	62	51.17	3.07
Sweeteners	49	66	97	94	103	107	86.00	5.16
Pulses, nuts, oilcrops	36	46	49	52	44	69	49.33	2.96
Fruit and vegetables	514	660	1069	799	521	477	673.33	40.36
Vegetable oils	22	25	29	32	47	56	35.17	2.11
Animal fats	11	9	14	10	7	8	9.83	0.59
Meat and offals	38	37	64	59	53	65	52.67	3.16
Fish and seafood	2	5	7	2	2	7	4.17	0.25
Milk and eggs	172	154	280	259	240	261	227.67	13.65
Other	6	6	9	10	12	14	9.50	0.57
TOTAL	1293	1515	2165	1886	1559	1591	1668.17	100

According to the data, the total food quantity as average was calculated as 1668.17 g/(dayxcapita) (Table 3). This was used for the percentage estimation of each food component in the regular diet of Syrians. The percentage of each food group in the daily diet was given in the last column of Table 3.

Additionally, the food requirements (quantity in ton) based on the food groups were calculated, which were used to determine the amount of food to feed Syria and investment projection on the food sector. In order to feed the Syrian peoples, the major food groups as regular food requirements will be demanded for the future of Syria. Therefore, the major food groups required to feed the people were firstly determined as cereals, starchy roots, sweeteners, pulses, nuts, oilcrops, fruits, vegetables, vegetable oils, animal fats, meat, offals, fish, seafood, milk, eggs and other foods. The average amounts of major food groups required for the Syrian peoples in the future were calculated using the FAO data (Table 3). The data was based on the fundamental major food categories and the average weight supply of each food group daily per capita for Syrians for the different years, and it was presumed the fluctuations over the years are because of the decreases or increases in the supply due to the climatic conditions (FAO, 2005).

In order to calculate the required daily amount, gram/dayxper capita was multiplied with the estimated future populations and the obtained unit (gram/day) was converted into tons per day (ton/day) and tons per year (ton/year) to determine the annual and daily food requirements.

In order to determine the required numbers of food plants in Syria for the furture, firstly, the major food products' values (as groups) in Table 3 were used for the calculation of the total required amount of food. For estimation of the number of plants, the calculated required amount of food was divided by the one food plant capacity.

3.Results and Discussion

3.1 Calculation of Nutritionally Energy and Food Requirements

The first step of the calculation was to estimate the total nutritional energy requirement based on the food requirement for feeding Syrian peoples in the future. For the calculation of total energy requirement, the total population estimation (Table 4) and age-gender percentages in the population (Table 4) of Syria for 2020, 2030, 2040 and 2050 were used. The calculations were based on multiplying the percentage of each age/gender group with the total population. Then, the average daily energy requirement for the total population was determined for the different age and gender groups (Table 4). In the present calculations, the incomes (low and high) of the households, spoilage or losses in the foods were underestimated. However, according to industrial processing yield values, loss/by-product ratios during the processing were given at the end of the study. As a result, the total energy requirements of Syria for 2020, 2030, 2040 and 2050 were calculated as 3793313529120, 5430696791200, 6343597344360 and 7051847364250 kcal/day, respectively.

Table 4. Total Energy Requirement for Each Age/Gender Group in The Population in The Future (kcal/day)

Age and gender group	Years			
	2020	2030	2040	2050
0-14	1.01E+12	1.17E+12	1.20E+12	1.16E+12
15-64	2.60E+12	3.93E+12	4.63E+12	5.10E+12
+65	1.85E+11	3.35E+11	5.11E+11	7.89E+11
Total energy requirement for all groups (kcal/day)	3.79E+12	5.43E+12	6.34E+12	7.05E+12

As a percentage of energy intake from carbohydrates, proteins and lipids were also provided. As explained previously, humans obtain the daily nutritional energy from carbohydrates (70%), proteins (20%) and lipids (10%). These ratios are also considered as the share of the daily diet for carbohydrates, proteins and lipids. Therefore, the required amounts of carbohydrates, proteins and lipids were determined by using the calculated total energy requirements values (kcal/day) (Table 5).

By using Table 5, the amount of carbohydrate (M_C), protein (M_P) and lipid (M_L) were calculated by using the Atwater system, which considers the caloric values of 1 g of carbohydrate, protein and lipid as 4, 4 and 9 kcal, respectively (FAO, 2003). By dividing the total energy requirements (kcal/day) into these conversion factors (kcal/g), the required amount of carbohydrate, protein and fat (g/day) were obtained (Table 5), then they were converted to annual quantity requirements (ton/year) for carbohydrate, protein and lipid for 2020, 2030, 2040 and 2050 for Syria (Table 6).

Table 5. Estimated Carbohydrate, Protein and Lipid Requirements in The Future (kcal/day, g/day, tons/year)

		Years			
		2020	2030	2040	2050
kcal/day	M_C for total population (70% share in diet)	2.66E+12	3.80E+12	4.44E+12	4.94E+12
	M_P for total population (20% share in diet)	7.59E+11	1.09E+12	1.27E+12	1.41E+12
	M_L for total population (10% share in diet)	3.79E+11	5.43E+11	6.34E+11	7.05E+11
g/day	M_C (g/day) for total population (conv. fac. 4 kcal/g)	6.64E+11	9.50E+11	1.11E+12	1.23E+12
	M_P (g/day) for total population (conv. fac. 4 kcal/g)	1.90E+11	2.72E+11	3.17E+11	3.53E+11
	M_L (g/day) for total population (conv. fac. 9 kcal/g)	4.21E+10	6.03E+10	7.05E+10	7.84E+10
tons/year	M_C (g/day) for total population (conv. fac. 4 kcal/g)	2.42E+08	3.47E+08	4.05E+08	4.50E+08
	M_P (g/day) for total population (conv. fac. 4 kcal/g)	6.92E+07	9.91E+07	1.16E+08	1.29E+08
	M_L (g/day) for total population (conv. fac. 9 kcal/g)	1.54E+07	2.20E+07	2.57E+07	2.86E+07

Notes: (M_C: Carbohydrate, M_P: Protein, M_L: Lipid)

Table 6. Required Amount of Food for the Year 2020, 2030, 2040 and 2050

Year	Type of food	Daily consumption (g/dayxcapita)	Ratio of foods in regular diet (%)	Total amount of foods	
				tons/day	tons/year
2020	Cereals	469.33	28.13	8881.66	3241807.36
	Starchy roots	51.17	3.07	968.28	353421.47
	Sweeteners	86.00	5.16	1,627.46	594024.36
	Pulses, nuts, oilcrops	49.33	2.96	933.58	340758.16
	Fruit and vegetables	673.33	40.36	12742.16	4650888.40
	Vegetable oils	35.17	2.11	665.49	242905.31
	Animal fats	9.83	0.59	186.09	67921.39
	Meat and offals	52.67	3.16	996.66	363782.36
	Fish and seafood	4.17	0.25	78.85	28780.25
	Milk and eggs	227.67	13.65	4308.36	1572552.86
	Other	9.50	0.57	179.78	65618.97
2030	Cereals	469.33	28.13	12488.02	4558127.79
	Starchy roots	51.17	3.07	1361.44	496926.57
	Sweeteners	86.00	5.16	2288.29	835225.12
	Pulses, nuts, oilcrops	49.33	2.96	1312.66	479121.39
	Fruit and vegetables	673.33	40.36	17916.05	6539359.47
	Vegetable oils	35.17	2.11	935.71	341535.85
	Animal fats	9.83	0.59	261.65	95500.55
	Meat and offals	52.67	3.16	1401.35	511494.45
	Fish and seafood	4.17	0.25	110.87	40466.33
	Milk and eggs	227.67	13.65	6057.75	2211080.45
	Other	9.50	0.57	252.78	92263.24
2040	Cereals	469.33	28.13	14455.00	5276074.03
	Starchy roots	51.17	3.07	1575.88	575196.99
	Sweeteners	86.00	5.16	2648.71	966780.61
	Pulses, nuts, oilcrops	49.33	2.96	1519.42	554587.33
	Fruit and vegetables	673.33	40.36	20737.99	7569367.57
	Vegetable oils	35.17	2.11	1083.10	395330.83
	Animal fats	9.83	0.59	302.86	110542.74
	Meat and offals	52.67	3.16	1622.08	592059.44
	Fish and seafood	4.17	0.25	128.33	46840.15
	Milk and eggs	227.67	13.65	7011.91	2559345.57
	Other	9.50	0.57	292.59	106795.53
2050	Cereals	469.33	28.13	15967.19	5828024.11
	Starchy roots	51.17	3.07	1740.74	635370.53
	Sweeteners	86.00	5.16	2925.81	1067919.19
	Pulses, nuts, oilcrops	49.33	2.96	1678.37	612604.81
	Fruit and vegetables	673.33	40.36	22907.47	8361227.77
	Vegetable oils	35.17	2.11	1196.41	436687.89
	Animal fats	9.83	0.59	334.54	122107.04
	Meat and offals	52.67	3.16	1791.77	653997.02
	Fish and seafood	4.17	0.25	141.75	51740.27
	Milk and eggs	227.67	13.65	7745.45	2827088.40
	Other	9.50	0.57	323.20	117967.82

With this study, it was intended to provide general information on the quantities of food products in terms of the daily and annually average intakes for the following dietary components/nutrients: carbohydrate (C), protein (P) and lipid (L). For 2020, the estimated requirement for nutritional intakes in terms of carbohydrates, protein and lipid were 242297902, 69227972 and 15383994 tons/year, respectively. However, due to the forecasted rapid increase in the annual population of Syria, these numbers were expected to rise by 450436750, 128696214 and 28599159 tons/year respectively in 2050. On the other hand, the source of carbohydrate, protein and lipid may be different for Syria, which depends on the availability of food products. According to Syrian people's food consumption habits, the nutrition can be obtained from cereals, starchy roots, pulses, nuts, fruits, vegetables, oils, etc. Therefore, the food quantities by selecting suitable food types for the Syrian people were calculated

In Table 6, the major food groups found in the diet of Syria were determined. According to the average daily food requirement (1,668.17 g/(dayxcapita) from Table 3) and the percentages of these major food groups, the projections were estimated for the future populations of 2020, 2030, 2040 and 2050 separately and the obtained data was converted into ton/day and ton/year for each major food groups (Table 6).

In Table 6, the percentage of each food group for a regular diet was calculated. It can be said that fruits and vegetables take a crucial place in the diet of Syrians with 40.36 percent, where it is followed by cereals 28.13 percent. Although, in the Syrian diet, the share of fish consumption is extremely low, which composes only 0.25 percent of the daily food consumption.

As a developing country, it is projected for Syria to show a regular increase in the future population according to the WorldBank estimations. However, while the population will reach 34,021,000 in the 2050s, it can be concluded that Syria will face with difficulties in feeding this expanding population, which is almost twofold of the current number (Table 6). Moreover, while the demand on each food group will be almost doubled by 2050 not only the impacts of war, but also climate changes are anticipated to restrict the country to fulfil the demand of Syrian people in the future. Therefore, it is projected that imports will rise continuously by 2050, if a new creative solution for the food and agriculture industries is not found.

3.2 Comparison of Calculated Food Demands to Available Food Production in Syria

In the previous section, the required amounts of major food groups were calculated (Table 6). The availability of the food and the potential of Syria were analyzed. As an important note, these calculated values were only food based, not for animal feeding, seeding or any other industrial utilization. Additionally, losses during transportation, processing or storing were not included to the calculations. However, according to industrial processing yield values, the ranges of loss/by-product ratios for different food groups were given.

3.2.1. Cereal Products

The official data states the total major cereal production (wheat, barley, millet and maize) of the country was 3898400 tons at 2010 (FAOSTAT, 2018). According to the calculations in the present study, this amount only for feeding people would be enough for meeting the cereal demand of the country almost until 2020. However, around 3077825 tons of cereal were imported in 2010, where the exported cereal of the same year is at a negligible value. The amount of import might be due to the other requirements such as animal feeding, seeding, etc. It could also be due to the maize demand as fodder in the growing poultry industry. Although, since the required amount of cereals is 3241807.36 tons for 2020, it can be deduced that the import value of the country will raise gradually if Syria does not enhance its cereal production.

Moreover, the general cereal import data of Syria depicts that the import quantity has increased notably for wheat and barley between 2007 and 2009, which were the years a disastrous drought took place in the country (FAOSTAT, 2018). Therefore, it is estimated that the foremost problem of the country is the shortcomings in the production infrastructure such as being highly dependent on rainfalls, that lead to fluctuations in the annual output. For reducing the impacts of climate on the agricultural production, irrigated lands should be enlarged, where only 65% of all cereals relied on the irrigation systems before the war (ACAPS & MapAction, 2013).

In the realm of marketing, the storing and processing of wheat, in 2006, there were 33 operating government-controlled mills with 2 million tons of total annual milling capacity. There were also 25 private mills available in Syria with a similar production capacity (Koopman, 2013). Therefore, it is estimated that the overall milling capacity can meet the demand of Syria for the next 30 years. However, after the war, the private sector should be supported for the rehabilitation and maintenance of the damaged plants.

3.2.2. Starchy Roots

Potato is the most produced starchy root in Syria, which enjoys comparative advantages, urges the export volume of the country. The total production of potato in 2011 was around 713000 tons. According to the present calculations, this amount will be sufficient even for supplying the demanded amount for the next 30 years, which was calculated as 635370.53 tons for 2050. However, the country should focus on improving the supporting services of this crop, providing the required amount of seeds in time with fair prices and boosting the yield due to the limited possibility of horizontal growth (Alammouri, 2008).

Additionally, the quality of the potato seeds also plays a critical role in increasing productivity, since the mean yield can be increased from 30 to 50 percent with the use of good quality seed (Wang, 2008).

3.2.3. Nuts, pulses and oil-crops

Before the war/crisis, the total production amount for nuts, pulses and oil-crops is 478900 tons according to FAO data for 2010 (FAOSTAT, 2018). According to the calculated results in the present study, the required quantity for 2030 is 479121.39 tons. Even though this amount seems numerically enough for the demand, Syria imported nuts, pulses or oil-crops in the past. This can be considered as an indicator for the requirement of a specific type of food product, such as pistachio and walnut.

In Syria, the most widely produced nuts are almonds, pistachios and walnuts, with a production amount of 73100, 57500 and 12100 tons, respectively in 2010 (CBSS, 2017). According to FAOSTAT records while Syria exports almond, imports pistachio and walnut (FAOSTAT, 2018).

During the war, because of the shortage of electricity and high diesel prices, a large number of pistachio trees has been cut down for firewood (Dost, 2015). When it is taken into consideration that pistachio trees can generally begin bearing from the fourth or fifth year of its age-yet a good amount of yield is harvested after its seventh or eighth year- (Malhotra, 2008); it can be concluded that Syria will need a period of time for producing the pistachio in the same capacity as it was in the 2000s, even if they are replaced with the same number of trees.

Also, for supplying the required demand of the expanding population of Syria, various strategies should be developed for increasing the crop yield. For instance, in Syria, the primary requirement to increase the yield is growing modern irrigation systems, as the cultivation of pistachio, almond and walnut trees are dependent upon water and the yields are affected in dry years (Baysan, 2001). Studies point out that irrigation treatment may increase the yield of a pistachio tree more than twofold in weight. However, it should be noted that irrigation does not affect fruit quality (Jain et al., 2000).

The Central Bureau of Statistics of Syria (CBSS) data illustrates that the total amount of pulses (legumes) of Syria was 174800 tons in 2010. According to the data of the cropped area and the volume of production for legumes between 2006 and 2010, while the harvested area in the country had been nearly constant, output fluctuated considerably (CBSS, 2011). It can be concluded that productivity depends on the rainfall, that increases in wet years and drives a decline in dry years (Mawlawi & Tawil, 1990). This demonstrates the importance of adopting modern irrigation systems one more time, which will help the productivity to remain at a stable level.

According to FAO data, the only oilcrops of the country are soybean, cotton and sesame and their production amounts were 91400, 49200 and 20800 tons at 2010, respectively (FAOSAT, 2018). However, due to the limited information about oilcrops, the production conditions could not be evaluated.

3.2.4. Fruits and Vegetables

Fruits and vegetables are crucial for the Syrian market and their total production amount was around 7246000 tons in 2011 (CBSS, 2017). If Syria can reach these production numbers when the crisis/war ends, this number will meet the country's needs until the mid of 2030-2040s. However, Syria should take steps for addressing the fruit and vegetable requirements of the forecasted growing population, which is calculated as 7569367.57 tons for 2040. One of the steps to be followed could be increasing the fruit and vegetable harvested lands, which were 13540 m^2 and 48378965 m^2, respectively between the years of 2010 and 2011 (CBSS, 2017). When the rainfall amount and other conditions are neglected, it is estimated that around 15% increase in the harvested area will cover the needs of the country in the 2050s.

3.2.5. Vegetable Oils

FAO data illustrates that the main vegetable oils consumed and produced in Syria are olive oil and sunflower oil, where the production amount in 2011 was 208329 and 9400 tons, respectively (FAOSTAT, 2018). Before the war/crisis, Syria made little foreign trade in olive oil. It did not import any olive oil and its export numbers were very small. Besides, the country was importing sunflower oil to satisfy the needs of domestic consumption. The imported amount of sunflower was around 124963 tons in 2011, which is quite higher than the production amount (FAOSTAT, 2018). According to the calculations in the present study, the required amount for vegetable oils was calculated as 242905.31 tons for 2020. In the light of these findings, one could say that Syria will continue importing sunflower oil since there is a large gap between of the produced and imported quantity, and it will not be logical to expect the country to close this gap. Therefore, the most crucial step after the war/crisis would be focusing on the constraints of the olive oil sector at least for meeting the olive oil requirements in the future.

The most important constraints of the Syrian olive oil sector are insufficient labor availability for olive harvesting, inadequate quality control for marketing standards in foreign trade, the lack of effective branding, olive cultivars have problems in chemical quality, 50% of the oil mills are press and awareness among the local consumers is low (Brillante et al., 2007).

In 2009, the number of olive oil processing plants was 1066 in Syria, with 6700 (ton/8 hr) daily capacity (International Olive Council, 2012). This number of plants will enable Syria to process 1608000 tons/year of olive.

When it is assumed that 5 kg of olive yields 1 kg of olive oil with a 1/5 ratio, this number of plants can produce about 321200 tons of olive oil in a year. Therefore, it is estimated the olive plant capacity of Syria will be sufficient for satisfying the olive oil demand of the country by 2050s.

Since olive growing in Syria is centred in the southern and western regions like Aleppo, Idleb, Lattakia, Daraa and Rural Damascus (International Olive Council, 2012), the factories should be located around these areas. This will facilitate access by suppliers and distributors.

Even though the number of plants in the country was sufficient, there were many issues within the sector such as improper procedures for post harvesting and processing, limited mill and wholesaler sizes, lack of modern containers and absence of business linkages between processors and farmers (Fiorillo & Vercueil, 2003).

It is estimated that there is a high potential for improving the quality in case the country adapts strategies to overcome these challenges (Brillante et al., 2007). The primary approach for the sector could be upgrading milling plants with improved storage conditions and a grading system complies with international and external market standards (Wattenbach, 2006). This will enable Syria to expand into new markets and enhance the competitiveness of olive oil exports.

3.2.6. Animal Fats

Due to the limited information regarding this subject, the available animal fats data of the country could not be evaluated. According to the calculations, the demanded amount will be 67921.39 tons for 2020 as a near future.

3.2.7. Meat

The total meat production of Syria was about 421142 tons in 2010 (FAOSTAT, 2018), which excludes consumption of offals. It was estimated for this amount to meet the requirements of the country until the mid-2020s. However, Syria will encounter shortcomings in satisfying the meat demand in the future as it is calculated as 511494.45 tons for 2030. Moreover, for meat, aside from the calculations, it is expected that the per capita consumption is likely to increase as incomes of people grows (Bahhady et al., 1998).

Shomo et al. (2010) states that despite the rapid increase in the number of sheep, the ratio of output to input remained low in the country. Addition to this, the poultry industry was suffering from high market prices due to the high cost of fodders. As poultry meat production had significantly increased in the last ten years of Syria, just prior to the crisis/war, Syria was self-sufficient for poultry meat production and had a surplus for export. However, the sector is anticipated to face competition with imported frozen chicken meat in the local market due to the high prices of domestic product and unsuitable transportation, conserving and slaughtering methods, which are causing health risks. Therefore, after the crisis/war, in order to turn into advantage its geographical location in the crossroad between Europe and Asia and highly importing Gulf markets, the livestock sector should be monitored closely and more attention should be paid for reducing the production cost of chicken meat (Al-Hamwi & Lancon, 2011).

According to Cummins (2000), "the ability of the Syrian livestock sector to meet the domestic demand for livestock products will depend on its ability to intensify production and improve the quality of its animals". The study of Shomo et al., 2010 points out the various ways for improving the efficiency in sheep production.

Moreover, overgrazing of the large population of sheep in dry regions causes land degradation (Baghasa, 2006a). Therefore, while the sector is being supported for growth, it should be balanced with measures for maintaining agricultural and environmental sustainability.

3.2.8. Fish

Syrian fishery production in 2010 was approximately 15245 tons (from aquaculture 56%) (Encyclopedia Britannica, 2014). This amount is considerably lower than the required amount for consumption even for 2020, which is calculated as 28780.25 tons.

The major constraints of the fishery industry in Syria are stated as limited available resources, exploitation of demersal assemblages, lack of government support to small-scale fisheries and unwillingness of fishers to practice modern methods. Moreover, the fisheries are having the deficiency of being monitored and supported by governmental bodies specified for this sector even though there are two governmental bodies established for this aim (the Department of Fisheries and the General Establishment of Fisheries) (Villegas, 1983).

When the country available imports-exports data and the self-production amount of Syria is taken into consideration, it can be deduced that there is a need for urgent action for reviving the fishery sector.

Based on the FAO report published for improving the quality of fishery products and market chains in Asia, the main steps that should also be followed in Syria can be enumerated as (FAO, 2013); i) government support should be provided for enhancing productivity and product marketing, ii) for the improvement of hygiene, product quality and nutritional value, a cold chain should be adopted and trainings provided to small and medium enterprises on hygiene and sanitation techniques, iii) sanitary conditions and poor facilities of the fish markets and landing centers should be enhanced for improving the standards and value of fishery products, iv) basic awareness should be raised for enhancing the water quality for reducing risks from contaminated water and quality of water needs to be monitored regularly, v) government regulations should be set for product safety and implemented for management of landing sites and fish markets and they should be regularly monitored.

3.2.9. Milk and Eggs

The milk production in Syria was mainly supplied by dairy cattle farms with small and micro units; these are scattered all around the country. Besides, there was a small number of states and collective farms in addition to the private pilot farms established most recently, which were providing only 10-15% of the total milk production in Syria (Fayad, 2009).

The small traditional dairy farms were accompanied by two main constraints: the collection, low productivity and quality. Due to the distance from well-equipped collection centers, around 80-90% of the produced milk is collected by traders called Hallab, who store and transport the collected milk in primitive and unsanitary conditions. As the milk sector of Syria was being led by Hallabs, the most of them adulterated the milk for covering the defects of their products, which ended up with low quality dairy products in Syria. These practices also decreased the prices and made the products processed with good quality standards impossible to compete with them (Fayad, 2009). It can be concluded that the development of the dairy industry with an efficient location and production capacity will play an important role not only in the economy of Syria but also for the health of the local people.

According to the available country data, the total milk production of Syria in 2007 was around 2588554 tons/year, which is equal to 2588554000 litres/year (Fayad, 2009). Using these numbers, the dairy plant demand of the country was calculated. For these calculations, the daily capacity of the plant is considered as 5000 litres per day, five working days/week and working 48 weeks in a year. This is equal to 1020000 litres/year annual capacity. Because it is not practical to presume a plant to run full capacity in a year-around, the operating capacity of plants is calculated at 85 percent, which is equal to 1020000 litres/year.

According to the calculations for processing the same total milk production in 2007, 2588554 tons/year, 2537 dairy plants will be fulfilling the demand. However, due to the current situation of Syria, where the livestock sector has been severely influenced by the conflict, reduction in the supply is considered and the required number of plants were calculated for a decline by 60% in the supply (Table 7).

Table 7. Estimation of Required Plant Number in Syria

Percentage of Reduction in Supply	Produced milk (lt/year)	Required number of plants (operating with 85% capacity)
10%	2329698600	2284
20%	2070843200	2030
30%	1811987800	1776
40%	1553132400	1523
50%	1294277000	1269
60%	1035421600	1015

One of the critical points in planning the dairy industry is allocating plants near to sources for bearing on the profitability of the dairy and initial quality of the milk, minimizing the transportation cost and increasing the profit. For that reason, following factors should be considered in selecting the area: accessibility of raw material, market and labor, water supplies and its quality, transportation facilities, climatic and environmental conditions of the area including direction of prevailing wind and possible increase in dust and smoke nuisance from the neighbour, market potential and volume of power and fuel (Patel & Bhadania, 2016). In the past, the large-scale industrial processing used to be limited to the three state factories of Damascus, Aleppo and Homs. However, since the farms are located in the rural areas of Damascus, Aleppo, Hama, Homs, Lattakia, Al Hassakeh and Deir Ez-Zor (Fayad, 2009), it will be viable to construct plants in Hamma, Lattakia, Al Hassakeh and Deir Ez-Zor, too, to reduce the transportation cost.

Moreover, the egg production in 2007 was 170000 tons (in shells) (Subuh, 2008). If Syria can reach the same amount of production in 2007 for milk and egg, 2758554 tons, it will meet the demand by the end of the 2040s. The calculations also indicate that the country can cope with the milk and needs of expected population growth -which is calculated as 2827088.40 tons of milk and egg in 2050- with a relatively small effort in the sector.

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Table 8. Actual Values for The Required Amount of Food for 2020, 2030, 2040

Year	2020		2030		2040		2050	
Type of food	Theoretical Value	Actual Value	Theoretical Value	Actual Value	Theoretical Value	Actual Value	Theoretical Value	Actual Value
Cereals (excl. beer)	3241807.36	4631153.37	4558127.79	6511611.12	5276074.03	7537248.61	5828024.11	8325748.72
Starchy roots	353421.47	504887.81	496926.57	709895.10	575196.99	821709.99	635370.53	907672.18
Sweeteners	594024.36	848606.23	835225.12	1193178.74	966780.61	1381115.16	1067919.19	1525598.84
Pulses, nuts, oilcrops	340758.16	486797.37	479121.39	684459.12	554587.33	792267.61	612604.81	875149.72
Fruit and vegetables	4650888.40	6644126.29	6539359.47	9341942.10	7569367.57	10813382.24	8361227.77	11944611.10
Vegetable oils	242905.31	347007.59	341535.85	487908.36	395330.83	564758.33	436687.89	623839.84
Animal fats	67921.39	97030.56	95500.55	136429.35	110542.74	157918.21	122107.04	174438.63
Meat and offals	363782.36	519689.09	511494.45	730706.36	592059.44	845799.20	653997.02	934281,46
Fish and seafood	28780.25	41114.64	40466.33	57809.05	46840.15	66914.49	51740.27	73914.67
Milk and eggs	1572552.86	2246504.09	2211080.45	3158686.36	2559345.57	3656207.95	2827088.40	4038697.71
Other	65618.97	93741.39	92263.24	131804.63	106795.53	152565.05	117967.82	168525.45

3.3 Modified Values for Actual Requirement

The calculation of required amount of food was focused on the average daily supply per capita. However, these numbers do not illustrate the amount of food consumed actually because of over-consumption or waste by the human, variability in consumptions varying within regions of a country or between different socio-demographic subgroups in the population. Addition to these factors, food components are also used for feeding animals. Therefore, the actual values can be calculated by using 70% correction factor (actual value=calculated value/0.70) except for animal feeding (Table 8).

As a note, during the processing, some amounts of products are lost or obtained as by-product. They can be calculated by taking as 20-30%, 20-40%, 80-90%, 40-50%, 20-30%, 2-6%, 1-5%, 10-20%, 30-50% and 1-5% for cereals, starchy roots, sweeteners, pulses/nuts/oilcrop, fruits/vegetables, vegetable oils, animal fats, meat, fish and milk/eggs, respectively.

3.4 Effect on Interrelated Industries

The food industry is additionally related to other industries such as machinery, energy, water supply, irrigation, R&D, repairing, spare parts etc. Among these industries, machinery and energy (fuel, electricity) sectors, and water supply are the most important. After the crisis/war, when Syria starts the re-development and re-investment periods, food machinery industry will play an important role. Therefore, local and/or import food machinery will be very strategic in the future of Syria.

Additionally, energy (fuel, electricity) and water supplies will be other strategic issues. Especially, industrial zones for food plant investment need energy and water supplies. Therefore, a master plan will be required for the food industry of Syria.

4.Conclusion

In Syria, there will be an estimated 12 million more people to feed by 2050 and this forecasted increasing population is expected to result in resource scarcity and a rising demand for food. Syria will need to show a considerable effort to satisfy the requirements of the country which resulted not only from destructed agricultural infrastructure but also climate changes and financial incapabilities. However, when the high level of social and economic dependence on agriculture of Syria is considered, agricultural and food development will help to recover the devastated economy of the country.

The findings of this study indicate that Syria will be highly dependent on imports in the future. To close this gap there is a need for investments in agricultural and food researches for determining the best practices for improvement in productivity. Based upon the acknowledgments of this study, after the end of the conflict the most crucial steps that should be taken as; i) for sustainability of water resources and stability and enhancement of the productivity Syria should adopt modern technologies in irrigation, ii) it was observed that even though there are many governmental bodies for the control of many sectors, there is a lack of governmental monitoring in the production areas, therefore, it is essential to increase monitoring, controlling and inspections by the governmental bodies, iii) since agriculture takes the first place in terms of water consumption in Syria and total renewable water resources per capita are considered at a high water stress level, it is vital to provide trainings to farmers over the importance of water resources for the future of Syria, iv) to feed Syrian peoples in the future food plant investments should be planned from today, v) the most of the work at the farming level is carried out manually due to the low labor costs, which is impacting the quality of the products poorly, and Syrian farmers should be encouraged and supported to adoption appropriate technologies, vi) for reviving the agricultural sector, the government should respond to the needs of farmers and industrialists with short-term budget supports for rehabilitation of the damaged or destroyed infrastructure, agricultural equipment and plants, vii) since the fishery sector is considered to be one of the most promising agricultural activities, serious attention should be paid for reviving that sector, viii) to maintain the food and agricultural productivity at a constant level, it is essential to prevent the rural and urban income disparities, which will prevent migration from rural to urban areas, ix) the food industry will be a more critical industry for Syria similar to other arid countries and it should be supported for the food security of Syria, x) in the future after the crisis/war, the population of Syria will increase and reach to about 34 million in 2050 and Syria will face with difficulties in feeding this expanding population, which is two-folds the current number. Additionally, climatic change will cause more arid regions in the country to depress the growth of food.

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