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Evolution and sustainability of the olive production systems in Southern Tunisia: Comparative study between traditional and modern farms in Zarzis region

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Abstract – The objective of this work is to carry out a comparative study between irrigated and rain-fed olive farms in arid area, Zarzis belonging to Southern Tunisia. In order to achieve this objective, a survey was carried out on nearly 30 farms: 13 are in the irrigated lands and 17 are in dry areas. As a first step, we proceeded through a socio-economic, technical and environmental assessment in order to determine the characteristics of each type of farms. As a second part, we tried to identify the strengths, weaknesses, opportunities and threats specific to the olive sector in this arid region, through SWOT method.
The assessment shows that the irrigated farms were the object of modernization process, whose owners are really investors, aiming a rapid profitability by this farming activity. The farms are characterized by a high density of olive tree plantations and the stability of yields. Thus, they represent a source of employment in the region. On the other side, dry olive farms have a classic production system and low yields, generating not only a problem of profitability, but also of the viability of these farms, which explains the abandonment of these lands.

Keywords: olive farms, arid area, Southern Tunisia, Zarzis

1. Introduction

Farming is the most dominant activity in rural areas, playing a very important role to fix population and maintaining food security. In this context, Farming system based in olive oil production is an essential branch of agriculture sector, with high significance. The olive sector is a very important sector for Mediterranean countries.
Among these countries, we can mention Tunisia. Agriculture is important for rural communities and the overall Tunisian economy. The impacts of olive oil production and extraction on economic, environmental, and social issues are considerable. It must also be said that Tunisian olive oil is the main exported farming national product and is an essential source of currency for the country.
More precisely, the arid region of southern Tunisia, Zarzis is an olive-growing area, inheriting this vocation from ancestral traditions. Olive growing occupies all of farming lands given its climatic and soil conditions which are very favorable for this type of crop. (Labiadh, 2001).
Indeed, the area is characterized by the aridity of the environment, the scarcity of natural resources, the low annual rainfall, the massive frequency of years of drought and the decrease of active farming number, due to rural exodus.
Climate change and recurrent climate events are making water-scarce regions like the study area, and its agricultural lands drier and more vulnerable to drought. This created one of the major problems facing agriculture is the loss of farming land, because as more land is lost, it will become more difficult to produce the amount of food needed to the region. (Souissi, 2018).
Dealing with these socioeconomic and environmental crises, the agricultural sector in the region, basically olive growing and fishing, has always been the only solution for the population to face such adversities, despite the yields irregularities during these last decades et this, for many reasons such as: climate change, abandonment of agricultural activity, rural exodus and the lack of generational relay. (Karray, 2012).
The research work was carried out in Zarzis where olive-tree agriculture shows how well farmers are trying to adapt to climate change and climate variability. Current adaptation pathways to increase agricultural incomes and productivity focus on increasing olive-tree crops, which generally are more resilient to drought than field crops.
Still, improving water management is also an essential part of this adaptation plan. To resolve these problems and to encourage farmers to continue their olive-growing activities with stable incomes, there are those who have opted for modern production systems (the introduction of irrigation, intensification, so on...), and others that preferred to consolidate the traditional rainwater system.

2. Importance of the olive sector in Zarzis

Fruit growing plants occupies almost all the cultivated land with 93.5%. The rest of the area is occupied by cereals (3.5%), legumes (1.42%) and vegetables (1.46%); as can be seen in table 1.

Table1. Distribution of fruit trees in the study area.

Fruit trees	Production (T)	Area (Ha)	% Area of arboriculture
Olive trees	49000	63665	97.92
Almond trees	131	850	1.29
Pomegranate trees	12	10	0.01
Apple trees	60	180	0.27
Viticulture	81	69	0.10
Fig trees	85	200	0.30
Other trees	44	145	0.21
Total	49413	65388	100

Source: Ministry of Agriculture, Water Resources & Fisheries, 2018

Olive growing is the most dominant activity in the region with 63.665 ha, which represents almost 98% of the fruit tree area and 46% of the regional olive production of all the Governorate of Medenine. We can also notice the importance of almond tree with 25%, and that of fig trees with 23% of regional production. It is therefore, a real olive-growing area, occupying the first regional. The number of olive trees is 1.257.300.
As reported before, aridity is an obstacle for the increase, even for the maintenance of olive production. That's the reason why many farmers moved towards the integration of irrigation system, becoming a necessity to obtain a sufficient yield. However, it still having a dominance of rain-fed olive trees compared to irrigated system, as shown below, in table 2:

Table2. Distribution of olive trees in the Zarzis

Planting system	Area (ha)	Number of trees	percentage
Irrigated plantation	65	1300	0.68
Dry planting	62300	189475	99.32
Total	62365	190775	100

Source: Ministry of Agriculture, Water Resources & Fisheries, 2018

3. Objective and methods

The objective of this study is to carry out a comparative study between olive-growing farms conducted in irrigation with those conducted in rain-fed, through an evaluation on the socio-economic, technical and environmental levels. This would allow us to identify the characteristics of these two modern and traditional olive production systems in the region.
To achieve this objective, the methodology consists of carrying out a literature review, field visits, meetings, and cartographic analyzes, to analyze farms characteristics and visualize their components. During these field visits, a direct survey was fulfilled, concerning a sample of olive farms of both systems: the irrigated and rain-fed conditions. The selected sample includes 30 farmers (13 irrigated and 17 dry farms) in 8 localities of the study area, for more representativeness. This olive farms study is complemented by SWOT matrix in order to have a situational assessment.

4. Results and Discussion

As mentioned above, the results will focus at first, on olive farming system on general, and then, with more emphasis on its two components. At the end, some recommendations will be suggested for a better situation.

4.1. Farmers description

The average age of farmers is around 57 years, with a minimum value of 30 years and a maximum of 89 years.

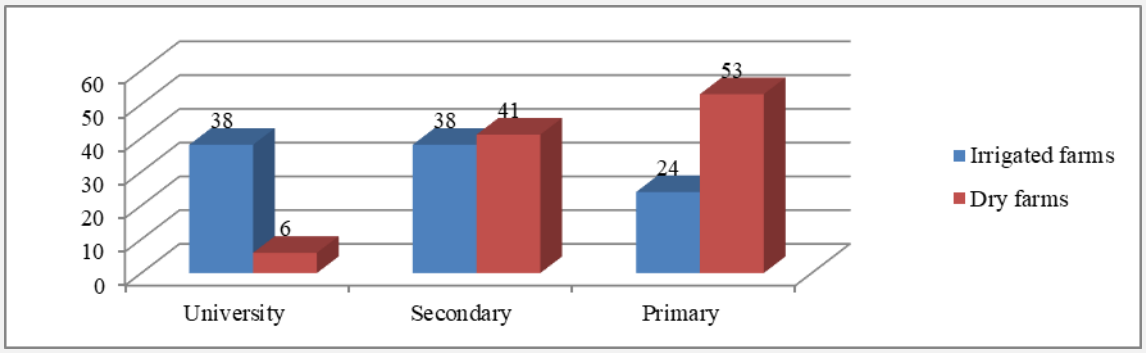

Figure1. Distribution of farmer's age

Source: Field survey

As seen above (Figure 1), in irrigated farms 76% of farmers are less than 60 years old (38% are less than 50 years old and 38% between 50 and 60 years old). Only 24% of them are over 60 years old, against a majority of dry land's farmers (57%) are over 60 years old.

This shows that young rural people can be encouraged when they are endowed with technical skills, to remain and modernize the farming sector, instead of the temptation of emigrating abroad. Access to modern technologies, such as the irrigation system used by this age group, proves to them that agriculture can be a viable and profitable business. Thus, they ensure a generational succession.

This is more palpable when we analyze the intellectual level of farmers. In fact, 38% of irrigated land farmers have a high educational level (university) and 38% have a secondary level (secondary school). On the other hand, the majority of dry land farmers (53%) have only a primary level (primary school), as shown below:

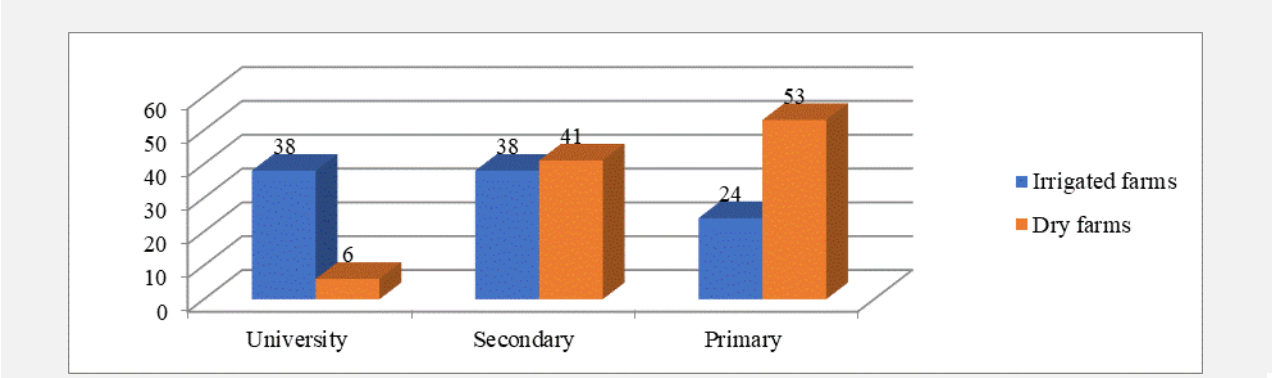

Figure2. Educational levels of farmers

Source: Field survey

4.2. Farms properties

4.2.1. Farms system typologies

The farms have different sizes, ranging from 1 to 237 Ha, with different levels of productions. From the density of the plantations we can identify of three types of olive growing systems in irrigated farms:

- The extensive system with a density of plantations varying from 20 to 25 plants per hectare
- The intensive system whose planting density fluctuates between 100 and 250 plants per hectare
- The hyper-intensive system with a planting density of around 850 plants per hectare

Regarding farms that are conducted in dry areas, they are adopting extensive mode and the density of plantations is between 15 and 30 plants per hectare.

Moreover, survey shows that olive tree system is divided also in two others ways typologies, which are:

- Full land method: Olive trees are cultivated only in the exploitation surface, mainly in dry farms. This is explained by the strong adaptation of olive trees compared to other crops to the aridity of the environment and the scarcity of water resources in the region, as explained previously.
- Intercropping method: Olive trees are planted with other arboreal plantations, vegetable cultivations, mainly in irrigated lands. There is therefore, a diversification of crops thanks to the regular presence of water.

4.2.3. Olive varieties

There is a diversification of olive varieties in the study areas:

- Local varieties: such as Chemlali, Zalamti, Zarrassi, Jemri. They are characterized by their strong vigor and adaptation to the difficult conditions in southern Tunisia. All dry farmers are using these local varieties, based on the olive oil genetic heritage of the region.
- - Foreign varieties: They have recently been introduced in the region, basically in irrigated farms. They are from Spain (Arbequina, Arbosana) as well as from Greece (Koroneiki). In fact, 31% of them are using both local and foreign varieties, 23% with foreign varieties and 46% have only local varieties. So we can also underline the modernization of the olive sector through the introduction of new varieties, and this, even if it was done with a progressive manner. They are used in crescendo, due to many reasons: a high and constant productivity, very early entry into production, reduced vigor, very interesting for intensive crops and finally they are appreciated for its organoleptic characteristics.

4.3. Environmental dimensions

4.3.1. Water resources management

There are two types of irrigation sources: 54% of farmers are using surface wells and 46% of the others have water that is accessible thanks to the borehole and the pump. The salinity is varying from 3 to 5.7 g/l which generates an important problem in term of quality of water and soil in the affected areas.

As pointed out previously, the annual precipitation hardly exceeds 200 mm. This causes directly an irregularity of the yields and the reduction of production for olive-growing farms, especially in dry conditions. This is the reason why, to overcome this glaring lack of water from which the region suffers, farmers have moved progressively, to the irrigation with the integration of surface wells and boreholes, to ensure sufficient quantities of water for the irrigation of these olive trees.

The irrigation techniques used are the following:

- Drop by drop: 77% of farms are irrigated with drip system. It enables better optimization of water consumption.
- Cistern: 23% of farms are using this ancestral tank technique.

4.3.2. Soil management

To improve the physical and chemical qualities of the soil, the majority of farmers incorporate organic manure and fertilizers. The first one is derived from sheep and goat farming, produced by farmers themselves (40%), and the rest are bought from neighboring farmers or belonging to the same cooperative. For more correction, farmers are adding nitrogenous fertilizers, ammonium nitrates, produced chemically. Their excessive use would lead to the deterioration of water and air quality.

In terms of fertilizer consumption depending on the type of system we have as follows:

- In irrigated farms: unless for two farmers (preferring organic farming), all of them are using e nitrogenous fertilizers, as a complementary treatment at variable doses ranging from 20 to 100 kg/Ha. It should be noted that the results show that most irrigated farmers use nitrogen with doses higher than the estimated dose. This has a very dangerous effect on the environment, especially on the water table and the quality of the water.
- In rain-fed farms: All farmers do not use nitrogenous fertilizers for their olive trees.

4.4. Social dimensions

4.4.1. Farm labor

The degree of employment depends on farm size and its production system, which need precise several interventions during known periods. Farm labor is permanent in irrigated farms. While it is absent in rain-fed farms due to their seasonal and random nature.

For the first group, the number of permanent workers varies according to the farm, ranging from 1 to 10 workers per farm. They work 8 hours a day, during the year, with salaries varying from 300 to 500 DT.

For the second group, the seasonal vocation of production means that we have more seasonal workers. The concentration of work is limited to the pruning and the harvest periods: 8 weeks per year of work if it is considered prolific one. It should be noted that it’s on general a family workforce

4.4.2. Associations and cooperatives

It is noticed that only 30% of surveyed farmers are members of cooperatives associations. This shows a weak culture of cooperatives in the region which reaches downright 0% in the dry system.

In return, most of the farmers (70%) are irrigated by joining cooperatives, in order to manage the available water in a common way, share production and transport costs.

4.4.3. Agricultural extension

The success of the olive-growing activity depends on the mode of conduct and the management practiced by farmers. That’s the reason why engineers and technicians from farming extension structures intervene to guide and help farmers. That’s why 77% of farmers in irrigated lands have contacts with extension workers or have received training sessions, to improve knowledge and resolve various technical problems encountered in the farm. Nevertheless, the totality of the rain-fed farmers is disinterested by this kind of help extension.

4.5. Economic dimensions

In this session the agricultural profitability is analyzed by calculating the gross margins between the producers of each type of production system. At the beginning, we started with that of irrigated farms, as shown below, in Table 3.

Table 3: Economic analysis and estimate of profitability for irrigated farms

Farm	Olive production (T)	Oil production (T)	Gross Product (DT)	Variable charges (DT)	Total gross margin (DT)	Gross margin (DT / Ha)
1	154	30.8	169833	59513	110319	5515
2	14	2.8	15400	3818	7082	505
3	36.81	7.36	43462	16923	26538	1517
4	134	26.86	148100	69442	78657	524
5	1.97	0.39	2174	3351	823	205
6	0	0	0	1275	-1257	-212
7	228.53	45.71	251733	89159	162573	691
8	12.5	2.5	13916	6503	7412	105
9	10.02	2	11433	4719	6713	2237
10	0	0	0	629	-629	-666
11	3.96	0.79	4362	1388	2973	371
12	0	0	0	433	-433	-433
13	5.72	1.14	31503	7254	24249	3464

Source: Field survey

This analysis through the previous table shows the different productions, charges and gross margins for irrigated farmers. We note that there are some negative values in terms of gross margin of three farms (6, 10 and 12) because the plantations are young and therefore, are not yet productive. Otherwise, for farms which are already productive, the gross margin per hectare varies between a maximum value of 5516 TD (farmer 1) and a minimum value of 106 TD (farmer 8). This is due to the age of the plantations and the different techniques used.

This also reflects the volume of investment relating to the farms concerned whose owners are not necessary simple farmers, but rather people with other professional activities and have been able to invest in this activity. We can mention like example of this kind of people, in particular Tunisian people living abroad, businessmen, doctors, lawyers, so on.

The same was done for rain-fed farms. The table 4 shows the different economic indicators relating to this agrarian system, reaching their respective gross margins.

Table 4: Economic analysis and estimation of the profitability of rain-fed farms

Farm	Olive production (T)	Oil production (T)	Gross Product (DT)	Variable charges (DT)	Total gross margin (DT)	Gross margin (DT / Ha)
1	6	1	6780	3546	3234	215
2	1	0.122	690	358	332	66
3	0	0.072	380	233	146	36
4	1	0.110	598	317	282	281
5	2	0.407	2020	1541	479	79
6	2	0.367	1988	1132	856	171
7	2	0.337	1787	1008	779	194
8	4	0.707	33740	2033	1707	213
9	5	0.970	5170	1907	3246	472
10	7	1.4	5307	7406	2249	114
11	7	1.380	12484	4964	7521	627
12	2	0.474	2447	1395	1052	175
13	44	8,372	80431	42396	38063	264
14	53	10	91430	49533	41897	290
15	3	0.647	3447	2565	882	80
16	4	0.727	3824	2217	1607	229
17	2	0.487	2512	2033	738	122

Source: Field survey

This analysis through the previous table shows the different productions, charges and gross margins for dry farmers. We can deduce that the values fluctuate between 36 and 627 DT (Farms 3 and 11). These indicators, on general, are below expectations. This is due to several reasons such as irregularity in yields, lack of know-how for some farmers, neglect or even abandonment of farms and mainly the unfavorable climatic conditions of the region.

These economic indicators are so low, as explained before. This demonstrates that there is a problem of profitability, even of viability for the farmers concerned. There are many among them who have abandoned their farms, not only for lack of profitability, but also for lack of interest or because of the estrangement of farms from their residences.

Thus, we understand better why, looking for more profitability some farmers, the most determined to remain, opting for irrigation techniques, diversify plantations by alternating them with olive trees like market

gardening and other arboriculture, diversify with other agricultural activities such as breeding or oil mill. They are so-called integrated farms since there are diversifications of crops and activities.

4.6. SWOT analysis

This SWOT analysis helps to provide direction for the farmers and administrations serving as a basis for their respective plans. It can indicate Strengths and Opportunities that will help the farm to achieve its goals, or indicate an obstacle that must be overcome or minimized to achieve success (Weaknesses or Threats).

Table 5: SWOT Matrix Analysis

Strength	**Weakness**
-The large capacity of production at regional and nation al level - Satisfying family oil needs - Decrease of unemployment in the region - Olive oil sector modernization projects	-The lack of know-how of olive growers -The occasional and aleatory nature of employment - The problem of fragmentation and small sizes farms - The problem of geographic distance from the consumption hub - The salinity problem
Opportunities	**Threats**
-The presence of favorable conditions for production - Protection of the genetic heritage of local varieties - The increase in yields - The evolution of regional and national oil production	-The aging of olive trees - The abandonment of the activity - Degradation of natural resources

Source: Field survey

5. Conclusion

Despite the climatic aridity, drought, desertification and fragile edaphic resources, Zarzis is considered among the most important agricultural regions of southern Tunisia. The olive sector is one of its most active branches. This activity, in fact, is of great socio-economic and environmental importance.

The olive production system in this region is classic and is based on annual rainfall. However, this system has undergone a modernization during this decade by the introduction of intensification and irrigation with large amounts of investment.

The objective of carrying out a comparative study between irrigated and rain-fed olive farms in the study area, through a socio-economic, technical and environmental assessment. In order to achieve this objective, a survey was carried out on nearly 30 farms, of which 13 are of the irrigated type which represent all the farms in the region, and 17 are of the dry type.

The assessment shows that the irrigated olive farms are modern and characterized by plantations of foreign varieties and a permanent employment. On the other hand, rain-fed farms are characterized by low yields and the occasional nature of jobs.

The intensification of olive-growing farms makes it possible to increase profitability compared to traditional systems based on rain-fed cultivation. However, in the long term, intensive systems can lead to the degradation of the region's natural resources which are inherently fragile.

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