

Activity 3.1.2

PP4 - University of Sfax

DESK REVIEW





Overview on local agriculture and food heritage: Case of Sfax and Sahel in Tunisia

DESK REVIEW

Prepared and submitted by the University of Sfax (US) under the project “Sustainable Networks for Agro-food Innovation Leading in the Mediterranean - MedSNAIL”



Fondazione Slow Food
per la Biodiversità
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Tunisia Overview

I. Generality

I.1. Geographical presentation and climate characteristics

Tunisia is located in North Africa, between longitudes 7° and 12° E and latitudes 32° and 38°N. Belonging to the Maghreb, It is bordered on the North and the East by the Mediterranean. Its western border opens on Algeria (965 km) and its South-eastern border on Libya (459 km, Figure 1). Tunisia covers 163 610 km², which makes it the smallest country of the Maghreb. It has a relief relatively contrasting according to the areas and a significant maritime front of almost 1300 km mainly directed towards the east. Tunisia, as an integral part of the Maghreb and the northernmost country of Africa, has a strategic location dominating the Strait of Sicily, between Cap Bon Peninsula and Italy. The Strait of 200 km wide, is one of the most frequented pathways in the world.



Figure 1. Tunisia geographical position

Due to this geographical position and general orientation of the main relief, Tunisia is influenced in the North by the Mediterranean, the South being under the influence of the desert. About 40 % of the surface area of Tunisia is occupied by the Sahara desert. The Center is under the joint effect of these two elements. The principal mountain chain crosses the country from the south-western direction to the North-East on the way to Cap Bon. It is the Tunisian dorsal, which constitutes the Eastern end of the Atlas chain. Its highest peak is Djebel Chambi (1544

m) and the average altitude is 700 m. Between the mountains, there are fertile valleys and plains. Only one river is continuously feeding: Medjerda which flows into the Gulf of Tunis.

The climate of Tunisia is divided into 7 bioclimatic areas favorable for a great diversity of husbandries. Subjected to a Mediterranean climate, the north part of the country is characterized by a hot and dry summer and mild and relatively rainy winter. This region is agriculturally rich. The Center and the Gulf of Gabes have a semi-arid climate, characterized by relatively high temperatures and modest rainfall (between 200 and 400 mm/year). The mountains are separated by fertile valleys and large olive plains (the Sahel and Sfax region) appears in the east. The rest of the country marked by the large depression of Chott El Djerid and its riparian palm groves, witnesses a desert arid climate characterized by high temperatures as well as important amplitudes were rainfall rarely exceeding 100 mm. The great difference between the north and the rest of the country is due to the Tunisian dorsal which separates the areas influenced by the Mediterranean climate from those influenced by the arid climate engendered by the Sahara. Such a characteristic makes Tunisia a country particularly vulnerable to climate change.

The summer season in Tunisia is marked by significant aridity, which is characterized by heat and dryness due in part, to the sirocco. The temperatures vary because of the latitude, and the nearness to or farness from the Mediterranean Sea. The average temperatures for the entire country are 12 °C in December and 30 °C in July. The country also profits from a rate of significant sunshine which exceeds 3000 hours a year. The temperature may be a few degrees below 0°C in winter in the mountains of Kroumirie, and sometimes it can be, in summer, around 50°C in the shade in the desert areas.

Thanks of Tunisia's geographical location, many different peoples have entered and dominated the country.

I.2. Tunisia History and Culture

In the heart of the Mediterranean, Tunisia has been a crossroads of civilizations. The first known inhabitants of the country were the Berbers. There is also African, Asian (brought by the Phoenicians and by Judaism and Christianity from the East), Arabo-Iranian, Islamo-European (through Andalusia) and European, comprising Greek, Roman, and French influences.

In 814 B.C, the first invaders were the Phoenicians, who settled Carthage, used it as a trading base, and eventually entered into a losing conflict with Rome. Then Romans dominated Tunisia for several centuries. After the decline of the Romans, the Vandals invaded from the west, followed by a Byzantine reconquer from the east. In the seventh century, the Byzantines were

replaced by Muslim Arabs from the east. Though dynasties have come and gone, Tunisia has been predominantly Arabic-speaking and Muslim since then. In 1574, Tunisia was incorporated into the Ottoman Empire. The Spanish held parts of Tunisia briefly before the Ottomans, and the French ruled Tunisia during the colonial period for 75 years.

After the Jasmin revolution in January 2011, Tunisia has become a model of peaceful democratic transition benefiting from a developed local governance system. Since that time, culture has become increasingly politicized and polarized in Tunisia, becoming a political stake in itself. It is seen as a tool for development and dialogue with a view to promoting Tunisian culture. The 2014 Constitution and state structure deal with culture made decentralization an unavoidable choice by instituting the principle of local power and by considering citizen participation as a guarantee of democratic governance.

I.3. Tunisian Demography and social environment

History, as well as natural environment, generate inequality population density between north and south and between east and west since Independence (Figure 2).

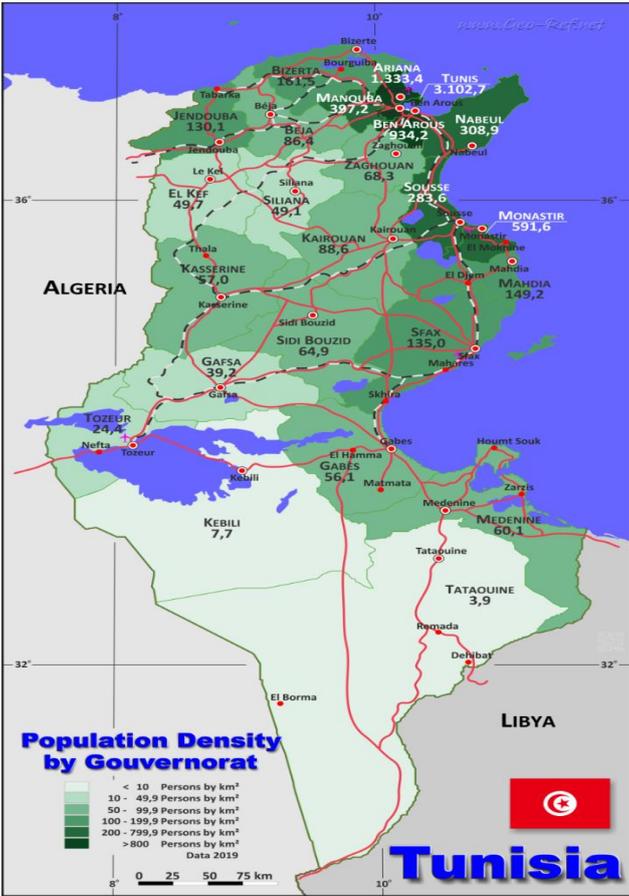


Figure 2. Population density according to Governorates

Tunisia has no cities with more than a million people, 6 cities with between 100,000 and 1 million people, and 81 cities with between 10,000 and 100,000 people. The largest city in Tunisia is Tunis, with a population of people. The population includes Arabs (98 %), Europeans (1 %), Jews and others (1 %). In 2018, Tunisians under the age of 14 were estimated at 25.25 % (male 1.502.655 / female 1.405.310) of the total population, those between 15 and 64 years were 66.53 % of the population, and 8.22 % were 65 years old and above (male 448.784 /female 498.400). Two-third of the total Tunisian population live in urban centers, particularly in coastal governorates. Thus, the geographical distribution of urban areas is mainly concentrated along the coastal strip. It includes 71 % of the urban population, whereas only a third of the Tunisian population lives in the country, which has several sizable cities of rural areas based precisely on promoting agricultural activities. This structural imbalance between coastal regions and regions of the interior is mainly due to the presence of a modern public infrastructure and a social and cultural infrastructure, high regional population density, regions size and urbanization (Karray and Driss, 2006). Looking for a better balance, some development policies have been adopted to reduce these regional development inequalities. It consists of creating in each governorate a general commission for regional development, a regional commissioner for agricultural development, offices of irrigated perimeters as well as municipalities. Other several measures have been adopted by Tunisian authorities such as the classification of the less developed regions as regional development areas and priority development areas. Such actions provide several advantages and may improve the attractiveness of industrial enterprises and therefore the development of the region. On the other hand, the Tunisian social environment is “modern” which promoted women's rights and ratified a modern personal status code. Furthermore, Tunisia’s population is more so educated than any other Arab country. It has an efficient educational system making the middle class considerable. All these reasons made Tunisia one of the most modern and socially advanced countries in the Muslim world (“Islamists set sights,” 2011).

I.4. Tunisian Economic environment

The geographical location of Tunisia, adjacent to many European cities, is considered an asset necessary to enhance the tourism industry and improve the country’s infrastructure. Historically Tunisian economy was linked to agriculture (wheat, dates, olives, citrus fruits, and sea products), to mines and energy (a large producer of phosphates), to tourism (6.5 million tourists in 2006) and to manufacturing industries (textile, food processing, and electromechanical engineering). After a half-century of rapid growth, the structure of the Tunisian economy has

changed. It has a diversified economy. Industry and services share in output have increased, that of agriculture has gradually decreased. Tunisia engaged in economic liberalization, global economy opening, and integration. Thus, as early as 1991, Tunisia became a member of the GATT. It was the first Mediterranean country which had agreed to free trade with the European Union (17 July 1995). According to the terms of this agreement, Tunisia and the European Union are committed to gradually create by the year 2008 a free trade area. A stronger Euro-Mediterranean partnership grew out. It states a progressive lifting of customs barriers on the imports of goods and services from the countries of the Union, until their total removal at the end of 2007.

Over the past five decades, agriculture had a large but volatile influence on overall growth performance. The contribution of this sector to real GDP growth rates fluctuated in the past decade. It has an average of 13.4 percent during 2000-07 but declined to 10 percent between 2005 and 2009 (Chemingui and Sánchez 2011). Manufacturing was the fastest growing sector. Three important manufacturing subsectors: textiles/clothing-leather/footwear, agro-food, and mechanical, electrical and electronic industries are the main industry involved in GDP growth. Excluding the agro-food industry, manufacturing value-added grew at 11 percent annually over nearly four decades, until 2000. During the years 2000-07, the contribution of the industry to GDP stood at 29.2 percent and its growth rate averaged at 4.2 percent (Chemingui and Sánchez 2011). Tourism value-added grew at an average annual rate of 12 percent over the period 1962-2000. The employment share of the sector grew from an insignificant proportion to almost 3 percent of the total labor force (Ayadi et al. 2005). During the period 1990-2007, the contribution of services to GDP stood at 57.4 percent and its average growth rate was equal to 5.6 percent (Chemingui and Sánchez 2011).

I.5. Agriculture production system and biodiversity

The agricultural sector in Tunisia remains economically and socially important for its contribution to the achievement of national objectives as regards to food security, employment, regional equilibrium and social cohesion despite the change and diversification observed in the Tunisian economy (industrialization, growth of service sector and the expansion of tourism). Ensuring the bulk of food supplies of the country, this sector not only provides resources to the non-agricultural sectors but is also an important market for industrial products and benefits in turn as industry helps modernize traditional production techniques by providing technology, modern inputs, and improved managerial skills. The agricultural sector which occupies a quarter of the active population in Tunisia is conducted over 10 million hectares throughout

more than 500000 farmlands. The income for a large part of the population depends on agriculture and the use of natural resources.

Characterized by a large diversity of habitats, ecosystems and biodiversity, the current area of forest land in Tunisia is 1.141.628 ha (13 % of total superficies), comprising 679.099 ha (59 %) of forests, 336.788 ha (29 %) of other forest formations (fire trenches, rocky terrain, etc.) and 131.850 ha (12 %) of wasteland. The national afforestation rate exceeds 13 %. This rate covers very significant regional differences (governorates) ranging from less than 1 % in the southern governorates to 39.06 % in Jendouba in the North of Tunisia. The Country includes wetlands (5 %), cultivated land (32 %), urban land (0.5 %), as well as unexploited land (50 %). About 40 % of this latter is made up by the desert. This means that only about half the country contributes to agricultural production.

1.5.1. Crop production and plant biodiversity

Bioclimatic diversity, morphological and geological diversity, as well as soils diversified, are at the origin for the existence of a mosaic of genetically different cultures. Crop production in Tunisia depends mainly on major crops; grains (wheat and barley) that cover 43 % of total agriculture land which is about 1.7 million hectares. More than half (53 %) of agriculture land cultivated under grains are located in the central and southern part of the country. The rest is distributed in the north of Tunisia where grains cultivation is relatively stable compared to the central and southern parts. Also, tree crops (mainly olives) that cover on average 1.9 million hectares occupy an average of 44 % of total land. As per grains, most tree crop cultivated areas (87 %) are located in the center and south and are cultivated under essentially rain-fed conditions. 1.4 million hectares are under olive cultivation followed by almond, pistachio, date, apple and pear trees, and grapevines. The remaining 17 % of total agriculture land is allocated between forage crops (7 %), vegetable crops (3 %), legumes (2.5 %), and others (0.5 %). Tunisian flora comprises 2,162 species, of which 2103 species are distributed among 115 families and 742 genera.

- **Native plants:** showed mainly in the northern Tunisia forest area including *Quercus ilex* (the evergreen oak/holm oak) and *Pinus halepensis* as well as *Myrtus communis* (myrtle), *Arbutus unedo* (strawberry tree), *Erica arborea* (tree heath), and *Crataegus monogyna* (hawthorn), which have been commonly used as folk remedies. Trees such as *Cupressus sempervirens* (italian cypress) and *O. europaea* (olive tree) also grow in the Mediterranean region.

- **Medicinal plants:** Up to 80 % of the population in Africa use traditional medicine to meet their health care needs. Tunisia occupies the 32nd place in the world of the exporting countries of Aromatic and Medicinal Plants. With more than 2.160 vascular species, Tunisia constitutes a veritable phylogenetic reservoir in the Mediterranean. They grow spontaneously and in wild form, especially in large forest areas. The list is very long and flexible and includes a large number of spontaneous species. Their number varies from a few tens to more than two hundred species. However, despite this potential, Tunisia is only 38th globally among exporting countries. The contribution of the medicinal and aromatic plants sector to agricultural production does not exceed 0.8 %, although Tunisia is among the main countries producing these forest plants in the Arab world. Products extracted from plants with multiple virtues, including thyme and rosemary, are in increasing demand on the national and international markets. It should be noted that the average annual sales of rosemary over the 2016-2017 period amounted to around 865 thousand dinars and 134 thousand dinars for thyme. In Tunisia, the cultivation of these plants covers around 340.000 hectares, spread over the different governorates including around 60.000 hectares of organic crops.
- Some medicinal plants are commonly used in various health systems and are of economic importance. *E. maritimum* (sea holly, Figure 3A) is one of the major medicinal plants found in the area used in preventing diseases including atherosclerosis, diabetes, and cancer. *A. campestris* (field wormwood; Figure 3B) is used for diabetes, bronchitis, diarrhea, high blood pressure, and nerve pain treatment. According to Sefi et al (2012), the essential oil is also effective in treating diabetes by protecting the kidneys. *A. armatus* (milkvetch; Figure 3C) is widely distributed in the pre-Saharan zones. It is used to treat cough, asthma, arthritis, anemia, and paralysis. *J. phoenicea* (*Phoenician juniper*; Figure 3D) grows across the northern and central regions of Tunisia. It is usually used for the production of essential oil which has the potential to treat obesity and diabetes.
- Desert plants: Steppe and desert climate regions are important habitats for plants that have adapted to dry conditions such *Acacia tortilis subsp. Raddiana*, *A. tortilis*, *Vachellia*, *Stipagrostis pungens subsp.*, *Argania spinose*, *P. harmala*... .

Plant biodiversity and agriculture sector, extremely important, are evolving in a fragile natural environment, with highly sensitive dependence on weather conditions.



Figure 3. Medicinal and aromatic species in Tunisia. A, *Eryngium maritimum*; B, *Artemisia campestris*; C, *Astragalus armatus*; D, *Juniperus phoenicea*

One third of Tunisia territory was in danger of desertification. In particular, the loss of biodiversity (Figure 4) caused by overgrazing is a serious issue in southern Tunisia. This environmental problem enhancing soil dryness produce only 1 to 10 % of vegetation that covers the ground and a dry biomass of perennial plants of about 100 kg/y/ha (Gamoun et al 2012). An effective means for ensuring plant diversity should be based on improved skills related to conservation management of potential plants to combat desertification.

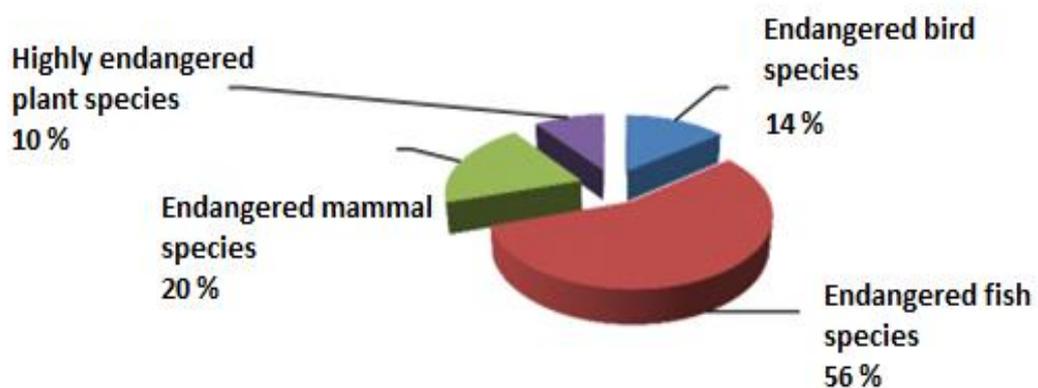


Figure 4. Plant and animal species in danger

The main protected species in Tunisia that are important parts of arid and semiarid landscapes preventing soil erosion and desertification include *Salvia aegyptiaca*, *Cenchrus ciliaris*, *Echiochilon fruticosum*, *Helianthemum kahiricum*, *Helianthemum sessiliflorum*, *Helianthemum scoparium*, *Marrubium deserti*, *Haloxylon schmittianum*, and *Deverra tortuosa*. However, they are negatively influenced by various human activities.

The study on biological diversity in Tunisia highlighted the interest of conserving it because it fulfills vital functions for all ecosystems and natural systems. Despite the fact that the economic potential of all-natural resources is not expressed by current forms of development, these resources are over-exploited without significant investment, times to ensure their protection, and to improve their productivity. Investing in the protection and development of these natural resources will help increase their economic and environmental returns. As part of this economic development of natural resources and Biodiversity for development sustainable, Tunisia is oriented towards supporting activities, projects, and programs, in relation to this development. As part of the promotion of sustainable agriculture is the launch of a strategy to develop biological farming. A strategy for the development of the organic farming sector has been put in place for the five-year plan (2016/2020). The objective of this strategy is to strengthen the contribution of professionals in the biological farming sector and working on major areas such as, for example, the sector's best value, the preservation of the environment and health and the promotion of organic products, as well as the increase in the area devoted to biological agriculture. Thus, this national strategy has led to the development of the organic farming sector. Organic farming areas have reached 370.000 hectares in 2017 compared to 18.600 hectares in 2002 and 300 ha in 1997. As for the number of operators, it increased from 481 in 2002 to 4.700 in 2017.

1.5.2. Animal production biodiversity

Tunisia, like other North African countries, is characterized by vast pastoral territories. The main vocation of these areas was livestock production. Pastoral lands provide not only forage to feed livestock but also play a critical role in alleviating many of the most challenging environmental and ecological problems. Since phenomena of drought, these lands are subject to increasing pressure leading to their degradation. Adding grain price escalation some breeders stop their activity in search of more lucrative chances. On the other hand, Tunisia disposes of 7 lagoons, covering a total surface of more than 100 000 ha and an exceptional continental shelf of a few 88 000 Km² and it claimed an Exclusive Economic Zone (EEZ), of 102.300 km². The coast is characterized by the presence of several shallow water zones, notably in the vicinity of

Kerkennah Islands and in the Gabes Gulf. Both provide an exceptional biotope to the maritime fauna and facilitating its capture. The current assessment of marine biodiversity shows 3480 species, distributed among 15 groups. This number represents around 45 % of Mediterranean biodiversity. The number of exotic species continues to increase, reaching 191 species in 2018, while the number of threatened species is around 55 species. This biodiversity offers 190 species, as targets for fishing. Fishing is an important economic sector, employing 51.565 people (1.35 % of the active national population), by means of 13702 fishing units. The fact that Tunisia has 1300 km of coastline, fishing represents a very important activity, insofar as it occupies 54.000 fishermen, corresponding to an equivalent number of households. Fish production has grown steadily since 2010, ranging from a total production of 102.066 to 130.289 tons in 2017. During the period 2007-2016, fisheries and aquaculture provided 7.5 % of the value of agricultural production and 15.2 % of the value of agricultural exports. Average consumption, per capita and per year, is around 11 Kg. The large extension of soft bottoms has contributed to the development of artisanal and industrial fisheries in the Gulf of Gabès, where over 40 % of total landings are generated (Najar et al. 2010). The artisanal sector, consisting of a fishing fleet of around 10,300 boats (in 2008), is well developed along the Tunisian coast, and it is mainly performed by about 4,500 small boats, of which 66 % were motorized (in 2008); they use a wide variety of fishing techniques and target high-value species. Traditional fishing techniques, the so-called *cherfiya* plays a key role in the economy of the country. The Tunisian department of fisheries has applied correction factors to the landings data since the end of the 1970s to take into account subsistence and unreported commercial catches, which amount to considerable quantities of fishing products sold directly to hotels and restaurants or in local markets without being accounted by the statistical agents. These correction factors account for 42 % of total commercial catches in the artisanal fishery, 17 % in the trawl fishery and 15 % in the small pelagic fishery. Fish and sea product exports reached about 20 555 tons evaluated at 202 millions dinars in 2005 (Annuaire Statistiques de la Direction Générale de la Pêche et de aquaculture, 2009). The biodiversity of marine and coastal ecosystems is rich and extremely diverse due to the wide assortment of environments along the coast. Mammalian diversity comprises 11 large mammals, including the wild boar, Barbary sheep, Barbary deer, 4 distributed species of gazelles, oryx and addax antelope and water buffalo... The number of bird species reported in Tunisia is about 400 species while carnivores are represented by 15 species (civet, zorille, mongoose, weasel, red fox, otter, striped hyena, golden jackal, Rüppell's fox, fennec fox, serval, lynx, caracal...). At this time, 7 species of amphibians are known in Tunisia. As for reptiles, 6 species of turtles have been reported. Lizards are represented by 36

species, of which the Trogonophide de Wiegmann is considered rare and requires special protection measures. Snakes are represented by 24 species, including 14 species of garter snakes and 7 species of vipers. The country has at least 671 species of insects, distributed among 14 orders and 82 families.

The greatest negative impacts to wildlife are due to land use exploitation and population growth. The last lion disappeared long time ago in 1891 in Babouche, between Tabarka et Ain Draham (northwest); the leopard (*Panthera pardus*) previously occupied the mountains along the Algerian border, near El Feidja to Nefza. The hartebeest (*Alcelaphus buselaphus*) has also been eradicated, with its last sighting in 1902, 150 km southwest of Tataouine (Lavauden, 1924a). Other species that have disappeared are the addax (1932, in Litt.) and the oryx.

I.6. Food System in Tunisia

Food in the Mediterranean region has been forged through the many and varied contacts of distant cultures over the different colonial eras. Each having introduced and disseminated their plants, animals and beliefs. The current Mediterranean food model is, therefore, the fruit of borrowing, spreading and adopting in space and over the last centuries, cultural innovations in the form of various food products and practices coming from Asia, India, the Middle East, and America, as well as the development of the international agricultural market and the increasing population's mobility.

In Tunisia, like most developing countries, food expenditure represents a high percentage of total family expenditure.

1.6.1. Sustainable production and consumption

Value chain and value chain development projects aim to ensure better sustainable production and promote the marketing of agricultural products, are part of a development vision of sustainable agriculture and concern several sectors financed by different financing tools, the TASDIR project (2018), the North West value chain development project (2018) World Bank, the GIZ collaborative platforms project in 8 governorates, etc. All of these projects are aimed at promoting sustainable production and support for the marketing of agricultural products for consumption sustainable. Measures are also taken to ensure sustainable production and consumption and to maintain the impact of the use of natural resources within safe ecological limits. Within the framework of the National Strategy for the Development and Sustainable Management of Forests and Rangelands (2015-2024), the Project integrated co-management of forest and pastoral ecosystems is made. This project supports the co-management of forests and

routes in the state domain by local communities based on integrated landscape management plans within targeted areas, by involving the populations through the Agricultural Development Group (ADG) and service companies. For example, the project aims to diversify livelihoods and create direct employment for 636 people in the oasis. The job openings offer non-permanent support jobs to promote sustainable production by using production techniques and tools that enable sustainability. Also, the project provided support for the electrification of boreholes, including two boreholes with photovoltaic pumps. Support projects for the use of renewable energies have been initiated by ANME to ensure sustainability from the production of energies. However, these projects have an impact on the costs of production and their durability.

I.6.2. Tunisian diet

Tunisia is characterized by a diet entirely based on cereals. Although the quantities consumed in these products are in continuous decline, cereals still the main product of the Tunisian diet (Figure 5). Conversely, the ration recorded an increasingly important contribution in meat, fish, milk, and eggs but also vegetables and fruits, which are almost present during the year (Figure 5).

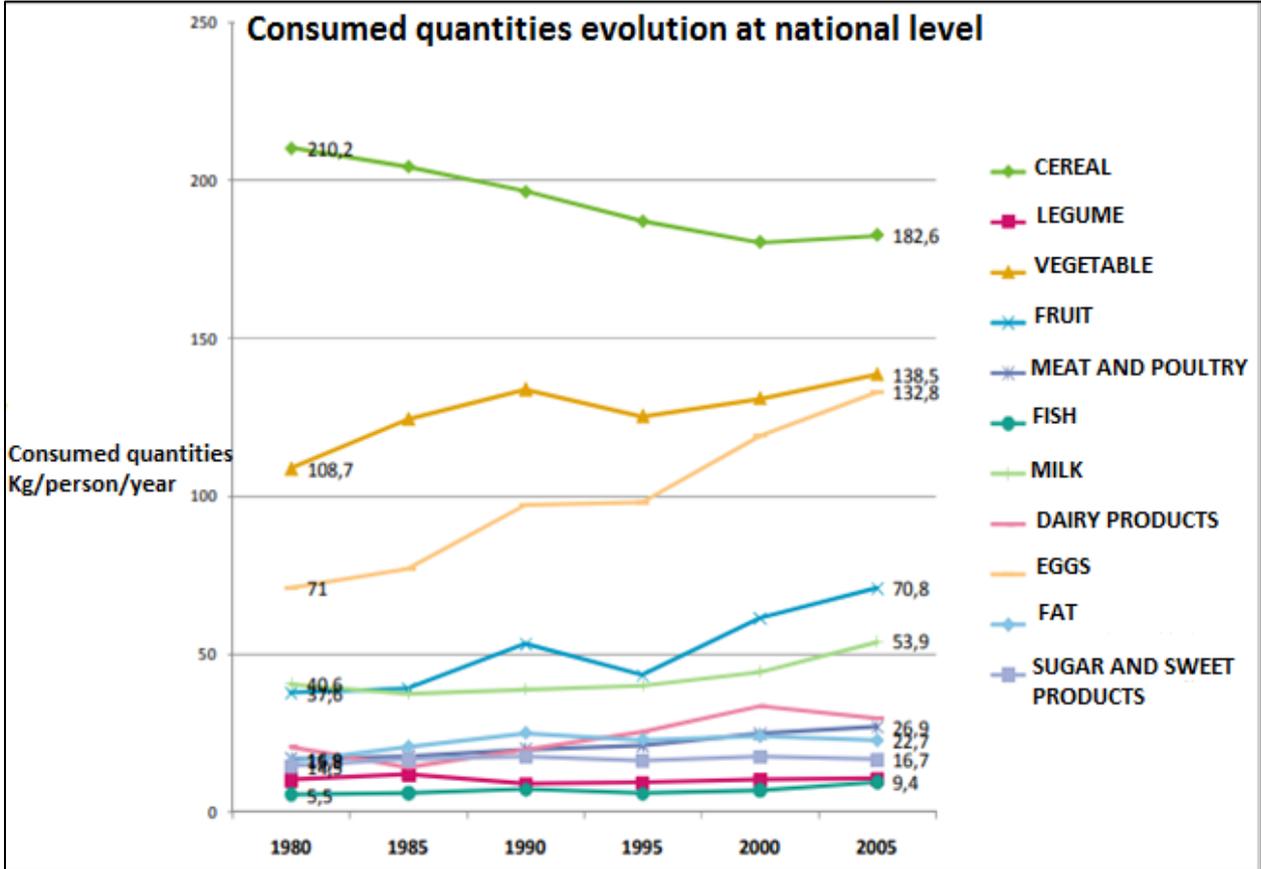


Figure 5. Evolution of the quantities consumed / person / year at the national level from 1980 to 2005

They are produced locally and therefore consumed according to the seasons. Indeed, there is greater diversification of the Tunisian diet with higher consumption of legumes and eggs. Due to the performances achieved by the dairy sector, we note a strong decrease in the share of milk against dairy products (yogurt, cheese, and others; Figure 5). Mixture oils (rich in saturated acids) are also consumed. Because of the urbanization, the increasing trend in the consumption of animal proteins (meat, poultry, fish, eggs, and yogurt) is observed. The evolution of Tunisian food consumption during the last two decades is characterized by:

- An average energy level almost stable and within the tolerated range;
- A change in the structure of the daily ration: the proportion of carbohydrates has significantly decreased in favor of lipids;
- A decrease in absolute protein intake with an increased protein of animal origin against vegetable protein;
- Nowadays, fast food in Tunisia increases and dominates Tunisian diet.

Tunisia has developed its own version of fast food with Tunisian sandwiches over the years. When you visit Tunisia, you will notice the fast food industry is not dominated by major fast food franchises, but rather there are little street-side restaurants scattered throughout the country. At the center of the Tunisian fast food culture is the enjoyment of bread, which comes in all forms of shapes and sizes. Bread has existed in Tunisia since over thousands of years ago and has a rich history and local bread culture. Tunisians have since developed it into many varieties of bread since ancient times. Although bread is a staple food item in Tunisia, there are also plate options for those who are gluten-free or do not enjoy bread.

1.6.3. Traditional food system in Tunisia

The evolution of eating habits towards the urban model with an increasing migration towards industrialized products, therefore, more fatty, sweeter, saltier which gradually replace the traditional products made at home. This transition is mainly due to socio-economic changes including: urbanization, mainly young population, feminization of economic life (statistics in Tunisia), household members moving out, organization of working time, collective environment replaces the family group favoring the development of taste, appearance and development of mass distribution and food "Modern", the appearance of fast food culture and coke culture, overall decrease in traditional products, industrial production focused on energy-dense products (multiplication of production of margarine, biscuits, confectionery, sugary

drinks...) and increased income. Also, it should be noted that agricultural production levels also condition the quantities consumed at home, particularly in non-municipal areas.

1.6.4. Culinary heritage in Tunisia

Culinary heritage is one expression among others of intangible heritage that the United Nations for Education, Science, and Culture (UNESCO) grants a growing interest through its actions and legislation to safeguard and enhance this heritage. The several States, like Tunisia, have also accepted its conventions and recommendations to develop the culinary heritage present in their territories. In Tunisia, measures have been taken at the national level to ensure the preservation of the culinary heritage which finds its place within North African society and civilization. This consideration is mainly expressed through the celebration and staging of these culinary “traditions” as part of Tunisian heritage month, in which all regions of the country participate. Thus, several events are organized displaying a “return” to food “traditions”, in reality to practices rich in whole grains, legumes, vegetables, and promoting olive oil. "Tradition" that we represent as having ensured food security and the fight against deficiencies in various members of the community. The Tunisian Sahel (Monastir, Sousse, Mahdia, and Nabeul) stood out in the celebration of this month, by the national festival of culinary heritage. The 11th edition of the culinary heritage flavors festival: “Olive Oil & Traditional Bread” was held from in Boumerdès (Mahdia Governorate) 2018. It was marked, by the programming of several contests and competitions of painting, cooking, photos having for theme the traditional cooking, and the historical couple” olive oil and traditional bread. The 19th edition of the festival: “Culinary Heritage of Lamta” was held from in Lamta (Monastir Governorate) 2018 (Figure 6).

1.6.5. Example of Tunisian "Mediterranean" dishes

- Vegetables make salads, soups, mixes of cooked vegetables, and they are used in the composition of many preparations (associated with fish, cereals, legumes ...).
- Fruits eaten most often plain, at the end of meals or as a snack,
- Cereals present at all meals and snacks,
- Legumes Simmered incomplete dishes, or mashed, they are also used in the form of flour (making cakes, pancakes),
- Fermented milk: Raeib, Iben,
- Salad Mechwia (vegetable-based: tomato, chilli, onion, eggplant, garlic, tuna or sardine, olive oil), Tunisian salad (vegetable-based: tomato, cucumber, onion, radish, parsley, pepper, fruit: apple, tuna or sardine, olive oil, egg),



Figure 6. Culinary Heritage of Lamta brochure

- Omek houria (carrots, garlic, harissa, olive oil),
- Vegetable stew (vegetable based: spinach, parsley, carrots, onion, tomato, ... legumes: lentils, chickpeas, olive oil, meat ...),
- Stew in general (based on sauce with all kinds of vegetables and legumes, meat or fish, olive oil),
- Kobiza (vegetable-based: kobiza, salk, harissa (chili),
- Couscous example djerbien, barkoukech, malthouth, farfouch... (cereal-based: wheat, barley, vegetables: tomato, onion, carrots, chilli, zucchini, pumpkin, fennel, legumes: chickpeas, peas, potatoes, meat: red, white or fish),
- Barkoukech sahel (cereal-based: mhamssa made in the state, vegetables: tomato, onion, carrots, chilli, zucchini, pumpkin, legumes: beans),
- chebtia (in the form of kefta): vegetable-based: parsley, salk, chilli, cereals: smid, egg),
- Felfel with onions (vegetable based: onion, garlic, egg, olive oil),
- Hlelem (based on cereals, vegetables: spinach, parsley, korchef, starchy foods: beans, lentils, chickpeas) accompanied by fish (especially chawri from May-June),

- Tlailou, kad khmira, nwassar, rechta njara, homemade macaroni (all made from cereals, vegetables: carrots..., legumes: chickpeas, broad beans,...),
- Lablabi (cereal-based: bread crouton, vegetables: garlic, legumes: chickpeas, Harissa, fish: tuna or sardines, olive oil),
- Chorba frik (based on cereals, vegetables: onion, garlic, tomato, celery, legumes: lentils, chickpeas, meat or fish),
- Bsissa (based on cereal flour: wheat or barley, sorghum, legumes: chickpeas, lentils, fenugreek, anise seeds, olive oil, spice, sometimes vegetables: onion or fruit: pomegranate, grapes, fig, dates, carob),
- Couscous (Figure 7), kefta, mergues and the list is still long...



Figure 7. Couscous: Traditional Food in Tunisia

*Case-study area 1: Sfax
governorate*

II. Sfax Overview

II.1. Location

The governorate of Sfax (Tunisia) extends over a surface of 7,545 km² (5 % of the total surface area in Tunisia). With more than 950 000 inhabitants in 2017 and with 16 delegations and 16 communes, Sfax constitutes the Tunisian second peopled region and the second-largest city in Tunisia. It is located 270 km south-east of the Tunisian capital. It is a coastal city oriented towards the Mediterranean Sea with a seafront of over 30 km. Its latitude and longitude are 34°43' in North and 10°46'E respectively. It is limited by Mahdia to the North, Kairouan, Sidi Bouzid, and Gafsa to the west, Gabes to the South, and finally the Mediterranean to the East. Accounting more than 500.000 inhabitants the urban area of Greater Sfax are Sfax City, Thyna, Sfax West, Sfax South, Sakiet Ezzit, and Sakiet Eddaier (Figure 8). Except for Sakiet Ezzit, the other five delegations have a seafront. It represents the second demographic and economic pole as well as an important production and consumption center. Kerkennah is an archipelago, 32.7 km away from the mainland city of Sfax (34°42N 11°10E). Along 35 km, this archipelago grouped two main islands are Chergui and Gharbi (Eastern and Western in Arabic) and ten small islands and islets (< 4 ha, Figure 8). The coastline is 174 km, 98,5% of which is stable (DGEQV, 2012). There are 12 uninhabited islets concentrated in the north of Kerkennah, among them Gremdi (207 ha), Roumadiya (160 ha), Sefnou (50 ha), Rakadia (5 ha) and Charmandia (3.3 ha). According to the classification of APAL (2001), they are sensitive littoral areas.



Figure 8. Location, topography, toponymical and localities of Sfax and Kerkennah archipelago

Metropolis in full expansion, the city occupies a strategic location in the Mediterranean and plays an important role in economic exchanges. The urban system of the city is characterized by macrocephaly between a central town which has the largest part of the activities and more than half of the total population of the agglomeration (64 %) and peripheral towns that are almost residential (Ben Nasr, 2006). The main economic activities of Sfax are industries (phosphate processing), agriculture (olive and olive oil, nuts), fishing (largest fishing port in Tunisia), and trade (import-export).

II.2. History

Founded in 849 AD, Sfax is an ancient city with a wealth of cultural and historical heritage. It includes a succession of several civilizations: From the Punic to the Byzantine to the Roman and Islamic. During the Roman area, the town was known as Taparura, a place that has transformed into a modern suburb. “In the books of history, you always find Sfax referred to as the guarded town or ‘al-Mahroussa.’ This is because the walls of the fences surrounding the medina of Sfax remained intact through the centuries (Figure 9 A),” historian Wahid Lotfi Mokni said. “From afar, the medina of Sfax always looks guarded and shielded.”



Figure 9. (A) Sfax Walls (B) Borj El H'sar

The walls are among the city’s most majestic and captivating hallmarks. Built-in 850 during the rule of Aghlabid Prince Abu Abbas Muhammad, they make up what is believed to be one of the oldest forts in the Maghreb. Made of clay and stones, the medina has two main doors: Bab Jebli, facing the northern lands, and Bab Bhar, facing the sea. Other doors were built throughout the years some during the Ottoman rule, others during the French colonial era. Besides, Kerkennah, this forgotten paradise, is almost untouched by history, save a brief point. Since the 12th century BC, the Phoenicians, a sea people, have lived in Kerkennah islands, developed an economy based on trade and agriculture, and saw the archipelago as a strategic viewpoint and a trading post and stopover for ships coming from the east. Later, in 814 BC,

they settled on the western coast of Kerkennah where they built the town and port of Cercina where Borj El H'sar. Presenting a compelling sight, Borj El H'sar is an ancient ruin of a fort built almost 1000 years ago (Figure 9 B). In the 5th century, the Greek historian Herodotus spoke of Kyrannis (Kerkennah) as prosperous islands famous for its major trading port. Another reminder of the Phoenician Empire in Kerkennah is the Punic underground tombs in Karraba, near Borj El H'sar, and in Mellita (Fehri A., 2003). After the Phoenicians came the Romans. Since the 9th century comes the Islamic period. The strategic importance of Kerkennah gradually dwindled. In the Aghlabite and Hafsid age, it had not completely lost its prosperity place, but in the 11th century, with the Hilalian tribes' invasion that gave it over for their cattle, Kerkennah suffered economically. During 400 years, many attacks; Italian, Spanish and Ottoman, made the people flee the west coast to settle on the east part of Kerkennah, where shallows prevented big ships from sailing and landing, or in the interior; this is how the present village network was set up (Kebaili Tarchouna M., 2014).

II.3. Topology and climate conditions

The studied area is characterized by a very flat relief. It has a semi-arid Mediterranean climate, largely influenced by its gentle topography and its maritime exposure. The average annual temperature is about 18.8 °C. The average winter and summer temperatures are 12.3 °C and 24.9°C, respectively. The hot season extends over a period of five months from May (average temperature = 24.2 °C) to September (average temperature = 29.4 °C). The region receives little rainfall (an average of 217 mm per year). Annual precipitation greatly varies from one year to another and generally varies between 100 and 400mm (Dahech, 2007). It is characterized by its seasonal irregularity. October, the wettest month, has an average of 44 mm. while, July is the driest month, with an average of less than 1 mm. The winds come mostly from the north and the north-east and east in summer and spring and from the west in autumn and winter.

Kerkennah archipelago topography is made up of a succession of flatlands, occupied by shorrs, sebkhas, and irregular hillocks. The archipelago is the tip part of a vast underwater plateau that extends from 9-50 km around the islands. Its average varies between 0 and 5m, the plateau is interspersed with channels that can reach 20 m and pits up to 30 m. The highest point is no more than 13 m located in Ouled Ezzedine. Kerkennah's very extensive coastal sebkhas lie at the edge of the sea. It allows rainwater to run off into the sea. They are always very low, less than 2 m high. It makes their outside margins frequently affected by seawater. The bioclimatic conditions of the archipelago are one of the main reasons for the vulnerability of the natural environment in the Kerkennah Islands. Although the presence of moisture in the sea around the

archipelago increases humidity and decreases the temperature difference between the land and the sea (Etienne, 2014), the low rainfall, the relatively high temperatures, and the winds cause active evaporation resulting in soil salinization and a big water deficit of over 1,036 mm./year (Fehri, 2011).

II.4. Water resources

The shortage of water resources in the governorate of Sfax limited its socio-economic development. The quantities of water brought from the North and from the centre-west (Sbeïtla, Jelma) are not enough to cover the water deficit in the studied area. The severity of the water problem in Sfax (Tunisia) was realized since the beginning of the 1950s. Because of the extension of draught, water scarcity increases. The Sfax urban area is crossed by several small wadis, most of their beds are now completely obscured by urbanization. These watercourses are temporary flows, converge towards the center of the city and lead into the Mediterranean Sea. From north to south, there are Oued Ezzit, Oued El Haffara, Oued Agareb, and Oued El Maou.

Facing rising serious water shortage problems, reuse of urban wastewater for non-potable purposes, such as agriculture was adopted as water management policy in the governorate. While the archipelago of Kerkennah is located on two aquifers. The first is shallow flush in low natural or artificial areas. It is salt and only used for irrigation contributing to soil salinization when excess water is not drained by a drainage system. The second is deep (350 m) and it is used for the freshwater supply of the population. The features of these resources mainly depend on climatic, geological, and hydrogeological conditions. Groundwaters (oueds) are almost inexistent because of the flat topography and numerous sebkhas communicating with the sea. Underground water has a low potential in Kerkennah which is constituted by superficial phreatic sheets. These laterals are exploited by surface wells (over 400 wells with average-to-mediocre water quality) of little depth, frequently sunk in the centre of little basins where surface water accumulates. The brackish water desalination plant in Kerkennah (the first in Tunisia) is in operation since 1983; its capacity is 3,300 m³ /day. It uses the inverse osmosis technique (DGAT, 2011). Yet, during the tourist season, water demand enhances significantly thus, saline water is added to the freshwater to produce up to 6000 m³ / day. Due to the low quality and quantity of water in the distribution network and connection rates, the vast majority of the archipelago's buildings have a recovery tank of rainwater. Discards of water loaded with high salt content (14 g/l) are now carried out directly on the shore.

II.5. Soil resources

Sfax is characterized by a light-colored soil which are generally sandy to sandy clay, or sandy loam, sometimes gypsum or salty. Their pH is generally basic to neutral. Their depth is very variable; we often have aeolian sandy veneers on the surface giving rise to fouling. While, soil quality has been strongly conditioned by the geological substratum, climate, and topography and the insular nature of Sfax (negative water balance, subsidence, sea-level rise, dissolution of Gypsum). In some places, erosion (wind or water) can seriously degrade the soil. Depending on the case, the roots can be removed (sometimes on more than 50 cm), or the trunks will be silted up, to at least similar depths. Agriculture land in the governorate of Sfax covers 575 000 Ha. However, urban expansion (residential and industrial) has taken place at the expense of rural areas (almond and olive fields), whose thermal and radiative properties are different from those of urbanized environments. Several practices promoted soil salinization. In fact, the use of treated wastewater for irrigated perimeters poses a soil salinization problem when dispersed outside the drained areas. Natural factors have encouraged the forming of salty to alkaline land with the degraded structure in the archipelago of Kerkennah. Saline soil with a crumbly surface structure occupied 7,315 hectares (about 47 % of the total surface area of the archipelago). These soils are characteristic of the sebkhas and their edges (Fehri, 2011, Figure 10). Kerkennah soil salinization by raising the roof of the water table or dissolution of gypsum naturally contained in the subsoil of islands is also an important factor to take into account.

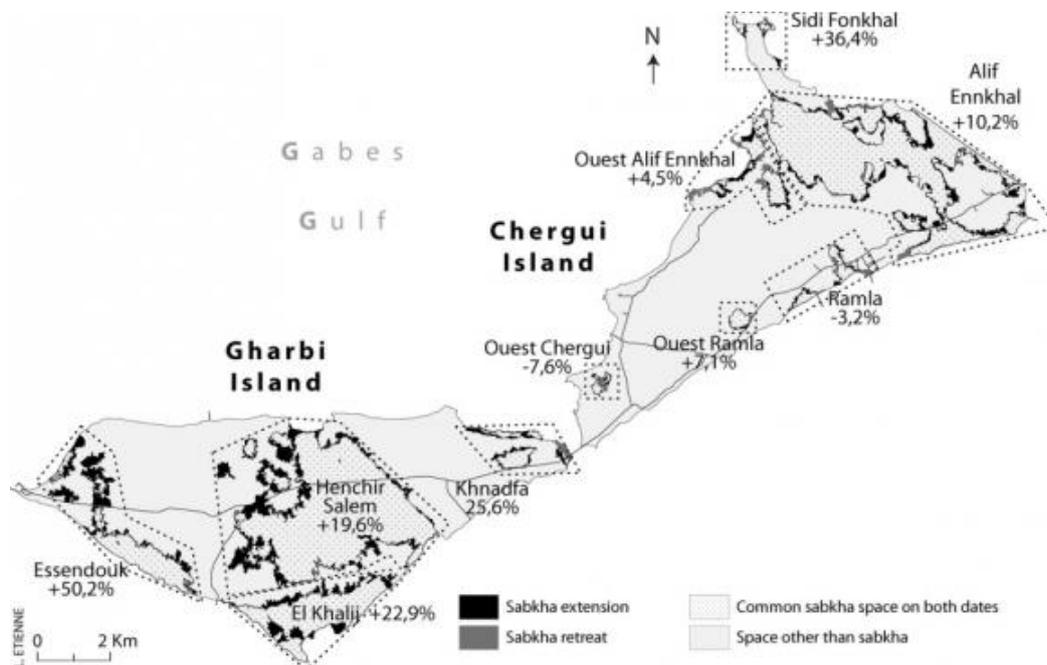


Figure 10. Salty surfaces extension in the Kerkennah archipelago

Soil salinization is favorable to the expansion of artificial sebkhas resulting a beautiful orchard of Sidi Ezzorai, Sidi Frej and Ouled Yaneg where soil is thick are constructed in the lower parts of the breaks in the slopes that loose formations with running water. Other loose outcrops are the dunes that appear at the edges of some sebkhas in Remla and between Mellita and Sidi Yousef (Oueslati, 1995). Although the formation of such beautiful structures, soil salinization phenomena has affected freshwater resources in the Kerkennah archipelago and degrade soil quality that influence land vegetation occupation by decimating non-halophytic vegetation.

II.6. Economic activity evolution

Sfax is a large industrial center, (the second after the capital) which is constantly developing. Sfax economy is essentially based on olive oil, peach, and phosphates. Since the 1960s, the industrialization of the economy has been adopted with the appearance of small and medium-sized manufacturing companies and the development of the tertiary sector. In Kerkennah, the economic activity is essentially based on the primary sector, marked by a very old form of agriculture and, particularly, a fishing activity that constitutes the base of the economy around which life in the archipelago is structured.

II.6.1. Vegetable production and breeding

The different physical characteristics (topography, hydrography, geology), Bioclimatic (climate, soil), and anthropic have largely influenced the natural plant cover of Sfax governorate. The plant cover is roughly degraded and not very dense. It is visible only in Skhira and Menzel Chaker and on the reliefs of the central-west governorate (Figure 11). Land distribution in Sfax shows a very limited forest cover of around 5,680 ha (0.8 % of Sfax total area). Agriculture land is mainly extensive in Skhira, Menzel Chaker, and Bir Ali Ben Khalifa delegation covering respectively 38 %, 24 %, and 15 % of the total area (Figure 11). Yet, agricultural land use is relatively high in the governorate of Sfax. In 2011, 469,893 ha were exploited (i.e. 73.8 % of the total agricultural land). We noted the presence of arboriculture (92.2 %), cereal crops (4.9 %), market gardening (2.1 %) and fodder (0.8 %). If we go further, by comparing the different delegations, Menzel Chaker includes 131,135 ha of cultivated agricultural land, of which 130,320 ha cultivated in arboriculture (i.e. 99.4 %). Forages, mostly irrigated, exist mostly in Djebeniana (32.6 %), Tina (29.5 %), and Mahres (14.2 %). They are very limited in Western delegations, ensuring costly feeding for livestock.

Agriculture, in particular the cultivation of the olive and almonds (326.000 ha and 87 000 ha respectively), has an important place in the regional economy. More than 50 thousand farmers

work in the agricultural fields. The governorate produces on average 40 % of olive oil and 30 % of almonds from Tunisia, making it the leading national producer. The Sfax region is the leading exporter of olive oil with 60 % of national exports.

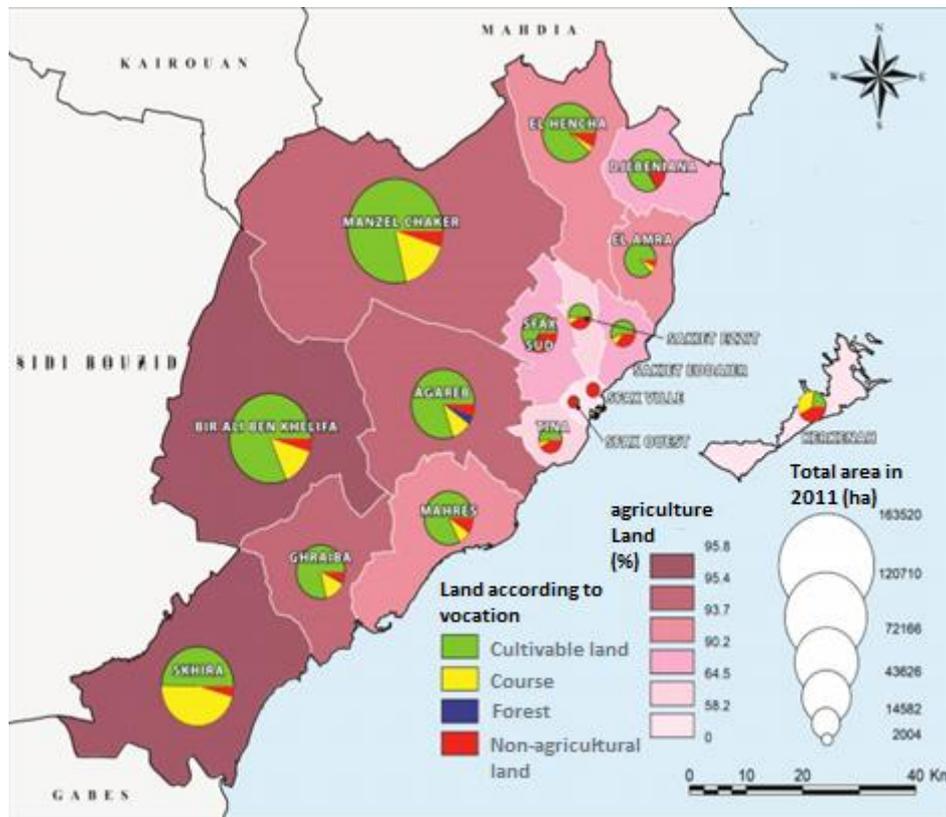


Figure 11. Sfax land distribution by delegation and by vocation in 2011 (in ha)

Furthermore, the surface area of the archipelago is about 15.000 hectares, 55 % of which are farmland. However, 5.500 hectares (i.e. 66 % of the usable farmable surface area) are not cultivated and occupied by palm trees and natural herbaceous vegetation. Only three irrigated areas in Remla, Melliti, and newly in Ouled Ezzedine exist Kerkennah archipelago. Natural and anthropic archipelago conditions marked by water resources scarcity, soil salinization, and the frequency of violent winds enhance the dry farming, extensive arboriculture, and cereal growing (1,200 hectares), particularly of barley collected generally by women (Figure 12). Figs (300 hectares), vines (500 hectares), olive trees (600 hectares), and 200 hectares of various fruit trees are widespread throughout the archipelago. We note the existence of 8 varieties of fig such as “El Bithri”, 7 varieties of vine-like “El Assli” and 2 varieties of olives, ‘Chemlali’ and ‘Chetwi’ (Kebaïli Tarchouna M., 2014). Date palms in Kerkennah constitute the archipelago’s most numerous natural plants. The Kerkennah date palm’s genetic diversity is very rich were each individual is a clone head (DGEQV, 2012).



Figure 12. Barley collection in Kerkennah

4 decades ago, agriculture and orchards were more occupied by food crops. However, in 2000 More than 85% of fruit trees have been lost (Rhouma et al., 2005) because of the growing phenomenon of drought, the exodus of the workforce, and the high cost of plowing. Nowadays, several short-term olive producers' projects are made in the islands to reverse that trend.

Likewise, stock breeding is an activity that involves a few small herds integrated into the farm, has remained traditional and supplementary. Containing mainly sheep (about 10,000 head), the livestock is dominated by small ruminants. Moreover, increasing the irrigated areas has enabled the growing of fodder to feed cattle, the breeding of which did not form part of the archipelago's traditions. Currently, milk production is about 350,000 l/year (CRDA Sfax, 2014). The development of breeding in the Kerkennah archipelago corresponds to a need to supplement income and savings. It did not constitute a stable source of income. Indeed, civil servants, shopkeepers, and wage laborers often invest in this activity.

II.6.2. Fishing

Fishing is a strategic activity for the local economy: modern port infrastructure: 8 fishing ports providing 20,000 tons, or 20 % of national production, of which 10,000 tons are exported (i.e. 45 % of national seafood exports). The amount produced from sea salt constitutes 60 % of national production. Likewise, the fishing activity is very old and is an important part of Kerkennah's culture as well as the economy. It is that they revolve around social and institutional relations. Appropriate traditional fishing techniques (transmitted from generation to generation), scheduled in time and space, are managed by accepted social rules and strictly

respected by the community. The studied archipelago possesses three fishing ports, the coastal ports of Sidi Youssef, El Ataya and El Kraten, and about 17 unloading sites throughout the islands. Ports contain infrastructure that is relatively sufficient to provide the services necessary for the fishing fleet they shelter. The fishing units that exist in the archipelago made up of 1,663 units are coastal craft, usually of wood, falling into two categories; 1,449 Non-motorized Coastal Craft (BCNM) and Motorized Coastal Boats (BCM). The archipelago's fleet is relatively big compared with the Sfax governorate. It represents 52% of that of the entire governorate. The traditional artisanal fishing system of a vast range of fishing gear characterizes this sector in Kerkennah. As well as fixed fisheries of the 'Charfia' (Figure 13) type, 22 kinds of fishing gear used by coastal boats were found in the archipelago mostly used trammel for cuttlefish, bottom mesh for various benthic fishes, trammel for shrimps, trammel for fishes, hollow stones for octopus, surface mesh for fishing various pelagic fishes, and keepnets.



Figure 13. Charfia a traditional fishing technique

Traditionally chrafis installed and operated in the autumn (September-October) in early summer (June-July) and then dismantled for a period of biological recovery, were built mainly with products of the date palm. Nowadays fishing nets, PVC pipes and ferrous materials have replaced the products from the date palm and are left in place for several years; they no longer respect the biological rest. The production from the coastal fishery in the Kerkennah Islands is about 33.4 % and 7.4 % of the production of coastal fishing in the Sfax governorate and nationally. The value of the production was assessed at 9,150 thousand Tunisian dinars, corresponding to 11 % and 2.1 % respectively for the same product in the Sfax governorate and

nationally. With 42,7 % of the total archipelago's halieutic production, the Mellita zone has the biggest share followed by the Kraten zone (34.3 %), and lastly the El Ataya zone (23 %). Fisherman production is made up of species of high commercial value (octopus, sea bass, cuttlefish, king prawn, breams, etc.).

II.7. Biodiversity and biological heritage

The archipelago of Kerkennah exhibit remarkable biological richness, with many rare or endangered endemic animal and plant species (APAL, 2001). Since November 2010, part of the island of Chergui is listed as a Ramsar site. Kerkennah benthos seems relatively original compared to that of all the other parts of the Mediterranean. This specificity is true for both qualities with the presence of rare and endemic species and species threatened with extinction and quantity. As to algae, 30 species to be identified, 8 chlorobionta (green algae), 12 rhodobionta (red algae), and 10 xenobionta (brown algae). The seagrass *Posidonia* and *Cymodocea* are very widespread in the archipelago of Kerkennah (Romdhane and Missaoui, 2002). These seagrasses have great heritage value constituting the major ecosystems of the Mediterranean. It is a biodiversity center that provides refuge to a quarter of species, Mediterranean (fauna and flora), and playing a significant role in coastal protection against erosion. Other species that have high heritage value are the noble pen shell *Pinna nobilis* (although it is rare in the Mediterranean its quantity in the Kerkennah beds with meadows is relatively great) and *Gibbula umbilicaris latior* with its albino form, which, despite environmental constraints, remains abundant. Kerkennah Islands are also an important wintering grounds (Romdhane Missaoui and 2002) for shoreline seabirds and other water birds; it is also an important crossing site for passerine birds during migration. The Kerkennah Islands are recognized as a Zone Important for the Conservation of Birds (ZICO) because they are an important wintering area for the cormorant *Phalacrocorax carbo*, a protected species that feed almost exclusively on fishes.

In the land environment, the floristic inventory of the Kerkennah Islands shows four main plant associations; the *Artemisia herba-alba* and *Asparagus albus* association, the *Lygeum spartum*, and *Thymaelea hirsuta* association, the *Frankenia thymifolia* and *Suaeda mollis* association and the *Arthrocnemum indicum* and *Halocnemum strobilaceum* association. In some places where the plant cover is well-preserved, islands have a varied floristic gathering where certain rare high heritage value species are present, such as *Cenchrus ciliaris*. This species is present mostly in the islet of Gremdi. The Kerkennah date palm is widespread throughout the archipelago naturally as clumps. It is seen as spontaneously growing, not cultivated. Local resources of alfa

and palms are used to make nets and braid ropes, but also hats and baskets often made at home, even if a weaving center exists in Chergui. Because of the aridity of the climate, the land fauna is less important than the marine fauna. There are insects and some mammals like the hare. The herpetofauna is made up of ten species of reptile, between lizards and snakes (not venomous).

II.8. Food tradition

The Sfaxian kitchen is characterized by its diversity where there are daily dishes and dishes devoted to celebrations and special occasions. The Sfaxian pastry ranked the first in Tunisia, it consists of two types: Daily pastry or hlou arbi such as makroudh asmar, ghraiba homs , doria, maachach ... and the high range pastry used for weddings and other ceremonies such as baklawa, le kaak ouarka, mlabbes ... (Figure 14).



Figure 14. Sfaxien and Kerkennian cuisine

The Bezine is a culinary specialty of the region of Sfax. It is consumed on the day of Eid el Adha or during the month of Ramadhan. It is a kind of cream is eaten early in the morning, as a breakfast, accompanied by the famous "Kleya of Sfax " and the honey. The Kleya also prepared in advance, it is small pieces of mutton, liver, heart, and kidneys, all associated with salt and pepper and cooked into olive oil and a little fat tail sheep. The Charmoula, famous in

Sfax, consists of mashed raisins and onions cooked in olive oil along with spices. The charmoula accompanied by salted fish is a specific dish in the Sfax region, which is eaten on the first day of Eid al-Fitr in breakfast. The Marka, also known as "Market sbarès" (Type of fish known in Sfax) is mainly eaten with couscous, but it can also be used to make soups baked inside the 'Tchich' (Tchich bil marka) mini "mhammas" (m'hammas bil marka), or just vermicelli (chorbat Hout) or It can be eaten with barley bread or "bechmat" (small pieces of bread cut in cubes and put into the oven to become crunchy). The Saffoud, lafif bread, couscous, melthouth....

The Kerkennian specialties offer delicious food value local fish, such as pataclet, mullet or sea bream, crushed barley, dates, and raisins, with a special place for octopus caught and dried on-site. These are local products easily stored in jars which were the subject of a barter exchange with the merchants of Djerba. The arrival of electricity in the archipelago allowed refrigeration and the proliferation of convenience stores, present in all the villages, which widen the range of food products. Paradoxically, fish are becoming rarer because it is a product with high added value and not all Kerkennians can afford to eat them as often as before. Palm wine is produced in Kerkennah, from the legmi (sweet sap) and called qêchem, which must be drunk fresh. However, this production remains very limited.

Case-study area 2: Tunisian

Sahel

III. Sahel Overview

III.1. Location

The Sahel is the coastal region of central Tunisia. Geographically, this area is between 36° 14' and 35° 7' North latitude and between 11° 10' and 9° 45' East longitude. The Sahel extends from the north of Sousse to the south of Mahdia. It includes the regions of Enfidha, Sousse, Mahdia, Monastir, and the Gulf of Hammamet. It is made up of Cap Bon and Hammamet Gulf in the North and Kairouan in the South. To the east, it extends into the sea through the pelagic block (Figure 15). The Sahel maximum length is 140 km from north to south and its width varies between 20 and 60 km from east to west. It covers 4.02 % (i.e. 163.610 km²) of the total area of Tunisia.

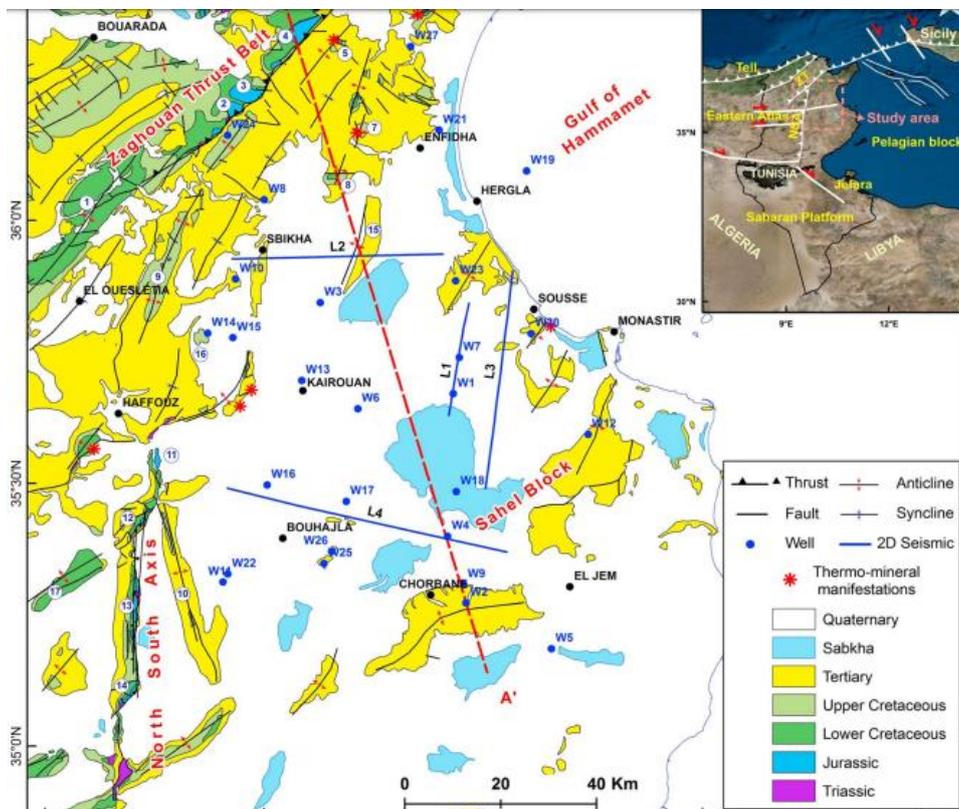


Figure 15. Location and topography of the Sahel

Its name comes from the Arabic word Sahel for the coastline. The region attracts tourists to its fine beaches, historic sites, good hotels, and its countryside, a patchwork of olive groves, grain, and flocks of sheep. The capital of the Sahel, Sousse is Tunisia's third-largest city. Although it is a major port and a busy commercial and industrial center, the workings of the city do not impinge on the relaxed atmosphere of the medina or waterfront. The golden sands stretch for miles north of town, lined with resorts, to the marina of Port el Kantaoui (Figure 15). Located in the heart of the vast Sahel region of Tunisia, Mahdia Governorate opens on the eastern basin

of the Mediterranean Sea with a coastline of more than 75 km. As a tourist town with a rich historical and cultural heritage, Mahdia has an economy mainly focused on agriculture and fishing and emerging industry.

III.2. History

Since antiquity, the Tunisian Sahel seems to have been a distinct region dominated by urban settlements on the sea. The Phoenicians founded most of its cities. Thus, Hadrumetum (Sousse now) was founded at the beginning of the 9th century BC. It gained importance in the following centuries, becoming one of the main Phoenician ports in the Western Mediterranean. The area was a key part of the Carthaginian empire (Figure 16A), but after the Second Punic War, it came under increasing Numidian influence. In 146 BC, after the Third Punic War, it became part of the new Roman province of Africa. The Sahel was the location of one of the key battles of the War between Pompey and Caesar. The Battle of Thapsus took place on 6 April 46 BC and was a massive victory for Caesar and the city surrendered to him shortly after. Then he proceeded to take control of northern Tunisia. Around 293 AD the Romans divided the province of Africa and the Sahel became its province.

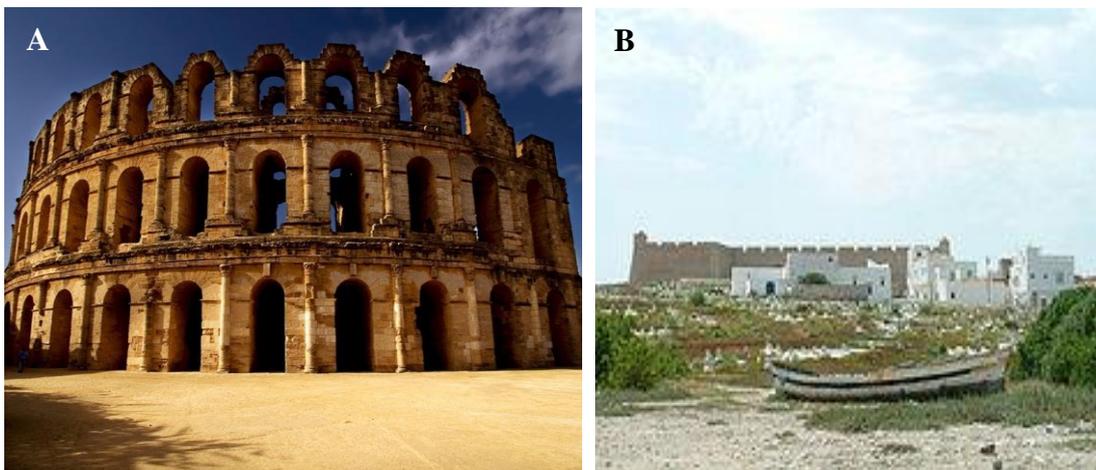


Figure 18. (A) The Roman amphitheater at El Jem (B) Fort of Mahdia

With the arrival of Islam and the establishment of the capital of Ifriqiya, the Sahel's maritime ports became the key to its security. This explains the construction of several ribats in the region, which particularly served defensive. The most important ribats are those of Monastir and Sousse.

The foundation of Mahdia by the Fatamids in 916 gave the Sahel a key political role, which continued under the Zirids. Kairouan lost some of its religious roles to Monastir, where the Zirid princes and other luminaries were buried. Mahdia with its magnificent fort (Figure 16B),

became the seat of a splendid court that drew poets from across the Maghreb, Al-Andalus, and Sicily. However, the invasion of Banu Hilal plunged the region into chaos, and Tunisia fractured into numerous taifas; only the Sahel remained under Zirid control. The invasion led to the further urbanization of the region, with the establishment of many villages that still exist today. Later the region suffered from Norman attacks. Mahdia was taken in 1148 by troops of Roger II of Sicily, until 1160 when Almohads arrived. After this period, the Sahel experienced a decline in importance following the transfer of the capital to Tunis. In the 19th century, the Sahel was divided into two qaidates, one based at Sousse and the other at Monastir. After the establishment of a French protectorate, the new power established the qaidate of Jemmal (which took part in modern Monastir and Mahdia governorates) and centralized the region at Sousse which became the seat of civil government, contributing to the weakening of the other regional centers. After independence, the government of Neo Destour ended the Sahel's administrative union during the abolition of the qaidates and establishment of the modern system of governorates. The whole region was under the control of the governor of Sousse from 1956 to 1974, when the governorates of Monastir and Mahdia were created.

III.3. Topology and climate conditions

The topography of the region, made up of plains and hills, is disturbed by different morphological levels. Its reliefs generally do not exceed 200 meters above sea level. These morphological levels determine the actual distribution of soils and particularly the hydrological functioning of the landscape. These later are traversed by small temporary rivers (Oueds Mlal, Gharraf Chrita and Oued Chrichira existing in the three delegations of Chorben, Souassi, and Eljem). Below the high steppes near the study area extend vast coastal plains steep with small hills enclosing the wadis. These plains end in the East by a low coastline barely hilly by small "Rass" (caps) such as Chebba and Mahdia. They are stretched at sea by a vast continental platform.

The Sahel is subject to a Mediterranean coastal climate characterized by hot and dry summers and mild and wet winters. Marked by transitional between the arid stages in the southwest and semi-arid stages in the East, the average annual rainfall is about 300 millimeters. The study area is subject to two types of opposite climatic actions: the temperate Mediterranean climate on the East coasts and the dry arid climate in the West. There are no significant changes in rainfall, but rather a higher frequency of extreme events (floods and drought, etc.), which occur more often in recent decades, particularly in autumn and winter in the arid southwest part. Several floods have been observed, particularly in the past three decades. The study of temperatures

shows a warming of the order of 1 °C during the period 1976-2004, leading drought and aridity enhancement.

The Sahel coastal region's temperature (Bouficha, Enfidha, Hergla, Sousse, Monastir, Ksour Essef, Mahdia ...) is generally marked by an alternation of two seasons. The winter, from December to April, is characterized by mild temperatures. The average temperature is around 12 °C. During the coldest months of the year (January and February), the average temperature fluctuates between 11 °C and 13 °C. The summer is characterized by hot weather. The moderating effect of the sea only intervenes to ensure a relative cooling limited to the coastal fringe. The average summer temperature is 25 °C. During the day, the temperature rises to reach an average of 29 °C. Saharan winds from the southwest (Shehili), hot and dry, are responsible for strong heat waves which raise the temperature to levels exceeding 40 °C. The region is largely subject to Saharan and steppe influences. As for the temperature of the southwest zone (Hbira, Chorben, Ouled Chamekh, Eljem, Souassi with the recent appearance of a small arid zone to the East; Chebba and Meloulch) it is marked by the alternation of two seasons arid and steppe. The average winter temperature is around 10 °C. The hot summer is characterized by hot weather. The average summer temperature is 33 °C. During the day, the temperature rises to an average of 39 °C. Saharan winds "Shehili" which come from the southwest and the desert, very hot and dry are responsible for strong heat waves, which raise the temperature at levels above 45 °C. The region is largely subject to Saharan and steppe influences. It is confronted annually on average with more than 40 days of sirocco.

Rainfall is one of the most important elements of the Sahel's climate constituting the essential factor of its hydrological regime. An annual rainfall ranging from 200 to 350 mm characterizes it. However, rains are irregular from season to season and poorly distributed from year to year throughout the region. The relative weakness of the rains and their irregularity is aggravated by intense potential evaporation associated, in summer, with high temperatures, and in all seasons, with dry and sometimes violent winds.

III.4. Water resources

The region of the study constitutes a space made up of plains and hills interrupted by numerous "Sebkhas" depressions. These later collect runoff water including the endorheic flow by dry wadis (Oueds Mlal, Gharraf, Chrita, Bou Sayela, El Maleh, Soussi, Louza, Guendoul, Grida, Sidi Ahmed and Oued Chrichira) due to evaporation and infiltration. All the water coming from neighboring areas to the West is partially stored in these depressions and the rest is infiltrated

to supply the numerous underground aquifers that are at the origin of the development of irrigated agriculture.

In 1993, the water resources of the entire Sahel region were assessed with a total contribution of 23 Mm³ and a mobilizable contribution of 4 Mm³. Losses in the form of runoff are estimated at 3 Mm³ towards the sea and the “Sebkhats” of Sidi Abdel Hamid, Skaness, Mahdia, Halk El Menjel, Sidi el Hani, El Kelbia, Shéríta, El Ggherra. The hydrogeological balance of the region has highlighted a deficit of around 2 Mm³/year, which increases every year. The hydrogeological reserves are not very renewable and the piezometric level saw a significant lowering. It is a reservoir in the process of depletion by overexploitation resulting in a continuous drop in the piezometric level.

In the Tunisian Sahel, the peaks of the hills are kept overgrazed to produce runoff which will be redistributed in the plains (Majdoub et al, 2011). The hills thus form the impluvium known as the “meskat” and serve as a collector for precipitation waters. The plains, areas cultivated, are arranged in lockers known as mankáas and are used to recover runoff from the meskat. The traps are often established in two or four olive trees. The meskat and the lockers form a hydraulic system that has been developed since Roman times. It is about the Meskat-mankâas system which represents the model of anti-erosion management typical of the Tunisian Sahel region. This system, which covers 200.000 ha in the Sousse region, effectively contributes to increasing the amount of water received by olive growing. The Meskat system seems to fit well into the geological, geomorphological, topographic, soil, and climatic contexts of the Sahel region. It is an example of sustainable agriculture by participating effectively in ensuring the production of olive growing while playing a leading role in the fight against water erosion.

III.5. Soil resources

Limestones, more or fewer gypsum marls, and coarse and fine sands dominate Tunisian Sahel pedogenesis. According to their degree of development, soils differ recording to the climate, the rock source, and the relief. A clear diversity takes place between soils of the eastern semi-arid zones and soils of the southwest part characterized by its arid climate. Due to drought enhancement, southern regions suffered from significant water deficiencies that promote soils salinization and desertification. These soils are poor in organic matter, rocky, and often eroded. They are suitable for grazing and olive plantations. In the alluvial plains, they are suitable for many crops, especially irrigated ones. Furthermore, the urban extension of the Sahel, outside the limits of the city center, has created an intermediate space between the urban agglomeration and spaces qualified as "deep" rural. In this transitional fringe, changes in the use of certain

agricultural land for urban purposes are significant. Peri-urbanization is often a conflicting process that produces territorial changes.

The municipal population of Mahdia increased from 25 711 inhabitants in 1975 (INS, 1975) to 54 902 in 2004. Due to the economic development and especially that of tourism migratory relationship enhance in the region providing significant employment opportunities. In parallel with population growth, accommodation increased from 4 997 in 1975 (INS, 1975) to 14 548 in 2004 (INS , 2004). Therefore, rural areas have experienced territorial changes in connection with the spread of a new form of life marked by the city, the way of life, and city activities. Even the “ghaba” has recorded the establishment of industrial units on both sides of the road axes and the construction of second homes on the impluviums of olive groves (Houimli, 2008). Urban sprawl at the expense of agricultural land has led to a decrease in the cultivable land area, farms number, and agricultural assets. Indeed, agricultural land has decreased by 44 % from 1962 to 2008. The total irrigated area declined about 30 % (CRDA de Mahdia, 2009). Furthermore, farms number failed from 5 100 units in 1980 to 2 584 units in 2008 (CRDA de Mahdia, 2009), a decrease of 50 %. Farmers have developed different logics according to their investment capacities related to higher production factors and to the distance to the city center. The traditional spatial organization with regard to agricultural production systems appeared in Mahdia (Figure 17).

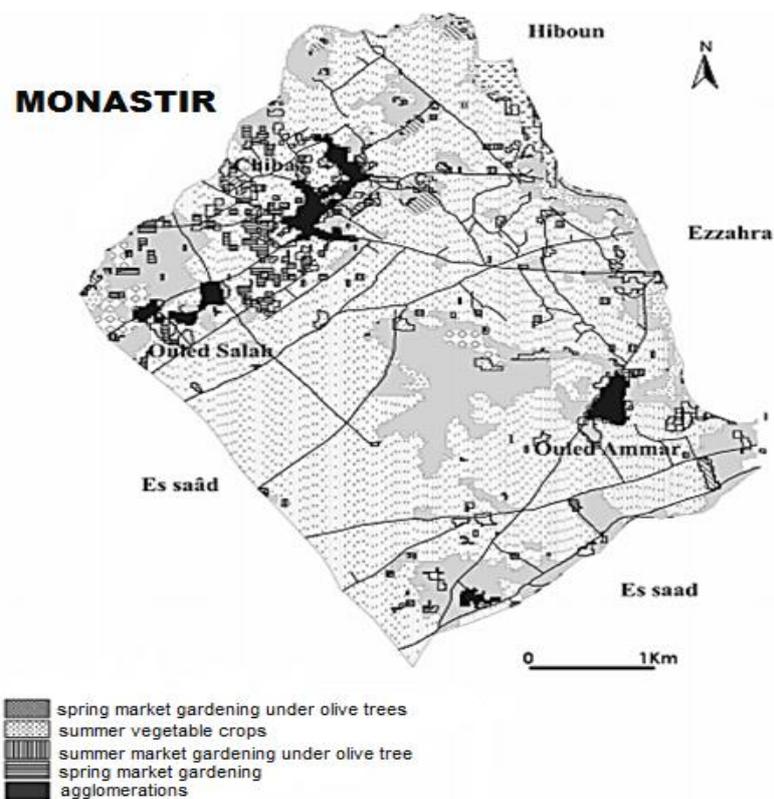


Figure 17. Traditional soils occupation in Mahdia

In nearby areas (Hiboun, Chiba, and Bir ben Kamla) where farmers have triggered a development dynamic, we find productivist agriculture. However, in remote areas (Dkhila and Saâfet) which are located 8 km from the center, farmers, lacking the means, have remained on the defensive (Prost, 1991) and practice extensive production systems (Figure 17). Farmers belonging to liberal socio-professional categories practice an intensive agricultural production system, based on the integration of high value-added crops, especially back-season market gardening and crops in tunnels and greenhouses on olive farms (Figure 17).

III.6. Economic activity evolution

Tunisian Sahel occupies a central position on the Mediterranean Sea and is one of the country's most important areas for agriculture, industries, bathing, and tourism. The cities of Monastir and Sousse are key tourist centers. As well as Mahdia region has been attempting to develop its tourist industry since the 1990s. In the Sahel and especially in Monastir, Habib Bourguiba International Airport is the busiest airport in Tunisia in terms of passenger numbers. In addition, it has the most charter flights of any airport in Africa. There is a commercial port at Sousse, numerous fishing ports, and two marinas (Port El Kantaoui and Cap Monastir).

Benefiting from a rich historical and cultural heritage, Mahdia, like Sahel has an economy mainly focused on agriculture and fishing and emerging industry. With a varied economic potential, adequate infrastructure, and legislation favorable to investment in regional development areas, the governorate of Mahdia offers wide possibilities for setting up and hosting tourism and agricultural projects, industrial and services. It is a safe destination and an undeniable opportunity for development and success.

III.6.1. Vegetable production and breeding

The available data relating to the plant resources of the Sahel region illustrate forest areas with different strata (forests, scrub...), and rangelands (steppes, alfa, meadows, lawns). The comparison between different forest and pastoral inventories highlights the presence of low and discontinuous vegetation, composed herbaceous plants, especially in the southwest area. This vegetation is diversified by its composition and its density and remains the fundamental stake of the pastor's life. Generally, the vegetation varies according to the zones. Coastal zone includes meadows, scrubland, scrub while, steppe type with a dominance of the alfa in the southwest part of the studied area.

The study of agrosystems and the exploitation of agricultural land of Sahel highlights all the problems relating to the extension of agriculture to the detriment of rangelands, notably cereal

growing in the north and arboriculture. Analysis of the dry and irrigated operating systems in different sites, particularly in the coastal area (Chot Meriem, Enfidha, Hergla, Ksour Essef, Moknine, Mahdia ...), reveals that in this environment the climate forcing was well resolved in the past through traditional techniques. Olive trees and cereals (wheat / barley) predominates throughout the region and occupies almost all of the agricultural areas each year, followed by the cultivation of legumes. The olive tree adapts well in Sahel soils particularly in the arid southwest (Figure 18).



Figure 18. The agricultural map of the Tunisian Sahel

It is the main fruit tree followed by the almond then the fig and some attempts to introduce other species such as pear and apple. Olive trees cultivation depend on rainfall, cultural practices, which are often unsuitable, and fertilization, which is also lacking, especially in the sites of the internal zone of the Sahel (Figure 18). The technical level of farmers is weak despite attempts to initiate awareness, observed in the region and particularly the internal area, concerning modern techniques of planting arboriculture and the introduction of fertilizers and manure. Land preparation is not done with great care, chemical weeding is lacking and it is by hand that weeds are uprooted during the spring and given to the animals.

Farmers do not use high yielding varieties of wheat and barley, but mostly use local variety. These varieties are less demanding and provide maximum security for the food of local and regional populations. The yields observed in the region are around 15 Q/ha during good years for wheat and 7 Q/ha for barley. The irrigated sector in Sahel contributes 34 % of total production and more than 20 % of agricultural export. It provides 95 % of vegetable production

and 45 % of fruit production. Socially, it is also a crucial sector since it employs 27 % of the workforce.

Aboveground dairy cattle farming has developed over the past twenty years in the coastal regions of the Sahel (Sousse and Mahdia). The emergence of milk production, in these areas marked by strong pressure on water and agricultural land, has certainly enabled the diversification and intensification of activities and sources of income (Darej et al 2010).

III.6.2. Fishing

Tunisia has 41 fishing ports. These ports can be classified, according to their importance, in two categories. Ten large ports, allowing to shelter trawlers, tuna vessels, sardine boats, and coastal fishing units. These ports are in Tazarka, Bizerte, la Goulette, Kélibia, Sousse, Monastir, Mahdia, Sfax, Gabès, and Zarzis and are equipped with all the services necessary for fishing. The small coastal fishing ports, thirty house coastal fishing units and provide adequate services for this type of boat. It existed mainly in the Sahel and Kerkennah regions.

In addition to the port infrastructure, there are several landing sites, particularly at the lagoons. From Roman times to the present day, the different civilizations that have settled in the Tunisian Sahel have identified the existence of fishing potential and have focused on their economic development and the exploitation of marine resources. Over the ages and civilizations, the processes of accumulation through contact with foreign fishermen (Italian and Maltese) have enabled marine populations to assert technical know-how and naturalistic knowledge which represents the two elements composing a local fishery heritage.

A rise in the sea level, coastal erosion, and an increase in the temperature of fishing waters caused by climate change are threatening habitats vital for both human activity and marine biodiversity. Thus, the main area of marine aquaculture production is in the governorates of Sousse, Monastir, Mahdia, and Nabeul of the Tunisian Sahel. In Monastir, the aquaculture sector experienced a turning point from 2008, with the establishment of seven offshore farms covering an overall marine area of around 70 000 ha, with around 400 ha of concession area (APAL, 2015). From that date, Monastir became the most important offshore aquaculture production area, where all the farms cultivate the wolf (*Dicentrarchus labrax*) and the sea bream (*Sparus aurata*). For these two species, exponential growth in production has produced, reaching 6579 tons in 2015, which represented 24.37 % of regional production in the same year.

Chebba is a coastal city in the Tunisian Sahel located 65 kilometers north of Sfax and 36 kilometers south of Mahdia. The city is located at the level of Cape Ras Kapoudia that is the

easternmost point of the Tunisian Sahel. Attached to the governorate of Mahdia, it constitutes a municipality with an area of 12 156 hectares and populated by 19 883 inhabitants. It has an important fishing port benefiting from an exceptional maritime situation because it is a fishing zone. This later is located at the intersection of the bluefish fishing zone (north towards Mahdia) and that of white fish (south towards Sfax).

III.7. Biodiversity and biological heritage

The northern Mediterranean coast of the Sahel, is formed of cork oak (*Q. suber*) forest. Trees such as *Cupressus sempervirens* and *O. europaea* also grow in the study region. Some medicinal plants that originated in North Africa are widely used in traditional folk medicine. Tunisia has more than 500 species of medicinal and aromatic plants, and 2 163 varieties; the majority of these plants are found in harsh environments such as semiarid conditions of the Sahel. *E. maritimum* is a perennial plant that belongs to the Apiaceae family and is one of the major medicinal plants found in the area. It is effective in preventing diseases including atherosclerosis, diabetes, and cancer due to its content on polyphenol and flavonoid. *A. campestris* grows in the arid and semiarid areas. It is widely used as a traditional medicinal plant for diabetes, bronchitis, diarrhea, high blood pressure, and nerve pain treatment. In Tunisia, especially in the Sahel, halophytes such as *Cakile maritima*, *Limoniastrum monopetalum*, *Mesembryanthemum crystallinum*, *Mesembryanthemum edule*, *Salsola kali*, and *Tamarix gallica* are widely used as traditional medicinal plants.

The plant cover of the first few centimeters of water is formed mainly by photophilic nitrophilic algae such as ulvae and enteromorphs, which proliferate throughout the year on the coast of the Tunisian Sahel. Its floristic landscape is mainly dominated by the phanerogam *Posidonia oceanica*.

The macrofaunistic community is mainly dominated by 3 Phylums: Molluscs, Crustaceae, and Annelids. These Phylums contribute with almost 94 % to the composition of the global fauna with a predominance of Crustaceans. The other groups are poorly represented. In the Sahel, at depths of 40 meters, large fish biodiversity detections have been observed. In the Gulf of Hammamet, these were horse mackerel (*Trachurus trachurus* and *Trachurus mediterraneus*). The biomass calculated in these two regions is 138 000 tons, 65 000 of which adults or 56.17%.

III.8. Food tradition

The Tunisian Sahel region (Monastir, Sousse, Mahdia) stood out in the celebration of Tunisian heritage month, by the national festival of culinary heritage specially dedicated to bsïssa. This

traditional dish is emblematic of the current heritage process, which should also be questioned very seriously. Several preparations of bsîssa are presented during this festival showing that there is not a tradition, but "traditions" (Figure 19). Bsîssa has nutritious and medicinal properties validated by nutritionists and confirming the "knowledge of ancestors". It is prepared according to different regional recipes. Snails or babouches present molluscs that are generally collected on rainy days in gardens and forests to cook them in traditional dishes, especially from the Tunisian Sahel region.



Figure 19. Bsîssa Sahlia

The bondleka also known as blibcha of Mahdia: It is a stew made from purslane: an annual plant whose leaf is very rich in omega 3 and trace elements: potassium, magnesium, and calcium are abundant. The “couseïla” is a nice word, invented by contraction of the words couscous and paella just for this Tunisian recipe. Indeed, it consists of semolina, lamb, chicken, fish, and seafood. This recipe uses only the ingredients of Cap Bon: like dried rosebuds, typical of Nabeul, and those of the Tunisian coast, very full of fish, which also offers a varied palette of seafood. In this oriental paella, semolina replaces traditional rice. Before being poured in rain, it must be moistened and then steamed in the couscoussier for 15 min. The “couseïla” of Nabeul remains an original dish between tradition and creativity, which brings together in the plates, flavors, and scents of the Mediterranean basin.

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