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## STATE OF AGRO-DIVERSITY IN A MOUNTAIN ECOSYSTEM: CASE OF THE OLIVE TREE (*OLEA EUROPEA L.*) IN THE MOUNTAINS OF BENI-SNOUS: (TLEMCCEN-ALGERIA)

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### ABSTRACT

Fruit growing in the Tlemcen region is carried out in a more or less traditional way, and this is largely the result of a lack of knowledge of areas favorable to a particular fruit species, but also of a lack of training and initiatives. Many fruit species are considered as a local product because they occupy mountainous areas with rugged relief. The latter have organoleptic qualities specific to the ecosystem in which they live. Hence the name of niche product. The most significant example is the Sigoise olive or Olive of the Tlemcen mountains. Thus the present study aims to enhance and preserve some experiences of upkeep and preservation of olive trees in mountainous ecological sites with very difficult relief. This aspect has made it possible to generate varieties of olives with by-products of highly appreciated qualitative value.

**Keywords:** Tlemcen, arboriculture, oleiculture, climat, terroir.

### INTRODUCTION

Mediterranean rural areas, in particular mountain and piedmont areas, have always been geographic locations and symbolic places of a dynamic of local development favoring the existence of a variety of high quality agricultural and agrifood systems and products. . These systems and products first of all ensured the food security of an often large and demanding population, but they also contributed to making known the spaces, the know-how and the cultural and heritage representations. This is the case for local products such as olive oil in the Béni Snous region. (Bendi-Djelloul, 2020)

Olive growing has long been maintained in mountainous regions as a food crop, it has always symbolized attachment to the land. It is a very representative culture in these regions, stemming from a historical heritage.

In this work we will try to highlight all the ecological and anthropogenic characteristics that distinguish this mountain ecosystem from other areas. In the first place, the work identifies the region by a presentation of the geographical coordinates enameled by a climatic overview of the area. Then a presentation of the structure of human activities through the description of agronomic activities in a socioeconomic aspect of the area.

-Agronomic activity in these areas has certain distinctions compared to intensive areas. Because of the presence of certain plant species or varieties which have adapted well to the ecological specificities of these regions. For this reason we have tried to present the different cultural practices followed in these areas which, despite technological

progress, have never been able to abandon ancestral practices. These practices are mainly concentrated on certain characteristic agricultural products, in particular the olive tree. The latter, through the two varieties present ‘Sigoise and Chemlal in the region, aroused in this work a particular interest through the presentation in this article of all the cultural practices that surround it, from tillage to the picking and processing and the quality of these by-products.

Thus, this study aims to enhance and preserve certain experiences of maintenance, preservation and cultivation of mountain varieties in order to project them into the future towards labeling.

### The study area

The Béni Snous region, covering an area of 55,543 ha, is part of the Tlemcen mountains in the North-West of Algeria (Figure. 1). It is located 35 km west of Tlemcen and stretches 40 km to the Moroccan border. This region clinging to the mountainsides is known for its olive groves, its famous orchards and its cultivated terraces. The steep slopes exceeding 30%, the shallow soils on a limestone substrate maintaining fairly dense natural vegetation in the form of oak and coniferous scrub (Chemouri *et al.*, 2015)

### MATERIALS AND METHODS

Our work was carried out in the Béni Snous region on family farms. Fieldwork focused on surveys of olive growers. A survey was carried out with a fairly large sample of farmers well distributed in the most important areas of cultivation of olive varieties so as to cover, as much as

possible, the territory of the area to be studied in order to reflect more or less the most common production systems in this region. A total of 110 farms were prospected in the Béni Snous region.

Through these surveys, we carried out a diagnosis which allowed us to know the cultivation practices and the specific characteristics of the olive variety and olive oil in the Béni Snous region. With donation degree of virginity and a comparison with neighboring resorts.

A case study which specifies the characteristics of the farms, but also the technical,

organizational and cultural choices which constitute the determining elements of the offer. This study covers the state of agro-diversity in the region, from the way olive farms are run to the methods of harvesting and arriving at the marketing and processing stages.

We will cover the following points:

- Climate overview
- Socio-economic aspect
- General overview of agricultural activity in the region
- State of agro-diversity in the region
- The olive production system
- Olive varieties
- Driving mode (Tillage , irrigation ,size ,fertilization, picking, processing and marketing

Finally, due to the importance of water in these areas, we have presented the ancestral techniques of water and soil conservation in the olive groves of Béni- Snous.

## RESULTS AND DISCUSSIONS

### Climate overview

The prevailing climate in the region is semi-arid with cool winter. The average annual precipitation is 417.94 mm (average calculated over the period 1980-2019). The dry period extends from June to October (deficit period) hence the harshness of this region and therefore the need to adapt local agro-diversity to thermal and water stress. The relatively abundant and aggressive rains in winters and in spring, the risks of erosion and gullyng are very high in this region. The temperature ranges are quite high. This clearly shows the tolerance of plants to these high amplitudes and what also applies to local cultivars well adapted to these thermal irregularities (Ghezlaoui and Benabadji, 2018).

The consideration of the GBC (Global bioclimatic classification) places the Atlas mountain range on the borders of the sites chosen for this study, and which overlaps in the interference of the Mediterranean oceanic rain-season bioclimate, on its northern slope and the oceanic xeric Mediterranean. on its southern slopes (Sayre

*et al.*, 2013).

Regarding the thermotypes, they are of the supra-Mediterranean type for the stations on the northern slope (Beni-Snous and Tlemcen), and this for the old period (1913-1938). For the recent period (1980-2015) the thermotypes of the Beni-Snous and Tlemcen stations are of the Meso-Mediterranean type. The ombrotypes recorded for the early period (1913-1938) are of the hyper-sub-humid type for the stations on the northern slope (Beni-Snous and Tlemcen). During the recent period (1980-2015) the ombrotypes are of the upper semi-arid (Beni-Snous) and medium semi-arid (Tlemcen) type (Table 1).

### Socio-economic aspect

The characteristics specific to this area are: it's Mediterranean climate, its rugged relief and its douars which are often enclosed in valleys or isolated in the mountains.

From a socio-economic point of view, the peasants lead a simple life often translated by the adoption of a traditional mode which is expressed by a subsistence agriculture which can be associated with the breeding to meet the immediate needs. The cultivation practices still present allow the maintenance of a significant agro-diversity (Chemouri *et al.*, 2015)

### Size and legal nature of farms

In this region, the number of farms is 1.423. The legal status is mainly private. The majority of these farms are collective lands of the "Arch" type, that is, tribal lands whose legal nature, according to Benmoussa (2013), is not clear until now. They do not have a deed of ownership, which greatly hinders the participation of the State in their financing (credits and subsidies) and causing, in most cases, conflicts which hamper any decision to develop farms. There are only three E.A.I (Individual agricultural exploitation) type operations in the region.

The size of farms in this zone can range from a few square meters to 140 Ha with the preponderance of small farms with an area of less than 2 Ha (Bendi-Djelloul, 2020).

The cultivated lands have been bequeathed for generations by inheritance, hence the high number of small farms (Figure. 2). This is what was noticed after examining the size of the areas of the farms surveyed, where those with an area of less than 02 ha, dominate compared to other area sizes (Table 02). The fragmentation is very extensive because of the impossibility of extending farms on the one hand and inheritance rules on the other. This situation can limit the productivity of land and labor compared to that of mechanized crops over large areas (Jouve, 2001; Niroula and Thapa, 2005; Todorova and Lulcheva, 2005; Austin *et al.*, 2012; Jia and Petrick , 2013; Latruffe and Piet, 2014). In addition, according to Sahli (2001), these fragmented

farms qualified as family farms constitute a handicap to land use planning in these mountainous areas.

### General overview of agricultural activity in the region (Figure. 3)

Agriculture is an important branch of economic activity in the region. It is characterized in particular by fruit growing (olive trees), cereals, market gardening and livestock (sheep, cattle, goats and poultry). This diversification is a good solution for maintaining fragile agriculture in mountain areas and for it to be able to adapt to climatic hazards and the risks of market fluctuations (Simon, 1997; Hammami and Bechir Sai, 2002; Revel *et al.*, 2002; Simon, 2002; Barnaud *et al.*, 2006; Lin, 2011) Livestock is also a complementary source of income to compensate for the low and irregular yields generally characterizing extensive cereal farming in arid regions with uncertain climates (F.A.O , 2008; Vandamme *et al.*, 2010).

Fruit trees are characteristic of these traditional agro-systems (Bentayeb, 1993) where orchards present a great diversity of fruit species.

The orchards are made up of arboreal species: stone (peach, plum, apricot), pome (pear, apple) and rustic (olive, pomegranate, Fig and walnut). Various species are planted in the same orchard at varying distances intercropped with the vegetable crops. All this is done in order to make the best use of the soil in a confined space.

This state of affairs is linked to the small size of farms, the dispersion of plots and the slope of the land. This constraint pushes the farmer to want to make the most of his land by associating several species with each other, which leads to anarchic plantations that are difficult to develop.

Cultivation in these small orchards remains traditional. The vast majority of farms do not work under the technical supervision of supervisory structures. Technical performance is poor, and owners are just starting to use fertilizers and treatment products. In the orchards, family labor provides almost all agricultural activities. This trend from mountain farms to family farms has been reported by several authors (Hammami and Bechir Sai, 2002; Revel *et al.*, 2002; Bousquet, 2004; Wymann Von Dach *et al.*, 2013). Maintaining the reproduction of small family subsistence farms therefore resides in free work performed by family labor and in providing non-farm income (Ahlonsou *et al.*, 1999).

### State of agro-diversity in the region

Agriculture in this region is traditional agriculture. From the point of view of agrobiodiversity, the region has an enormous wealth represented by the diversity of cultivated species, based essentially on the use of local races and varieties (Khemies, 2013). Particular which falls within the field of the conservation of plant genetic resources.

Surveys carried out in this region have shown its richness in local varieties. Examples include: peach (Farouki), pomegranate (Sefri, Admi), durum wheat (Merouani and Meter), etc. There are varieties which are specific to Béni Snous and are highly endangered.

### The olive production system

The region of Béni Snous is endowed with an invaluable phyto-genetic heritage of which the olive tree constitutes the pillar and the shield of the typical landscape. Few of the farms do not have an olive tree, even a few feet. This species performs multiple functions of erosion control, enhancement of agricultural land and is the main source of income on many farms. This situation is undoubtedly the result of the adaptation of this species to the agro-ecological conditions of the region. There is no other crop in the region that is practiced by so many farms. This activity is very largely predominant and strongly marks the social, economic and cultural life of the region. It is an ancestral activity from before the colonial era, the cultivation of the olive tree has a moral value. Each inhabitant of Béni Snous has his olive tree and it is more a symbol than a property. (Bendi-Djelloul 2020). Thus, despite the cyclical droughts, the rugged relief and the poor soils, especially in high altitude areas, the olive tree continues to develop in the region. The adaptive capacity of the olive tree is explained by a number of qualities specific to the species, namely: its resistance to bad weather, its ease of multiplication and its ability to produce even in critical climatic conditions. All these qualities make the olive tree a means of risk management and consequently a species appreciated by farmers in the region for a long time (Morseli *et al.*, 2004).

### Olive varieties

The olive varieties existing in the Béni Snous region are: The “Sigoise” variety: Photo 1: Variety denomination: SIGOISE

There is the variety “Sigoise” represented by trees multi-centenary and millennial which is endemic to the region. It is the most common variety in the region. These are plantations that are often scattered and isolated on sloping land. This variety gives a very good yield which can go up to 04 Qx / tree despite its age and the poor care given to it. It is the variety most appreciated by farmers in the region.

There is the variety “Sigoise” from new plantations, generally between 05 and 70 years old. These plantations are generally found in mass and on flat ground. Its yield obtained is on average 40 Qx / ha (at the rate of 200 plants / ha).

Self-fertile variety, Main variety, Destination of production: Double purposes, Fruit weight: High Pulp / Core ratio: Medium, Oil yield: 18%, Oil quality: Medium

Drought resistance: Low, Rooting rate: Medium-



The “Chemlal” variety: Photo 2: Variety denomination: Chemlal intended solely for the production of olive oil.

During our exploration in the region, we noted the introduction of the “Sevillane” variety by two operators. Self-sterile variety. Main variety Production destination: Oil Fruit weight: Low Pulp / Core Ratio: Low. Oil yield: 18 - 24%. Oil quality: Very good

Drought resistance: Medium. Rooting rate: Very low

### Driving mode

#### The tillage

Irregular plantings, rugged terrain, and intercropping do not allow maintenance work to be carried out in good conditions. The tillage practiced for the olive tree comes down to shallow plowing by animal traction or the making of basins around the tree feet. It should be remembered that the small size of farms in this mountainous region and the terrain with uneven relief hamper access to machinery which is often replaced by manual labor and / or animal traction. Lhoste *et al.*, (2010) drew attention to the place of animal traction, although it is very old, has not gone out of fashion and is still relevant in many countries. Animals still make a significant contribution to reducing the drudgery of agricultural work and various other activities, such as transport. They thus make it possible to improve working conditions and incomes in small farms (Lawrence *et al.*, 1997; FAO, 2007; Ajav, 2000; Belal *et al.*, 2015). The arable land on sloping land presents less risk than that of mechanized work and even that of soils left fallow grazed (Roose *et al.*, 1996).

#### Irrigation (Figure. 4)

Low rainfall and high heat are chronic problems facing the Béni Snous region. Irrigation is a factor that determines the profitability of any agricultural operation. The agro-system is dependent on the functioning of traditional techniques for collecting surface water and irrigation, of which the *seguia* system is predominant.

The *seguia* is a water diversion and collection channel made of earth or stone arranged to bring water taken from the wadi to the plots to be irrigated using a rudimentary dike (Sed). This is a water storage structure upstream of a bund generally made of earth transversely to a temporary watercourse with a kind of lateral weir. With a capacity of a few thousand cubic meters, it is generally repaired or completely redone after each major flood by the “Touiza” (volunteer worksite). Thus, traditional irrigation is a factor of social cohesion within irrigation communities (Mazour, 2004).

The irrigation system is gravity-fed, it affects almost all olive groves. This system is widely used because the olive groves are old. For the rest of the farms, most of the water source is probably made up of equipped wells and boreholes. However, in the early 1990s, a motorized irrigation technique appeared in the region: the motor

pump. This innovation spawned an agricultural revolution within the traditional system (Mazour, 2004).

The farmers surveyed irrigate their olive trees especially during the critical period (summer). The frequency of intake varies from once a week to once every 2 weeks. Therefore, the total number of irrigations over the entire vegetative cycle of the olive tree is on average 10 irrigations. Farms without a water source is rare. Only 11% of the prospected olive groves were managed in dry conditions. But their owners have estimated that the yield obtained is significantly lower compared to an olive grove with irrigation (Roose *et al.*, 1996).

#### Size

Olive trees in the Béni Snous region are generally characterized by their large size. Some trees happily exceed fifteen meters in height. For the elders, it was necessary to let it develop at its ease. Pruning was limited to a thinning that was done only reluctantly when it became essential to eliminate the most distant branches and the branches broken during the galling. For other orchards newly planted, maintenance pruning is practiced after harvest between January and February. This pruning is most often poorly practiced, because the majority of farmers do not master the required techniques (Bendi-Djelloul *et al.*, 2020).

#### Fertilization

For 61% of the farms surveyed, fertilization is carried out by adding manure when preparing the water retention basins around the trees between February-March at a rate of 25 to 50 kg / tree (Figure. 5). It should be remembered that the very useful properties of manure in terms of improving the structure of the soil, supplying crops with nutrients, and above all improving the water retention capacity are indisputable (Soltner, 1999), as well as its role in improving productivity and conserving water and soil (Mazour *et al.*, 2008).

Mineral fertilization is rarely practiced in the region. The few farmers who practice it (8%) do so only once a year and at low doses not exceeding 5 kg / tree. However, the use of NPK type fertilizers (0-20-25) has been noted. Farmers are aware of the importance of mineral fertilization, but do not do it for various reasons: the very high cost of mineral fertilizers, lack of a deed of land ownership for the acquisition of this type of inputs due to the nature of land ownership (joint holdings).

On 13% of farms, the two previous methods are used simultaneously. On the other hand, 18% of the farmers surveyed do not fertilize their olive trees (Khemies, 2013)

#### Phytosanitary treatment (Figure. 6)

The problem of diseases and pests is not an acute one in the region. The results of our diagnostic survey confirm this finding. Indeed, with the exception of the peacock eye (*Spilocaea oleaginum*) observed in two

farmers, fungal diseases do not pose a problem for olive cultivation in the Béni Snous region characterized by a dry and cold climate. The attack of insects such as the olive bark beetle or the Neirun (*Phloeotribus scarabaeoides*) has been observed on a farm in Azail, on a young olive plantation. The farmers surveyed claimed that they never used phytosanitary products to treat their olive trees (Belal *et al.*, 2015)

### Picking

Traditionally, the harvest is carried out in this region by galling using long saplings called “tawwal” or “kassariya”. Béni Snous is a mountain region where flat land is rather rare. But if the difficulty of the relief complicates its harvest, the farmers have the satisfaction of having the best olive tree which will produce an oil of excellent quality. In large family olive groves like that of Azail (locality Tafesra, place called Batha) and Béni Snous (locality Beni âchir, place called Djenene Tour); olive picking is done mainly with the family. This is an opportunity to bring together all the families who own olive trees and including those who live far away around the same financial objective. All families, large and small, are mobilizing to carry out a harvest which has become a millennial ritual well rooted in the customs of the owners. It is also an opportunity to make children discover and participate in this kind of “touiza” (work of general interest) for the benefit of the family and the community. It is one of the most important events in village life.

The action of the “Touiza” being secular, better known in the rural world. Its main objective remains to strengthen ties between families and to foster the spirit of solidarity and mutual aid between them. It is a tradition which tends to disappear nowadays, in an individualistic society. It continues to exist in this region where centuries-old traditions have not yet disappeared (Khemies, 2013).

### Processing and marketing

The olive sector has some potential. Olive oil remains a natural and healthy product in this region. It is fairly high quality oil. It is highly regarded by the people of the region and even nationally. There are 5 oil mills in the region, 3 of which are traditional, 1 automatic and 1 semi-automatic. The interview with the owners of these oil mills revealed that they provide services to olive growers who pay them either in cash or in kind. Among the owners of the oil mills, there are two who are at the same time olive growers.

Traditional oil mills keep the by-products that are used as fuel at the oil mill (olive pomace). While automatic and semi-automatic oil mills throw them into nature. The product is presented either in can in plastics or in bottles.

There is no organized marketing channel in the region. The oil collected by olive growers is generally intended for home consumption as it is the property of several heirs. The oil collected by the oil mill is sold

directly to customers.

There is also a real desire among olive growers and olive oil producers in the region to promote the local and heritage characteristics of their oil by positively participating in the labeling projects for this product proposed by ministry of agriculture and the F.A.O. (Food agricultural organization) Generally the oil extracted in the region of Beni-Snous is described as extra virgin (Figure. 7), with a rate of 60% (Bendi-Djelloul *et al.*, 2020).

### The ancestral techniques of water and soil conservation in the olive groves of Béni- Snous.

This region is characterized by a very rugged relief: the average slope varies between 20 and 60% and the altitudes are between 500 and 1700m. This region is strongly threatened by erosion due to the strength of the relief and the aggressiveness of the climate, which greatly intensifies this phenomenon. In addition, there are uncontrolled human, agricultural, pastoral or forestry activities which play an essential role in accelerating the erosion process (Hien, 2002; Mazour, 2004, Roose, and De Noni, 2004) .

Rural landscapes are the product of developments slowly developed by farmers. Farmers in the region have been able to develop for a very long time (in Andalusian times according to the local population) methods and techniques that are sometimes simple but effective allowing them to control runoff water, store it and use it for water. ‘irrigation of landscaped terraces, olive trees and other fruit trees (pomegranate, apple, peach, plum, pear, etc.). At the foot of olive trees, circular or half-moon infiltration basins are often made with the use of “mulching” in straw but sometimes also in stones.

According to Mazour (2004), the terraces and small terraces which admirably sculpt this mountain landscape, allow excellent water conservation.

Working in association with water diversion and storage techniques (Séguia, Seds Madjen, Jboub) and plant cords, their efficiency is multiplied: the surface runoff collected, the runoff attenuated by the cords and the tillage and channeled by the Séguia, improved infiltration at the level of the terraces (Morsli *et al.*, 2004).

These techniques are perfectly suited to the agro-ecological and socio-economic conditions of the region. Their presence to this day proves that farmers have always maintained these developments. The cultural practices adopted by farmers in this region have generally shown a positive impact on water and soil conservation and on improving land productivity (Mazour *et al.*, 2008). These are simple, inexpensive techniques within the reach of farmers. We can cite for example: working the soil with a plow, the practice of crops in ridges, use of manure, etc. It seems that some farmers are interested in these techniques more as a practice of improving production and reduction of arduous work than as a practice of soil

Table 1: Bioclimatic data, bioclimatic stages, thermotypes and ombrotypes)

Stations	(M-m) °C		Types of climates		Bioclimatic stages		Thermotypes		Ombrotypes	
	1913-1938	1980-2019	1913-1938	1980-2019	1913-1938	1980-2019	1913-1938	1980-2019	1913-1938	1980-2019
Beni-Snous	28.7	29.89	Semi-continental	Semi-continental	Medium sub-humid to cool winter	Semi-arid greater than cold winter	Supra méditerranéan	Mésoméditerranéan	Hyper-Sub-humid	Upper semi-arid
Tlemcen	27.2	25.6	Semi-continental	Semi-continental	Moderate sub-humid to moderate winter	Semi-aride moyen à hiver tempéré	Supra méditerranéan	Mésoméditerranéan	Hyper-Sub-humid	Middle Semi-arid

Figure 1. Map of the geographical location of the study area

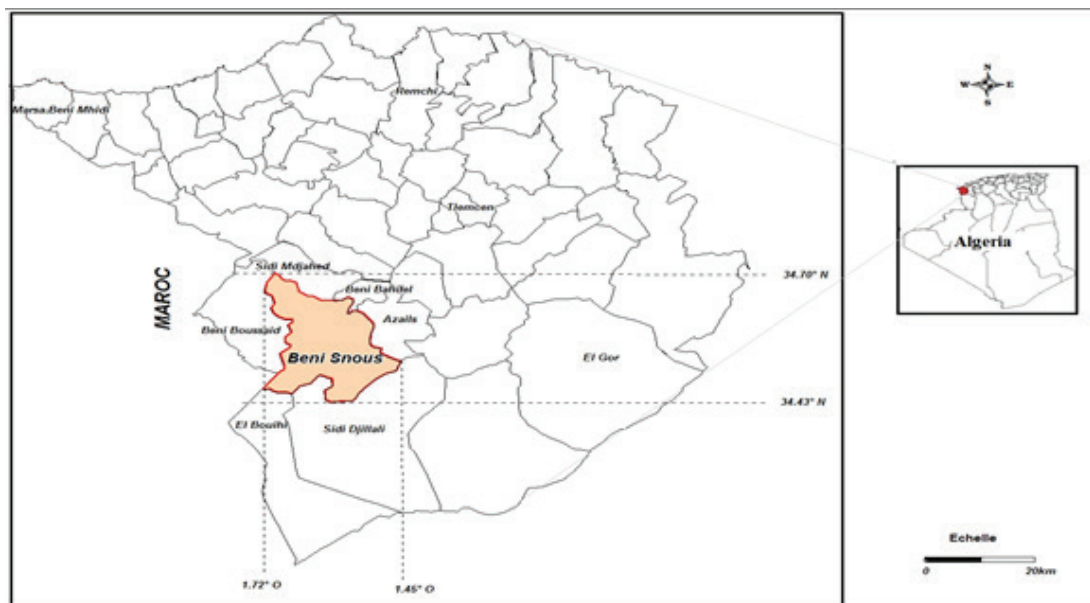


Figure 2. Distribution of farms surveyed by surface class

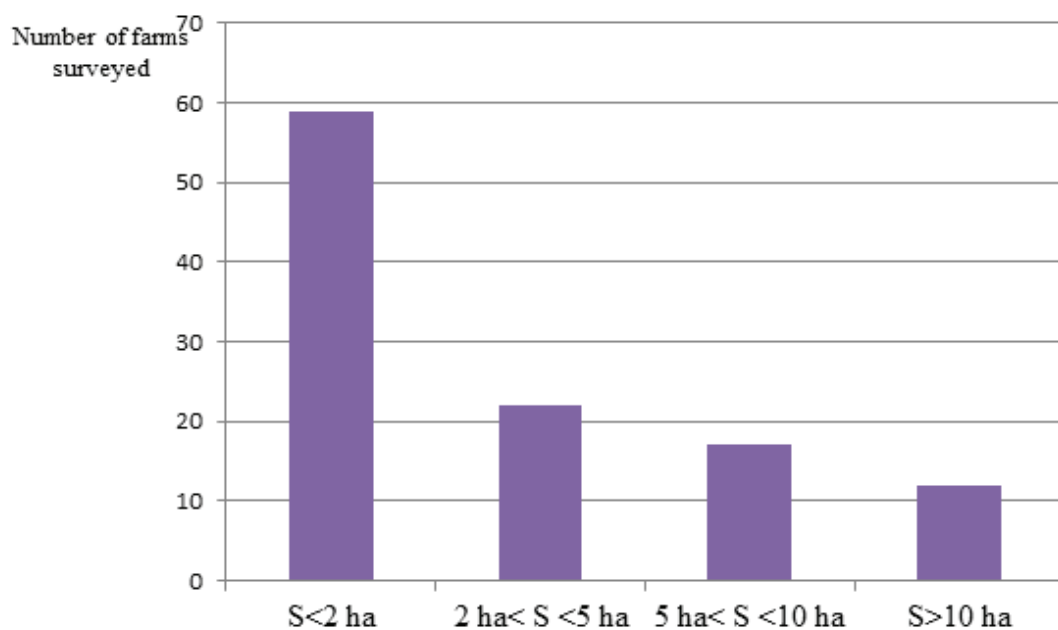
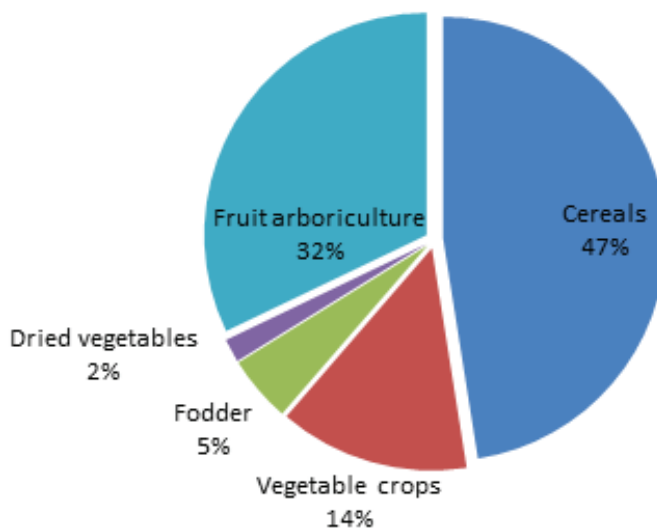
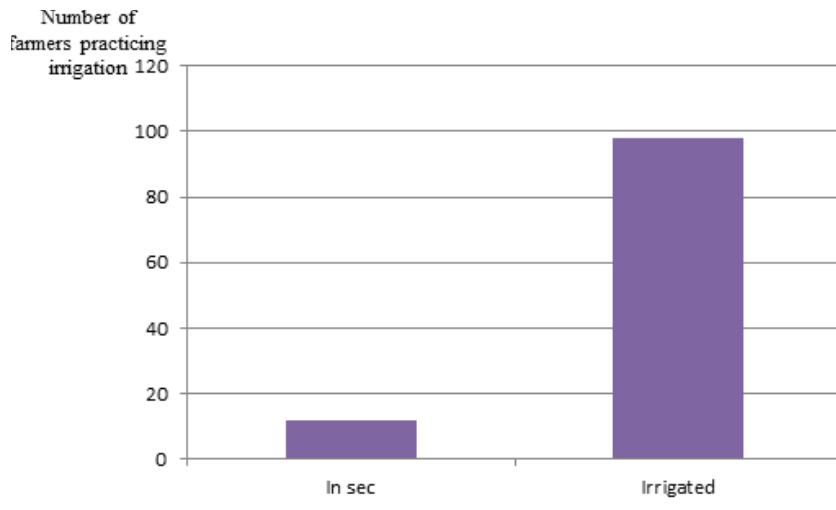


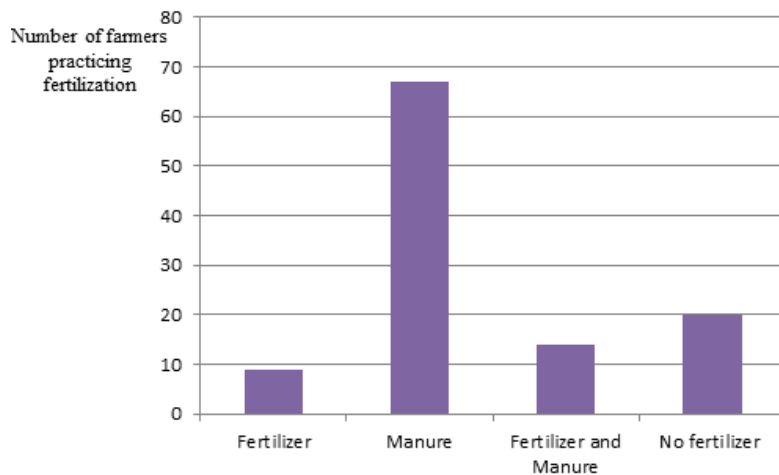
Figure 3: Distribution of agriculture area by speculation in the Béni Snous region.



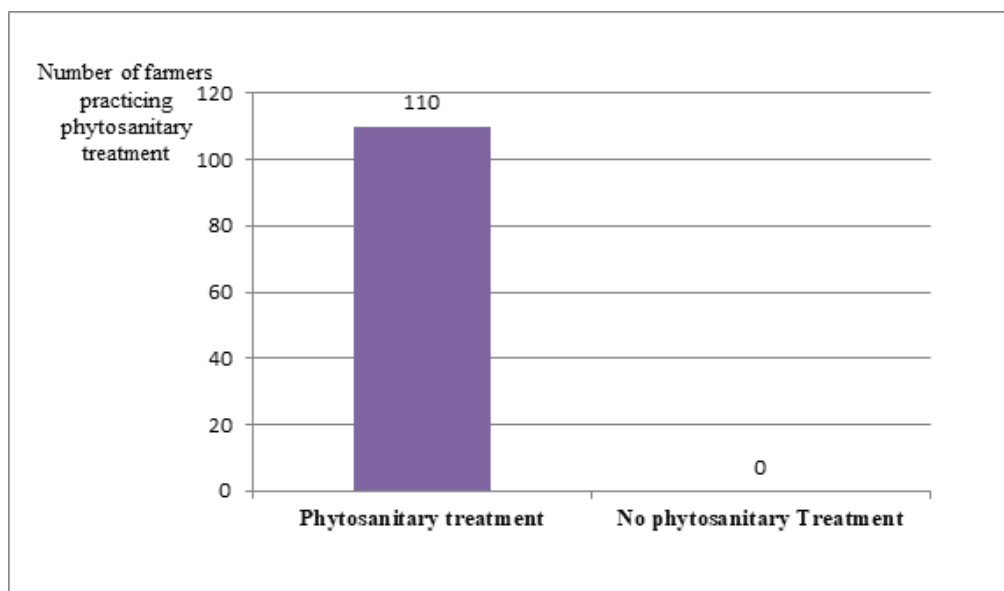
**Figure 4.** The management of olive groves in the Béni Snous region



**Figure 5.** The practice of fertilization in the olive groves surveyed



**Figure 6.** The practice of phytosanitary treatment in the olive groves surveyed



conservation (Mazour *et al.*, 2008). All these traditional and ancestral techniques have shown a certain remarkable stability and effectiveness with regard to erosion. On the other hand, the modern techniques recently put in place by the Forestry Administration (gabion sills, dry stone sills, etc.) are often abandoned despite a very high cost of implementation (Zekri-Bellahcen *et al.*, 2012).

### CONCLUSION

The cropping system which can be defined as a whole formed by the succession of crops on a plot and the cultivation techniques applied to them is the important factor where man can intervene to protect and improve the productivity of resources (Mazour *et al.*, 2008).

The region studied has a predominantly agricultural economy, with a strong predominance of small family subsistence farms.

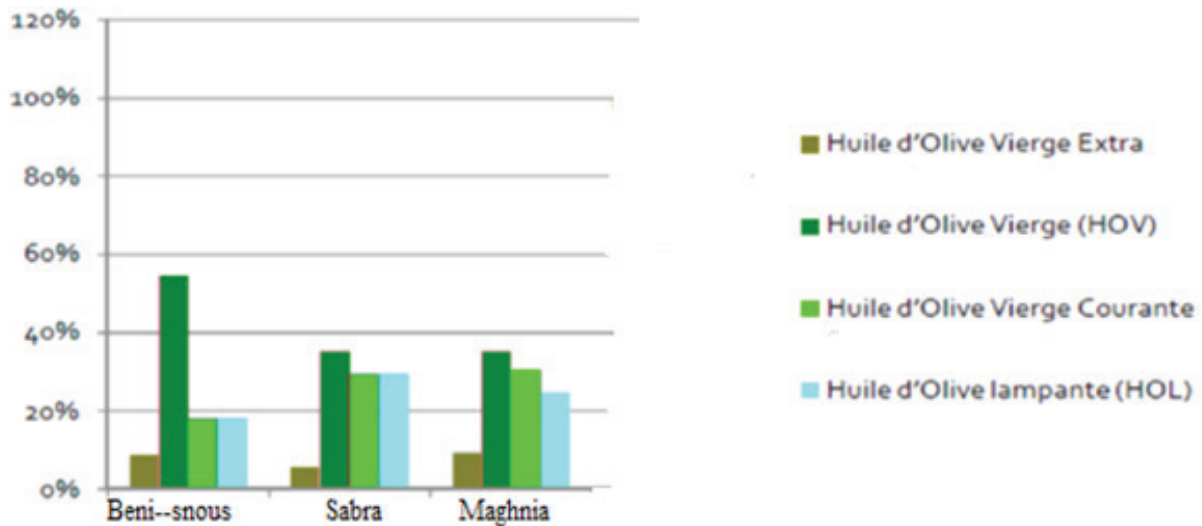
If we analyze the spatial and temporal distribution of cultivated land in this mountainous area, we often observe traditional management systems characterized by:

- A diversification of crops: cereals, fruit trees, fodder crops and vegetable crops associated with livestock.
- Traditional tillage (agrarian, manual).
- Use of manure and low use of inputs.

The promotion of local products,



**Figure 7.** Quality of olive oil produced in the regions of Tlemcen



**Photo 1:** Variety denomination: SIGOISE (Khemies 2013)

especially olives and olive oil, should be considered as a tool to protect the know-how and heritage of this rural community, against any usurpation of identity. The origin, the specific know-how is sure assets, which it is necessary to promote and directly associate with this type of product in order to meet the needs of consumers interested in originality. The promotion of traditional know-how and territorial roots would allow the conservation of traditional olive groves well adapted to socio-economic realities For this, we believe it is necessary to improve production techniques, harvesting, and processing and storage conditions. This effort should be supported by the State and supervised by technical institutes, which could relieve producers and allow them to improve their production qualitatively and quantitatively (Bendi-Djelloul, 2020).

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**Photo 2:** Variety denomination: CHEMLAL (Khemies 2013)

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