

Activity 3.1.2

PP6 – NAMAA

DESK REVIEW



Project funded by the
EUROPEAN UNION



REGIONE AUTÒNOMA DE SARDIGNA
REGIONE AUTONOMA DELLA SARDEGNA





Sustainable Networks For Agro-Food Innovation Leading In The Mediterranean (MedSNAIL)

**WP3 – AGRO-FOOD ALLIANCE
Output 3.1.- Agro Biodiversity Study
3.1.2. DESK REVIEW**

**Country: Jordan
Partner 6: Women for Cultural Development (Namaa)**

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1. INTRODUCTION AND BACKGROUND

Jordan is an Eastern Mediterranean country in Western Asia, on the East Bank of the Jordan River, bordered by Palestine, Syria, Iraq, and Saudi Arabia with a total area of 89,342 km². Jordan has a population of 10,162,808 inhabitants (World Population Review 2020).

Jordan is a constitutional monarchy, which gained independence in 1946. Since its independence agriculture has played a major role in its economy but has been in decline ever since. During the early 1950s, agriculture constituted almost 40 percent of GDP declining in the mid-1980s to about 6 percent to 5.6 percent today (Department of Statistics 2018). Many reasons contributed to this decline such as rural to city migration, immigrants, water scarcity, desertification, climate change, urbanization, agricultural policies, economic restructuring as whole, miss management of the water resources, the increase of big land ownership on the account of the small farms and the formation agricultural unions and associations.

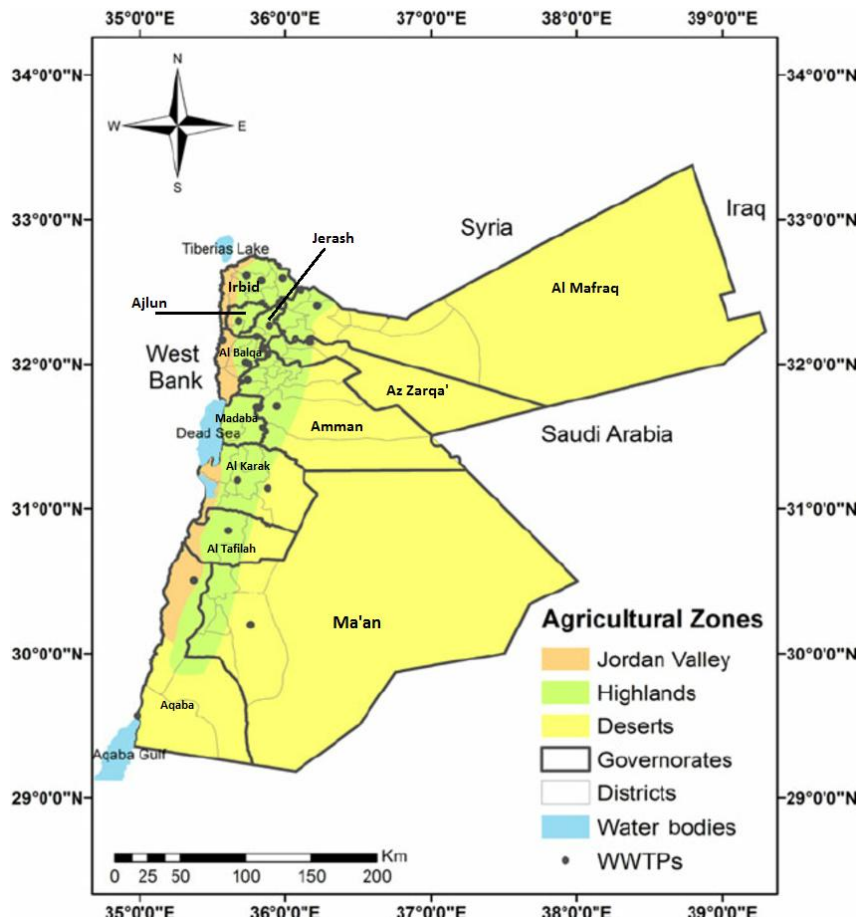
Jordan is a heavily urbanized, lower middle-income country. the Urban population 91.4% of total population (2020) at annual rate of 1.62.43% (2015-2020 est.). (Source CIA Factbook; www.cia.gov/library/publications/the-world-factbook/geos/jo.html) . In July 2017 the World bank reclassified Jordan as lower middle income country from being upper middle income in July of the previous year 2016, this classifications are based on Gross National income per capita (GNI/Capita) of the country and world basis it's clasificatiocation on the previous year's GNI per capita estimates. The estimate for Jordan's 2016 GNI/capita places it in this year's Lower-middle income group. Last year's classification based on the 2015 GNI/capita estimate placed it in the Upper-middle-income group.

Due to non-stop conflicts in the region starting in the early 20th century; Jordanians have provided a safe haven for the refugees and the persecuted, yet this trait has led to massive increase in population in the shape of refugee influxes during short periods of time, usually too fast for the planning and development processes to cope with. Consequently, the total population of Jordan has grown since 1948 from approximately 600,000 to 10.11 million in 2017. For instance, the capital city Amman had 60,000 inhabitants in 1948 compared to 4 million in 2017, comprising almost 40% of the total population. (Department of Statistics), the significant growth in population can be attributed to fertility rate and the refugees / immigrants the country received through the years. In terms of fertility the rate in 1955 was 7.38% and by 1970 reached 8% then it started a steady decline ever since. (<https://www.worldometers.info/world-population/jordan-population/>). Following Arab-Israeli 1948-war about 506,200 Palestinians settled in Jordan, and after the Israeli occupation of West Bank and East Jerusalem in 1967, about 240,000 Jordanians of Palestinian origin fled from the West Bank, 1988 between 1990 - 1995 The Gulf War brought a new wave of refugees from Iraq, and from 2003 invasion of Iraq, exceeding one million today. Also, around 300,000 Jordanian evacuees returned to Jordan after the Gulf War, many of whom are of Palestinian origin. Starting in 2011, the Syrian civil war has resulted in large numbers of Syrian nationals fleeing to neighbouring states, by April 2013, according to the UNHCR, 424,771 Syrian nationals reached Jordan (MPC – MIGRATION POLICY

CENTRE - MIGRATION PROFILE Jordan 2013). Now Jordan is considered the most refugee hosting country; 2.8 million refugees registered by UNHCR and UNRWA.

Such population growth has led to major implications regarding civil services, along with scarcity in natural resources to back up the economy, the government debt has grown threefold since the year 2000 (The World Bank) with minimal development to the quality of life and economic growth. In Addition, Jordan is amongst the top four countries globally regarding water scarcity, water supply has also become a great challenge for local authorities.

The country is divided into twelve governorates in three regions: the North Region: Irbid, Ajloun, Jerash, Mafrq, the Central Region: Balqa, Amman, Zarqa, Madaba, and the South Region governorates: Karak, Tafilah, Ma'an, Aqaba.



2. HISTORICAL BRIEF

The country is named for the River Jordan which means "to descend" or "flow downwards". Jordan being part of the Levant region played a key role through ancient civilization in the development of agriculture. Until 1921 Jordan did not have a separate political identity. It is earlier in history, that the Amirate of Transjordan was established under the British patronage on the East Bank by the Hashemites who were the rulers of Mecca. It was until 1946 that Britain abolished its mandate on the area and declared it as The Hashemite Kingdom of Jordan.

As part of the Fertile Crescent and with the earliest traces of first farmers in the world in northern Jordan and southern Syria dating approximately 7000 BC. Agriculture is deep rooted in the local culture and identity, from folk dances and music to everyday language and proverbs. The diverse climatic regions now forming Jordan has allowed the local communities to produce essential commodities such as wheat, barley and other field crops from north to south, along with a wide variety of vegetables, fruits, olives, citrus and other products. Which makes Jordan unique when it comes to the capability of producing various crops all year round.

Historically, Petra, an ancient metropolis with a state-of-the-art agriculture, water harvesting systems and urban water distribution for that era was established by the Nabataeans (400 B.C. and A.D. 106) who were famous for their distinct techniques in agriculture. In the early stages of their history, religion and traditions prohibited the Nabataeans, under threat of punishment, to grow wheat, trees and wine and to live in stone houses. Afterwards this changed quickly. As early as the Hellenistic era, they turned to agriculture and became experts in water management and hydraulic techniques. They constructed the necessary aqueducts, cisterns, channels, dams and water reservoirs. Furthermore, Nabataeans had mastered their unique art of irrigation and enjoyed rich harvests of cereal and fruits from across the kingdom. (Agriculture in sixth-century Petra and its hinterland, the evidence from the Petra papyri, Arabian Archology and Epigraphy, 2012)

In 106 AD Petra became part of the Roman Empire. In the era of the Roman rule in the region, cities of Philadelphia (Amman), Gerasa (Jerash), Gadara (Umm Qais), Pella and Arbila (Irbid) joined with other cities in Palestine and southern Syria to form the Decapolis League. Those cities were the first line of defense against the Persian Empire and produced a big percentage of the empire's food consumption, mainly wheat and barley. In the mountains and highlands of the west, agricultural development led to demographic and economic development, mostly focused on olive trees, through the proliferation of villages, increased road network density and the growth and development of towns. (Atlas of Jordan: History, Territories and Society, 2013)

During the Byzantine period, 324 AD -636 AD a major part of construction took place throughout Jordan. All of the main cities of the Roman Empire continued to flourish, and the regional population grew. The economy remained principally based on the traditional cultivation of vines and olive trees.

The Petra region during this period was part of a network of agricultural sites and provided an important market for local agricultural products. Agriculture was the spine of its economy in the sixth century, particularly in its hinterland. The possessed orchards, vineyards, threshing floors, grain land and other properties of an agricultural nature such as farmsteads and farmhouses. (Agriculture in sixth-century Petra and its hinterland, the evidence from the Petra papyri, Arabian Archology and Epigraphy, 2012)

In the year 636 AD Arab Muslims conquered the lands of Syria including Jordan. The Umayyad Period was a period of transition between the Byzantine and Islamic world in Jordan. During the Early Islamic period (Umayyad and Abbasid) saw the introduction of numerous new crops into the Middle East area, causing an Agricultural revolution. Many of these new crops, as sorghum, Asiatic rice, wheat, barley, sugar cane, cotton, citrus fruits, banana, watermelon, and spinach, among others, are from the tropical climate of South Asia did not match the cooler and drier climates of the Middle East; but, except for rice planting all of these new crops proved successful in Jordan. (The Abbasid Occupation at Gadara (Umm Qais), 2011 Excavation Season, 2015)

In regards of its economic significance, the use of farmland in Jordan reached its maximum potential by the Mamluk state to support the financial and social reinforcements of its military. The basis of the Mamluks' agricultural regime was grains; Jordan was a key supplier of wheat to Cairo and the rejoin in times of shortages. During this period the peasants of the area proclaimed control over their own natural resources and markets rather than being passive participants. (The Role Of Agriculture In Mamluk-Jordanian Power Relations, Department of History, Grand Valley State University)

In 1516 CE, the Ottoman Turks defeated the Mamluks, Jordan became part of the Ottoman Empire and continued to be so for the next 400 years. In general, during this period, Jordan faced lack of progress. The Ottomans were mainly interested in Jordan in terms of its importance to the pilgrimage route to Mecca al-Mukarrama. The Hejaz railway was constructed, linking Istanbul and Mecca. The railway across Jordan was constructed separating the landscape climatically, with the areas to the west of the railway being arable and east of it being non-arable, which mainly comprised of desert and steppe regions. Over the course of Ottoman rule, many towns and villages were abandoned, agriculture declined, families and tribes moved regularly from one village to another. (An Agricultural Question in Jordan, 1991)

In the early 20th century, post the First World War and fall of the Ottoman Empire, Jordan became under British rule, appointing -later King- Prince Abdullah I as ruler of Transjordan under the British mandate. With the decline that the area faced throughout the ottoman period Jordan lacked agricultural resources, the British Mandate authorities also was only was interested in

Jordan's strategic location in the Levant. Thus, the development of agriculture in Jordan under the British Mandate was on a limited scale, and the cultivated land compared to the area of arable land continued to be limited. (An Agricultural Question in Jordan, 1991)

In 1946, Prince Abdullah negotiated a new Anglo-Transjordanian treaty, ending the British mandate and gaining full independence for Transjordan, the Transjordanian parliament proclaimed Abdullah king, while officially changing the name of the country from the Emirate of Transjordan to the Hashemite Kingdom of Jordan.

Agriculture in Jordan contributed considerably to the economy at the time of Jordan's independence, but it then underwent a steady decline for decades. In the early 1950s, agriculture constituted almost 40 percent of GNP; on the eve of the June 1967 War, it became 17 percent, including the yields from the West Bank which was under Jordan's mandate at the time.

By the mid-1980s, due to many factors, agriculture's share of GNP in Jordan became only about 6 percent. With the Israeli occupation of the West Bank, Jordan lost major farmland that was part of it since 1949. The inability of agriculture to keep pace with the growth of the rest of the economy caused insufficiency in domestic food supply. Accordingly, Jordan needed to import many food staples such as cereals, grains, and meat. . (Chapin Metz, Helen (1989). "Jordan: A Country Study: Agriculture". Library of Congress, Washington D.C).

2. JORDAN AGRICULTURE NATURAL RESOURCES

2.1. CLIMATE

Jordan is a dry, semi-arid and drought prone country, ranging between hot dry relatively uniform summers, and cool variable winters. The rainy season is between October and May with 80% of the annual rainfall experienced between December and March. The temperature mildly increases from North to South of Jordan except for some parts in the south which are known as the Southern Highlands, though it varies from year-to-year and season to season, where the temperature may drop below zero in the coldest months with frost formation in some places, such is the case in the mountainous areas, on the other hand it may reach 50°C in locations such as the area covering entire length of the eastern part of the country which is known as the Rift Valley.

Jordan has three notable agro-climatic zones: the Jordan Valley, The Highlands, and the Marginal Areas and Eastern Deserts:

- 1) The Jordan Valley is part of the Rift Valley and covers over 5.6% of Jordan's total area and can be divided into the Jordan Valley, the Dead Sea and the Araba Valley, extends from the northern border of Jordan to the Dead Sea with altitudes ranging between 220 m below sea level to 407 m below sea level at the Dead Sea. It's the most fertile area in the country, and due to the warmer climate in winter, and availability of water for irrigation, it has year-around agricultural production.
- 2) The Highlands extend from the north to the south throughout the western part of Jordan, with elevation varies from 600 m to about 1500 m above sea level. This area receives the highest rainfall in Jordan, and the climate can be described as Mediterranean with a hot dry summer and a wet winter with two short periods of Fall and Spring.
- 3) The Marginal area and the Eastern Desert. The Marginal area is located to the east of the Western highland, and has an arid and semi-arid climate and where almost half of the irrigated lands are located (Dr. Ahmad Shukri Al-Rimawi, 2001, STRUCTURE & ADMINISTRATION OF HOLDINGS BY AGRO-CLIMATIC ZONES IN JORDAN, Department of Statistics) , as underground water is the main source of irrigation, the main crops grown in the area are melons, tomatoes, cucumber, apples and peaches which are under irrigation specifically drip irrigation, grains are also produced in this area, but under rain-fed conditions making it a miner production. as for Eastern Desert which covers around 88% of Jordan's total area which is arid with hot dry summers and cold dry winters, it's elevation between 600 m to 900 m above sea level, the rainfall in this region is very low all throughout the year, which does not allow crop cultivation however this region is the home to the traditional sheep and goat herders who provide part of the meat for the rest of the country, as for the temperatures it varies strongly between day and night in both summer and winter.

The winter months have moderately cool to very cold weather, averaging about 13°C, and January typically being the coldest month, also frost can be expected during the winter with occasional snow in the western and northern highlands. Summers are the longest, starting from the middle of May to the end of September, which reach a peak during August with daytime temperatures often exceeding 36°C and an average of 32°C. Before summer's dry season a hot and dry air from the desert is expected, due to low pressure, this is called the (khamasini) which are strong winds from the south or southeast that sometimes reach storm force usually accompanied by large dust clouds and a drop in relative humidity to about 10% and temperature rise to a 10°C to 15°C, these typically last for a day or more and can have significant effect on the rainfed crops. Also between June and September there is the Shamal wind from the north and northwest this is characterized by nighttime breezes that are usually dry and causes high daytime temperatures that become moderate after sunset.

In terms of rainfall, Jordan is generally arid with more than 90% of Jordan's total area receiving less than 200 millimeters rainfall per year, and more than 70% of the country receiving less than 100 millimeters, and only 2% of the area located in the north-western highlands has an annual precipitation exceeding 300 millimeters reaching as much as 600 mm, noting in general the amount of rainfall decreases from north to south and from west to east. (Medicinal and Herbal Plants Cultivation, for MOA/NCARTT 2002). The rain normally falls during winter and spring starting as early as November sometimes extending to April, with maximum amount being during January and February, most of the rainfall is in the form of rain or drizzle, but snow may fall on highlands and also hail is not unusual as it is associated with instability during winter fronts or thunderstorms.

As for rainfall in relation to crops, in the cultivated areas, where field crops and trees are grown, it has a high variability from season to season, even between months within the same season. This seriously affects crops productivity over the years.

Jordan is vulnerable to climate change and according to the National Biodiversity Strategy and Action Plan 2015-2020 it is predicted that the temperatures will increase 1-2 degrees centigrade by 2030-2050, as well as increase in evaporation from by soil moisture reduction, as well as diminished recharge of aquifers and oasis, with projected shrinkage of grasslands that cover over 10% of Jordan, the strategy also projected a shift of semi-arid rangeland to become arid desert. Based on these implications on biodiversity Jordan deemed it necessary to Improve and continue its conservation planning and management.

2.2. WATER

Today, Jordan is going through a severe water scarcity, one of the ten most water scarce countries in the world, characterized by not enough freshwater resources to meet the water demand. Jordan lies in the heart of the Middle East landlocked with minimal coastline. Its drying climate, population increases through a succession of shocks of refugees along with the disadvantaged downstream location on the Yarmouk-Jordan River, will further increase the

vulnerability of the country's freshwater resources. Jordan is facing a deepening freshwater crisis due to the long-term decline in rainfall and declining groundwater levels and the closing of water resources from Israel as well as regional conflict and immigration. Jordan's per capita water availability has decreased from 3600 million cubic meters year in 1946 to 135 million cubic meters/year in the recent years putting the nation far below the 500 million cubic meters/year level of "absolute scarcity" (Research Article: Climate Change Effects: Increasing Drought In Jordan in Science Advances 2017)

The total annual renewable amount of water is about 789 million cubic meters, out of which 505 million cubic meters from surface water and 275 million cubic meters from groundwater resources. (Assessment of the Agricultural sector in Jordan, EU report 2012) Non-renewable groundwater resources are estimated at 240 million cubic meters per year in Disi and Jafr Basins. (Assessment of the Agricultural sector in Jordan, EU report 2012) Groundwater makes 70% of water in Jordan and groundwater aquifers were over pumped in 2006 which led to severe decline in the groundwater level. (Assessment of the Agricultural sector in Jordan, EU report 2012) The annual supply of surface water is 214.69 million cubic meters, with the Jordan Rift Valley contributing 108 million cubic meters. Springs account for 57.2 million cubic meters and base flows and floods account for 49.4 million cubic meters. Most of the surface water (73.5%) is allocated for agricultural activity, with about 152 million cubic meters allocated for the purpose of irrigation. Most surface water used for irrigation is used in the Jordan Valley. (Assessment of the Agricultural sector in Jordan, EU report 2012)

Irrigated agriculture is the major water consumer and accounts for 66% of the water consumed in year 2000 (Medicinal and Herbal Plants Cultivation, for MOA/NCARTT 2002). With the high population growth and the increase in industrial requirements It is expected that the demand for water from different sectors will grow fast, as a result irrigated agriculture will face serious problems in the future, and have to depend more on other water sources, such as treated wastewater. As well as the demand to introduce new technologies, crops and cropping patterns that could save water and maximize the return and also can grow and produce by using low quality water.

The Ministry of Water and Irrigation gave projections for the available water for the different sectors, it indicated that after 10 years, agriculture will have less fresh water, and will have to be more reliant on treated wastewater and by 20 years from now that will amount for around 30% of the available water for agriculture. Noting the amount of water available for agriculture will not change, it's just its quality that will significantly decline.

The water resources of Jordan consist of surface water, groundwater, treated wastewater

1) Surface water

The resources are unevenly distributed among 15 basins. River flows are generally of a flash-flood nature, with large seasonal and annual variation. The largest source of external surface water is the Yarmouk River and it is also the main source of water for the King Abdullah Canal that is considered to be the backbone of development in the Jordan Valley. The water

of Yarmouk River enters from Syria after first forming in the border, then it joins the Jordan River coming from Palestine. The natural annual flow of the Yarmouk River is estimated at about 400 million cubic meters , of which about 100 million cubic meters are withdrawn by Israel (FAO Irrigation in the Middle East region in figures – AQUASTAT Survey 2008).

The total actual flow is much lower at present as result of the upstream Syrian development works that started in 1980s as well as a result of the drought, today decreased to 83-99 million cubic meters (UN-ESCWA and BGR (United Nations Economic and Social Commission for Western Asia; Bundesanstalt für Geowissenschaften und Rohstoffe, 2013).. Inventory of Shared Water Resources in Western Asia- Jordan River B.) There is also the Zarqa River that is considered the main branch of the Jordan River, and controlled by the King Talal Dam and also feeding the King Abdullah Canal. There are also 10 small rivers, called “Side Wadis” going from the mountains to the Jordan Valley. Other basins include the Mujib, the Dead Sea, Hasa and Wadi Araba.

2) Groundwater

This resource is distributed among twelve major basins, ten of which are renewable groundwater basins and two in the southeast of the country fossil groundwater aquifers. At the present most of it is exploited at maximum capacity, in some cases beyond safe yield. From the twelve groundwater basins, six are being overexploited, four are balanced and two are underexploited. The overexploitation of groundwater resources has decreased the water quality and reduced exploitable quantities, resulting in the abandonment of many municipal and irrigation water-well fields.

Total internal renewable groundwater resources have been estimated at 500 million cubic meters per year, of which 253 million cubic meters per year constitute the base flow of the rivers. Groundwater resources are concentrated mainly in the Yarmouk, Amman–Zarqa and Dead Sea basins. The safe yield of renewable groundwater resources is estimated at 275.5 million cubic meters per year (Assessment of the Agricultural sector in Jordan, EU report 2012).

The main non-renewable aquifer is the Disi aquifer (sandstone fossil) in southern Jordan and it is presently exploited, with a yield estimated at 125 million cubic meters per year for 50 years. Other non-renewable water resources are found in the Jafer Basin, with the annual yield of 18 million cubic meters. The Water Authority of Jordan estimates that the total yield of fossil groundwater is 143 million cubic meters per year for 50 years. (FAO Irrigation in the Middle East region in figures – AQUASTAT Survey 2008)

Ten dams have been constructed in the last five decades with a total reservoir capacity of around 275 million cubic meters. The main dam is the King Talal Dam on the Zarqa River, with a total reservoir capacity of 80 million cubic meters. The Unity Dam on the Yarmouk River shared between Jordan and Syria with a total reservoir capacity of 110 million cubic meters. All the dams are built on the Side Wadis with their outlets to Jordan River with the exception of the Karamah Dam on Wadi Mallaha. They are used to store floods and base flows and to

regulate water and release it for irrigation. A regulating dam was built on the Yarmouk River downstream of the diversion point of King Abdullah Canal, in accordance with the Jordanian Israeli treaty's water annex. (FAO Irrigation in the Middle East region in figures – AQUASTAT Survey 2008).

Below map shows the location of the rivers and dams:



Dams along rivers and side valleys in Jordan, (Fanack after Jordan's Water Resource Challenges and the Prospects for Sustainability Amelia Altz-Stamm GIS for Water Resources Fall 2012)

3) Treated Wastewater

Over the last three decades sewage water networks have been constructed in cities and towns with twenty-three sewage treatment plants in operation to serve around 70% Jordan and this treated wastewater is used in irrigation. More than 80% of sewage water of the Greater Municipality of Amman is treated in four plants and then released into the Zarqa River. The mixed water is then stored in the King Talal Dam reservoir to be used in irrigation in the middle Jordan Valley irrigation schemes which constitute 78% of the treated wastewater. A small quantity of around 9 percent is used for irrigation in the Zarqa River

catchment area. Treated wastewater from the other plants is used around the plants and/or mixed with surface water to irrigate areas in the Side Wadis. (FAO Irrigation in the Middle East region in figures – AQUASTAT Survey 2008)

As mentioned earlier, rapid population growth coupled with increased urbanization and industrialization are leading to the over-exploitation of aquifers adding to this the contamination of diminishing supplies through: Inadequate industrial and municipal wastewater treatment capacities; the location of industrial plants near or immediately upstream from freshwater supplies; and overuse and misuse of pesticides, insecticides, fungicides and fertilisers leading to pollution of ground and surface water resources by irrigation drainage. Other surface waters affected by pollution are wadis, creeks, rivers and dams lying downstream from wastewater treatment plants and solid waste disposal sites. (Environmental Issues in Jordan, Solutions and Recommendations article in American Journal of Environmental Sciences, 2007)

The King Talal Dam reservoir, Jordan's largest surface reservoir is not a dependable long-term water source, as it is threatened by the emission of untreated waste into the reservoir's tributaries, raising salinity and levels of chemical and metal. In addition, many valleys are dammed which means that their waters are collected in reservoirs, these too are reported to be overly enriched with minerals and nutrients which induce excessive growth of algae that resulted in oxygen depletion of the water. (Environmental Issues in Jordan, Solutions and Recommendations article in American Journal of Environmental Sciences, 2007) Noting that Groundwater salinization and agricultural residues also influence surface waters.

The chaotic nature of the surface water levels frequently minimizes levels of trapped water, sometimes reducing them to below the dam's holding capacity of 86 million cubic meter. Meanwhile, pollution has played a role in these reduced water supply levels as factories dispose of untreated waste materials in the tributaries leading to the dam, rendering this water supply not useful due to the raised levels of chemicals and metals. Also, some water wells in the Amman-Zarqa catchments area in 1990 showed heavy contamination with TDS, Na, Cl and NO₃. (Evaluation of chlorinated pesticides residues in foodstuff of animal origin from middle districts of Jordan in 2013–2014)

2.3. SOIL

The distribution of soils in Jordan follows closely the climate and topography, the geology includes basaltic rocks, sandstone, limestone, chalks, marls and cherts (Soils of Jordan 2001), This wide range in physical features has produced an equally wide range of soils and landscapes. Many soil surveys were carried to classify and the soil in Jordan and started in 1947 using the US soil classification system of 1938, other surveys also conducted using this classification in 1959 and 1974 and twelve great soil groups are recognized:

Terra Rossa, Red Mediterranean Soil, Basalt Soil, Grumusol, Rendzina, Mountain Marl, Regosols and Lithosols, Yellow Mediterranean Soil, Chernozemic-like Soils, Yellow Soil, Yellow Steppe Soil, Grey Desert Soil, Jordan Valley or Alluvial Soils, Solonchak, Gypsum Soils.

other surveys were conducted in specific areas of Jordan using U S Soil Taxonomy which became the official classification of soil , adopted by the World Reference Base for Soil Resources (WRB) and accordingly classified the soil in Jordan by their taxonomy to four great groups namely:

Aridisols (Soils with aridic moisture regime), Vertisols (Deep cracking soils, mostly red), Entisol (Very weakly developed initial soils) and Inceptisols (Moderately developed soils, in Jordan mostly red) (Atlas of Jordan: History, Territories and Society 2013)

However, the classification of the soil according to topography will be discussed here as follows:

- 1) Highlands are non-cracking soils and cracking with a texture clayey to shallow heavy loamy, this soil is mainly red and yellow Mediterranean soil with high water holding capacity. The soils are generally calcareous which have a fair nutrient level but suffer from nitrogen and phosphorous deficiency and in many areas suffer iron and manganese deficiency.
- 2) Steppe region (marginal areas) soils are deep to moderately deep, slightly gravelly, with fine siltloam texture composed of sand, silt and some clay found in the surface and subsoil layers. The subsoil layers are characterized as rich in CaCO_3 , and the surface layer is dark, yellowish brown to brown in color. The high silt content of the surface soil and the absence of suitable organic content makes the soil low in water storage capacity due to the poor penetration rate of the water. This cripples the vegetation growth and more soil degradation occurs. These soils suffer from deficiencies of nitrogen and phosphorus and are highly prone to water and wind erosion particularly when disturbed by ploughing or grazing.
- 3) Jordan Valley and Wadi Araba. The soils are weakly-developed soils mostly alluvial, saline, sandy and granitic. In the north of the Valley, the soils are deep and of moderate to medium structure. These soils have good water holding capacity and are relatively fertile.
- 4) The Desert region soils are in general low in organic matter, sandy to sandy loam in texture, often highly saline or alkaline with no vegetation growth, these soils have a very low water holding capacity and fertility. Additionally, the soil depth varies considerably from one place to another. In the north it is considered basalt area with soils are deep clay and well-structured and occur below the moderately weathered basalt pavement. Recent soils are saline, rather silty either due to the effect of wind residues or are like the soils which occupy the mudflats, on the other hand older soils are clayey, deep, and contain higher amounts of CaCO_3 . In the middle of Badia and to the south of Azraq area the soils become saline and contain gypsum. In the south around Disi and Mudawwara the soils are sandy formed from the weathered sandstone shale and granite. (Assessment of the Agricultural sector in Jordan, EU report 2012)

3. BIODIVERSITY

Jordan's distinctive location at the intersection of three continents renders it as a rare case of rich biodiversity, as Jordan comprises four different bio-geographical regions: The Mediterranean, Irano-Turanian, Saharo-Arabian, and the Sudanian Penetration. The existence of those different regions in a small country embraces the richness of landforms and biological diversity in terms of species, landscapes and ecosystems. The four regions provide the natural habitats for over 4,000 species of fauna and flora that fall into thirteen types, whether it is terrestrial, marine or freshwater environments as well exotic genetic resources.

The country is home to around 2543 species of vascular plants representing 1% of the world flora. It also hosts 644 animal species of which: 83 are mammal species, 436 species of birds, 348 species of fish and around 300 species of soft and hard corals. The formation of the Jordan Rift Valley many millions years ago is a major reason for the country's diversity, as its formation also produced the high western mountains causing a great fluctuation in altitudes from around 400m below sea level in the Dead Sea up to more than 1850 m at the southern heights. Besides that, the rest of Jordan is mainly desert consisting of basalt or Hammada, a unique ecologically rich ecosystem that is recognized in Jordan and Syria. As for the classification of Jordan's biodiversity, it is mainly based on the country's eco-regions, ecosystems and vegetation types. (Jordan Biodiversity First National Report 2001)

3.1. Bio-geographical Regions

Mediterranean

It is limited to the highlands starting from Irbid in the north to Ras Al-Naqab in the south in addition to some isolated areas in the mountains of Wadi Rum in the South. Altitudes vary from 700 to 1850 m above sea level. The rainfall ranges from 300 to 600 mm. The minimum annual temperature ranges from 5-10° C and the maximum from 20-30° C. Soil is mainly red and yellow Mediterranean soil. This region includes the most fertile part of the country and inhabits 90% of the population.

Irano-Turanian

A thin strip of varied width that surrounds all the Mediterranean eco-zone apart from the north. It does not contain any trees, but mainly consists of small shrubs and bushes. Altitudes vary from 500-700 m, and rainfall from 150-300° mm. Annual minimum temperatures range from 5-2° C, and mean annual maxima range from 15-25° C. Soil is calcareous or transported by wind.

Saharo-Arabian

This is the eastern desert (Badia) that encompasses the largest part of Jordan covering around 80% of the country's total area. Altitude is between 500-700 m. The mean annual rainfall is from 50-200 mm; mean annual minimum temperatures are from 15 -2° C and mean annual maxima are from 25-40° C. The soil in this region is poor (clay, hamada, saline, sandy or calcareous). Vegetation consists mainly of small shrubs and annuals in the wadi beds.

Sudanian Penetration

This region begins from the northern part of the Dead Sea and ends at the tip of the Gulf of Aqaba in the south along the Dead Sea depression and Wadi Araba. This region is considered the lowest point on earth (410 m below sea level near the Dead Sea). Rainfall is from 50-100 mm, the mean annual minimum temperature is from 10-29° C, and mean annual maximum temperatures are from 20-35° C. Soils are mostly alluvial, saline, sandy and granitic. The only inland sand dunes are present in this region. The vegetation is known for tropical tree elements along with few shrubs and annual herbs. (Atlas of Jordan 2013)

3.2. Vegetation Types

The vegetation map of Jordan developed by Al-Eisawi in 1985 and 1996 is the main scientific reference to the classification of floral biodiversity. It was then updated by The Royal Society for The Conservation of Nature (RSCN) in cooperation with the Ministry of Environment, academia and other international partners as follows: (The Plants of Jordan, An Annotated Checklist, Royal Botanical Gardens 2016)

- Pine forest (*Pinus halepensis*)
- Evergreen Oak forest (*Quercus calliprinos*)
- Deciduous Oak forest (*Quercus ithaburens*)
- Juniper forest
- Mediterranean non-forest region
- Steppe vegetation (*Ziziphus lotus*, *Ferula communis*)
- Halophytic (*Haloxylon persicum*, *Arthrocnemum* spp.)
- Sandy dunes
- Hammada (*Retama raetam*, *Artemisia herba-alba*, *Tamarix* spp. *Astragalus* spp., *Anabasis* spp.)
- Tropical
- Acacia and rocky vegetation
- Hydrophytes
- Mud flats

3.3. Plant Genetic Resources

Jordan is considered a center of origin to a great diversity of landraces, old cultivars, wild species and wild relatives of wheat and barley, legumes, olives, lentils, chickpeas, almond, grapes and figs. These crops and products derived from them play a central role for the food security and livelihood of Jordanian farmers.

Many crop species are on the verge of extinction, as plant diversity is facing major decline and are on a high risk of extinction. At present, around 200 and 250 plant species are nationally rare and 100 to 150 species are nationally threatened.

Triticum dicoccoides the direct ancestor of durum wheat is one of the most threatened species in Jordan, other crops such as wild almond and ancient olive trees are on the verge of extinction as during the course of history they were replaced by new varieties. Wild plants' diversity is also radically decreasing and now are rarely found in the wild. This is the consequence of many actions, whether political, economic or social, that are leading to the destruction of natural habitats and ecosystems. Furthermore, proper studies on genetic diversity for various species are lacking such as Sumac, native pomegranate, figs and pistachios. (Draft, The Second Country Report on the State of the Plant Genetic Resources for Food and Agriculture, National Center for Agricultural Research and Technology Transfer)

3.4. Challenges

Despite its rich biodiversity, Jordan's nature is facing numerous threats and challenges; from the loss and degradation of habitats, extensive agricultural, over exploitation and over harvesting of plant species, introduction of invasive species, water shortages, intensive use of agro-chemicals, population pressure, land use legislations, pollution, climate change, overgrazing and urbanization. These challenges highly affect all production systems of crops, forestry, and livestock all over the country affecting its biodiversity. (The National Biodiversity Strategy and Action Plan (2015-2020), Ministry of Environment).

Additionally, existing local policies on loss of biodiversity for food and agriculture are not effective and need to be revised, as thorough national studies, regarding fauna for food and agriculture are limited and lack proper scientific documentation. In November 2015, the Royal Botanical Gardens published The Jordan Plant Red List, Volume 1, which only includes the natural wild flora species.

Other issues pose challenges to biodiversity are related to the existing scientific studies that lack accuracy in terms of numbers and need significant validation, and plant diseases lack proper research, as well as the effect of climate change on the production systems biodiversity is unidentified.

In addition, one of the most critical challenges that is facing the different production systems and affecting the country's biodiversity is the lack of connection between science and development. As various studies and research is being carried out with little implementation on the actual ground.

3.5. Biodiversity and Traditional Knowledge

Traditional knowledge on biodiversity for food and agriculture in Jordan is decreasing and is limited to the elderly, this cultural heritage highly vulnerable and in danger of getting extinct as it is not documented and researched properly. Economic, social and political factors influenced conservation of this knowledge and its passing from a generation to another.

Although some forms of use of resources for food and medicine are previously documented (NCARE, 2008) with special interest on the sustainable cultivation of medicinal wild plants, most of the plants that are used in traditional medicine are still not registered in any official sources and have not been properly studied or researched. The existing studies focus mostly on the medicinal herbs of Jordan rather than all edible plants and crops. (FAO, 2013, Country Report: Jordan: The State of Jordan's Biodiversity for Food and Agriculture)

3.6. PROJECTS OF INTEREST ALREADY IN TERRITORY

A. The National Center for Agricultural Research and Extension (NCARE)

An agricultural research and extension center mainly working on agricultural sectors research and development; bee keeping, biodiversity, field crops, horticulture, livestock, olive trees, plant protection, range and forestry, socioeconomic, water soil and environment.

Examples of related projects:

- 1) NCARE established a full Program of Biodiversity, Plant Genetic Resources and Medicinal Herbal Plant; this program hosts the national seed gene bank that contains crop wild relatives and land races conserved seeds exsitu, where more than 4000 accessions are documented for use.
- 2) Agrobiodiversity Project (2001-2004): The project focused on the issues and the solutions to agrobiodiversity threats for 16 target species and was mainly a learning project. Its primary results and objectives were awareness raising, capacity building and knowledge creation.
- 3) Jordan Conservation of Medicinal and Herbal Plants 2008-2010: design and test models to improve the conservation of medicinal and herbal plants and the livelihood of rural communities. The project places emphasis on improving water resource management and environmental protection as a means to fight poverty.
- 4) National Programs of NCARE for Conservation of Wild Species from 2015-2018: Survey, collecting and hot spot identification of CWR and of selected Jordanian vegetable crops and their wild relatives.

- 5) NCARE Herbarium. (Continuous Project): Floral survey of all local ecosystems for authenticating vegetation cover of different habitats and conservation of herbarium specimens representing native species.
- 6) Badia Ecosystem Livelihood Project Component of Vegetation Assessment and Restoration (2010): Determination of Floral covers and status reports of vegetation cover of 3 designated range land reserves (Wadi Bayer, Husineyh and Hashimeyh). Restoration of the habitats with certain emphasis on endangered species.
- 7) Collection, Conservation and Utilization of Crop Wild Relatives of Vegetables Native to Jordan.(2015-2020).
- 8) Collecting Wild Relatives of Barely (*Hordeum vulgare* ssp. *spontaneum*) in Jordan,(2012): Collecting seeds for further diversity analysis. Comparing new samples with old germplasm to assess changes in genetic diversity and adaptation to environmental changes over time.

B. The Royal Society for the Conservation of Nature (RSCN)

The Royal Society for The Conservation of Nature (RSCN) is an independent voluntary organization devoted to the conservation of Jordan's natural resources. RSCN has the mission of protecting and managing the natural resources of Jordan, for it is responsible for protecting wildlife and wild places.

Examples of related projects:

- 1) Establishing seven protected areas covering over 1200 square kilometers. These areas comprise of wild plants, animals and other natural resources.
- 2) Sustainable Use & Conservation of Herbal & Medicinal Plants: This project aims to improve the conservation of medicinal and herbal plants.

C. Ministry of Agriculture(MOA)

The Ministry of Agriculture is a governmental institute, its main role is regulation of the agricultural sector in line with national goals to contribute to the achievement of sustainable development with the preservation of the environment and agricultural resources and promoting self-sufficiency, rural development, linking production requirements of the internal and external markets.

Examples of related projects:

- 1) The establishment of The Forestry Department/ Ministry of Agriculture on the Sustainable Use of biodiversity.

- 2) The Seed Centre at the Forestry Department/Ministry of Agriculture, which focuses on genetic materials and biodiversity conservation. Its activities include collecting indigenous and threatened species, documenting accompanying data, and carrying out experiments to determine best germination procedures for each species. The Seed Center has seeds of about 100 forest trees and rangeland shrubs species preserved and provides forest nurseries with seeds every year.
- 3) The adoption of the bylaw (G9/2008) under the agricultural law No. 44 of the year 2002 which deals with positive incentives given to communities in and around forestry areas by allowing local communities –under special regulations- to collect fruits and wood logs and to cultivate mushrooms in caves located near to their residence. Moreover, each family is allowed to make benefit of bare forest area (1,000 m²) to cultivate medicinal and ornamental plants as an income generating project. In return the local community members are expected to help in forestry resources protection efforts. Nowadays, about 50 families are benefiting from this project.
- 4) National reserves established by MoA, and Royal Society for Conservation of Nature (RSCN) that improved the Ecosystem services in temperate, sub-tropic and Badia production systems.

D. The Ministry of the Environment (MOE)

The ministry was established in 2003, the ministry seeks to maintain and improve the quality of Jordan 's environment, conserve natural resources and contribute to sustainable development through effective policies, legislation, strategies, monitoring and enforcement and by mainstreaming environmental concepts into all national development plans.

Examples of related projects:

The ministry developed the Biodiversity strategy and action plan 2015-2010

E. Royal Botanic Garden (RBG)

Is a non-governmental non-profit entity that was founded in 2005 to conserve the flora and biodiversity of Jordan by propagating and displaying native plants, rehabilitating habitats at the whole-systems level, conducting research, demonstrating sustainable practices, and sharing information.

Examples of related projects:

- 1) Habitat Re-Creation Project: Restoring three Jordanian Habitats and demonstrating two at the Royal Botanic Garden
- 2) National Herbarium of Jordan

The National Herbarium of Jordan launched the National Virtual Herbarium (NVH) on January 12, 2012, to allow online consultation of specimens from all of Jordan's herbaria. More than 2,700 specimens are now available onscreen at the NVH, and specimens will continue to be added until the entire flora of Jordan is represented.

3) Preparation of several Native Plant Conservation Strategies:

- Flora of Jordan;
- The Jordan Plant Red List;
- Wild Socioeconomic Plant Conservation Strategy for Jordan;
- The Plants of Jordan - An Annotated Checklist;
- Native Plant Database

4) Seed Bank

In 2009, the RBG Seed Bank began collecting seeds from native plants growing at Tal AlRumman site. So far, the bank contains seeds for around 180 plant species of Jordan. (The State of Jordan's Biodiversity for Food and Agriculture, Country Report, Joran, FAO 2013)

4. AGRICULTURE PRODUCTION SYSTEMS

The agricultural sector is equally shared by two subsectors: 55% livestock production and 45% cropping. About 4.7% (4.20 million dunum) of the land surface is considered cultivable land of which 25% is under irrigation and 75% rain-fed (Assessment of the Agricultural sector in Jordan, EU report 2012). The most fertile and productive agricultural areas are in the Jordan Rift Valley in the west part of the country, mainly based on marginal water resources, whereas irrigation in the highlands is based on groundwater.

4.1. Crop Based Production Systems

Farming system in Jordan is mainly dependent upon water availability. Due to scarcity of water and low rainfall only about 380 KM² are suitable for cultivation and only 17% of this area is irrigated. (Medicinal and Herbal Plants Cultivation, for MOA/NCARTT 2002).

4.1.1. Rain-fed Production Systems

This system comprises of 89.3 million **dunum** and is distributed in the highland to the east of the Rift Valley; in Irbid, Ajloun and Jerash in the north, Amman, Madaba in the center, and Karak, Tafelah and Showbak in the south. These areas are highly populated having the country's labor force and the major local markets. The system is based on annual rainfall and land characteristics, and can be divided into: arid zone which receives less than 200mm annual rainfall, the marginal zone region which receive 200-350 mm, the Semi Arid Zone which receive from 350-500 mm, Semi Humid Zone which receive around 500 mm annual rainfall. (THE STATE OF JORDAN'S BIODIVERSITY FOR FOOD AND AGRICULTURE, Country Profile FAO 2013) This system includes the fruit trees, forestry, wheat, barley, and the range land.

1) Fruit Trees Production System

This system is located in the areas which receive more than 400 mm of annual rainfall, with hilly and mountainous land. It covers the hills and mountains in Ajloun, Jerash, Salt, Amman, Madaba, Karak, Tafelah and Showbak. By the year 2000 the area planted with fruit trees was 539 thousand **dunum**, 89% was occupied with olive and the rest of the area planted with grape, fig, apple, almond, peach, apricot, pear and plum. (Medicinal and Herbal Plants Cultivation, for MOA/NCARTT 2002).

2) Forestry Production System

Jordan has limited forest resources, with about 1 percent of the country classified as forest rain-fed (Assessment of the Agricultural sector in Jordan, EU report 2012). However these forests are generally neither productive nor capable of producing good quality wood for commercial or industrial purposes, still they provide important services, including contribution to soil conservation, watershed management, aesthetic and recreational value, biodiversity

conservation and carbon fixing. The forests in Jordan consist of natural and man-made forests and are in government owned areas. The forest cover and diversity were affected by urban and agricultural development, deforestation, and deterioration of rangelands by overgrazing and soil erosion. Forests in Jordan play only a modest role in meeting the needs for timber products, however, The existing limited industry produces firewood, Furniture, and fruit boxes, as well as some mushrooms, wild fruits, aromatic and medicinal plants.

Natural Forests represent only 0.44 % of Jordan's total land area 500,800 dunum and over half are considered to be degraded by having a very poor density of less than 20 % and very limited capacity to only be regenerated by rain (Assessment of the Agricultural sector in Jordan, EU report 2012). These forests are mainly in northern-west areas of the country in Ajloun/Jerash/Irbid highlands with dominance of Oak species. They are mainly considered degraded forests. They are not commercial timber producing forests, however, a significant number of rural communities depend on them for their daily life needs and occasionally for small scale trade.

Planted Forests were established on public lands that cover an estimated 450,000 **dunum** which less than 0.5% of the area of the country mainly planted during the 1960s-1980s located where rainfall is above 200 mm, distributed mainly to the north and middle mountains of the rift valley in the regions of Irbid, Ajloun, Jerash, Balqa, Amman, Madaba, and Karak and Dana occupy between 20-30% of their land area rainfed (Assessment of the Agricultural sector in Jordan, EU report 2012). These forests are mainly Pine, Cyprus, and mixed forests dominated by non-native species and mainly have recreational functions for domestic tourism. The ministry of agriculture often uses them for greening and soil conservation.

3) Wheat Production System

Located in areas that receive between 300 to 400 mm annual rainfall, with a land slope less than 9% (Medicinal and Herbal Plants Cultivation, for MOA/NCARTT 2002). This area is the main field crop production characterized by high rainfall and small farming properties. The production system is based on wheat that occupy more than 70% of the total cultivated land in these areas, with flexible two years or three years crop rotation, that easily accommodate new winter and summer crops. The crop rotation is usually with food legumes (lentils and chickpeas), and also includes summer crops such as summer vegetables and tobacco, also some medicinal and herbal plants such as cumin, anis, and fenugreek. In the last three years, fruit trees, mainly olives, started to enter the production system in these areas. The strategy in the past is to plant field crops in land with a slope less than 9%, and fruit trees in areas with slopes exceeding 9%, this has not been strictly followed, and more olive trees are now planted in areas suitable for annual field crops.

4) Barley Production System

This system is located in areas that receive between 200 to 300 mm annual rainfall extending from the north to the south of Jordan and located to the east of the Western Highland, and to the west of the desert. The major crops grown are barley and some wheat, both are grown in

rotation with fallow. The productivity of these areas is usually unstable and depends on the amount of rainfall received. Farmers in these areas, usually own small ruminants (sheep and goats) are traditionally raised on rangelands where animals graze the natural vegetation and those who do not own animals, sell their products to the sheep owners. In dry years, the crop is grazed directly by animals.

5) Range Land Production System

This system occupied the largest area in Jordan the Badia and occupy around 80% of the land mass (Assessment of the Agricultural sector in Jordan, EU report 2012), located in the eastern part of the country it consists of the range land area and the desert, and the highest productive areas are located in the very low annual rainfall zones 100-250 mm mainly steppe grassland and brush and it is dominated by the natural range land plants, some of which are important medicinal and herbal plants such as Yarro, Lavender Cotton, Alhagi, Aloe, Worm Wood, Caper Bush, Cactus Pear, Peganum, and Headed Thyme. The inhabitants of the area are the Bedouins who are using these plants to cure certain ailments in humans and animals. Currently range vegetation provides between 0-90 days of supplemental grazing each year to Badia livestock depending on the location and the rainfall. Grazing is performed twice: in the spring and in the autumn. However, the natural vegetation is severely degraded due to overgrazing by sheep and goats, uprooting the whole plant to be used for fire or cooking, and forging to be used in folk medicine.

4.1.2. Irrigated Production Systems

As mentioned before, the irrigated areas in Jordan are located either in the Jordan Valley or in the highland. The major irrigation water in the Jordan Valley is the surface water from the Yarmouk river that is collected in dams such as King Hussein dam, as for the highlands the water source is mainly from underground water.

1) The Jordan Valley Production System:

The Jordan Valley is considered a natural greenhouse with some 0.3 million dunum cropped land (Jordan, Water Along the Food Chain, FAO/EBRD 2015), depends largely on irrigation where farmers are using mostly drip irrigation systems to save the water as it is a scarce resource in Jordan. Greenhouse cultivation systems increase productivity and allow for two or sometimes three seasons of vegetable production. The Jordan Valley is characterized by its fertile soil and unique climate with long day hours and high temperatures and the ability to produce fresh products in winter. Also the area is considered the food basket of Jordan where high quality and high return fruit and vegetables are being produced outside the season. Accounts for a limited 23% of the entire Jordanian fruit and vegetable land use but it produces almost half of the national output of these crops. Over half of Jordan Valley lands are used for vegetable production, while more than one-third is under fruit crops.

Fruit trees are grown on 35% of the cropped lands; 18 % of which is citrus, 7% is banana which is a profitable and the most water-consuming crop grown, date palm was 3% by 2015 and is expanding rapidly, 19 % of the area is farmed with mixed fruit trees including grapes and peach (Jordan, Water Along the Food Chain, FAO/EBRD 2015). Vegetables land use includes mainly tomatoes, squash, cucumbers and eggplants. In terms of output, tomatoes are the leading crop, followed by cucumbers and eggplants. While vegetables in the valley are mainly produced in the winter, few farmers, with modern greenhouses (temperature controlled) and proper management systems, produce summer vegetables in a profitable way.

The Jordan Valley is where a variety of long-term intensive greenhouse agricultural activities (i.e., irrigation, fertilization, etc.) are undertaken. It is also where the presence of pesticide residues in soil is a matter of serious concern as many compounds have been shown to produce adverse effects. (Jordan, Water Along the Food Chain, FAO/EBRD 2015) Extensive use of pesticides of all kinds has created severe problems related to pesticide residues in soil, pest resistance to pesticides, and health hazards including high residue of chemicals in breast milk for women in the Jordan Valley.

2) The Highlands Production System

The production system in the highland depends mainly on fruit trees and vegetable plantations. Large areas were planted with olive and other stone fruit such as apples, peaches and almond. Farmers have also successfully grown oregano, mint and sage and made good profits. The vegetables in the highlands are being produced in two seasons: winter and summer.

4.1.3. Medicinal Herbs And Aromatic Plants Production System

This system possesses higher water use efficiency, relatively higher economic returns to conventional crops, and the potential to add value by processing and marketing. Utilizing the unique climate and diverse agro-ecosystems of Jordan allows production on large and small-scales across all seasons of the year. Production and export of fresh herbs is very feasible in Jordan. Fresh herbs can be produced around the year in Jordan due to the multiple ecosystems in the country but particularly because of warm conditions in the Jordan Valley during the winter. The crops traded in local markets are: – mint, parsley, sage, oregano, fennel, purslane, coriander, cumin, anis and fenugreek are the most prevalent. The demand for fresh herbs is generally increasing. The amount of herbs marketed reached 15,000 Tonnes in 2004 (Assessment of the Agricultural sector in Jordan, EU report 2012).

4.1.4. Organic Farming Production System

Starting in 2008 and by 2009 Jordan developed a National Program for Organic Farming, and then the Ministry of Agriculture established a separate organic farming section to enhance the

productivity of organic farming and successfully enrolled part of the local community in this field, now more than 98 farmers started to shift to organic farming. In 2015, new organic farmers' markets have been opening in Amman promoting sustainable development and local organic produce and vegetables, a small community of like-minded farmers and consumers is slowly raising awareness about the importance of sustainable farming practices and healthy eating. (Critical Obstacles to Adopt the Organic Farming in Jordan: From Marketing Perspective, 2019).

However, there are obstacles facing farmers in regard to organic methods such as the high cost of producing organic crops due to higher cost of fertilizer for organic crops, crop rotation, post-harvest handling cost, organic certification and cost of covering higher loss. In addition to the weak financial capacity of farmers, the absence of a specific market for organic products, and the brokers who share profits with those farmers. In addition to the weakness of knowledge regarding the organic farming among farmers all are critical factors that affect the adoption of organic farming in Jordan.

Also, a large obstacle to the promoting organic farming is the lack of an organization to assess and give certification to organic produce (Towards a Green Economy in Jordan, 2011). In addition to the lack of an organization that can independently assess if the produce sold by farms are organic for real. Also, the organic farmers are failing to compete with the prices of conventional vegetables. (Critical Obstacles to Adopt the Organic Farming in Jordan: From Marketing Perspective 2017)

4.1.5. Aquaponics Production System

Aquaponics in Jordan is very recent and was first introduced in 2012 through a partnership with ETH Zurich sustainability summer schools utilizing Jordan's advanced greenhouse horticulture production practices, this system is considered one of the best techniques for country, as this system provides a reliable, predictable, and consistent food production and has proven to be suitable for arid and semi-arid regions as it targets the two main growing concerns including the diminishing soil quality and availability, and water scarcity and in general hydroponic farming has also shown to be economically and environmentally advantageous to traditional soil farming.

Now, there are about 12 domestic / small-scale systems in Jordan, though only half are currently operational. They range in size from 25 to 30 m² and use tilapia often situated on rooftops. (Report of the FAO Technical Training Workshop On Advancing Aquaponics: An Efficient Use Of Limited Resources, 2015) More recently, applied experiments have been conducted by the National Centre for Agriculture Research and Extension (NCARE) of the Ministry of Agriculture in three different locations, each of these projects uses single-span plastic greenhouses of about 500 m². In addition, the Bait Ali Hotel in Wadi Rum uses a small aquaponic system located within a 100 m² greenhouse to supplement the restaurant's needs and provide educational opportunities.

The most common aquaponic vegetables are strawberry (50 farms; 75 ha), cucumber (9 farms; 13 ha), ornamental plants (30 farms; about 45 ha) as well as lettuce and herbs (few). Most farms use plastic-covered raised beds with micro drip irrigation under greenhouse / high-tunnel conditions. (Report of the FAO Technical Training Workshop on Advancing Aquaponics: An Efficient Use Of Limited Resources, 2015)

4.2. Livestock Production Systems

More than half of the agricultural holders were found to keep animals, and the animal production accounted for 55% of the agricultural gross domestic product in 2006 (MOA, 2007). Most livestock in Jordan consist mainly of small ruminants of sheep and goats, cows, poultry, however horses (estimated to be around 400 heads), camels (11 thousand) and donkeys (estimated at about 18, 000 heads) are also raised for labor although camels produce milk but it is mostly for the use of the small rural communities in the Badia regions.

4.2.1. Small Ruminants (Sheep And Goats)

They are the most important livestock breeds raised in Jordan, the main production system is semi intensive and depends mainly on rangeland and stubble grazing, the intensive system is so rare and only found in few governmental stations and private farms. Sheep are distributed mainly in the east and south of Jordan while goats are mainly concentrated in the mountainous areas, however many farmers mix sheep and goats in one flock, Sheep and goats are raised in Jordan for multiple purposes; milk products, meat, wool, hair and hides, Sheep contribute up to 28% of locally produced milk, while goats represent about 6-8% of the fresh milk supply. About 57% of the small ruminants are raised in Northern Jordan, 27% in the Center and 16% in the South. Although the number of small ruminants has increased slightly over the years, the number of livestock producers has been declining indicating an increase in large scale commercial operations and movement of small herders out of their traditional livelihood occupation as the number of sheep and goat keepers was reduced from 29,650 families in 2010 to 25,469 in 2011 (Assessment of the Agricultural sector in Jordan, EU report 2012).

4.2.2. Cows and Dairy Farming

Cattle in Jordan belong to several breeds, during the last two decades most of the farmers have replaced their local cows with high yielding Holstein Friesian due to its high productivity as local cows yield less milk and have low growth rate and fertility. The main system for cattle is the intensive system and cows raised under this system are totally imported cows (Holstein-Friesian), however the local breeds and crossbreeds are raised under semi-extensive system.

The dairy industry plays an important role in the economy of Jordan. In the early 70's, Jordan established a program to promote dairy farming - new breeds of more productive dairy cows were imported, farmers learned to comply with top industry operating standards. Today there are 25 large dairy companies across Jordan. While milk production continues to steadily increase at 78% of the market demand in 2015 according to the Ministry of Agriculture—the country is

well below the production levels required for self-sufficiency. (Market System Assessment for The Dairy Value Chain Irbid & Mafrqa Governorates, Jordan March 2017).

Cattle farms are scattered all over the countryside but concentrated in middle and northern parts of Jordan specifically Mafrqa and Irbid and characterized by industrial-scale farms, processing plants, small-scale farms and dairy shops respectively. 50% of the farms are located in Mafrqa governorate and 15% in Irbid, according to the Ministry of Agriculture (Market System Assessment for The Dairy Value Chain Irbid & Mafrqa Governorates, Jordan March 2017). The Mafrqa dairy market is large and medium sized industrialized dairy farms with 200- 4000 cows who sell to supermarkets in major cities, still there are also small farms and herders, as well as household dairy processing operations. As for Irbid dairy market it entirely small dairy farms (up to 40 cows), Small-scale production systems also exist in other different regions in the country where the farm size ranges from 1 to 10 dairy cows, particularly in the northern highlands where they have been rearing cows a long time ago using local breeds, and in the Jordan Valley (Ghor region). However the production systems in the Jordan Valley region are slightly different from dairy farming in the highlands, as the dairy in Highlands is fed from fodder (e.g. alfalfa) and grain crops grown under irrigation in quantities and quality that meets the nutritional demands of the cows.

4.2.3. Poultry

Forty-five years ago Jordan was completely dependent on the small-scale production of poultry to meet the consumption requirements of chicken meat and table eggs, with a quantity of table eggs being imported to satisfy the market requirements. The commercial poultry industry has undergone a rapid development in recent years due to shortage in the supply of competitive products (red meat) and their high prices production cost compared to that of poultry, as a result poultry production in Jordan achieved a high level of self-sufficiency, whereas broiler meat reached 95% and egg production 100% (Poultry sector country review FAO 2008). Poultry production falls under three distinctive systems: Industrial, other commercial and village/backyard productions.

1) Industrial integrated system

What makes this system distinctive is that the producers establish integrated production systems with sophisticated modern farms and marketing facilities. This system consists of the boiler meat and egg production that are marketed commercially. The broiler meat represents around 35% of the broiler market, and the production companies have their own breeding farms, hatcheries, broilers farms, feed factories, slaughterhouses and marketing facilities.

The production period for this system: broilers are sold at 36 – 40 days of age while keeping layers for 52 weeks in production (Poultry sector country review FAO 2008)

2) Other Commercial Poultry Production Systems

This system includes the traditional commercial broiler and egg production of which those marketed commercially the farms with birds kept indoors continuously strictly preventing

contact with other poultry or wildlife, and caged layer farm with birds in open shed with poultry spending time outside the shed (both chickens and waterfowl).

The production period for this system: the broilers are sold at 40 – 45 days age while keeping the layers for 20 weeks rearing and 60 weeks in production. (Poultry sector country review FAO 2008).

This system includes four different productions: egg hatcheries, broiler meat, table eggs and other birds' production:

- Egg hatcheries

The number of operating farms solely hatcheries in Jordan by 2017 reached 38, producing eggs for hatching amounted to 282.613 million eggs producing 165.22 million chicks as 14 million of these eggs were exported. The number of licensed layer mothers' farms is 333, producing 7.6 million birds in 2017. (Statistical Annual report, MOA 2017)

- Broiler meats

The total farms by 2017 reached 1645, with the capacity of 116 thousand while the total produced boiler meat reached 290 thousand tons (Statistical Annual report, MOA 2017), The total distribution of broiler farms in Jordan according to governorates, the highest proportion of broiler farms is in Irbid, (24.2%) followed by Amman 17.3%, and Al Mafraq 15.2% . (Poultry sector country review FAO 2008)

- Hen table eggs

In 2017, layer farms in Jordan reached 333 farms with a total capacity of 7.6 million birds and producing 1403 eggs, the actual production of table eggs was around 949.26 million eggs, 98% produced from layer farms while the rest were produced from mothers' of broilers and layers unsuitable for hatching. (Statistical Annual report, MOA 2017)

- Other birds production

Include ostriches and quail farms. There are 6 ostrich farms; two farms located in Amman governorate and one in Balqa, Madaba, Karak, and Ma'an governorates. The largest one is located in Karak with a capacity of two thousand birds, while those located in Balqa and Ma'an have a capacity of 500 and 300 birds respectively. The capacity of other farms ranges between 50-80 birds. There is one quail farm located in Jerash governorate. (Poultry sector country review FAO 2008)

3) Village or backyard production

The main purpose of domesticated bird-keeping is home consumption. The local chicken primary functions were egg production for home consumption 65% of households, 35% to generate cash income (Poultry sector country review FAO 2008). Domestic birds in Jordan are kept in backyards; they move around the home in free areas where they are exposed to wild birds. Their feeding system depends mostly on some grains or food leftovers and water which are provided

in open dishes outside their pens. Other domestic birds kept in Jordan are pigeons that are local & mixed breeds, ducks, geese and turkey that are completely local breeds. Since the last agricultural census the chicken is still the main bird kept for home consumption and the pigeon is the second.

4.3. Bee Keeping

Jordan gave special importance to the Honey bee Sector in which local breeds are under conservation and local honey producers are being encouraged. Accordingly between 2003 and 2017 there more than 3,000 beekeepers in Jordan by 2017 the number of hives reached 60,000 hives and produces about 590 Tons of honey (Statistical Annual report, MOA 2017), 85% of beekeepers are poor low income producers (Assessment of the Agricultural sector in Jordan, EU report 2012). The two main honey-flows occur in the spring, one coming from the Jordan Valley citrus trees, and the other from the mountainous areas. The indigenous honey bee is *Apis mellifera syriaca* that is found throughout Jordan. Sadly, due to a half-century of foreign bee importation and inter species breeding, pure *syriaca* bees are now difficult to find. Recently, a new bee species has come to Aqaba threatening the local bees, *Apis florea* a dwarf honey bee that is originally native in South-east Asia.

4.4. Fishery And Aquaculture Production System

The total production of this system was estimated in 2001 at 540 tons of which around 80 tons (15%) were freshwater species such as carp and the rest were salt-water tilapia production (Jordan, FISHERY COUNTRY PROFILE, FAO 2003). Freshwater aquaculture production has been in decline for some years as water resources came under pressure from alternate uses and environmental degradation.

1) Marine fisheries

The marine fishing industry in Jordan is small and is based in Aqaba on the Red Sea coast. The fishery is entirely artisanal consisting of approximately 85 fishermen and 40 boats. This number remained static in recent years, worth noting that there are no cold storage facilities and catches are sold upon landing. The total catch in 2001 was only 170 tons of which about 65% of the catch were tuna, compared with catches from 1995 of 150 mt, and 103 mt recorded for 1993 (Jordan, FISHERY COUNTRY PROFILE, FAO 2003). Also, recreational SCUBA divers are reported to collect a small number of aquarium fish but with no specific data. The development of marine fisheries in the Red Sea is limited by the availability of suitable sites and environmental concerns, particularly the impacts of nutrient enrichment by aquaculture on Jordan's extensive and important coral reefs and seagrass nursery areas.

2) Aquaculture

Recently National Agricultural Research Center (NCARE) along with the private sector and with support from The Japan Cooperation Association (JICA) a production system is under

implementation at the Jordan Valley near the Dead Sea due to availability of artificial lakes that are used for crop production, 16 farmers were selected to implement this technology (The State Of Jordan's Biodiversity For Food And Agriculture, Country Profile FAO 2013). In this system intensive salt-water aquaculture production of Tilapia species is carried out, with the largest producer being Jordan Valley Fisheries (JVF) a company that operates a modern salt water Tilapia farm which can produce up to 700 ton per year (Jordan, FISHERY COUNTRY PROFILE, FAO 2003). The farm incorporates an intensive system based on solar technology and a 'green water' system for algal production and heating. This system has expanded in recent years and appears a viable industry although the capital-intensive nature of its development may affect further significant expansion.

5. MAJOR CROPS AND ANIMAL BREEDS

Crops

1) Fruit Trees

Olives, Wild Almonds, Bitter Almonds, Apples, Figs, Grapes, Peach, Pear, Apricots, Plums, Prunes, Orange, Lemon, Clementine, Pomelo, Grapefruit, Banana, Date, Pomegranate, Mulberry, Quince.

2) Legumes and Cereals

Wild Lentils, Wild Chickpeas, Wild Barley, Corn, Fava Beans, Wheat; Cultivated durum (Triticum durum) and bread (Triticum aestivum) wheat, wild wheat forms; Triticum monoccocum, T. beoticum, T. turgidum, T. dicoecum, T. dicoccoides, and wild relatives of wheat, the Agilops spp.

3) Green Leaves, Medicinal and Herbal Plants

Roman Lettuce, Spinach, Faiteh (White Mustard), Molokhiah (Jute Mallow) , Morrar(Iberian Centaury),Hendeba (Wild Chicory) , Khabaisah (Little Mallow), Humaith (Red Sorrel), Faijan (African Rue), Lsaineh (Bugloss), Sheeh (Jerusalem Sage), Chamomile, Cumin, Black Cumin, Anise, Fenugreek, Mint, Parsley, Sage, Oregano, Purslane, Coriander, Rashad (Garden Cress), Germander, Watercress, Sumac, Wild Celery, Capers, Thyme, Bongardia

Vulnerable Species: Akoob (Gundelia), Syrian Oregano.

Near Threatened Species: Hwairneh (Giant Reed), Wild Beet, Fennel, Botom (Atlantic Pistachio).
Endangered: Luff (Green Arum), Common Cyclamen, Eminium, Roman Nettle.

4) Fruits and Vegetables

Tomatoes, Eggplants, Squash, Strawberry, Cucumber, Snake Cucumber, Broad Beans, Cabbage, Onion, Garlic, Potatoes, Watermelon, Melon, Okra, Bell Peppers, Green Beans, Cauliflower, Peas, Cactus, Globe Artichoke, Fennel, Carrots, Beets, Turnip, Radish, Hot Peppers, Baby marrow, Broccoli, Cow Peas.

Animal Breeds

1) Livestock

- Sheep The main sheep breed in Jordan is Awassi, Najdi Assaf and Chios
- Mountain Black Goat, Desert Goat, Dhawi Goats and Shami (Damascus)
- Cows Holstein-Friesian and Baladi
- Camels Baladi (The Dromedary)

2) Poultry

- Chicken layer: Haysesex, Babkok, Lohman and Haylayan breeds, Broiler Hybrid and Lohman, Roos.
- Pigeons Baladi.
- Duck Baladi.
- Turkey Baladi.

3) Fish

Carp, Salt-Water Tilapia, Yellowfin Tuna

6. ECONOMIC AND SOCIAL CONTEXT

Jordan's Agriculture sector from the mid-1990s till 2000 faced many challenges; including the decrease of the annual GDP, the urban development at the expense of agriculture land, climate change affected the consistency of the amount of rainfall, and many economic changes influenced the agriculture market and trade. However, it was part of the structural reforms by the World Bank including the Agricultural Structural Adjustment Program (ASTAP) and the Agriculture Structural Adjustment Loan (ASAL) which aimed to minimize the effect of the challenges and ensuring a balance between the use of natural resources for agricultural and non-agricultural uses.

Therefore, Jordan has experienced significant structural change in the agriculture sector of the economy, generally moving from growing cereals to fruits and vegetables. As a result this pushed Jordan to import practically all the wheat and other cereals consumed in the country.

The first National strategy for Agricultural development was developed for the period of 2002 – 2010 to implement strategic planning for the sector on a national level, involving the private sector and the agricultural businesses along with related government bodies.

According to the Department of Statistics agriculture in Jordan accounts for 5.6 percent of the country's GDP in 2018. One quarter of total agricultural exports are vegetables and fruits, which are mainly exported to other countries in the MENA region. On the other hand Jordan imports partly basic food commodities (wheat, legumes, red meat and fish), and some vegetables, while rice and sugar are completely imported. This constitutes the highest share of agricultural imports, resulting in 91 percent of all agricultural products being imported, making the agriculture sector export oriented, with 23 percent of all agricultural products are exported, 40 percent of which are vegetables and fruits (The Role of Agriculture and Agro-processing for development in Jordan, 2018) The WTO Committee on Agriculture classified Jordan as “a net food importing developing country”.

Although agriculture currently has a low share of the national economy, this was not the case in earlier years as agriculture in Jordan contributed substantially to the economy since the time of Jordan's independence. In the early 1950s, agriculture constituted almost 40 percent of GDP but it subsequently suffered a decades-long steady decline. On the eve of the June 1967 War, the percentage became 17 percent, and by the mid- 1980s agriculture's share of GDP in Jordan was only about 6 percent. (NATIONAL AGRO-FOOD POLICIES IN JORDAN, SUSTAINMED Project , 2012)

The sector has displayed promising growth rates over the past few years, its contribution to GDP doubled between the years 2000 and 2015 from 2.3 to 4.2 percent due to the increase in domestic demand, and between 2010 and 2015 it reached a compound annual growth rate of 12 percent. Despite the recent increase in the contribution of agriculture to Jordan's economy the share of agriculture in 1970 was 11.6 percent compared to 4.2 percent share in 2015 according to the department of statistics (The Role of Agriculture and Agro-processing for development in

Jordan, IFPRI Middle East and North Africa Jan. 2018), showing that the importance of agriculture to Jordan's economy is significantly less now than it was four decades ago, this is attributed mostly to the reduced agricultural areas, fragmentation of agricultural holdings, the number of holdings within medium-sized groups and decreased agricultural land per capita. In addition to the fact that the Jordanian economy is going through structural transformation with the significant growth of the industry sector.

Most small-scale agriculture in about 50% of the agricultural areas in Jordan is family farming, which is aimed for the local or domestic consumption. However, larger farming activities are taking place in the Jordan Valley in the form of larger production farms which are mainly geared towards export, these farms are dependent on foreign (non-Jordanian) labor force.

Agriculture plays a significant social role, especially in the rural areas, where the 20% below poverty line of Jordan's population live. This is evident in the broad participation of the Jordanian family in agricultural work, according to the Ministry of Agriculture 80 thousand families are dependent on agriculture as the main source of income (National Strategy for Agriculture Development Document 2016-2025) which amassed in livestock breeding farms and possession of small agricultural land. Thus, family labor is the main supporter of agricultural work in Jordan regardless of space, agriculture type, province, or rain region. Although youth in rural areas are steering away from agriculture as employment preferring government appointment, agriculture will always be constituted as an important source of employment in such rural communities. According to official statistics released by the Ministry of Agriculture (2010) about 81 thousand laborers are working in the Agricultural sector, (10%) of the total workers are Jordanian, and most of them women. It is considered important to maintain the family farming activities for social reasons to maintain the rural production areas, in addition to economic reasons to improve the living situation of rural families; also for environmental reasons because the use of chemicals and energy sources is low in family farming.

Between 1991 and 2000 the agriculture sector created 41 thousand and up to 114 thousand work opportunities of which 31% to 55 % were Jordanians. Full time workers in the Jordan Valley area reached 60 % on account of just 9% in the highlands. (Agriculture in Jordan Article 7 March 2019, www.foodprotection.news)

The role of the agriculture sector for employment has been decreasing, the number of population active in agriculture in 2005 was 194 thousand which accounts for 9.8% of the economically active population that year (FAO Irrigation in the Middle East region in figures – AQUASTAT Survey 2008), by 2011 the sector employed 124 thousand which is 7.7% (Assessment of the Agricultural sector in Jordan, EU report 2012), and according to the Department of Statistics in 2018 the percentage of Jordanians actively employed in the agriculture sector was 1.7% of the total economically active population 2% male and 0.9% women, as for non-Jordanians legally employed in this sector the number was 87338 workers of these 85780 men and 1558 women.

This decrease came together with an increase in the importance of industry and services. However agriculture is more important in rural than in urban areas, by 2015 the share of

agriculture in total employment was 5.0 percent in rural areas and 1.3 percent in urban areas (The Role of Agriculture and Agro-processing for development in Jordan, IFPRI Middle East and North Africa Jan. 2018). While the share of Jordanians working in agriculture has gone down it remains important for migrant laborers, as many refugees are employed in the sector. According to the Department of Statistics, non-Jordanians constitute the majority of labor in agriculture – about 85 percent of livestock workers and 92 percent of crop labor in 2015 were non-Jordanians and permanent employment is far more important than seasonal and casual employment. At the same time, employment in crops has been decreasing between 2013 and 2015, years during which Jordan experienced a large influx of refugees.

Due to the influx of more than a 1.4 million Syrian refugees in the past years the country's population increased, in addition to the Kingdom's population of about 6.7 million people (National Strategy and Action Plan For Sustainable Consumption And Production In Jordan | 2016 – 2025). This led to a significant increase in the consumption of food items, putting a high demand to provide food that keeps up with population growth which translates to the need to increase agricultural production. This can be achieved by increasing the cultivated and irrigated areas and thereby optimizing the use of water resources (treated wastewater and saline water) for irrigation purposes.

7. DESCRIPTION OF FOOD CONSUMPTION PATTERNS

In Jordan, cereals, wheat in particular, is considered staple food and is commonly eaten in form of bread, rice has also become a staple, although it is not native to the land, it is consumed nowadays cooked accompanied with local stews and dishes. Vegetables either cooked or consumed fresh occupy an important place in the diet. Dairy products such as cheeses and yogurt are also a staple, eaten fresh or used in cooking some dishes. Consumption of fruit also plays a major role in the local diet and varies according to season. Many dishes with legumes such as chickpeas and lentils are also typical and consumed often. As for meat, lamb is typical of Jordanian cuisine, poultry and beef are used nowadays with minimal consumption of fish and seafood.

There are three main meals in the Jordanian diet during the day. Breakfast is essential and the traditional one is diverse and consists of different dishes such as fried or boiled eggs, labaneh (drained yoghurt), cheese, zaatar (thyme with sesame seeds and sumaq) with olive oil, hummus, falafel, Mankeesh (dough topped with Zaatar, cheese, or ground meat) and some fresh vegetables such as tomatoes and cucumbers along with bread and a cup of tea.

Lunch is considered the main meal of the day; a typical meal normally consists of a main dish made of rice or legumes, meat (mainly chicken, beef or lamb) or cooked vegetables accompanied with bread. Traditionally lunch is eaten while the family is gathered but with the changing pace of life, time and place of consuming the lunch meal has changed. However it is still an important aspect of lunch whether it is consumed at home among family members or at work with coworkers and friends. As for dinner, it is generally very similar to breakfast. It is diverse, could consist of several types of food, and normally is enjoyed with family members and friends.

Monueh still plays a major role in the Jordanian food consumption habits, the act of storing food that is abundant in its season using different methods for yearlong storage, traditionally households used to allocate a sizable cool or a shaded space to store those products from jams, pickles, dried yogurt, ghee, olive oil, dried legumes, vegetables and fruits. Whereas modern families nowadays keep their Mouneh in kitchen cupboards, refrigerators, or tiny shelved pantry rooms. Nowadays the food products either are still processed by the family in their households or bought from local markets or directly from small producers that are producing in their homes in local communities.

Jordan has been witnessing a change in food consumption patterns since the mid of the last century (Nutrition in Jordan: A review of the Current Nutritional Trends and Major Strategic Directions of the National Food and Nutrition Policy, 2006). Urbanization played a major role in this transition in food consumption habits, the percentage of urban population went from 46.3 in 1960 to 82.6 in 2010 and to 90.3 years in 2016, while the percentage of rural population decreased from 53.7 in 1960 to 17.4 in 2010 and to 9.7 in 2016 (Department of Statistics, 2016, 2011). This rapid change in the demographic structure had a socio-economic influence on the

new urbanized communities that got reinforced with the effect of globalization on markets resulting in the adaptation of westernized food style.

Poverty is also one of the major factors affecting food consumption habits; the wealth of families is a major factor in food selection. Unemployment rate, especially amongst women, is high affecting the poverty rate, which according to World Bank data was reported to be 14% in 2010 and reached 18.6% in 2015. Noting that a third of the population in Jordan live below the poverty line, at least one quarter of the year which is known as transient poverty. (World Bank, 2016).

Agricultural policies that affect relative food prices also played a role in changing the food consumption patterns.

In the past few decades, dramatic changes have occurred in the food consumption patterns in Jordan and the region due to multiple factors including changes in the lifestyle and socioeconomic and political situations that has led to this transition. In Jordan, the following trends have been noticed since the mid of the last century:

- 1) Consumption of foods of animal-origin increased, while the consumption of foods of plant-origin decreased. Based on the Jordanian Household Expenditures and Income Surveys (JHEIS) from 1992 to 2010 the energy intake in 2010 was higher than in the years 1992 to 2006-2007 for foods of animal origin: meat and poultry, fish, dairy products and eggs, whereas it was lower for foods of plant origin: legumes and fruits and vegetables. The consumption of meat, especially poultry showed a four-fold increase over the 1960s to 1980s; and has remained rather stable since. The consumption of milk and milk products almost doubled between 1965-1967 and 2005-2007 due to the increase of local production of meat (caused by barley subsidization) specifically for poultry and eggs as they are sufficiently produced in the country with relatively cheap prices. The increased imports of beef has also contributed to the higher consumption. Consumption of fish is still low but it has also shown a large increase over the last four decades. The higher intake of fish may be due to the fact that most of the marketed fish in Jordan is the cheap imported frozen fish.
- 2) The diet is shifting towards the consumption of high-energy and poor nutritional foods. The population's consumption of fast foods is increasing, including ready-to-eat processed foods, rich in fat, salt, sweeteners and soft drinks. The demand for ready to eat meals is higher due to the increasing number of working women and the long working hours. In rural areas, the diet is still more traditional; households depend mainly on homemade food and less on ready-to-eat food. Although signs of a change in food consumption habits are also currently appearing in rural areas.
- 3) As for carbohydrates, consumption of cereals, mainly of wheat and to a lesser extent rice has been stable since the early 1980s. Although consumption of rice increased slightly over the period. Consumption of potatoes has more than doubled over the last four decades, due to the support of both the government and the private sector in providing access to land and

water to grow potatoes, in addition to an increase in imports. (Food and nutrition profile, Jordan. Nutrition and Consumer Protection Division, FAO, 2011)

- 4) Consumption of sweeteners and vegetable oils increased considerably in the last decade. The consumption of locally produced olive oil has decreased to the advantage of the imported soybean, sunflower and palm oil that are less expensive than olive oil. (Food and nutrition profile, Jordan. Nutrition and Consumer Protection Division, FAO, 2011)
- 5) Due to these changes in food consumption patterns and practices, the rate of many diseases such as obesity, diabetes, mellitus and cardiovascular diseases have also increased in the last decade (Trends of Energy and Macronutrients Intakes in Jordan as Obtained by Household Expenditure and Income Surveys, University of Jordan, 2019).

8. POLITICAL CONTEXT

As mentioned before Jordan's agriculture faced many challenges throughout the years. Politics played a significant role in these challenges, whether because of internal government policies, or external political actions and instability in the region. Nevertheless, at certain times these were happening simultaneously or one being the outcome of the other.

Jordan's economy, people and agriculture have been heavily affected by the repercussions of conflict and instability in the region since 1948, including the Palestinian crisis, the Gulf War, Iraq invasion, and the Syrian conflict.

As the Israeli-Palestinian conflict started in 1948 up until the occupation of the West Bank in 1967 Jordan was directly affected, as in 1950 the Israeli army began to expand into Jordan. Israeli forces crossed the Jordan River and seized territory in the northern al-Baqura seizing an estimated 1,390 dunums (1.39 sq. km). After 1967 following what was known as the Six-Day War, Israel occupied a vast area of Jordanian territory in Wadi Araba south of the Dead Sea and changed the border in Wadi Araba by placing military and security installations and in certain regions the area reached up to 8 km. Afterwards, the Al Ghamr area totaled approximately 4,000 dunums (4 sq. km), of which 1,000 dunums (1 sq. km) was cultivated (Will Jordan reclaim its territory from Israel in the next year? Article, www.7iber.com, 2018), and fell just one kilometer from the old Dead Sea Highway. Other agricultural lands were seized by Israel through the years of the war, decreasing the Jordanian areas of land suitable for agriculture. On October 26, 1994 a Jordan-Israel Peace Treaty was signed in Wadi 'Araba. The treaty stated Jordan's restoration of its occupied land mentioned earlier (approximately 380 square kilometers) and assured the Kingdom an equitable share of water from the Yarmouk and Jordan rivers. Jordan, as part of the agreement, placed al-Baqura and al-Ghamr on lease to Israel for a period of 25 years. And both sides are entitled to inform the other party of any desire to end this agreement within that time period. Jordan was able to regain sovereignty over them in November 2019, restoring these agricultural lands is expected to have a positive impact on the agriculture sector in the long run.

In addition to the above, Jordan and Israel had political tension regarding water involving Syria as well. For most of its surface waters, Jordan is dependent on the Yarmouk and Jordan Rivers, whose waters both Syria and Israel have overused, as both have retained significant control over them, on one hand Syria has carried out unilateral water projects in the Upper Yarmouk basin, and Israel has carried out projects in the Upper Jordan River and the Golan. Their actions have violated long-standing agreements, and left Jordan with under 10% of the total flow of the freshwater resources of the Upper Yarmouk and Jordan Rivers. This could cause further conflict in the region especially as climate-related changes are expected to impact the water resources.

In the 1970's many changes and policies took place starting with 1974 when the Gulf states initiated an oil embargo on many countries as an effort to put pressure on Israel, subsequently raising the price of oil significantly which revived the economy in the Gulf as well as the Jordanian market, as many Jordanians were working in the Gulf by then. The price of land and real estate in Jordan went up with that the government issued a three year development plan

1973-1975 aimed at urban development and allowing building in low population areas, agricultural, and industrial sectors areas in hopes of creating more job opportunities for the population. This development came to be faster than any policies that protected the agriculture lands from being taken over by urbanization that by 1975 the agriculture cropped land especially wheat decreased by half and kept on decreasing from that point onwards without any sign of stopping. By now it has reached 250 thousand dunums, in addition to the fact that wheat farming returned little profit for the farmer while the price of land reached 1000 JD for a dunum putting the farmer in a difficult situation either keep growing wheat or sell the land. Adding to this the unstable rainfall seasons due to climate changes and the migration of Jordanians to the gulf state for better work opportunities. As the wheat production came down by 1976 the import of wheat had increased significantly from the west especially the USA which was supplying its wheat at very low prices as part of its policy of subsidizing it to the world. (Why Jordan stopped producing wheat, www.7iber.com 2018).

The first and second Gulf wars also influenced the agriculture sector, as it was affected by the external markets that were completely closed for Jordanian agriculture exports. Once the first gulf war started, the UN Security Council passed Resolution 661 which invoked economic trade sanctions against Iraq. Jordan complied with the resolution and this affected Jordan's interests and economy as a whole as Iraq was the largest Jordanian trade partner for the previous ten years before the war. Many Jordanian companies lost large amounts of money because Iraqi companies were unable to pay their debts and all the key Jordanian economic sectors that were mainly serving Iraq such as transportation, agriculture, and industry were severely affected by the resolution. At some point Jordan supported Iraq during the war, as a result Gulf countries cut off their support as well as many European countries, the U.S. and Japan took the same steps (a situation not reversed until Jordan became involved in the peace process with Israel). In addition, it is worth noting that Iraq and Kuwait themselves had previously been the source of 30 percent of the total financial aid received by Jordan (The 1991 Gulf War and Jordan's Economy, 2002). Jordanian exports especially agriculture to Arab and other countries declined drastically, as Kuwait and Saudi Arabia prohibited the import of Jordanian products because of Jordan's political position during the war. Jordanian agriculture, industry and trade sectors were thus shut out of the most important Gulf markets.

Recently, Iraq and the Syrian instability and crises both affected the exports negatively especially by instability in Syria and Iraq, the major exporting markets for the Jordanian agriculture products, with the closing of both the north border with Syria and the east border of Iraq, which were the main export portal for agriculture products to Turkey, Lebanon and eastern European countries. This closing resulted in the production accumulating in the Jordanian market and many farmers protested by dumping their produce in the streets. (Ministries and field experiments-12- Agriculture Article, 2019, www.sarayanews.com)

As mentioned in the introduction and background section Jordan witnessed many waves of refugees starting from the 1948 with Palestinian Refugees, to the Gulf war 1991 and after that the Invasion of Iraq in 2003 with Iraqi refugees and immigration, and up till recently the Syrian refugees. The waves of refugees and immigration to the country led to the population growth

which in turn increased the demand on food consumption and water resources and rapid urbanization. The Jordanian government sought to ensure food security by attempting to increase agriculture which lacked proper planning, and also produced structural distortions in the water sector. This expansion of agriculture dramatically increased total water demand, with irrigated agriculture taking a large share of available resources, at the same time the urban population was growing fast contributing to the increased demand on water resources. (Politics matter: Jordan's path to water security lies through political reforms and regional cooperation, National Centre of Competence in Research Working Paper No 2013/19, April 2013). Refugees and immigrants through the years played a significant role on the rapid urbanization due to population growth, which forced urban development in areas needed for agriculture. noting only 10% of Jordan's land is suitable for agricultural production, and most of it lies in the areas where population is already concentrated at high density. This has pushed agriculture to marginal areas in the Badia which already suffers from drought and soil degradation and will be suffering further from climate change in the coming years.

Internally government policies and strategies have impacted the agriculture sector starting from the structural reforms mentioned earlier. In the years before 1989, food security in Jordan was not considered an issue of great urgency compared to other political, social and economic problems facing Jordan and the region. A Ministry of Supply was established in 1974, with the task of securing basic food commodities at reasonable prices to consumers. It controlled external food trade, imported strategic food items, food and feed prices and subsidized consumption and production of basic food commodities. Since 1989, Jordan started on liberalizing its domestic and foreign trade as part of the ongoing structural adjustment program. (Jordan Agriculture Ministry Agriculture report for Jordan's National Report 16/17 to the Sixteenth Session of the Commission on Sustainable Development-UN)

In 1993, Jordan applied to join the the General Agreement on Tariffs and Trade (GATT) to be integrated into the international economy. Then in 1994 the government adopted the policy of trade liberalization as part of the Agricultural Structural Adjustment Program (ASTAP), and the Agriculture Structural Adjustment Loan (ASAL) provided by the World Bank then came the implementation of changes related to Jordan's joining the WTO (K4D Helpdesk Report: Jordan's environmental policies and engagement on climate change, 10 June 2019), Jordan subsequently took numerous measures to liberalize its domestic and international trade in agricultural commodities, all measures undertaken for the protection of local production from external competition where abolished and subsidies have been totally lifted such as removal of direct subsidies and removal of feed subsidy and non-customs protection, reducing support to irrigation water, and abolishing the monopoly of the Agricultural Marketing and Processing Company (AMPCO) for importing fresh vegetables and fruit short on the market. which resulted in the national agricultural products having to compete with imported goods in the domestic and export markets. These developments came with a decline in the quality and quantity of water available for irrigation, which affected crop productivity and quality of produce and its competitiveness in both quality and price in domestic and export markets. (Jordan Agriculture Ministry Agriculture report for Jordan's National Report 16/17 to the Sixteenth Session of the Commission on Sustainable Development-UN)

In 1995 the government reviewed the means and largely reduced subsidizing bread. In May 1995, the Government removed quantitative restrictions on all imports, re-approvals were stopped and customs duties on imports were reduced to a maximum of 30 percent. In 1996, the Government adopted a comprehensive Agricultural Policy Charter prepared by the Ministry of Agriculture, which aimed at achieving an integrated social and economic development while decreasing the impact of trade liberalizing in agricultural commodities. In 1998, Jordan joined the Great Arab Free Trade Zone, which required phasing out customs duties by 10 percent annually until it was completely canceled by 2005. (Jordan Agriculture Ministry Agriculture report for Jordan's National Report 16/17 to the Sixteenth Session of the Commission on Sustainable Development-UN)

In April 2000, Jordan signed the Jordan-EU Association Agreement, which provides for the establishment of a free trade area. The agreement provides facilities and exemption in customs duties on Jordanian exports of agricultural products. This agreement was implemented in May 2002. In May 2000, Jordan became a full member of the WTO. Thus, Jordan's local and foreign trade became subject to the provisions of the WTO agreements. (Jordan Agriculture Ministry Agriculture report for Jordan's National Report 16/17 to the Sixteenth Session of the Commission on Sustainable Development-UN)

In 2001, Jordan signed the Free Trade Agreement (FTA) with the United States of America (USA). This agreement provides for a wide range of Jordanian agricultural products to enter the U.S market exempted from customs duties or at reduced rates. In May 2004, Jordan signed the Free Trade Agreement with Singapore and implemented in August 2005, which provides for the establishment of a free trade area. The agreement provides facilities and exemption in customs duties on Jordanian exports of agricultural products. Since then Jordan also signed several bi-lateral trade agreements to establish free trade zones with some Arab countries. (Jordan Agriculture Ministry Agriculture report for Jordan's National Report 16/17 to the Sixteenth Session of the Commission on Sustainable Development-UN)

Most Government efforts have focused on developing agriculture production, which resulted in over-supply of some products, and wasting large quantities of produce because of imbalance between supply and demand, non-market-oriented production and poor relation between marketing and production sectors, due to government failure in involving the production sector in developing the marketing sector in maintaining free competition in the market, providing marketing support services in research and extension as well as credit and information. Involving the production sector will help ensure the stability and suitability of policies and mechanisms for direct economic intervention in the market, including support, protection, and promotion of investment. Also, the small size of the local market, subjecting the marketing of produce to the effects of regional markets, this adds to the challenges facing Jordanian produce as it already weak in competitiveness due to the small size of marketing entities and companies, which prevents them from benefiting from the economies of scale of large establishments. The government of Jordan / Ministry of Agriculture signed a loan agreement with World BANK to implement The Horticultural Exports Promotion and Technology Transfer Project, with total cost of (US \$ 5 million) with end of 2007. The objective of this project is to assist the Government of

Jordan to improve horticultural export marketing by establishing A system of out grower farming between large and small / medium scale farmers in order to achieve “ critical mass” or “ bulk volumes” demanded by target markets and improve the income of participating farmers, and building the technological capacity of farmers, especially the out growers, to improve crop husbandry practices and their produce quality to satisfy the requirements of target markets and reduce the rejection rates of exported consignment., the agreement included that a new national company to market horticultural produce will be established before the end of 2007 with capital of US\$ 10 million. (Jordan Agriculture Ministry Agriculture report for Jordan’s National Report 16/17 to the Sixteenth Session of the Commission on Sustainable Development-UN)

Jordan is currently implementing a two agricultural development policy: The long-term strategy which aims at to increase the total area under cultivation by better harnessing water resources to increase irrigation of arid desert areas for the cultivation of cereal crops, the country's most pressing need. In the short term, the government is attempting to maximize the efficiency of agricultural production in the Jordan River valley through rationalization or use of resources to produce those items in which the country had a relative advantage. However many policies, laws, bylaws and strategies were initiated since the end of the 1950’s, either directly related to the agriculture sector or indirectly affecting the sector, below listed are the most noteworthy (taken from the Assessment of the Agricultural sector in Jordan, EU report 2012):

In 1959 the most unworthy was the **Law of Agricultural Credit Corporation" (50) /1959** This law addresses Credit sources and credit policy in which it unified the agricultural credit sources and set a credit policy based on sound scientific, economic and technical bases, including securing an effective monitoring on the spending of the loans as per their purposes and objectives.

In 1988 the **Water Authority Law No 18 of 1988** was initiated. This law established the Water Authority of Jordan (WAJ) as an independent corporate body in terms of finance and administration. The law describes the Mandate of WAJ, in which WAJ is fully responsible for providing municipal water and wastewater services, and development and management of groundwater resources. It also clarifies WAJ's relationship with the Ministry of Water and Irrigation.

In 1992 came the **Ministry of Water and Irrigation By Law No 54 of 1992** It established that the Ministry of Water and Irrigation is given the full responsibility for water and public sewage in the country as well as all the related projects, includes formulation of the water policy and submitting it to the Council of Ministers for adoption. It also gives the Ministry full responsibility for the economic and social development of the Jordan Valley as well as carry out all the works which are necessary to see the objectives through.

Also in 1992 the government initiated the **National Environmental Strategy (NES)** . This strategy includes all environmental pressures and problems and offers many specific recommendations and suggested actions in the field of environmental protection and conservation in the country.

In 1995, three years after the National Environmental Strategy the government passed the **Jordan Environmental Law**, this law provided the appropriate legislative context for issuing the regulations and instructions regarding the protection of the environment.

In 1997 **The cooperative law number (18) for the year 1997 was issued** this law recognized the Jordan Credit Cooperatives officially as a general institution that is independent financially & administratively. The law also addressed restructuring the cooperative sector in adherence to implementing the valid active rules & laws in Jordan according to the Cooperative law.

Also in 1997 Jordan initiated **Jordan's Water Strategy**, this document helps describe Jordan's responsibility towards its water sector through: resource development, resource management, legislation and institutional, shared water resources, public awareness, performance, health standards, private sector participation, financing and research development.

In 1998 **Groundwater Management Policy** was issued, this policy aims to outline in more detail the statements contained in "Jordan's Water Strategy", it states the Government's policy and intentions regarding groundwater management including the development of the resource, its protection, management and measures needed to bring the various renewable aquifers' annual abstractions to their sustainable rate.

Also in 1998 the **Irrigation Water Policy** was also issued, this policy addresses water related issues of resource development: agricultural use, resource management, and the imperative of technology transfer, water quality, efficiency, cost recovery, management and other issues. It also includes separate chapters for the linkages with both energy and the environment. Noting this policy is compatible with the Water Strategy confirming its long-term objectives.

In the same year the **Wastewater Management Policy** was also issued and it also aimed to outline in more detail the statements contained in the document entitled "Jordan's Water Strategy" to set out the Government's policy and intentions concerning wastewater management aiming at the collection and treatment of wastewater from different locations, as well as the reuse of treated wastewater and sludge.

By 2001 Jordan initiated the **National Rangeland Strategy** developed with the main objectives of controlling deterioration of the rangelands and reversing desertification through increasing sustainable livestock production by restoring the productivity of rangelands and increasing sustainable range feed production by supporting it's production in order to encourage intensive breeding through encouraging local communities and sheep breeders to adopt intensive breeding techniques to regulate supplying rates.

Also in 2001 **Jordan Valley Law** was issued to develop the water resources of the Valley and utilizing them for irrigated farming, domestic and municipal uses, industry, generating hydroelectric power and other beneficial uses, also their protection and conservation and the carrying out of all the works related to the development, utilization, protection and conservation of these resources.

By 2002 the government issued **Agriculture Provisional Law No. (44)/2002**, aiming to organize and develop the agricultural sector to reach a developed, growing, diversified, and integrated agricultural production that conserves the environment and natural resources, also to enhance the local dependency while fitting the international, regional and domestic requirement.

In the same year the **Underground Water Control By-Law No 85 of 2002** was issued, this by-law describes and entails the different procedures that are needed for controlling groundwater resources in Jordan. It helps explain the utilization and extraction quantity allowed, and also includes conditions about licenses and their cost for borehole drilling and water extraction fees.

As mentioned earlier 2002 saw the development of the first **National Strategy for Agricultural Development 2002-2010**, to discuss the role of the agricultural sector in social and economic development in achieving a sustainable agricultural and rural development taking into consideration the protection and conservation of agro-biodiversity. The strategy presents proposed projects in the five agricultural sub sectors: rainfed agriculture, irrigated agriculture in the Jordan Valley, irrigated agriculture in the highlands, livestock and rangelands and marketing of agricultural produce.

Also 2002 the government initiated the **Poverty Reduction Strategy**, this strategy aims at improving living standards of all poor segments of the society, also to alleviate poverty includes short, medium, and long-term initiatives in each area of the policy.

In 2003 **Jordan's Valley Authority Strategy Plan for 2003 – 2008** was initiated, it came after **Jordan Valley Law** this five year strategy describe the responsibility towards its water sector by the following four major goals: water resource management and development, water supply and distribution, land development and management, organizational performance improvement and development

In 2006 the government launched it's **National Strategy and Action Plan to combat desertification**, this strategy includes six major project-based programs related to desertification monitoring and control, capacity building, natural resources rehabilitation and development.

The National Agenda 2006 -2017 was launched in 2006 as a comprehensive political and socio economic reform plan for the country with the main goal to achieve consistent policies and ensure that they will not be subject to government change while taking into considerations the need to regularly develop and update these policies

In 2008 the **Irrigation Equipment and System Design Policy** was issued it follows through with the longer-term objectives outlined in the Water Strategy and supplements the Irrigation Water Policy establishing a policy on irrigation equipment and system design standards. The policy includes defining and updating equipment standards, raising farmers' awareness of standards, testing and enforcement of standards, training and certifying drip system designers, and institutional responsibilities.

Also in 2008 the **Irrigation Water Allocation and Use Policy** was issued also following through with longer-term objectives outlined in the Water Strategy and elaborates on priorities specified in the Irrigation Water Policy by updating and extension of selected elements of the in that policy. In particular it establishes and elaborates on the elements of that policy relating to farm water management, management and administration, water tariffing, and irrigation efficiency. It also addresses: defining and updating crop water requirements, water allocation and billing practices, building farmers' water management skills, using reclaimed water, measuring deliveries and delivering water to groups.

In 2009 **Jordan's Water Strategy 2008-2022: Water for Life** was developed, this is the most recent strategy that specified drinking water as the main priority in water allocation, followed by industry and agriculture. It includes specific actions and plans with targets to be achieved and emphasis on the two mega projects; the Disi water conveyance and the Red-Dead seas Canal, and the reduction of the Non-Revenue for Water (NWR) by having cost reflective tariffs and restructuring the water sector institutions.

In 2016 the latest **National Strategy for Agricultural Development 2016-2025** was initiated following up on the National Strategy for Agricultural Development 2002-2010, and in line with Jordan Vision 2025 in the aim of sustainability and development of agricultural resources, preserving plant biological diversity, improving the investment environment in the agricultural sector, enhancing integration between animal and plant production, and strengthening the relationship between the agricultural sector and other economic sectors, also the development of agricultural research and extension and the use of modern technology in agriculture and improving the competitiveness of quality and price agricultural products. the vision and goals of the strategy will be achieved through projects and administrative and legislative procedures to be implemented over the life of the strategy distributed over 6 main sectors and there 25 sub-categories, the main sectors being: agriculture resources, animal production, plant production, forestry and rangeland, marketing, and the supporting environment.

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