



MOROCCAN BIODIVERSITY
& LIVELIHOODS ASSOCIATION



BUYING THYME:
LESSONS LEARNT ON THE SOCIO-
ECONOMIC SUSTAINABILITY OF
CULTURAL PRACTICES THAT ENHANCE
HIGH ATLAS BIODIVERSITY

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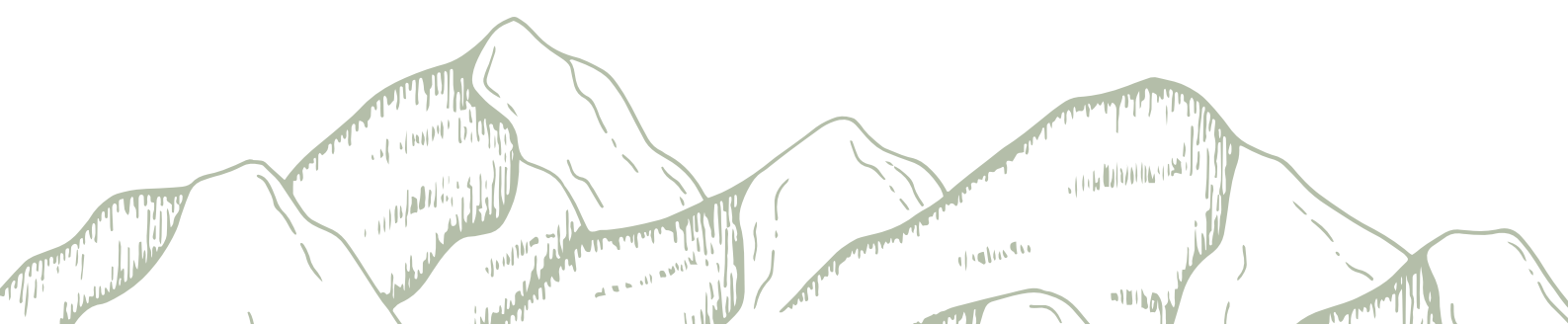
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Introduction

Our story began in 2014, when three students from Amazigh origin created the [Moroccan Biodiversity and Livelihoods Association](#). With support of our lead partner [Global Diversity Foundation](#) (GDF), a UK and US-based non-profit organization, MBLA was established as a Moroccan-based NGO dedicated to using community-based research to implement integrated in-situ and ex-situ conservation measures and strengthen cultural practices of conservation to protect biodiversity and enhance local livelihoods in the Moroccan High Atlas.

In collaboration with GDF, we launched the High Atlas Cultural Landscapes Programme in 2015 in Morocco to support rural communities to revitalise traditional practices, sustain livelihoods and protect local biodiversity. Since then, we have established 5 project sites across the High Atlas in Aït M'hamed, Imegdal, Ourika, Oukaïmeden, and Zaouiat Ahansal where we carry out scientific research on plant biodiversity and cultural practices, conservation actions such as establishing community plant nurseries and seedbanks, and capacity building and training for local community members, cooperatives and farmers.

Over the years we have gathered significant experience and knowledge about local plant and product commercialisation through our work with rural cooperatives by supporting them with trainings in (digital) marketing, product quality, pricing strategies, and more. With this publication, we aim to share some of the lessons we learned through our projects that promote sustainable land-use practices by improving marketing of local products.

In Chapter 1, we learn more about the High Atlas Mountains, including their geological features, biodiversity and aromatic and medicinal plant populations. We deepen our knowledge about traditional practices and medicinal plants in Chapter 2, with a focus on Moroccan wild thyme (*Thymus satureioides*). In Chapter 3, we zoom in on the commercialization of thyme in practice through three case studies based on experiences from three different cooperatives in the regions of Al Haouz, Azilal and Demnate. Chapter 4 provides concrete examples of different approaches, events and communication tools to promote local plant products. Finally, we share a series of infographics that includes key features and production information of 5 plant products: thyme, almonds, walnuts, carob and lavender.

Acknowledgements

We are extremely thankful for the dedicated work of our team members and for the long-term collaboration with our partner communities in the High Atlas in the provinces of Al Haouz and Azilal, without whom MBLA would not exist. We also want to acknowledge the local and regional authorities of the region without who have made our long-term local collaborations possible. Special thanks is due to our national and international partners for their support, advice and mentorship, in particular our partner Global Diversity Foundation. Finally, we thank our donors for their trust and for supporting our work, especially the MAVA Foundation, which has provided significant organizational support, in addition to the creation of this publication and its dissemination.

Chapter 1. An introduction to plant diversity in the Moroccan High Atlas

Chapter Lead: Omar Saadani Hassani

1.1 Introduction

Morocco benefits from favourable climate conditions allowing it to have a rich biological biodiversity. This is due to its location at the north-western end of the African continent, bordering both the Mediterranean Sea and the Atlantic ocean. Besides its various geology and 30 ecoregions, the country has a diverse bioclimatic range, covering the Sahara Desert and arid, semi-arid, subhumid, and humid zones (Menioui et al., 2006). Conditions that constitute a completely original natural setting, offering a full range of Mediterranean bioclimates, favouring a rich and varied flora with very marked endemism (Benabid, 2000). Morocco has the most varied and richest flora of all the countries of the southern Mediterranean (Fennane et Ibn Tattou, 2012), with around 3,913 taxa including 1,282 subspecies (Fennane and Ibn-Tattou, 2012; Valdés et al., 2013). Morocco is after Turkey the second most biologically diverse country in term of species in the Mediterranean basin (Montanari, 2013).

It is within this framework that in this chapter we will focus on the characteristics that make the High Atlas a biodiversity hotspot. We will also look at the socio-economic conditions of the area and its potential.

1.2 Study area characteristics

The High Atlas range, which covers 5,918,616 ha (as defined to date), stretches over roughly 750 kilometres from the Algerian border in the east to the Atlantic Ocean in the west and is bounded in the north by the valleys of the Moulouya and Oum Errabiaa rivers. The High Atlas range is geologically separated from the Anti-Atlas range on the southern end (Figure 1).

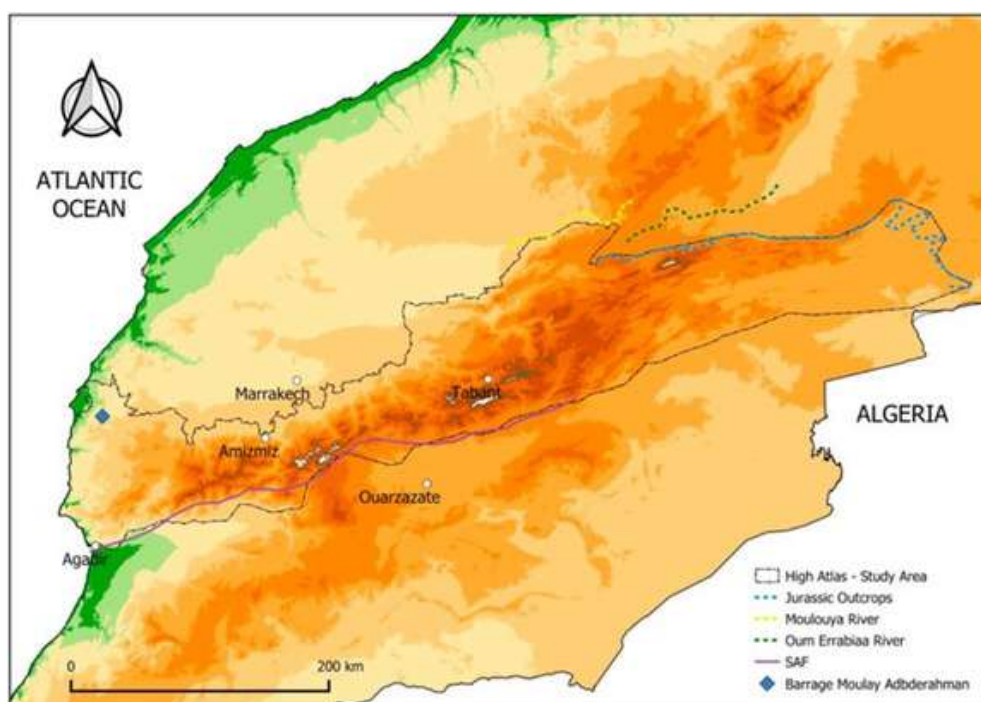


Figure 1. Location and limits of the High Atlas area (by Giandaniele Castangia)

The High Atlas is known for its high altitudes, with peaks exceeding 4,000 meters such as Jbel Akioud (4,030 meters), Jbel Afella (4,043 meters), Jbel Ouanoukrim (4,089 meters), and M'Goun mountain (4,071 meters); not to mention the Toubkal peak (4,167 meters) in the province of Al Haouz, which is the highest mountain peak in North Africa. All of these summits – with the exception of the M'Goun mountain – are located in the Toubkal region. The elevation of the study area, as well as its major rivers and water bodies, are represented in Figure 2.

The High Atlas' geological features permit the emergence of several rivers and watersheds. The High Atlas has approximately 28,715 km of water sources, 6,092 km of which are rivers, while the remainder are seasonal streams or man-made channels. On the southern slope, the Oued Sous and Oued Dades rivers are the most important, while on the northern slope the principal rivers are the Oued Nfiss, Oued Ourika, Oued Zat, Oued Tensift, Oued Tessaout, Oued Lakhdar, and Oued Al Abid (Figure 2).

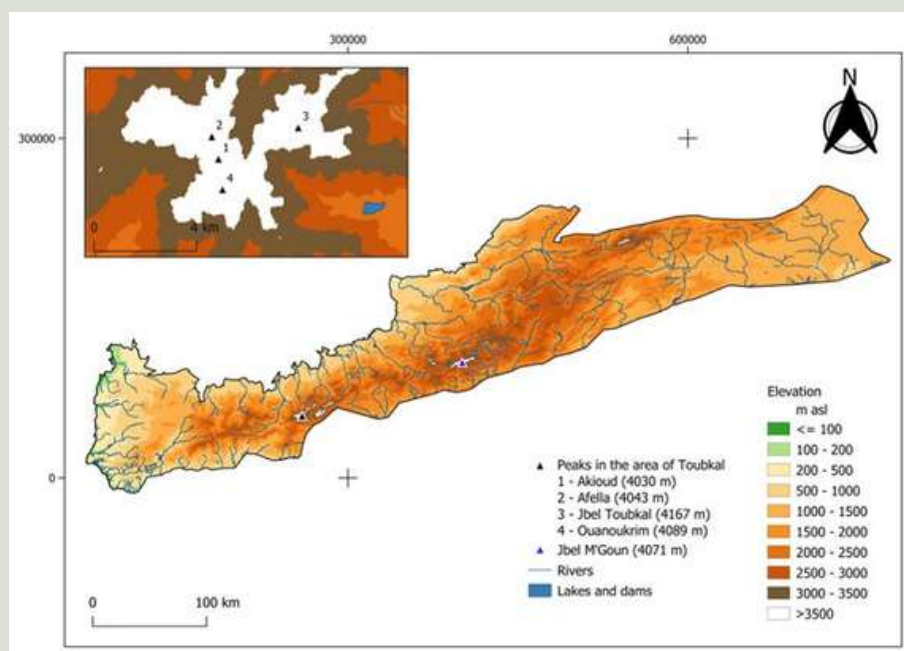


Figure 2. Map showing the elevation of the study area, together with main rivers and water bodies (by Giandaniele Castangia)

The High Atlas has two distinct mountain climates as a result of these geological characteristics. An oceanic subtropical climate is one of them, and it may be found on the northern and southern slopes of the western section (up to Jbel Toubkal) as well as the northern slope of the central part (from Toubkal to Imilchil). Given their exposure to Atlantic Ocean disturbances, these regions have sporadic, occasionally heavy rainfall, and a moderate amount of humidity. The High Atlas has 600 to 1,000 millimeters of precipitation annually on average. Thunderstorms are also present during the summer, however, the drought is severe. Snow cover is often maintained above 2,500 to 3,500 meters from November to April, and for the high peaks, it might extend from September to June (with large variations depending on their exposure).

Semi-arid continental climate is the second type of climate. On the southern slope of the central part (from Toubkal to Imilchil) and the entire eastern part (beyond Imilchil), with notable thermal amplitudes, the forest is essentially nonexistent here. High steppes, rocky deserts, seldom sand, and a few valleys with water where highly limited cultivation is feasible are its defining features.

1.3 Flora and biodiversity conservation in the High Atlas

The High Atlas has a particularly high rate of endemism, also present in the Middle Atlas but to a lesser extent in the Rif and the Anti Atlas (Montanari 2014). The location that are the richest in locally endemic species are the National Park of Ifrane, the National Park of Toubkal, Jbel Bounacher and Jbel Bou Iblane where approximately 7,000 species are distributed in 920 genera and 130 families, including approximately 4,500 species and sub-Vascular plant species that are found in the flora of Morocco (Taleb and Fennane, 2011; Montanari 2014).

The abundance of biodiversity in the High Atlas is reflected in the presence of various important biological sites, all of which are managed by the National Directorate of Water and Forests. There are five national parks in the High Atlas: Ain Asmama, Parc national du Toubkal, Parc national du Haut Atlas-Oriental, Tamga National Park, and Tamri Cap-Ghir Park. These parks represent around 4% of our study region, with a total area of 223,697 ha.

The Toubkal National Park, established in 1942, is Morocco's oldest and most well-protected park (Lamnouer 2002). It is located in the central portion of the High Atlas and covers an area of 38,000 hectares between the N' Fiss valley to the west and the Ourika valley to the east (31° 05' N - 07° 50' W). The tallest peaks in North Africa can be found in this area: Mount Toubkal (4,167m) which is the most picturesque top of the High Atlas Mountains, and easily accessible and regularly explored. From the Toubkal Mountain, seven valleys emerge, with streams falling in height as they convey snowfall water through diverse altitudinal zones and habitats before reaching the Tensift and Souss river basins (Montanari 2014).

Table 1 : List of the Natural Parks of the High Atlas (source : Giandaniele, 2021)

NAME	STATUS	STATUS YEAR	AREA (ha)
Ain Asmama	Proposed	2014	22,457
Parc National de Toubkal	Designated	1942	102,005
Parc National du Haut-Atlas-Oriental	Designated	2004	55,680
Tamga	Proposed	2014	13,957
Tamri Cap-Ghir	Proposed	2014	29,598

The High Atlas also includes the "Imarigha" biological reserve and 18 SIBE (Sites d'Interet Biologique et Ecologique), totaling 139,366 ha, or 2% of the total area of the High Atlas. These SIBEs have a diverse surface area, ranging from 3 to 25.203 ha, as demonstrated in the following table:

Table 2 : List of SIBES in the High Atlas
(source : Giandaniele, 2021)

NAME	STATUS	STATUS YEAR	AREA (ha)
Aghbar	Established	1994	6,564
Aguelmam Abekhane	Established	1994	39
Aqqa Wabzaza	Established	1994	2,930
Bou Tferda	Established	1994	25,203
Cascades d'Ouzoud	Established	1994	153
Grotte d'Akhyam	Established	1994	15,085
Jbel Amsittene	Established	1994	3,497
Jbel Ayachi	Established	1994	19,668
Jbel Taghioult	Established	1994	10,098
Jbel Tazerkount	Established	1994	15,232
Oued Lakhdar	Established	1994	574
Oued Todra	Established	1994	1,090
Sidi Meskeur	Established	1994	2,191
Source Tizi n'Test	Established	1994	3
Tafingoult	Established	1994	2,893
Tichka	Established	1994	7,567
Tizi n'Ait Ourra	Established	1994	14,202
Vallee de Telouat	Established	1994	12,377

Additionally, the High Atlas hosts six RAMSAR* sites (Wetlands of International Importance) including: Assif Ahançal-Melloul, Assif Mgoun, Assifs Réghaya-At Mizane, Cap Ghir-Imsouane, Haut Oued Lakhdar, and Lacs Isly-Tislite.

Furthermore, local agriculture contributes to biodiversity enhancement. The High Atlas is diversifying in terms of agrobiodiversity, with local varieties sometimes specific to a few douars (villages), such as "lbawen onayen," a rare Vicia Faba variety found in the region of Onayen, El Haouz.

**[1] A Ramsar site is a wetland site designated to be of international importance under the Ramsar Convention,[1] also known as "The Convention on Wetlands", an intergovernmental environmental treaty established in 1971 by UNESCO, which came into force in 1975.*

It's also worth mentioning the region's richness in Aromatic and Medicinal Plants (AMP), which farmers grow on their plots or which are harvested directly in the wild. However, the cultivation of aromatic and medicinal plants comes in third place after the production of vegetables and citrus fruits.

This is the case not only in the High Atlas, but across the whole country. According to research conducted in 2010 by the Moroccan Association of the Organic Production Sector (AMABIO), 800,000 ha of organic farming were certified in 2014, with over 8,000 hectares of cultivation and 1,841 hectares under conversion (Table 3).

Table 3 : organic cultivated, harvested and converted areas in Morocco (Source : AMABio, 2014)

Sectors Certified	Cultivated Areas (Ha)	Certified Wild Areas (Ha)	Areas in Conversion (Ha)
Fruits	4859	63 933	1002,64
Vegetables	255	0	48
AMP	1370	101 991	108,06
Cereals	132	0	80
Argan	507	617 770	0
Others	923	3675	601,85
Total	8046	787 369	1840,55

Aromatic and medicinal plants, as well as argan trees, occupy a considerable portion of the area surfaces, followed by fruit trees, in particular citrus fruits.

Vegetable crops (21,680 tonnes), citrus fruits (15,200 tonnes), and aromatic and medicinal plants (10,116 tonnes) account for more than 63 percent of total annual agricultural production in 2014 as demonstrated below (Figure 3).

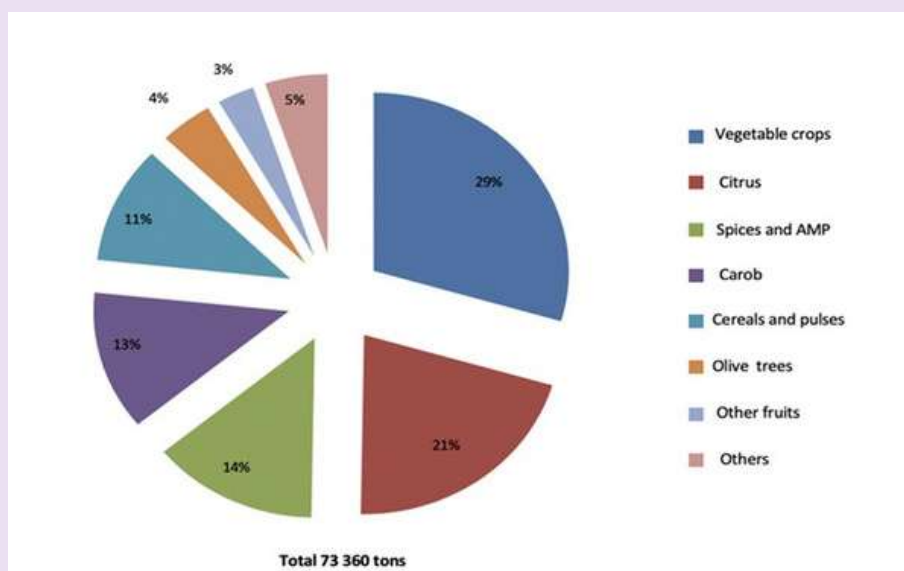


Figure 3. Certified organic Moroccan production (Source OCC 2014)

We also take note of the importance that farmers place on aromatic and medicinal plants considering their abundance both nationally and in the High Atlas region. The High Atlas is placed second in terms of richness in aromatic and medicinal plants by geographical division in Morocco, according to Jamaledine et al., 2019 (Figure 4).

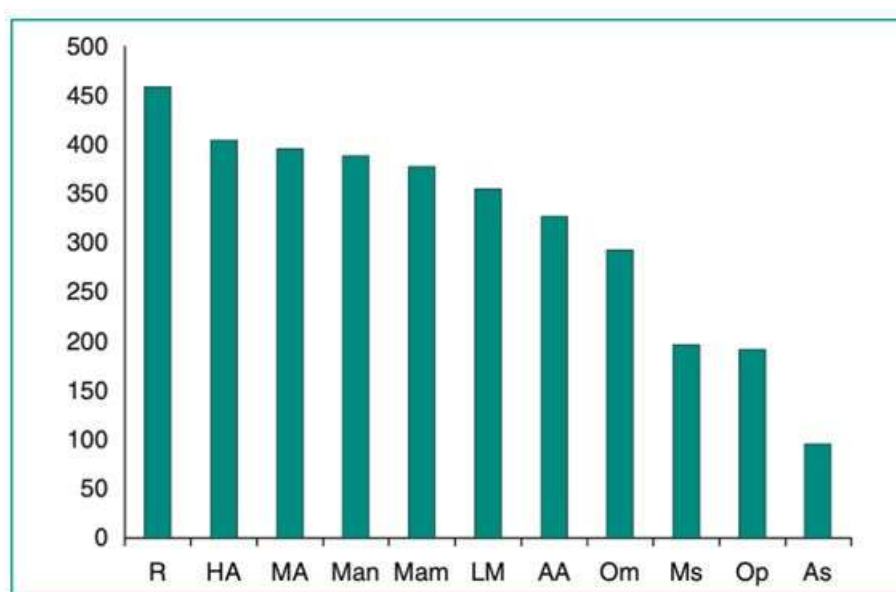


Figure 4. Richness in AMP by geographical division in Morocco

Ms (Marocsaharien), As (Atlassaharien), AA (AntiAtlas), HA (HautAtlas), MA (MoyenAtlas), Mam (Maroc atlantique moyen), Man (Maroc atlantique nord), Op (Plateaux du Maroc oriental), Om (monts du Maroc oriental), LM (littoral de la Méditerranée), R (Rif).



Figure 5. Medicinal plant harvest in Zaouiat Ahansal

1.4 Socioeconomic value of biodiversity (focus on Thyme)

The High Atlas is an important refuge for Amazigh populations, in addition to its distinctive biological and geological qualities. Despite the fact that many people migrate to cities due to the harsh conditions, population growth in the mountains is a key element of human capital. These populations have achieved economic self-sufficiency due to their management of natural resources.

Nevertheless, there are a number of disadvantages to living in the High Atlas. Topographical partitioning, a fragile environment, and a lack of basic infrastructure are some of the key factors. The High Atlas exemplifies many of the "poverty and livelihood" issues that mountain communities face in general (Crawford, 2003). Local communities are currently undergoing environmental deterioration, which is both a cause and a result of acute rural poverty (Rasmussen and Parvez, 2002). In addition, they face significant development challenges.

Moreover, living conditions in the High Atlas Mountains are often challenging to improve, mainly due to the central government's long-standing preference for development of the Atlantic seaboard and its hinterland (Boujrourf, 2003). People and landscapes have always changed, moved, and self-regenerated in these regions due to strong environmental constraints. People are supposed to manage their environment, which they do fairly well, despite popular belief that local communities mismanage their resources (Ostrom, 1990; Scoones, 1994; Pretty and Pimbert, 1995; Leach and Mearns, 1999; Pretty and Shab, 1997; Ghimire and Pimbert, 1997).

Given the abundance of aromatic and

medicinal plants (AMP) in the High Atlas, we will focus on the latter, in particular thyme due to its varied uses and socio-economic influence in the region.

There are no dispensaries or other forms of medical facilities in close proximity, and therefore the use of traditional medicine using aromatic and medicinal plants is widespread in this area. The phytochemical characteristics are also essential in some of the plants used. Both men and women in the High Atlas share a common plant knowledge, however this information is passed down exclusively through women within the community. However, since the community is more exposed to outside influences and initiatives, the transfer of herbal knowledge and other traditional subsistence activities is at risk.

Moroccan Thyme (*Thymus satureioides*) is an endemic aromatic plant found across the Mediterranean region, where it is frequently utilized in traditional medicine. Despite the fact that the genus *Thymus* is thought to contain roughly 350 species worldwide; *Thymus satureioides*, *Thymus broussonettii*, *Thymus maroccanus*, *Thymus leptobotrys*, and *Thymus willdenowii* are all endemic to Morocco and have all been used in traditional Moroccan medicine (Jaâfari et al., 2007).

Thyme is used to treat diarrhea, fever, and cough, and is used in the treatment of infected skin areas and wounds, such as ulcers, and various types of dermatitis. Thyme has been used and praised for its good effects, such as its nerve tonic and general stimulant characteristics, which produce an euphoric impact, which can help with depression, anxiety, and sleeplessness (Bellakdhar, 1996; Ismaili et al., 2001).

In addition, using thyme during body massages can help with sciatica, arthritis, lumbago, gout, and neurotic and rheumatic pain (Valnet, 1964).

Thyme, like tea tree (*Melaleuca alternifolia*) has strong anti-inflammatory and antibacterial characteristics. When applied topically in the optimum dilution, it speeds up the healing of wounds and inflamed skin, because it increases blood flow stimulated by increased oxygen and nutritional substances.

Thyme species are not only potent antioxidants, but they also have substantial antibacterial effects. Thyme essential oil has a direct inhibitory effect on pathogenic bacterial strains such as *E. coli*, *Salmonella enteritidis*, *Salmonella choleraesuis*, and *Salmonella Typhimurium* due to the presence of phenolic agents (Pelnaver et al., 2005). Therefore, it is widely used in food protection against rot and bacteria. Thymes from Morocco, such as *Thymus satureioides* and *Thymus wilddenowii*, demonstrated the presence of significant components, including luteolin and eriodictiol flavonoid derivatives, both unusual in *Lamiaceae*, as well as rosmarinic acid.

Thyme's therapeutic uses also include the digestive and respiratory systems, as well as the treatment of dyspepsia (slow digestion), colic, fermentation, flatulence, diarrhea, gastritis, and stomach ulcers. Thyme has potent expectorant, spasmolytic, and antiseptic qualities, making it an effective cure against colds, flu, and sinusitis, as well as bronchitis in both acute and chronic forms, and tuberculosis and irritated convulsive coughs (Zarzuelo and Crespo, 2002).

With all these benefits, Thyme is a plant in high demand and therefore a good source of income for local populations in the High Atlas. Using the territory of Imegdal (municipality of El Haouz) as an example, the region was able to sell over 40 tons of Thyme in bulk in 2021, resulting in good revenue for local cooperatives.

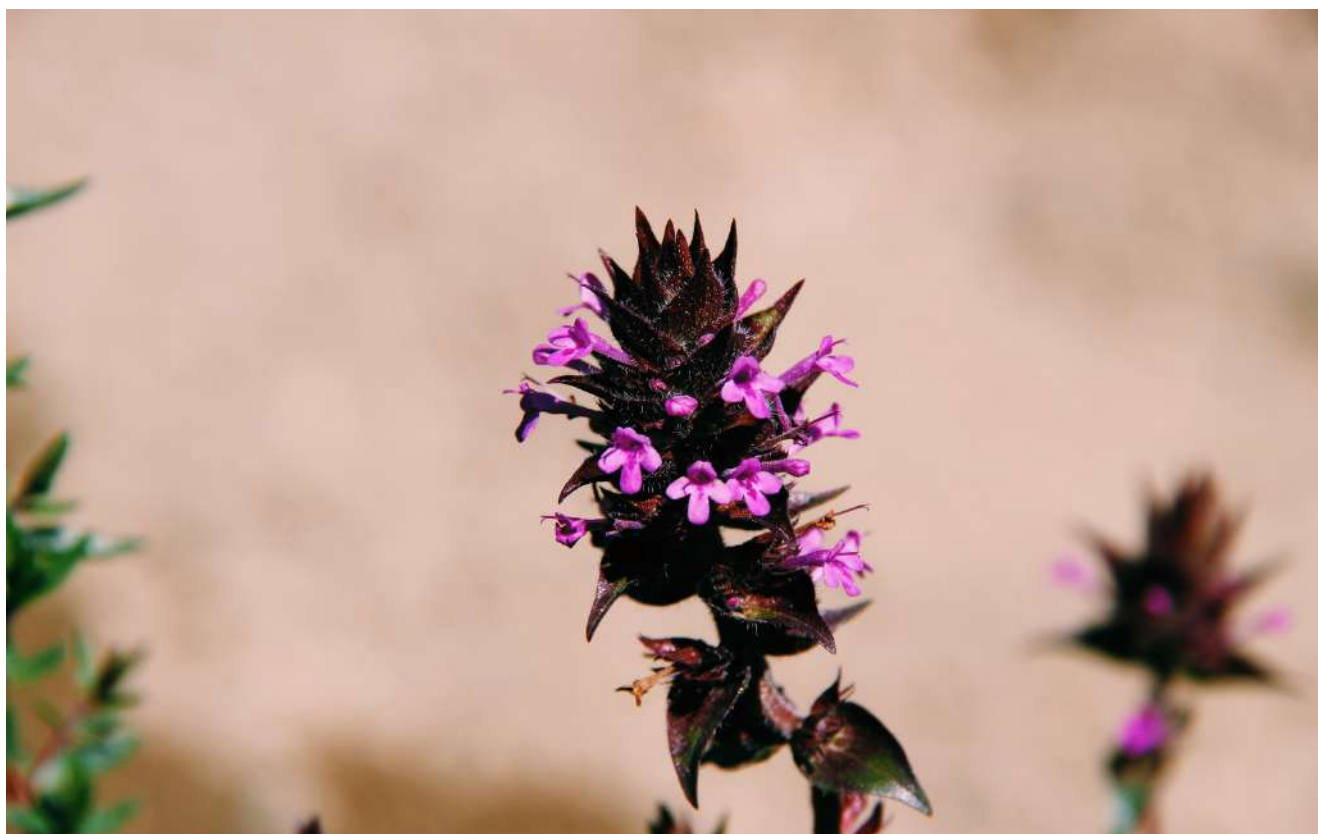


Figure 6. *Thymus broussonetii* Boiss.

1.5 Conclusion

Morocco has benefited from favourable conditions, which has resulted in a diverse biological richness. Its location near the northwestern tip of the African continent, bordering both the Mediterranean and the Atlantic, has made it a popular tourist destination, but also an important biodiversity hotspot.

Morocco, like many other countries around the world, has a long history and great expertise in traditional pharmacopeia.

For centuries, Moroccan Thyme species have been utilized in traditional medicine. Diabetes and various digestive, circulatory, genital, neurological, urinary, skin, and respiratory disorders have all been treated with thyme infusions, decoctions, powders, soaked leaves, flowers, stems, aerial sections, and whole plants. Many articles have demonstrated antibacterial, antifungal, antioxidant, anti-proliferative, anti-tumor, insecticidal, larvicidal, nematicide, anti-inflammatory, and anti-acetylcholinesterase activities in the *Thymus* genus (El Yaagoubi et al, 2021).

Unfortunately, these resources, which are part of the country's wealth and heritage, are being exploited by impoverished communities to supplement their income. Because of demographic pressures and the socioeconomic circumstances of these populations, the exploitation of PAMs has a negative impact on these resources (Jamaledine et al., 2019).

Within this framework, we established different community plant nurseries in four significant Moroccan High Atlas locations in collaboration with our partner Global Diversity Foundation.

The plant nurseries are located in Imegdal, Ait M'hamed, Oukameden, and Zaouiat Ahensal. The objective of these community nurseries is to disseminate the value of local biodiversity in each region, while reducing the risks of overharvesting in the High Atlas Mountains, by providing:

- 1) Training to local communities on sustainable harvesting techniques for aromatic and medicinal plants to reduce the common practice of removing plant roots, which halts the plant's regeneration.
- 2) Annual free distributions of plants grown in community plant nurseries to reduce pressure on wild populations and support local livelihoods.

The wild populations of aromatic and medicinal plants are currently being exploited in an abusive, excessive, and disorderly manner, posing a serious threat to national biodiversity and their conservation status. As a result, a national action plan for their uses and valorization is needed, one that is both commercially viable and protects the nation's natural capital and ensures the long-term viability of plant resources (Jamaledine et al., 2019).



Figure 7. Community plant nursery in Ait M'hamed

Chapter 2. Harvesting thyme: traditional plant knowledge and practices

Chapter Lead: Mohamed Ouknin

2.1 Introduction

The High Atlas landscapes have been shaped by millennial relationships between humans and nature. Rural Amazigh communities still maintain ancient practices, including seasonal transhumance, traditional irrigation systems, agricultural terraces, and communal management of pastures lands (*agdals*), which sustain the unique biodiversity of these extraordinary cultural landscapes.

Traditional plant knowledge and practices are an important part of well-being in High Atlas Amazigh communities. Although this knowledge is threatened to disappear due to various factors such as rural exodus, medicinal and aromatic plants still play an important role in traditional medicine and local gastronomy while also providing a source of income.

The genus *Thymus* consists of about 350 species of perennial, aromatic herbs and subshrubs native to Europe and North Africa (Stahl-Biskup et al., 2002). In Morocco, it is represented by 21 species, 12 of which are endemic. Among the latter category is *Thymus satureioides*, which is an endemic species to Morocco. It is widespread in forest clearings, brush and matorrals in low and medium mountains up to 2600m above sea level, on siliceous calcareous substrates and more or less earthy but well drained rocky soils (Peltier, 1983; Benabid, 2000; Nordine et al., 2013; Ouknin et al., 2019; Rankou et al., 2020).

2.2 Botanical description of *Thymus satureioides* L.

Thymus satureioides belongs to the botanical family Lamiaceae within the genus *Thymus*. It is an erect shrub, which can reach 60 cm in height with numerous branches. The leaves are spatulate, the inflorescence in loose glomerules, the corolla is pink or pale pink. Shrub, erect, fragrant, inflorescences in false whorls, bell-shaped tubular calyx with ten veins, bilabiate, upper lips 3-toothed, the lower one 2-lobed, ciliated, corolla bilabiate, the upper lip erect, the lower one spreading has 3 lobes, 4 stamens protruding more or less divergent (Bellakhdar, 1997).

Botanical identity

Family: Lamiaceae

Genus: *Thymus*

Species: *Thymus satureioides* Coss.

Vernacular identity

Tamazight: Tazoukennit

Arabic: Zaïtra

French: Thym, thym à feuilles de sarriette



Figure 8. Drawing *Thymus satureioides* L.

2.3 Distribution of *Thymus satureioides* in Morocco

Thymus satureioides is an endemic species to Morocco and Algeria with a restricted distribution to the Atlas mountains, Saharan Atlas regions and Middle Atlantic of Morocco, in addition to the Aurès region in Algeria.

In Morocco, thyme is found in the High Atlas and Anti-Atlas, in arid, semi-arid and sub-humid bioclimates with warm, temperate, and cool variants, in the infra-Mediterranean, thermo-Mediterranean and meso-mediterranean vegetation levels (Peltier, 1983; Hamamouchi, 1999; Benabid, 2000; Ichrak et al., 2011; El Bouzidi et al., 2013; Boubaker et al., 2016). *Thymus satureioides* occurs in a few major floristic divisions, including; Saharan Atlas (Grouz), Anti-Atlas (Kest), High Atlas (Ait M'hamed, Valley Ait Mezan, Amazmiz, Seksaoua, Matouga, Tezah), Middle Atlas and Middle Atlantic of Morocco (Abda, Souss, Titeki) (2004, Fennane and Ibn Tattou 2005, Fennane et al. 2007, and Chatelain 2010). Additionally, *Thymus satureioides* has also been collected from different localities in Morocco including; Ait Bazza and Serghina in Boulmane province (Naji 2012), Taroudant province (Sbayou et al. 2016), Asni and Moulay Brahim (Elhabazi et al. 2008), Idni (Kasrati et al. 2017), Midelt (et al. 2015), Ijoukak (Ou-Yahya et al. 2017) Azilal and Amsittene Forest (Mehdioui et al. 2009).

In the High Atlas, especially in Imegdal, the savory thyme of Morocco is considered among the most important aromatic and medicinal plants, and which generates a considerable income for the local population. This species is found in the Goundaffa forest.

Concerning the geographical distribution of this species, it can be found throughout the territory of Imegdal: the Znaga fraction and the Dekente fraction. In Znaga, there are several douars such as: Anamr, Taourirte, Ouasntoute, Smghorte, Taghzoute, Tiguirsalte, Tiziimlil, Agard, Tizirt, Ait hssayen and Ait Charah. Almost half of Azoukni's production in the commune of Imegdal comes from the first three douars (Anamr, Taourirte and ouasntoute).

The estimated area of occupancy (AOO) of *Thymus satureioides* is around 45,000 ha and the altitude ranges up to 2600 m.

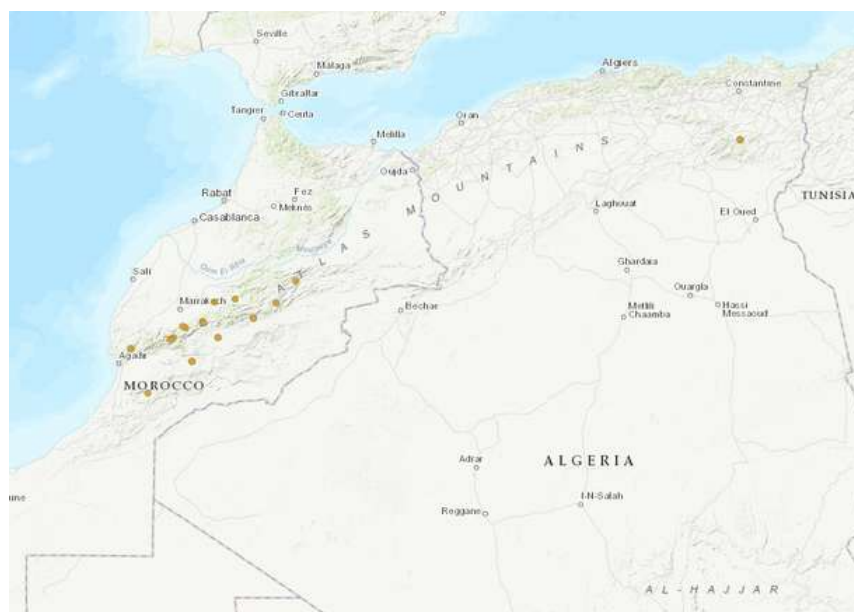


Figure 9. Distribution Map of *T. satureioides* Coss.

Thyme is a cold-hardy perennial that can withstand even cold climates in some cases. However, the best yields are obtained in countries with a Mediterranean climate, i.e. a climate with constant sun and a long growing season. The plant needs direct sunlight and prefers warm and moderately dry climates, mild winters and sunny summers. It thrives in areas where an average temperature of 20–30°C during spring and early summer is common. Soil temperatures above 18°C promote growth and regeneration after harvest.

Thyme can also grow in well-drained soils. It can tolerate a pH between 5 and 8. The best yields are often obtained in light calcareous soils, with a pH close to 7 and with excellent drainage. Drainage is very important because thyme often suffers from root rot.

Climatic characteristics



Figure 10. Climatic characteristics thyme

2.4 Ethnobotany and medicinal uses

The species of the genus *Thymus* L. are economically important due to their use in folk medicine, for flavor and organoleptic enhancement, and food preservation (Nieto, 2020). Their antioxidant and antimicrobial properties provide the basis for many applications in raw material preservation, processed foods, pharmaceuticals, alternative medicine and natural therapies (Ouknin, et al., 2019).

In addition, essential oils of *Thymus* species are ranked among the most potent antimicrobial plant agents due to their strong activity, especially against antibiotic-resistant pathogenic microorganisms (El Asbahani, et al., 2015; Porras et al., 2020). The majority of essential oils from the genus *Thymus* are characterized by their high content of monoterpenes, especially thymol and carvacrol, accompanied by a range of other more or less biologically active compounds, including eugenol, p-cymene, γ-terpinene, linalool, geraniol, and linalboreol (Ćavar Zeljković et al., 2015). The potent antimicrobial activity of thymol and carvacrol is well documented (Ćavar Zeljković et al., 2015), and their antibacterial mode of action has demonstrated their ability to permeabilize and depolarize the bacterial cytoplasmic membrane (El Bouzidi et al., 2013).

Thymus satureioides is an aromatic, medicinal, honey-bearing, condimentary and pastoral plant. Its dried leaves are used in folk medicine in the form of infusions and decoctions to treat whooping cough, bronchitis and rheumatism. The decoction of this thyme species is used to treat gastrointestinal infections, liver diseases, colitis, nephritis, coughs, bronchitis, throat and mouth infections, flu, colds, coryza, chills.

Through its culinary use as a means of flavoring dishes, thyme is an essential complement to Moroccan cuisine and Mediterranean dishes. *Thymus satureioides* is taken regularly, i.e. more or less daily, as a fresh infusion or as a dried herb. In the absence of other forms of conventional treatment, the dried herb is ground into a powder and taken regularly by women in case of painful menstruation, to relieve gastric disorders (stomachache, bile problems, indigestion, intestinal disorders), and respiratory disorders such as colds, coughs, chills, and headaches, because of its warming character.

The essential oil of this species is considered a broad-spectrum antibiotic, a regulator of the immune system, an antiparasitic, an antihyperglobulinemic and a general physical and mental tonic. The majority of essential oils of the genus *Thymus* are characterized by their high content of monoterpenes, in particular thymol and carvacrol, accompanied by a series of other more or less biologically active compounds, including eugenol, p-cymene, γ-terpinene, linalol and geraniol (Ismaili et al., 2004; Boubaker et al., 2016).

Their antioxidant and antimicrobial properties provide the basis for many applications in raw material preservation, processed foods, pharmaceuticals, alternative medicine and natural therapies (Alaoui et al., 2012; Kasrati et al., 2015). In addition to the food industry, Lamiaceae herbs are also of high demand in dyeing, fragrances, cosmetics, beverages and smoking industries (Nordine et al., 2013).

Thymus satureioides Coss is one of the most used plants in traditional Moroccan medicine because of its numerous medicinal and aromatic properties. Its leaves and flowering parts have been used in the form of powder in fumigation,

decoctions, infusions to treat digestive disorders such as diarrhea, fever, cough and many infections (Ouknin et al., 2019). However, the implementation of harvesting techniques and measures taking into account the protection of the environment is necessary. Current (over)exploitation of this national natural wealth is leading to a decrease and a dispersion of the species.

Today, it is clear that in Morocco, overexploitation of national resources of aromatic and medicinal plants is a real danger to national biodiversity, especially being practiced in an anarchic and abusive manner, and with lack of sufficient knowledge on biology, taxonomy and chorology of exploited species. Regarding aromatic and medicinal plants, national capacities are very important and an asset particularly for the rural socio-economic development.

Thymus satureioides Coss also suffers from overexploitation, especially for commercial purposes. According to the IUCN, *Thymus satureioides* is considered Vulnerable B2ab(ii,iii,v). One of the main threats to this plant is overgrazing in the forests of Imegdal Ait M'hamed and Zaouit Ahnsal. However, some collectors try to consciously follow good harvest practices of this species by mowing the aerial part and smoothing the roots and some stems to ensure the regeneration of the plant by vegetative way.



The collection of *Thymus satureioides* starts only after inflorescence (can go until fruiting) to ensure good quality of the product and feeding of the seed stock for seed regeneration.

2.5 Thyme cultivation and planting methods

Reproduction of *T. satureioides* occurs via sexual (seeds) and asexual (stolon, cuttings and layering) methods. Sexual reproduction is the most obvious mode of reproduction since we start from the seed to make a plant grow. Sexual reproduction concerns the majority of flowering plants and consists in crossing the genetic heritage of a male sex cell and a female cell, the parents of the plant. The plant to be born will thus carry the combined heritage of its parents. The most frequent modes of spread are: gravity, wind, water, animals (mammals, birds, insects, etc.) and humans. Goats ensure a large part of the spread through grazing and movement from one area to another. The cultural practice of *agdals* – a traditional land management practice of communally governed pastoral lands – plays therefore an important role in the distribution of seeds. Thyme seeds are very small. On average, 1 gram contains 4200 thyme seeds. When we grow herbs from seeds, we have to keep in mind that germination rates are low. To be able to produce 60,000 shoots (enough for 1 hectare), we need a seedbed of 60m². In this bed, we sow 43g of seeds.

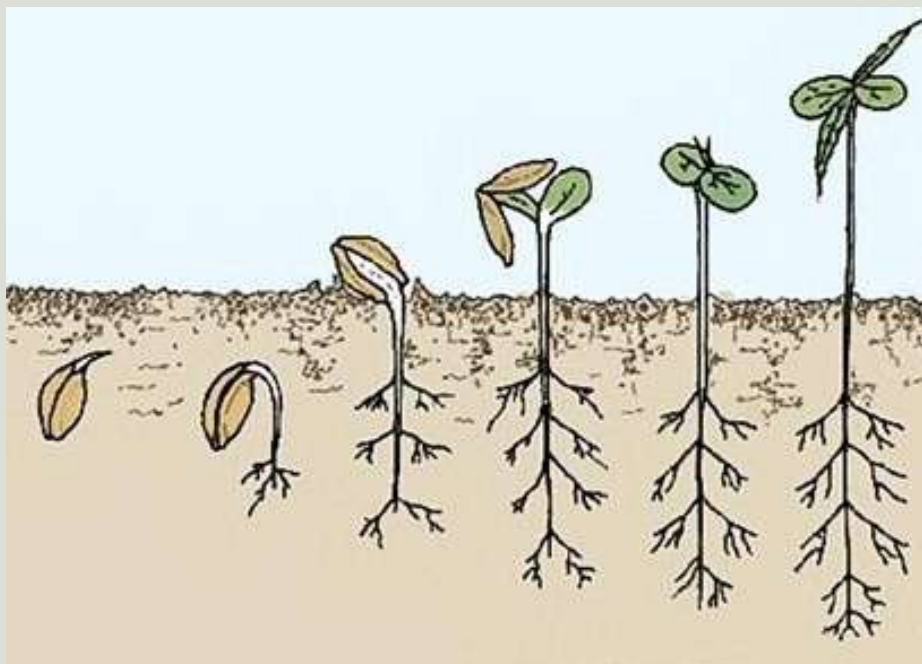


Figure 11. Sexual reproduction of *Thymus satureioides* Coss. by seeds.

The first stage is called germination. The part that looked like a stem during our observation is called the radicle. When the seed meets favorable conditions (moisture, heat) this radicle will lengthen and pierce the skin of the seed to sink into the ground. Then begins the second step: growth. The radicle will lengthen and develop roots which will go to seek in the ground the nutrients for the plant. On the surface, the plant develops a stem, then leaves. For that, it uses the food reserves contained in the cotyledon (the hard and yellow parts of our lentil seed).

Asexual reproduction gives birth to daughter plants having the same characteristics as the mother plant, since they inherit 100% of the genetic material of the mother plant they have the same characteristics, same color of the flowers, same genotype, and thus same phenotype.

Asexual methods for the reproduction and cultivation of thyme

Layering

Layering is a method of plant propagation by rhizogenesis (root development) on an aerial part of a mother plant. Some plants marcott naturally, it is the case of thyme and other aromatic and medicinal plants. In horticulture, layering is often used to clone woody plants, which are difficult to cut.

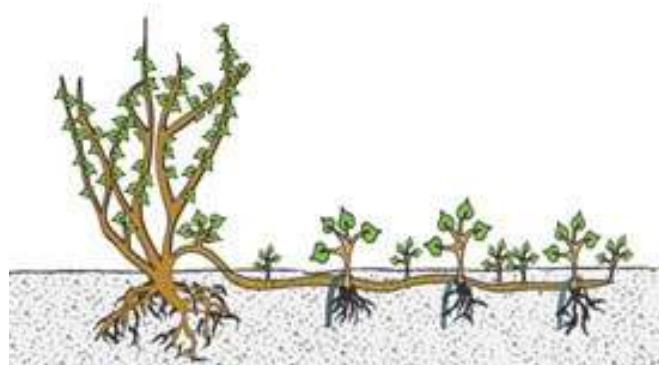


Figure 12. Layering method

Cutting

The cutting is a mode of vegetative multiplication of certain plants, consisting in giving birth to a new individual starting from an organ or a fragment of isolated organ (piece of branch, root, stem, scale of bulb). Cutting is a form of cloning: the cutting is genetically identical to the mother plant, since it is simply a piece of this plant. The "taking" of the cutting is done by cellular dedifferentiation at the meristem level.

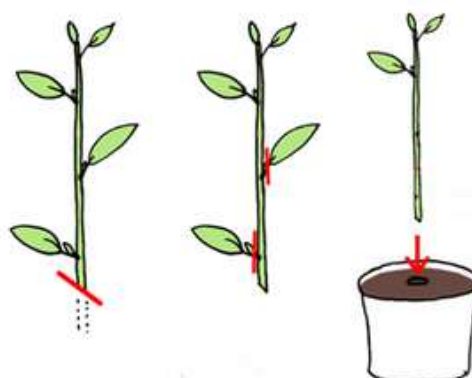


Figure 13. Cutting method

Stolonizing

Stoloniferous plants have a very specific way of reproducing without necessarily resorting to sexual multiplication (pollination of flowers to produce seeds). These plants produce stolon's, which are aerial stems generally growing horizontally on the surface of the ground. These stems connected to the mother plant carry one or more buds likely to produce one or more new plants identical in all points to the mother plant and able to take root in the periphery of this one.

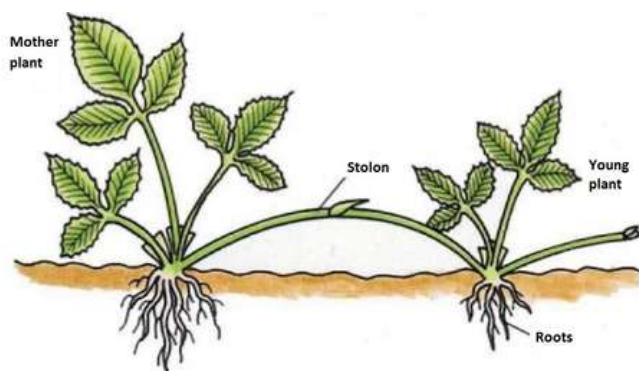


Figure 14. Stolonizing method

An **advantage** of asexual reproduction is that obtaining new individuals is easier, less random, less dependent on the ecosystem, and it gives rise to a homogeneous progeny (advantage appreciated by the gardener or the farmer).

One of the major **disadvantages** of asexual reproduction is that there is no mixing of genetic material and therefore no possible evolution of the species, or adaptation to the environment over the generations.

In terms of planting, thyme can be sown under cover in April–May and transplanted into the ground one and a half months later, spacing the plants 20 to 30 cm apart. It can also be multiplied more easily by dividing the clump in March–April or in September and by cutting the stem without flowers in July.

2.6 Wild thyme harvesting in the High Atlas

Thymus satureioides is usually collected in the High Atlas between late April and August. But if the collected material is intended for distillation to produce essential oil or other compounds, the thyme must be harvested when it is in full bloom.

Before launching the thyme harvesting season, each cooperative or contractor must have a valid exploitation authorization, issued by the government authority in charge of the management of aromatic and medicinal plant resources (i.e. High Commission for Water and Forests and the Fight against Desertification). Each collector must respect the quantity of phytomass to be harvested annually, which is mentioned in the contract. Additionally, collection of thyme on slopes exposed to erosion is prohibited.

Thyme is harvested at the level of the exploitation perimeter in the High Atlas by the inhabitants of the region including women, men and children. Harvesting is done mostly by women, especially in areas where the population lives close to the thyme collection areas. Women take advantage of the close surroundings to ensure other tasks such as gathering fodder in the forest. In these areas, women's activities are limited to gathering and sometimes marketing for members of cooperatives. The children are given the task of bagging the produce and putting it in the drying belts.

In regions where the collection areas are far away, pickers get up early and sometimes spend many hours walking to reach the massifs where they collect the thyme for a few hours or even the whole day. Most families prefer to pick in groups. The pickers use animals for transportation and in addition to their food, carry sickles and bags to fill with thyme. The women of these regions intervene at different levels, namely picking, drying and even marketing for the members of the cooperatives.

The harvesting and use of thyme is important for understanding the socio-ecological system of the High Atlas Mountains. Thyme is harvested throughout the region and yet remains widespread, implying that harvesters have developed sustainable systems for managing wild populations. Harvesting for the regional trade appears to be generally sustainable due to good harvesting practices, traditional ecological knowledge, and informal organization of harvesters.

Thyme has proven to be an extremely important plant for small-scale harvesters and rural communities. One of these uses was medicinal use applicable to the treatment of a number of diseases. Many practices associated with the harvesting and use of thyme have social and cultural value, such as tea drinking and communal harvesting. The main economic value of thyme lies in its displacement of the cost of medicines, disinfectants, and preservatives and flavorings. In addition, thyme is very important for its food preservation properties. The best example of this is the long-term storage of nutritious butter in the form of SMEN. For small-scale harvesters, thyme represents a vital economic income in a region where the level of education is very low and livelihood alternatives are scarce.



Figure 15. Wild thyme harvest in Zaouiat Ahansal

2.7 Cultural practices and traditional management

As mentioned above, the collection of *Thymus satureioides* in forest and in the wild by local community members or by cooperatives for commercial purposes requires a permit from the High Commission for Water and Forests and the Fight against Desertification; who determines the quantity to be collected in a specific area. In the High Atlas, for the preservation of this species, the local population uses a technique that allows the regeneration of *Thymus satureioides* in the forest, which is done by harvesting this species in well-defined plots and leaving the other plots for next year to ensure its regeneration. In addition, the High Commissioner for Water, Forests and the Fight against Desertification requires from those who exploit thyme to also cultivate it in a determined area according to the amount harvested each year in order to conserve particular species.

In the agdals, *Thymus satureioides* also follows a similar system of natural resource management; agdals are communally governed pasture lands with specific regulations regarding access rights. The key feature of pastoral agdals is the timing of the opening and closing dates of the pasture in order to allow the vegetation to complete its reproductive cycle before grazing is opened to herds. During this herding prohibition, the flowering, pollination and consequent production of seeds are guaranteed. This practice supports the continuity of these ecosystems and helps maintaining and encouraging plant diversity.

These areas are shared by various douars (villages) and communities and managed by customary law (laorf), which is passed down along family lineages. For example, it is forbidden to build, plant or cut trees within the grazing area. Agdals are left about three or four months untouched in spring, during the time of maximum growth of forage resources. Involved communes choose a guardian (aaessass) to guard the lands while the pasture land is closed. Not respecting the date of opening involves a fine. Various communal agdals are present in the Ait M'hamed region (Igourdane, Talmest, Allouz) and in Oukaïmeden.



Figure 16. Agdal in Igourdane

In collaboration with local communities and institutions, MBLA works to implement *ex situ* and *in situ* biodiversity conservation actions, such as establishing community plant nurseries that provide seedlings for community cultivation as well as enrichment planting of locally selected trees and medicinal and aromatic plants. We are currently cultivating over 30 endemic and threatened useful species that are annually distributed to community members for planting in designated areas in order to reduce pressure on wild populations. These plant distributions have played a significant role in mobilizing the conservation of endangered plants as well as strengthening populations of plants that have economic value to improve the livelihoods of High Atlas communities.

In partnership with Global Diversity Foundation, we are also collaborating with local farmers in Imegdäl and Ait M'hamed, to support them in the cultivation of *Tazoukennit* (*Thymus satureioides*), in order to further improve livelihoods and preserve this endangered species.



Figure 17. Plant distribution, Imegdäl



Figure 18. Plant nursery, Oukaïmeden



Figure 19. Thyme cultivation, Ait M'hamed

2.8 Conclusion

This chapter demonstrated the importance of aromatic and medicinal plants for the economic well-being of High Atlas communities, and which traditional practices are valued in this context. Natural resource management is an essential component of local traditional knowledge that has sustained livelihoods for centuries. The transmission of knowledge about plants, for example, is intimately tied to the fabric of the community's traditional ecological knowledge.

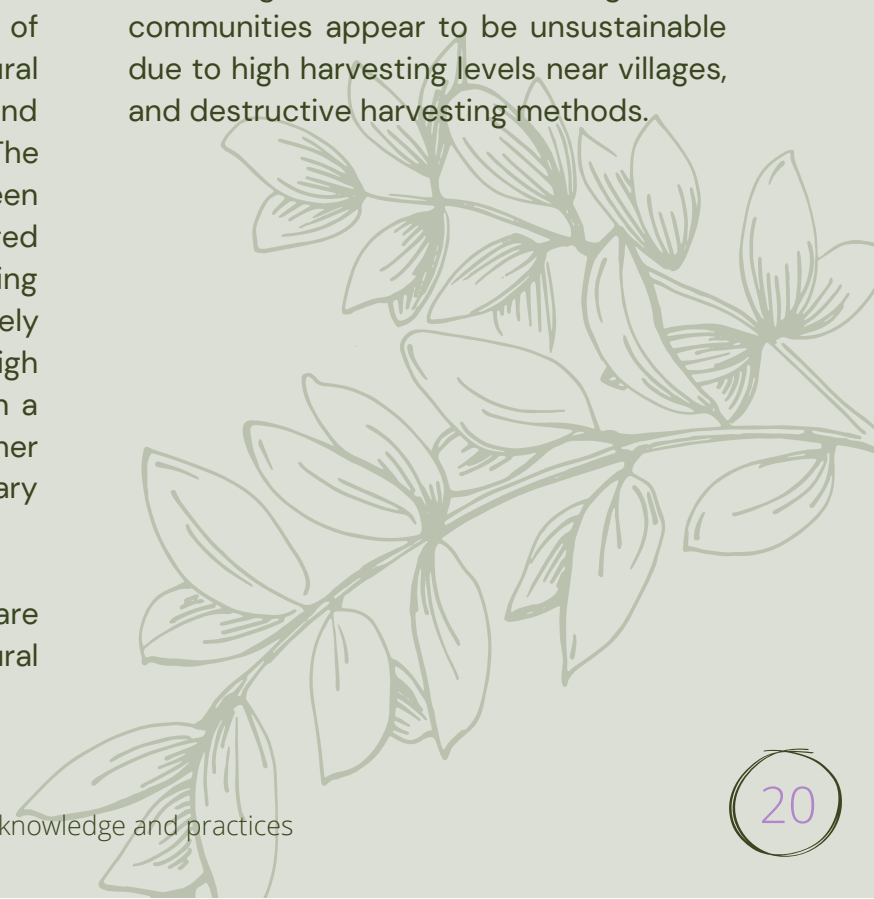
Thyme, more specifically *Thymus satureioides*, is a type of natural resource highly valued for its beneficial effects on human health, and for its importance in generating income for High Atlas households. This genus has been the subject of multiple uses ranging from traditional medicine to multiple industrial uses. Traditionally, thyme is known for its anti-infectious and anti-inflammatory properties, and its leaves are used in infusions to treat cough, headaches, hypertension and gastritis.

For communities, these forms of management are part of their cultural heritage, and the attachment to the land and the services it provides is strong. The people of the High Atlas have always been self-sufficient. They have managed agricultural resources, water, and grazing lands not only in a way that appropriately addresses the challenges of living at high altitudes and limited space, but also in a way that cushions extreme weather conditions through traditional customary law.

Local communities in the High Atlas are aware of their dependence on natural resources for their livelihood.

As an economic practice, thyme harvesting relies on the same traditional skills that traditionally sustained the resource. *Thymus satureioides*, like other resources, provides an essential source of income. The traditional skills applied to *Thymus satureioides* harvesting have been modified to ensure the continuity of the resource on which economic subsistence depends. The way villagers harvest thyme is not systematically unsustainable. For harvesters, the absence of rain is the main sign that change is occurring and that it is likely to affect the availability of thyme. They have witnessed this increasingly in the shortage of water and associated problems for garden irrigation and this confirms their suspicion that this may also affect thyme availability.

Harvesting for regional trade did appear to be sustainable in general due to good harvesting practices, traditional ecological knowledge, and informal organisation of harvesters. However, evidence also suggests that current domestic harvesting methods in some High Atlas communities appear to be unsustainable due to high harvesting levels near villages, and destructive harvesting methods.



Chapter 3. Lessons from the commercialization of thyme

Case studies of three cooperatives in Al Haouz, Azilal, and Demnate

Chapter Lead: Hafida Mazoud

3.1 Introduction

One of the pillar projects of our High Atlas Cultural Landscapes (HACL) program is local product commercialization, through close collaboration with Moroccan rural entrepreneurs. These entrepreneurs are primarily organized under the legal structure of a cooperative, to establish an upward cycle of support that helps to sustain rural communities, economies, and environments.

Cooperatives have long been ingrained in Moroccan and High Atlas culture, as they are founded on traditions of solidarity and mutual aid in different areas including agricultural work, irrigation water management, and more. The first formal cooperatives were formed in late 1930, with various updates occurring after 1956. The current juridic format of the cooperative emerged in late 2000 and is described under Law No. 112 -12, which defines cooperatives as a group of people who agree to work together to start a social business, allowing them to meet their economic and social needs following the terms of cooperation such as democratic decision making, voluntary membership, and more.

The High Atlas is Morocco's most extensive mountain range, spanning over 700 kilometres from the Atlantic in the west-southwest to the east-northeast of Morocco. Working in a large region such as the High Atlas is challenging, which is why we came up with the idea of identifying regional hubs as effective centres of MBLA's work that serve as a local network to connect our different partner. Our work with cooperatives in the High Atlas is currently focused primarily in 3 major hubs: Asni, Azilal, and Demnate. This system was designed to include more program beneficiaries and partners, with the 3 hubs (Figure 20) serving as a central point that is easily accessible for all parties from surrounding villages and cities. During the next 5 years, our work will encompass the entire perimeter of the High Atlas, including 7 hubs, while also expanding to other areas including the Souss valley and the Oasis region.

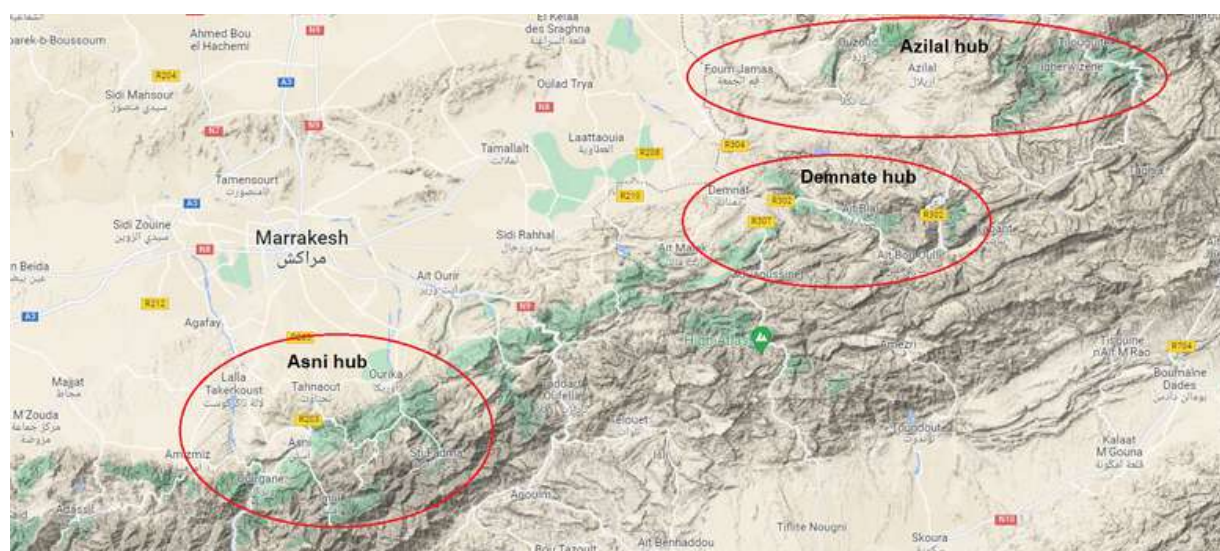


Figure 20. Map 3 cooperative hubs in the High Atlas

Currently, MBLA is collaborating with 15 cooperatives in the three hubs, including 5 cooperatives from Asni, 5 cooperatives from Demnate, and 5 cooperatives from Azilal. During our pilot project, we worked with 6 cooperatives from only 2 hubs: Asni and Al Haouz. We then expanded to an additional hub (Demnate) after initiating collaboration with an additional 9 cooperatives that were evaluated against established criteria. These criteria help us to identify viable rural cooperatives in Morocco's High Atlas region that are committed to sustainable natural resource management and are culturally sensitive.

The agricultural cooperatives feature in the case studies in this chapter focus on medicinal and aromatic plants, with thyme production being their primary activity. The harvested thyme in the region is currently sourced from wild forests, under the regulations of the Moroccan Water and Forest High Commission. Other cooperatives attempt to cultivate thyme themselves to improve production efficiency and quality. This chapter will help in identifying differences in thyme production across three High Atlas regions, as well as the impact of geographical aspects and collecting methods on overall thyme commercialization in the High Atlas.

3.2 Case study 1: Hiba Atlas Cooperative (Demnate)

In 2003, the Demnate-based cooperative Hiba Atlas was founded by only seven members, and it now employs over 50 seasonal workers (mostly women) depending on the work activity. Its business remains in the Demnate region and it specializes in carob and thyme products. The cooperative started with traditional materials and a large workforce along the production chain, which explains the low output in the early years. After 2009, the cooperative began to use sophisticated equipment to increase production while improving product quality, particularly during the collection and transformation stages.

Thyme is a wild plant that grows on mountain slopes and feet, and it is abundant in the Demnate region, which is surrounded by the High Atlas mountains. As pointed out in Chapter 2, this plant has long been recognized for its numerous benefits, and scientific research indicates that thyme, like most plants in the Lamiaceae family, has antibacterial, antifungal, and antioxidant properties. As evidenced by the significant price increase, consumers are very interested in these properties, particularly since the appearance of Covid-19.

The Demnate cooperative markets 100 to 150 tonnes of thyme per year on average. However, due to a lack of equipment and know-how, the cooperative initially exploits small quantities. The value chain begins with sieving using machines after receiving the raw material collected by collectors. During this process, 100 kg of raw material can yield 60 kg of well-dusted thyme leaves with an average plant material loss of 40% and up to 50% sometimes. Each year, the cooperative collects approximately 160 tons of raw thyme, but after sieving and filtering, they end up with approximately 90 tons marketed as leaves in bulk, 10 tons of leaves in sachets, and 1 ton transformed into powder, with minimal quantities remaining for essential oil production, which the cooperative is still testing.

In 2021, the cooperative spent approximately €185,000 to purchase 160 tons of raw thyme, which was purchased at a rate of €1.1/kg and sold after transformation at €4.4/kg in bulk and €5.8/kg, resulting in annual revenue of approximately €450,000 from the sale of thyme leaves alone. The powdered thyme was sold for €19.4/kg, netting the cooperative an extra €20,000 per year.

This left the Hiba Atlas cooperative with a total revenue of €470,000 in all by-products after transformation and an annual net profit of around €285,000, excluding fixed and variable costs.

For the Hiba Atlas cooperative, the commercialization channels for thyme are very basic: local collectors deliver their collected thyme directly to the cooperative, and the raw thyme is processed and then sold primarily to large factories in Casablanca, Marrakech, and Fes, with only a minimal quantity intended for the local market and herbalists in the region. However, the cooperative tries to ensure the plant's sustainability and encourage pickers by bringing back rootless and waste-free collections of the plants. The cooperative also includes bonuses and gifts for those who follow these rules. However, these measures were ineffective, especially with the interventions of many intermediaries who buy all crops regardless of their condition or harvesting method.

In recent years, the Hiba Atlas cooperative faces stiff competition from intermediaries attempting to monopolize the Demnate and other national thyme markets, by convincing collectors to sell for them. Overall, Hiba Atlas cooperative maintained its market position by ensuring the quality and purity of its products, maintaining a loyal customer base, and encouraging collectors to follow the law and land-use practices in exchange for an additional compensation.

3.3 Case study 2: Amaguar Cooperative (Azilal)

In 2017, five graduates in Zaouiat Ahnsal founded Amaguar cooperative, which now has 122 members. Its main business is the valorization of aromatic and medicinal plants native to the region, such as thyme. The 122 members generate a (modest) revenue through cooperative activities, which enables them to support their families and secure a steady and increasing income. Furthermore, the tourist appeal of the region allows the cooperative's activities to expand to a regional, national, and international scale through tourists and visitors.



Figure 21. Zaouiat Ahnsal valley

Amaguar cooperative is always looking for ways to improve the financial situation and social recognition of local women in the valley, while participating in the region's socio-economic development and the promotion of local products.

Zaouiat Ahansal is a rural commune administratively connected to the province of Azilal, and is characterized by harsh and cold winters and hot and dry summers with an average temperature of 14°C. This region has a high level of biological diversity which hosts diverse ecosystems that nourish local species and play an important economic, social, and ecological role in the valley. In 2018, Amaguar cooperative formed a partnership with the Moroccan Water and Forest High Commission for the legal use of a portion of the forest surrounding Zaouiat Ahansal for the collection of thyme, after which it will be valorised through the drying and milling process. Amaguar cooperative markets 36 tonnes of thyme collected from the forests on average annually, in addition to thyme grown in their own aromatic and medicinal plant nursery, which was established in 2019.



Figure 22. Drying thyme after harvest

The thyme is then processed so that it can be sold dried in sachets or transformed into powders or essential oils. These different production processes are possible thanks to the construction of an aromatic and medicinal plant distillation unit, as well as the food safety certification they obtained from Moroccan food authorities (i.e. the National Office for Food Safety (ONSSA)).

The cooperative was selling at a minimum price of €1.1 /kg in bulk, with prices fluctuating based on market demand and other factors such as obtaining ONSSA certification, improving product packaging, market prices, and other transformation costs.

Figure 23. Thyme produced by Amaguar cooperative



The cooperative's annual revenue increased due to the annual production of 5 liters of essential oils and 5 tons of herbal teas made from thyme, as well as sales of their products at two major permanent selling points in Azilal: Dar Safran and Espace Ouzoud. They also participate in national fairs and markets to reach new urban clients and customers. Another factor that contributed to the increase of their average annual revenue from €45,000 in 2020 to more than €67,000 in 2021 is the domestication and cultivation of thyme in their plant nursery. Additionally, the cultivated thyme is replanted on private land by members and local farmers, which allows for continuous production improvement.

In comparison to other cooperatives in the region, Amaguar cooperative does not sell in bulk and instead attempts to produce a finished product for sale in hypermarkets. They are also confident that their expertise, as well as the transparency of their process and legislative work, will limit competition from both domestic and foreign producers.

3.4 Case study 3: Cooperative Agoundiss (Al Haouz)

The Al-Haouz region is known for its high poverty rate (15.8% in the province of Al Haouz/HCP 2007) and the presence of aromatic and medicinal plants such as thyme, both cultivated and wild. In order to valorize these plants and incorporate them into development work, the region's extremely fragile ecosystems must be taken into account, particularly with climate change causing massive damage to natural resources.

The cooperative Agoundiss was founded in Ijoukak in 2009 by 7 locals and has since grown its members base to 70 members. The cooperative faced numerous challenges and devoted 4 years of effort in order to sign a contract with the Moroccan Water and Forest High Commission and to obtain ONSSA food regulation certification. In 2021, their average annual thyme production was about 33 tons, sourced from 3117 hectares of wild forests in line with regulations stated in their contract with the Water and Forest High Commission. When the quantity of their harvest is too small, they purchase thyme directly from local small producers in Oued Nfis and Ounayn.

The harvested thyme is processed into a variety of finished products such as dried thyme, powders, essential oils, creams, and more. The variety of products positively influenced the cooperatives' annual revenue, which was also influenced by variations in demand and supply. To manage the balance of supply and demand, the cooperative has established a strategy of targeting different markets including corporates, local markets and national fairs, which is possible through the obtainment of ONSSA certification.

Following its harvest, the thyme plants should be transported as soon as possible to a drying location, followed by different phases including storing, valorization, packaging, labeling, and finally commercialization. After collecting thyme, 80% of the total amount is intended for drying and direct sale (sold in bulk, sachets or herbal tea bags); 10% for essential oil extraction (amounting to 200 liters per year), 5% for cosmetic products and 5% for powdered thyme.

In 2021, the Agoundiss cooperative sold dried thyme for €2.9/kg, resulting in annual average revenue of more than €86,100, while essential oil was sold for €48.3/liter, generating more than €9,600. These numbers led to gross annual revenue of over €95,500 in 2021.

3.5 Conclusions and recommendations

The data for these case studies was collected in early 2022 and based on 2021 production and selling numbers in a post-covid world in order to analyse the commercialization issues faced by High Atlas cooperatives in three different regional hubs with varying contexts, identities, and attributes.

Of the three cooperatives, the Amaguar cooperative in the Azilal hub had the lowest quantity of thyme (36 tons) and the highest revenue of €67,000. This can be attributed to their marketing strategy of selling finished products to selling points rather than selling in bulk to larger merchants and businesses. In addition, they are a younger cooperative (founded in 2017) and have quickly established a market presence due to the high quality of their products, reasonable prices, and the origin of their products.

Despite Agoundiss cooperative's significant revenue of more than €28,000 over Amaguar cooperative, Agoundiss made €95,500 with a lower quantity of 33 tons compared to Amaguar cooperative's gain of €67,000 from 36 tons. This is explained by Agoundiss cooperative selling in bulk to larger entities and selling a small percentage as finished goods, which reduces production, packaging, labelling, storing, and transportation costs. Nonetheless, the Agoundiss cooperative is dealing with pandemic-related management issues, as well as the lack of an online presence and effective marketing strategy. However, we are certain that the cooperative would be able to overcome these issues through capacity building and support provided by MBLA, their strong collaboration with the Department of Water and Forests, and use of biodiversity friendly land-use

practices that ensure the species' sustainability.

The Hiba Atlas cooperative had the highest gross profit of €285,000 derived from 90 tons of thyme, which can be explained by their production process. The other two cooperatives collected thyme from members' owned lands, nurseries, or local forests (based on a contract with the authorities). However, Hiba Atlas only purchases from local producers from a larger area, rather than a limited one, and with an initial investment of €185,000, they were able to purchase about 150 tons of raw thyme transformed into 90 tons of pure thyme.

Hiba Atlas cooperative's ability to source thyme from a wide area is a positive aspect of their strategy, resulting in greater diversity in the composition of the plant material. This also allows them to provide more job opportunities for the region's households, particularly for women. On the other hand, this strategy could encourage the invasion of more forest areas and the involvement of more intermediaries with the potential of dominating and controlling the market, resulting in a decrease in biodiversity in the region, a continuous decrease in production, and the concentration of revenue in the hands of a small group of people.



Figure 24. Commercialized thyme

Commercialization remains a weakness of High Atlas cooperatives, mainly due to a lack of resources and training in this area. This prompted MBLA to become involved in supporting cooperatives in product commercialization through capacity building and targeted training. The growing consumer demand for thyme and its by-products on national and international markets presents significant opportunities for commercialization, which could increase High Atlas cooperatives' net profit.

However, focusing merely on the primary transformation on thyme does not help to increase its value. In order to valorize this plant, essential oils must be extracted, hydrosols must be produced, and it must be incorporated into cosmetic products, incense, herbal teas, and other food products. Concentrating on packaging innovation, and designing well-informed labels in accordance with national regulations will complete the process of improving the marketing of valuable products.

We have provided and continue to provide trainings to cooperatives on how to incorporate online selling strategies, access more urban markets and explore exportation opportunities. We also collaborate on product development and optimization by providing different

services such as the development of new visual identities for the cooperatives, including creating professional websites that display their products and the development of new packaging designs. These services, and others, aim to support their commercialization efforts in selling thyme in the local and international markets, particularly with increased awareness of the importance of plants, including thyme, following the post-covid era and people returning to plant-based diets and remedies.

To draw a conclusion to this study, we recommend that these cooperatives form a union and lay the groundwork to exchange knowledge and experiences between cooperatives and allow for better use of the potential of aromatic and medicinal plants, including thyme, in order to overcome the challenges linked to its valorization.

As an example, European Economic Interest Grouping is a type of union and model that could benefit the three cooperatives mentioned above, all of which operate in the same sector and in rural areas. This approach allows a number of businesses to interlink certain of their activities and deal with financial institutions as a single entity, while retaining their legal and economic independence.



Chapter 4. Promotion and marketing of local plant products

Chapter Lead: Mohamed Ouknin

4.1. Introduction

In Morocco, cooperatives and small and medium-sized businesses have been producing and selling local products and materialized this sector into a major economic, social, and territorial development project. However, the effective marketing of these products remains the bottleneck of the strategies of cooperatives and small and medium-sized businesses. The lack of knowledge in communication tools and digital marketing, in addition to inefficient product distribution networks, remain important shortcomings. Mastering skills and knowledge in different promotion and marketing tools by cooperatives and small and medium enterprises can improve their income derived from thyme and other plant products significantly.

The COVID-19 pandemic crisis has accelerated the expansion of e-commerce to new categories of businesses, consumers, and products. This expansion has allowed consumers to access a wide range of products while remaining comfortably and safely at home, and businesses to continue operating despite restrictions on physical contact and other containment measures.

Despite persistent differences between countries, the pandemic has brought additional dynamism to the e-commerce landscape in all countries and extended the scope of e-commerce to new categories of businesses, consumers (e.g. the elderly) and products (e.g. food products). At the same time, in many countries, online sales transactions have partly shifted from luxury products and services to everyday consumer products, used by many people.

Online visibility has become a critical issue for businesses of all sizes, especially when the competition is significant. As mentioned in Chapter 3, MBLA launched a number of initiatives to support cooperatives in accessing new markets and increasing their visibility online and offline, mainly through capacity building.

4.2 Online commercialization of products

In response to (online) visibility issues that the rural cooperatives faced, we launched several social media campaigns raising awareness of the importance of buying local biodiversity-friendly products that in turn also support community livelihoods. More importantly, in 2020 we launched a pilot project with our partner Global Diversity Foundation (GDF) to support specific online commercialization efforts of six cooperatives individually. We supported the development of brand new websites for 6 rural cooperatives (Al Oulfa, Amaguar, Manahil Al Maghrib, Nisae Aska, Taytmatine and Yamna) by providing professional product photography, website content, one year of domain hosting, full web design and e-commerce functionalities.

We also provide an additional approach to support online commercialization efforts of high Atlas cooperatives through a collaboration with GDF to establish an online marketplace called “[Digital Tiwizi](#)”. This marketplace promotes local products from the High Atlas and the wider region and provides an easy and accessible platform for the cooperatives and consumers, aimed at increasing cooperative sales and visibility of local products.

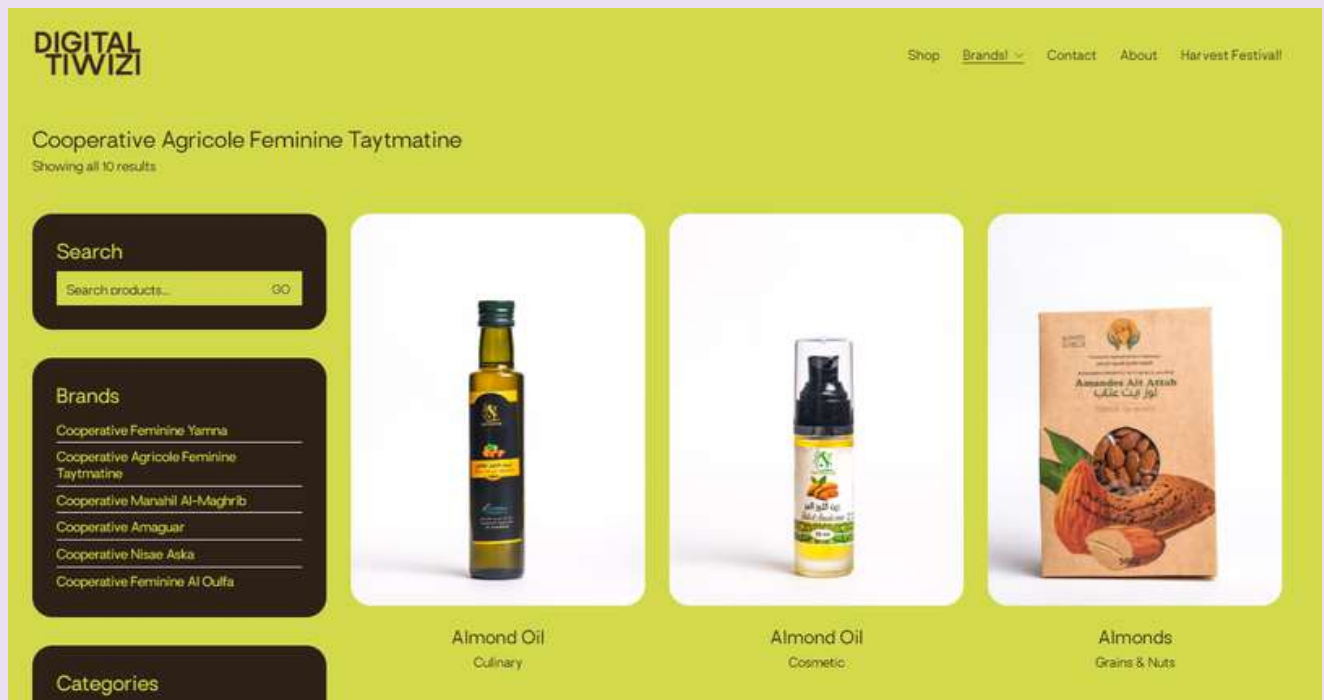


Figure 25. Digital tiwizi online market place

4.3 Cooperative capacity building

Through targeted capacity building, we support local cooperatives to sustainably manage the natural resources their products are dependent on, while also making sure they can benefit from these resources and market their products effectively.

We have offered training to over 15 cooperatives on the following topics: Law no. 112-12 on cooperatives, product quality, certification, labeling, packaging, digital marketing and [pricing strategies](#). Acquiring strong skills in these different topics is essential for the cooperatives to be successful.

As mentioned before, most cooperatives we collaborate with struggle with online visibility. During our evaluation of the cooperatives current marketing strategies, we noticed a major lack of social media presence, and therefore identified this as a key theme for capacity building in the three regional hubs. In collaboration with a social media expert, we provided extensive training in social media marketing and building an online presence strategy. Through these trainings, we showcased the potential of Instagram and other social media platforms as tools to promote their products, reach new and existing customers, encourage better retention, and to stay ahead of their competitors. Cooperative members learned how to effectively use social media platforms, increase their visibility and promote their brand and product in an accessible way.

4.4 Eco-tourism to support local cooperatives

The COVID-19 pandemic threatened the sustainability of an emerging green economy in Marrakech and its hinterland, which is directly linked to improving the livelihoods of rural communities involved in biodiversity conservation in the High Atlas. The pandemic had a particular impact on product innovation and commercialization due to decreased demand and prices for local products, disruptions in distribution systems, and a concomitant reluctance to engage in traditional land-use practices, including farming and wild plant gathering. The lack of infrastructure to preserve and store local products—including organic apples, barley and wheat couscous, almonds and walnuts, honey, and medicinal and aromatic plants—has resulted in losses of harvested products. These challenges contributed to increased unemployment in rural areas, which has had a negative impact on the custodians of the High Atlas' biodiversity and cultural landscapes.

Promoting ecotourism in the High Atlas provides travelers an experience to explore authentic beautiful landscapes as well as an opportunity to learn about local biodiversity and to directly support local communities within the area of their destination. For local cooperatives, ecotourism increases sales and the visibility of their products and provides and opportunity to connect with customers that are engaged in supporting their initiative. It also always local cooperative members to represent their own cultural products and the communities who are the custodians of the High Atlas biodiversity, while receiving direct benefits that will support their livelihoods.

We launched our first ecotourism project with GDF by developing video stories and promoting authentic travel itineraries to promote agricultural, culinary, and ecological tourism tours that encourage visits by small groups of international and national travelers. This project also aims to create a dynamic between the rural and urban worlds. Our itineraries focus on a broad geographical arc in the High Atlas, running from the south of Marrakech to the northeast. We designated three hubs, each comprising 4–5 cooperatives. Below we provide the itinerary maps and videos for each of the hubs.

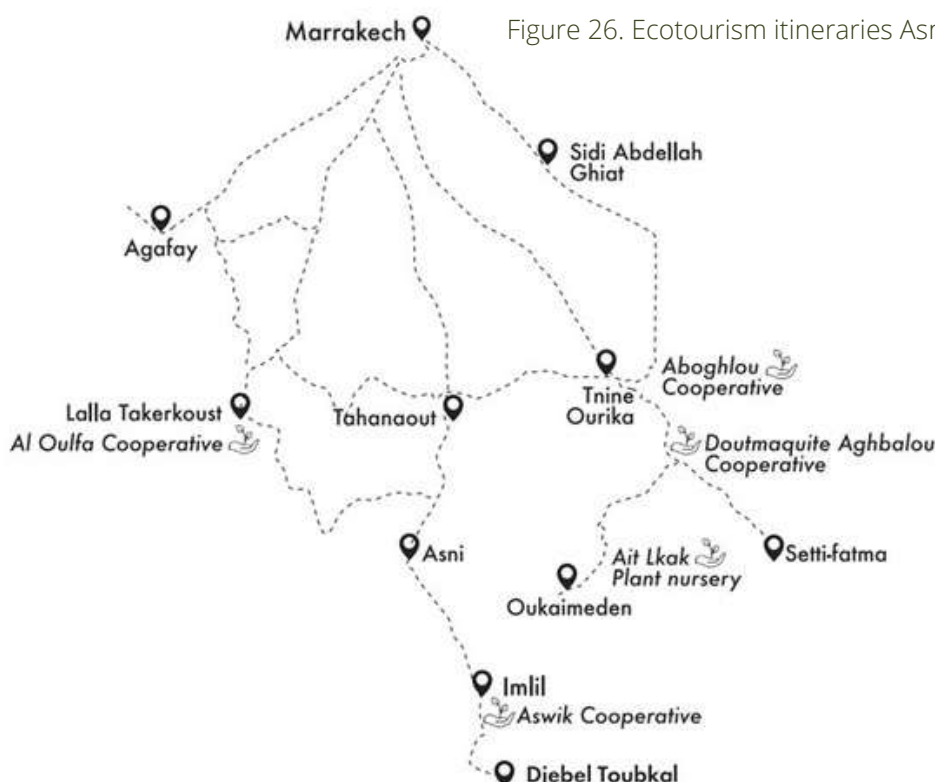


Figure 26. Ecotourism itineraries Asni hub



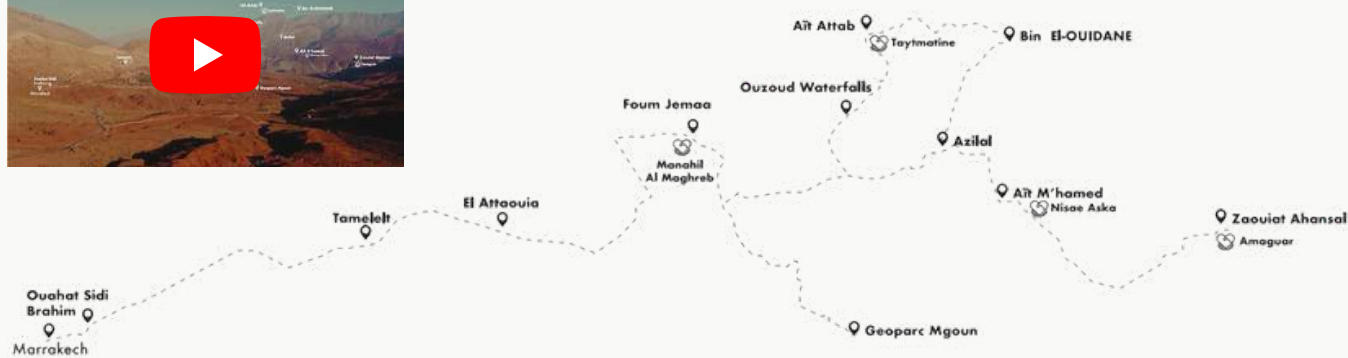


Figure 27. Ecotourism itineraries Azilal hub

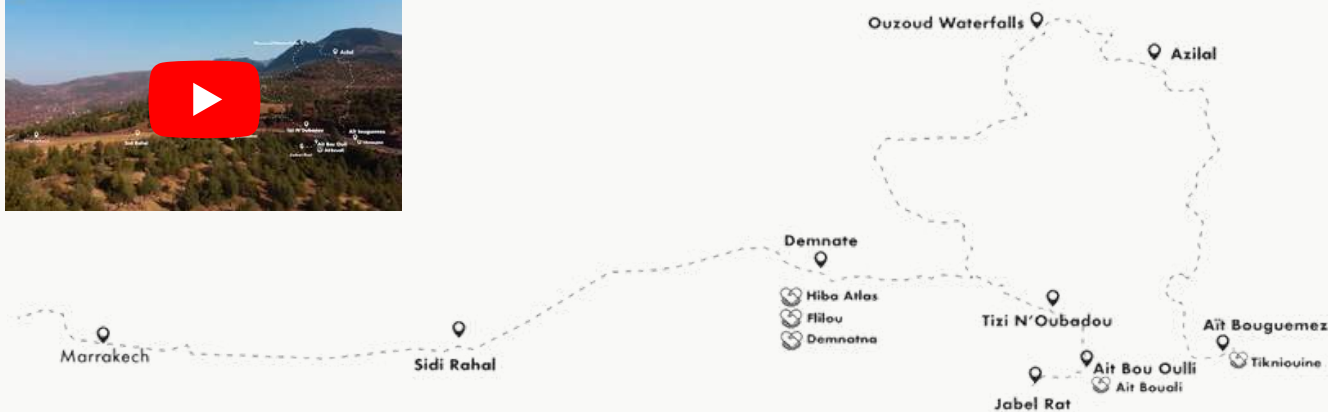


Figure 28. Ecotourism itineraries Demnate hub

4.5 Events and markets

Over the years, we hosted and organized a number of events to raise awareness about biodiversity conservation, cultural practices and traditional gastronomy and to support local communities. For example, we organized several biocultural fairs during the *moussem* (local community festival) in Ait M'hamed. These *moussesms* provide great opportunities for local producers and cooperatives to sell their products given the amount of visitors that these events attract annually.

Drawing on the tradition of holding an annual celebration around the time of the main harvest such as *moussesms* in Morocco, we launched the concept of the first Harvest Festival in 2021. The two-week Harvest Festival focused on celebrating local agroecology, biodiversity, culture, and gastronomy performed and produced in the Marrakech–Safi region and beyond. During the event we invited partners, local business owners, artist, and other community members to participate and co-design the festival program. The festival aimed at bringing together urban and rural communities through practical workshops on agroecology, food pop ups, film screenings, local product markets, art openings and more.

We invited rural cooperatives to participate in the festival and provided product stands and access to the festival activities, to encourage the promotion of their work and products. We have organized a second edition in May 2022 and are planning a third one in October 2022. In 2021, we also launched High Atlas Food Markets, an initiative to support the livelihoods of High Atlas communities by bringing together small local producers, cooperatives, and urban consumers to sell local products, organize food tastings, and hold discussion groups to raise awareness about local and healthy eating.

The market's first edition was held to promote biodiversity-friendly local products and to commemorate World Biodiversity Day in May 2021, as well as to remind everyone that biodiversity is the foundation of human well-being and that its rapid loss endangers all ecosystems, including humans and their quality of life. The second edition of the Market, held in October 2021, was intended to promote local products while also commemorating World Food Day and reminding attendees of the importance of knowing where their food comes from as well as how it is produced, prepared, and distributed.

To encourage more people to visit our markets and purchase local products, we launched an online giveaway through Instagram in advance of the High Atlas Food Market.

The short-term objective of these High Atlas Food Markets is to provide cooperative access to the urban market as well as local products from rural areas to urban consumers. However, the market's long-term goal is to spark a discussion and raise awareness about the importance of conscious food choices for good health, as well as how local cooperative products can serve as an alternative to highly processed and unsafe food products.



Figure 29. Give away baskets, each containing 7 products made by local cooperatives



4.6 Identifying urban retailers

Another approach to promote local products and support rural cooperatives is to identify local retailers that are interested and willing to become a permanent selling point. Through networking and promotion of the cooperatives' products, we have identified and established a number of retailers in Marrakech that are now selling High Atlas products on a permanent basis, including Ehtnobotanica café and shop (Jnane Tamsna), Fromagerie des Chefs, and others.

We also organized a two-days urban field trip in Marrakech for 30 members from 15 different cooperatives to support them in broadening their perspectives on how to market their products and compete in a post-Covid world.



Figure 31. Tasting recipes using cooperative products at restaurant BEY 961

As a result of this event, cooperative members learned about various commercialization options for their products by exploring urban niche markets such as local retailers, restaurants, and hotels, as well as through attending a seminar on how to use digital marketing to expand their markets.

We also encourage urban chefs to use locally sourced and biodiversity-friendly ingredients in their culinary creations to promote High Atlas products while supporting local livelihoods. Until now, we have been able to form a number of partnerships between cooperatives and local chefs, who incorporated these ethically sourced products into their menus rather than using highly processed and/or imported products. We have done so by offering a selection of products to renowned chefs in Marrakech in exchange for integrating the products into a recipe, documenting the process, and publishing it on their social media and websites.

Riad El Fenn's use of berkoukche and couscous from High Atlas cooperatives for its summer menu is one of the success stories of this initiative. Berkoukche was on the lunch menu at least twice a week, and couscous was served every Friday. In their current recipes, they use cheese from the Al-Oulfa cooperative in Lalla Takerkoust.

4.7 Conclusions and lessons learned

The COVID-19 pandemic has impacted many rural communities and local economies around the world, including Morocco. In order to adapt to its challenges, members of various rural cooperatives requested support to create online platforms to market and promote their products, and to improve their branding and marketing on social media.

As part of our local product commercialization program, we provided capacity building workshops that support the marketing of local products and supported rural cooperatives to increase their income through training in effective online marketing techniques and tools. Our approach focused on supporting rural cooperatives and businesses in key biodiversity areas of the High Atlas to market their cosmetic and culinary products through online platforms that shorten market chains and promote direct local sales, benefiting both consumers and producers. We have trained rural cooperatives and spin-off social media campaigns to inform the public about the availability of local biodiversity-friendly products that support community livelihoods. As part of this effort, we have developed websites using open-source software to provide rural cooperatives to promote local products from sustainably harvested and fairly traded organic resources and to profile the people who produce them.

One important lesson we learned through this process is that online marketing and social media have become essential to ensure effective product commercialization of local products, especially post Covid-19. Based on the different tools we developed with the cooperatives (e.g. professional website and social media accounts), we have noticed that a few months after our trainings and the development of individual online platforms, cooperatives started to expand their customer base, and were able to share more about their story and brand, while increasing their revenues and sales. We therefore highly recommend cooperatives and rural entrepreneur to invest in the establishment of an online platform to market their products and increase the visibility of their brand and story.

Reducing poverty and increasing livelihoods in the High Atlas are major concerns. The different approaches proposed in this chapter such as creating eco-tourism itineraries and organising food markets are concrete and effective examples of how to improve income generation while promoting biodiversity conservation to consumers. In order to succeed in these efforts, targeted training is needed, in addition to network building and investment in digital marketing tools.



Chapter 5. Infographics plant products

1. *Thymus satureioides* L.

Name in Amazigh: Tazeouknit
 Name in English: Thyme
 Used parts: Leaves and flowers
 Examples of use: Pastoral, condiment, infusion, incense, aromatherapy.
 Fun Fact: Thyme is used to add a zesty flavour to Lben (Moroccan buttermilk)

Name in Amazigh: Tikida
 Name in English: Carob
 Used parts: Fruits, leaves, tank.
 Examples of use: Cattle feed, cosmetics, pharmaceuticals & food
 Fun Fact: Carob does not contain caffeine and theobromine.

3. *Juglans regia* L.

Name in Amazigh: Teswik, Douj
 Name in English: Walnut tree
 Used parts: Fruits, leaves, barks
 Examples of use: Food, cosmetics, pharmaceuticals, natural dye.
 Fun Fact: Some walnut tree's potential lifespan can reach 400 years.

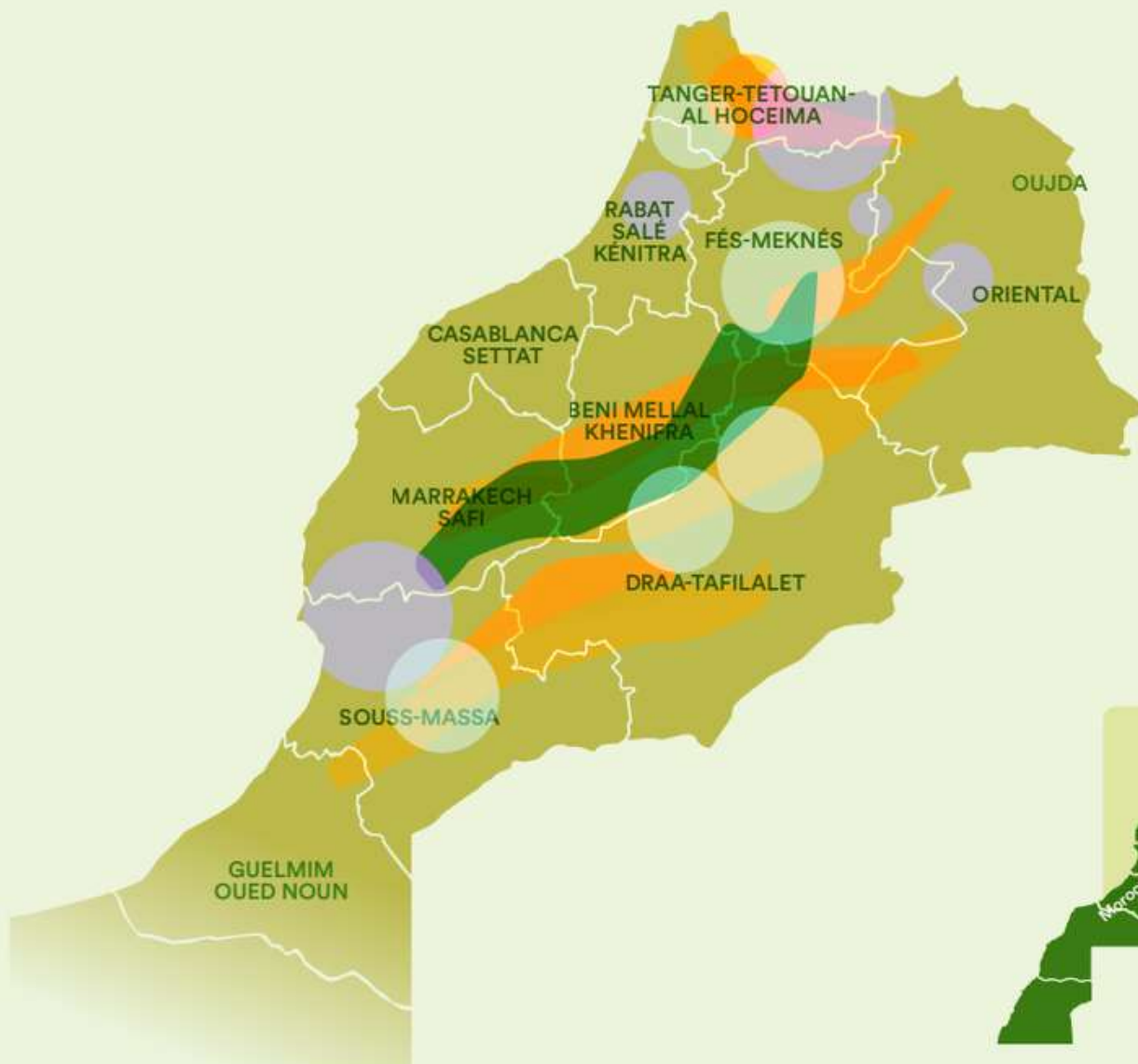
4. *Prunus dulcis* (Mill.) D.A.Webb

Name in Amazigh: Talouzet
 Name in English: Almond tree.
 Used parts: Leaves, fruit, trunk.
 Examples of use: Food, Cosmetic, pharmaceuticals, cattle feed.
 Fun Fact: Sweet almond oil is traditionally used for hair, while bitter almond oil is used for skin.



5. *Lavandula dentata* L.

Name in Amazigh: Timzori
 Name in English: Lavender
 Used parts: Leaves, fruit, trunk.
 Examples of use: Pastoral, infusion, incense, and aromatherapy.
 Fun Fact: Lavandula dentata is one of four endemic Moroccan Lavandula species.



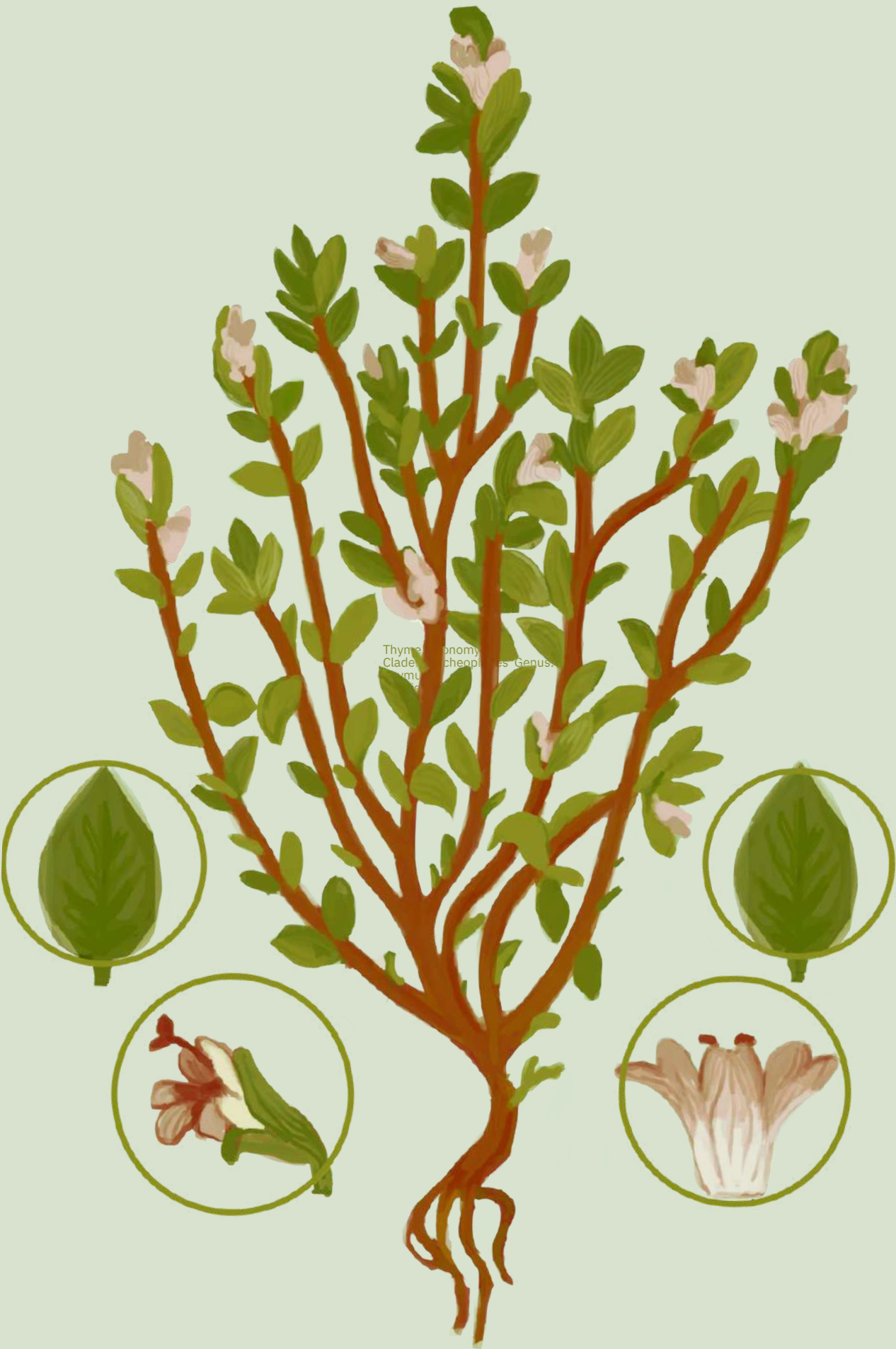
Elevation: 4,167 m / Area: 77,938 km²

High Atlas is a mountain range in central Morocco. According to the Flore Pratique du Maroc, **Different used parts:** fruits, leaves, seeds, **Mode of use:** Pastoral, Textile, Culinary, Morocco and the highest part of the Atlas the vascular flora of the High Atlas consists roots, bark, flowers, stems, whole plant, Cosmetic, Therapeutic, Incense, Aroma- Mountains. of approximately 1916 plant species.etc.therapy, etc

Thyme taxonomy tree:
Clade: Tracheophytes
Genus: Thymus
Species: *Thymus satureioides* L.

Thyme

Thyme in other tongues
In Amazigh: Azoukeni
In French: Thymes
In Arabic: الزعتر Zaetra

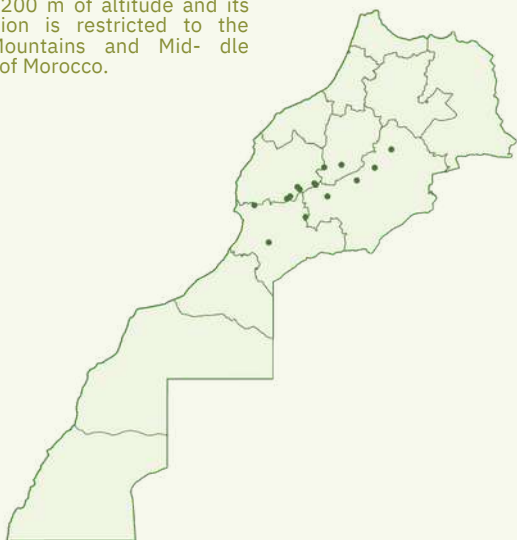


Thymus satureioides can be found up to 2,200 m of altitude and its distribution is restricted to the Atlas Mountains and Middle Atlantic of Morocco (Fennane et al., 2007), with its distinctive pink flowers, grows in the sun and dry conditions and in well-drained, rocky soil and it is col-

lected upon the harvest season from mid-May to mid-July. *Thymus satureioides* is used as a traditional medicine in the form of infuses and decoctions to treat whooping cough, bronchitis and rheumatism (Hmamouchi, 2001).

National distribution

Thymus saturejoides can be found up to 2,200 m of altitude and its distribution is restricted to the Atlas Mountains and Middle Atlantic of Morocco.



Source: Fennane et Al., 2007

Medical properties

Antispasmodic
Antibacterial
Antioxidant activities

Astigent
Antifungal
Anti-tabagism

Forms of usage

Herbal tea
Powder or essential oils
Gastrointestinal problems
Spasms
Cough

Bronchitis
Chest infection
Fatigue
Mouth infections
Gingivitis

The dried leaves are sometimes rolled into cigarettes and smoked as a cold and flu remedy. The dried leaves are sometimes rolled into cigarettes and smoked as a cold and flu remedy.

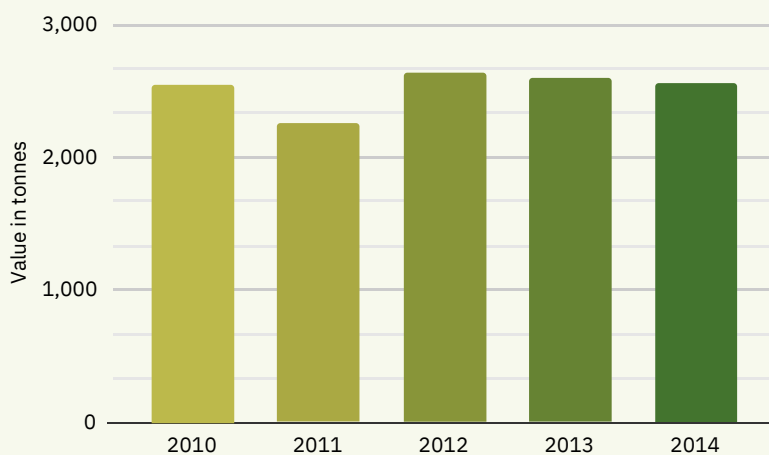
Source: (Essawi; Srour, 2000) (Dob et al., 2006) (Carlini et al., 2006), (Bellakhdar, 1997)

Moroccan Thyme Market Insights

Thymus L. species (family Lamiaceae) are economically important in Morocco and *Thymus satureioides* is one of the most produced and consumed aromatic herb in Morocco (Lahnine et al., 2016)

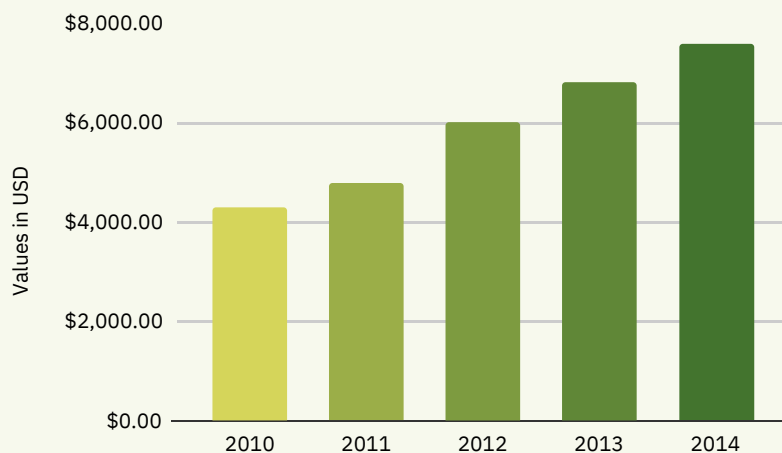
Gender influences income generation because the difference in income is explained by the fact that women tend to harvest on the mountains near the village, whereas men tend to collect larger quantities on the higher mountain summits.

Morocco thyme export quantities



Morocco thyme export quantities, selinawamucii.com

Morocco thyme export values

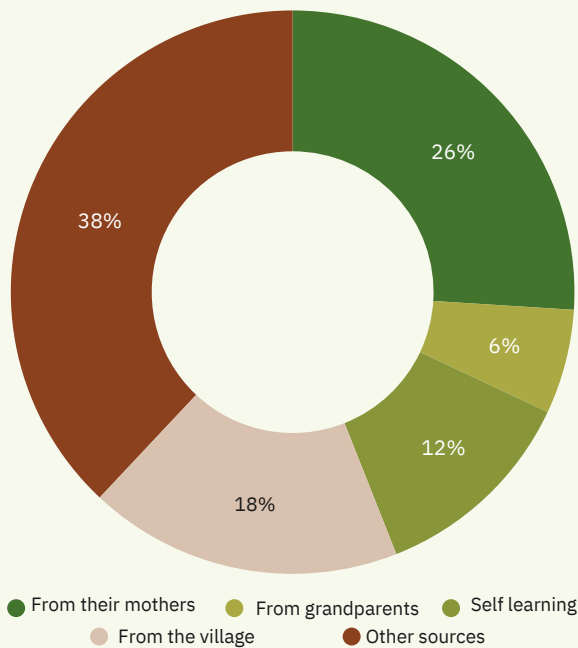


Morocco thyme export values, selinawamucii.com

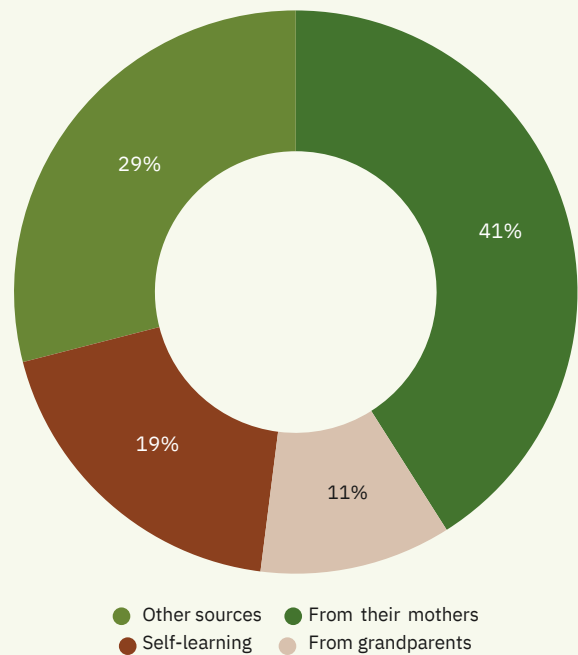
The transmission of thyme knowledge

Women learn 41% of their knowledge from their mothers, 11% from grandparents, and about 19% through self-learning and 29% from other sources (friends, herbalists, neighbors...). Men learn 26% of their knowledge from their mothers, 6% from grandparents, and about 12% through self-learning and 38% from the village people and 18% from other sources (friends, herbalists, neighbors...).

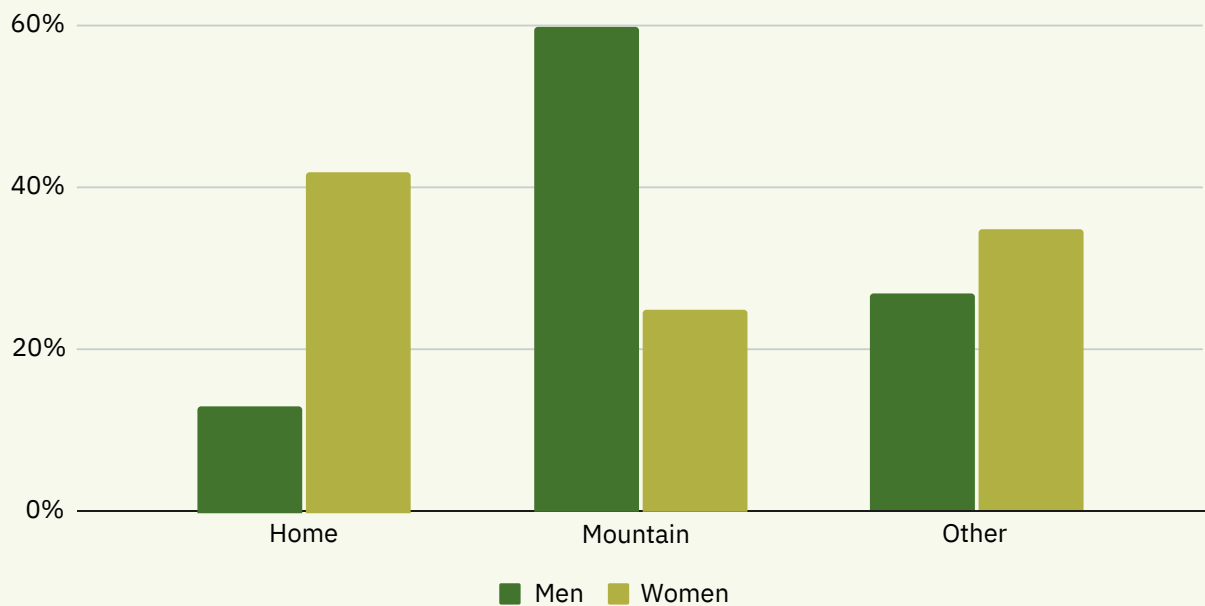
According to (Montanari, 2016), fathers have less influence on the transmission of traditional knowledge and practices to future generations.



Thyme knowledge transmission for women



Thyme knowledge transmission for men



Montanari, 2016

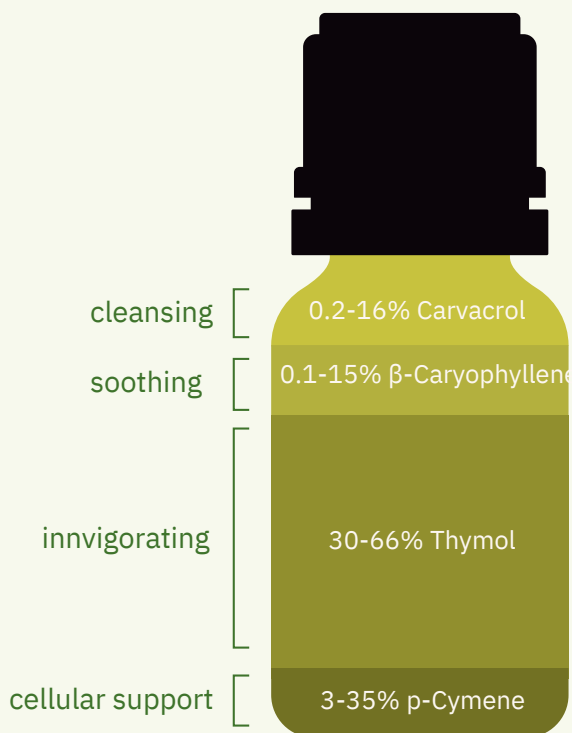
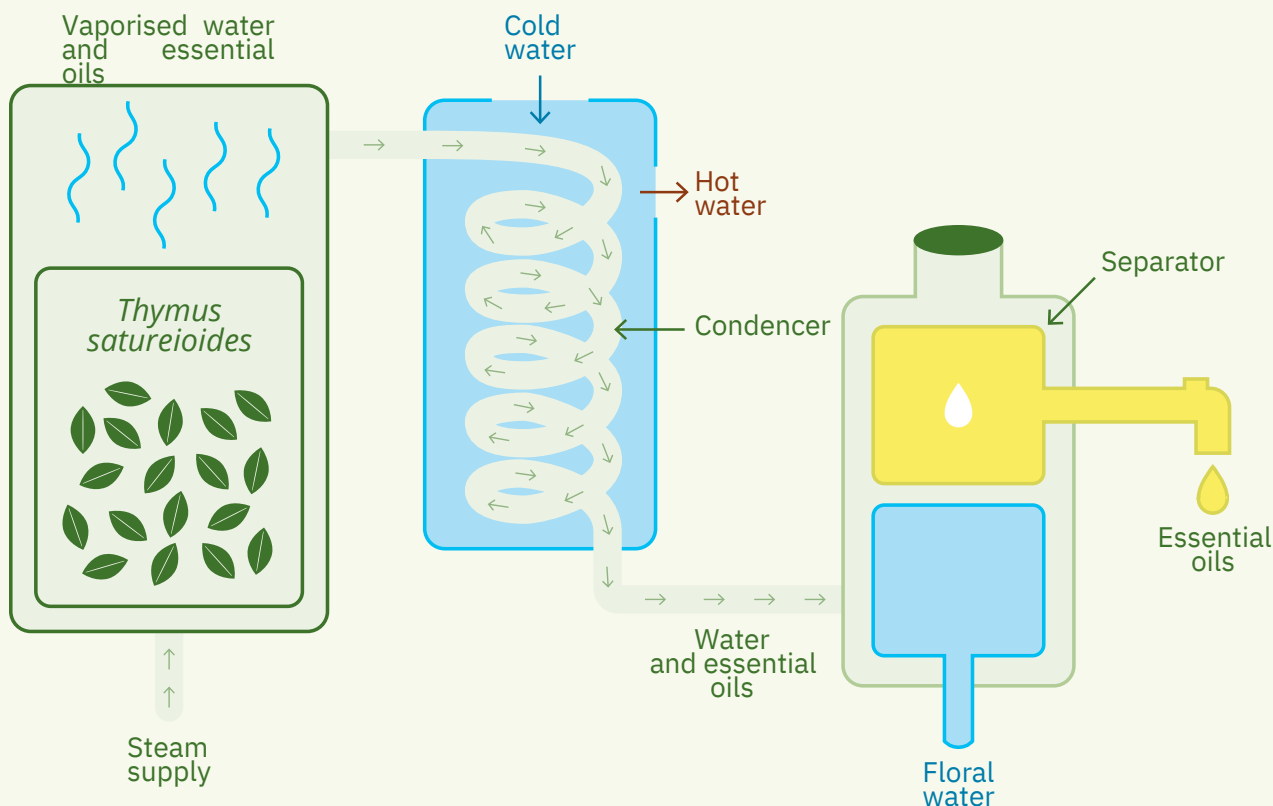
The transmission of knowledge and the preservation of traditional practices centered on plants, primarily thyme, in the high atlas ensures economic well-being and self-sufficiency. Developing a sustainable business based on thyme commercialization would require cultivation as well, but shifting to higher mountain summit thyme cultivation may jeopardize women's harvesting and income generation because they tend to collect more thyme locally and divide their time between thyme collection and household chores.

Thyme valorization

The most common method for extracting essential oils of *thymus satureioides* is steam distillation. Water vapor passes through the thyme leaves, causing the cells to burst and

release the essential oils, resulting in a "water/Essential oil" mixture. Using the condenser, the water is separated from the organic phase, which is pure essential oil.

Thyme steam distillation process



Chemical Composition:

Thymus satureioides contains 0.5 to 2% essential oil with a variable composition depending on factors such as the vegetative stage, harvest location...

The main chemical components of *Thymus satureioides* essential oil is thymol (23 to 40%) and carvacrol (1.8 to 21%)

Thymol acts as a medical disinfectant and can be found as an ingredient in several dental products such as mouthwashes.

Carvacrol possesses a wide range of bioactivities giving *Thymus satureioides* essential oil antimicrobial, antioxidant, and anticancer properties.

Pavida et al., 1976, 2015, Sharifi-Rad M et al., 2018

Thyme taxonomy tree:
Family: Rosaceae
Genus: Prunus L.
Species: *Prunus dulcis* (Mill.)

Almonds

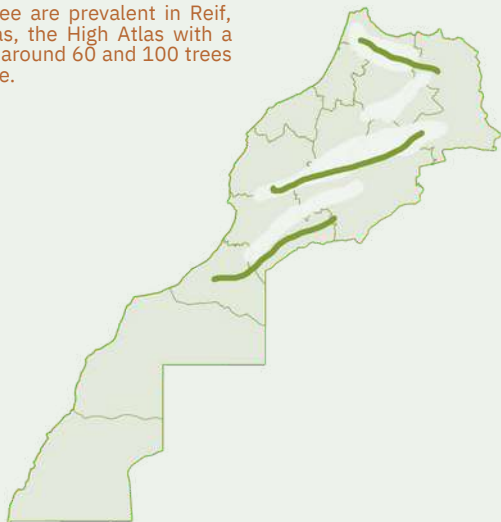
Almonds in other tongues
In Amazigh: Louz
In French: Amandes
In Arabic: اللوز



The great diversity of varieties as well as the forms of cultivation and the climatic characteristics determine the remarkable differences in almonds' chemical composition.

National Distribution

Almond tree are prevalent in Reif, Anti-Atlas, the High Atlas with a density of around 60 and 100 trees per hectare.

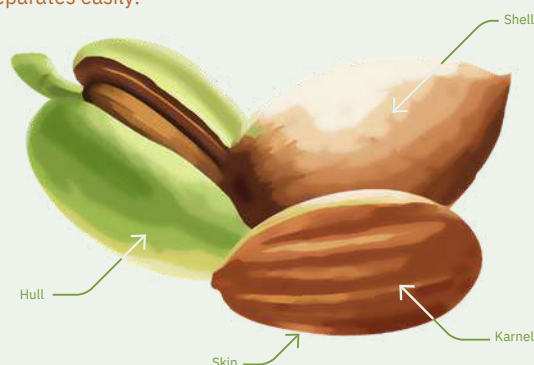


Source: Moayedi, A., Rezaei, K., Moini, S., & Keshavarz, B. (2011). Chemical compositions of oils from several wild almond species. Journal of the American Oil Chemists' Society, 88(4), 503-508

The Almond Kernel

The almond kernel is the edible part and is a seed formed by two large cotyledons covered by a brown skin and protected by an external hull, once maturity is reached, the hull opens and the seed separates easily.

The great diversity of varieties as well as the forms of cultivation and the climatic characteristics determine the remarkable differences in almonds' chemical composition.



Source: Walali & Rakii 2014; Walali et al., 2003; Bulletin mensuel d'information et de liaison du PNTTA, N° 119, Aout 2004.

Almond Trees Planting and Harvest in the High Atlas

Almond tree are prevalent in Reif, Anti-Atlas, the High Atlas with a density of around 60 and 100 trees per hectare.



Seed planting



Seedling



Mature tree



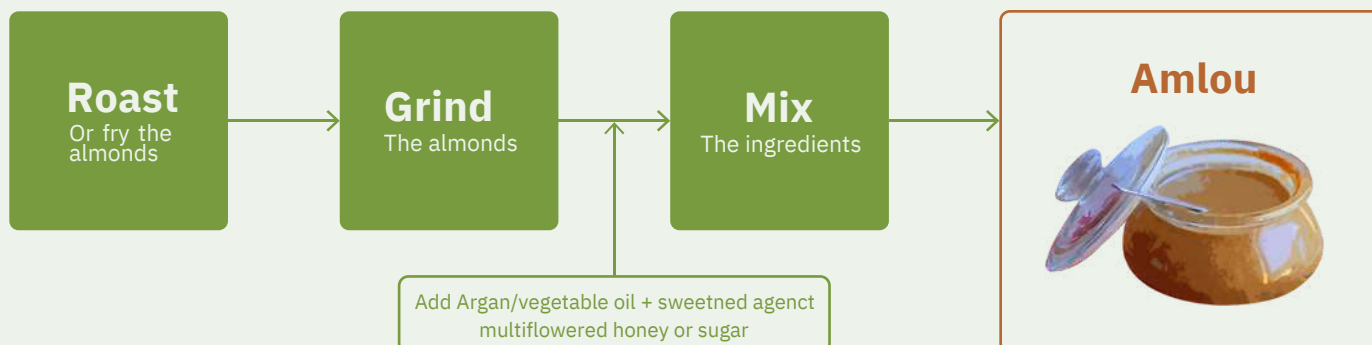
Tree with fruit

In the High Atlas, more than half of the almonds are grown mainly by sowing and is the long last traditional method of almonds tree propagation used by High Atlas farmers.

Almonds can be harvested before ripening (May-July) or when they are mature (August-September) and 1/10 of what is harvested is always giving for charity.

Amlou, the almond paste of the southern part of the High Atlas

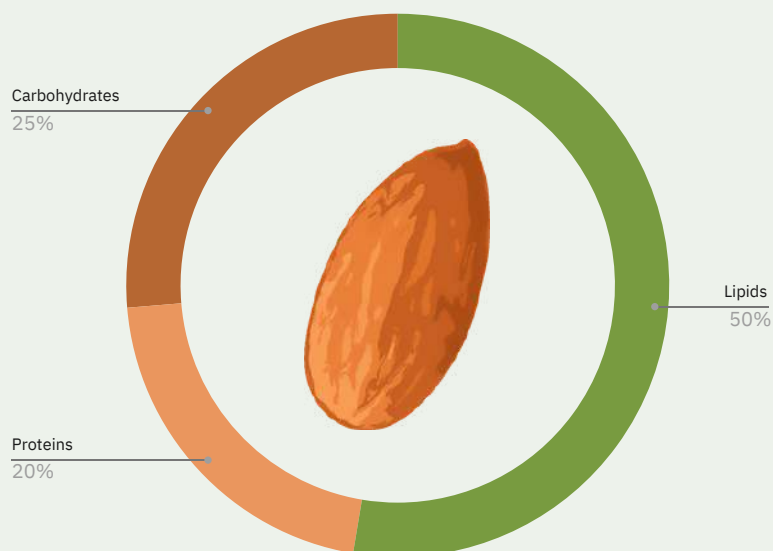
Amlou is a nutritious snack that can be eaten with bread, added to fruit salads, breakfast cereals or just with a spoon.



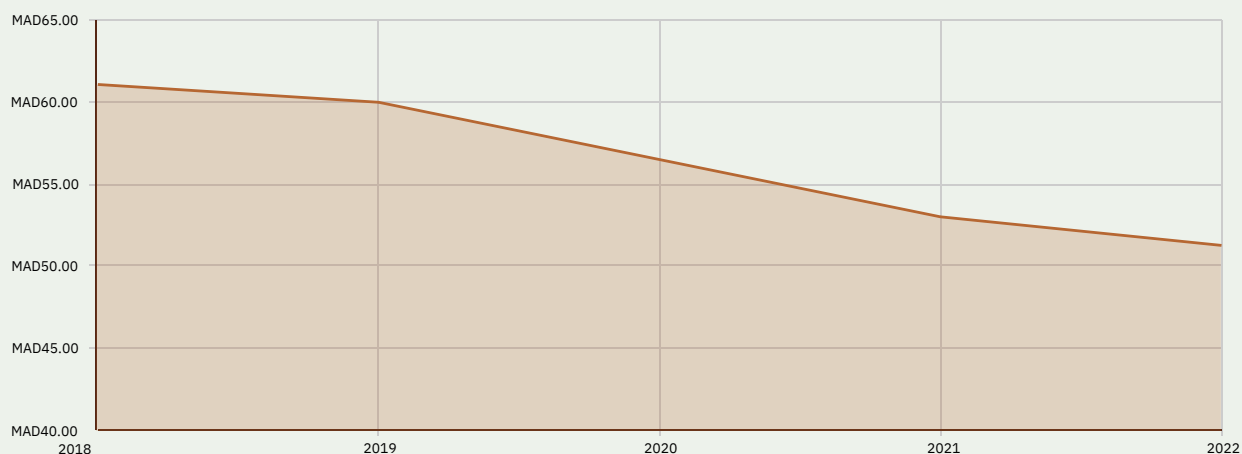
Almonds Components

Studies have reported positive effects of almonds consumption against obesity, hypertension, diabetes and metabolic syndromes.

- Low sodium
- High potassium
- Dietary Fiber
- Vitamin E

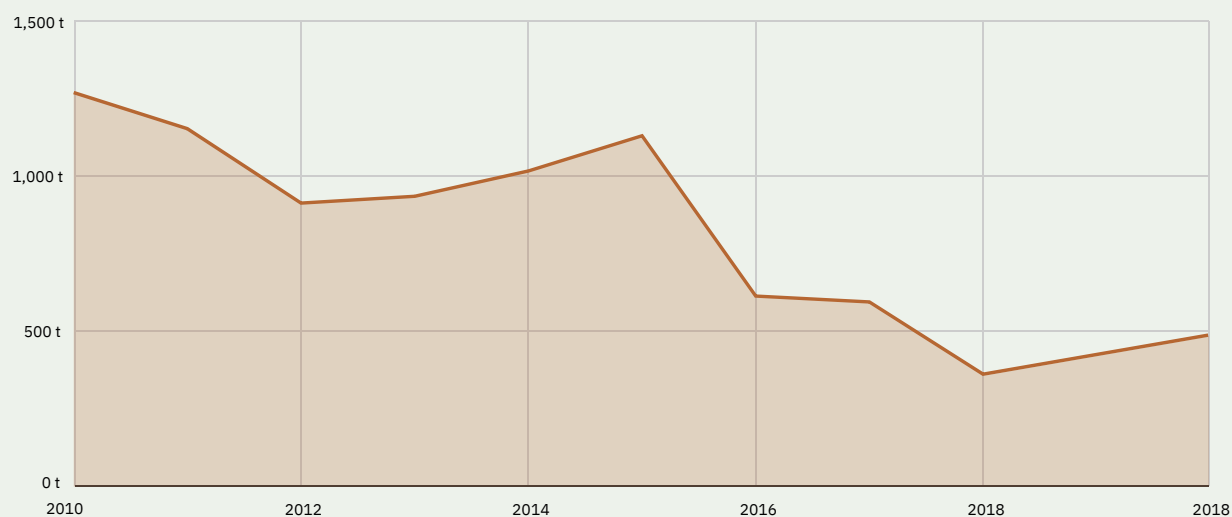


Almonds Selling Price Without Hull



Source: Selinawamucii

Moroccan Almond Export



Source: Selinawamucii

Walnuts taxonomy tree:
Family: Juglandaceae
Genus: Juglans L.
Species: *Juglans regia* L.

Walnuts

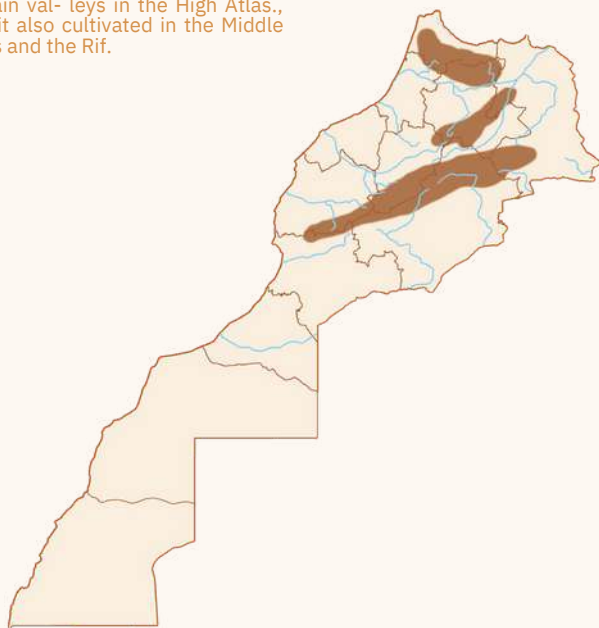
Walnut in other tongues
In Amazigh: Guergaa
In French: Noyer
In Arabic: الجوز



In Morocco, the first introduction of walnut is attributed to the Romans!
Morocco is one of the few countries that uses its root for its astringent properties and bark for cosmetics.

National distribution

Walnuts trees are planted along certain valleys in the High Atlas, and it also cultivated in the Middle Atlas and the Rif.

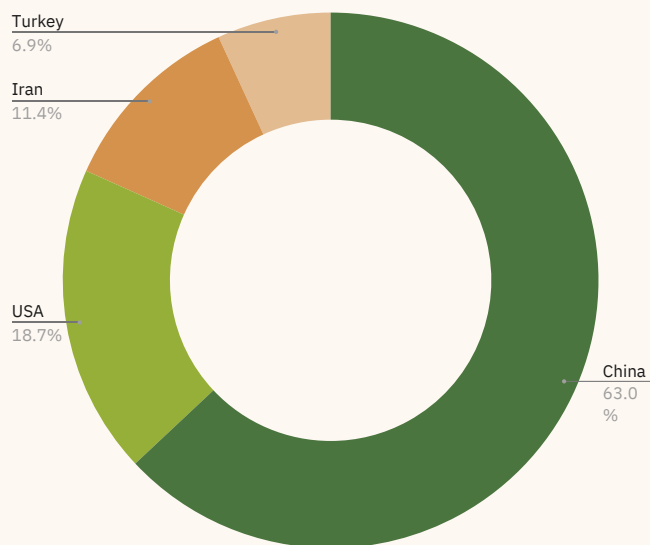


Source: Germain 1992; Kajji, 2014

Global production

The world production of cultivated walnut in 2017 was estimated 3,829,626 tons but Morocco was considered as a lower producer with an annual value of 12,736 tons

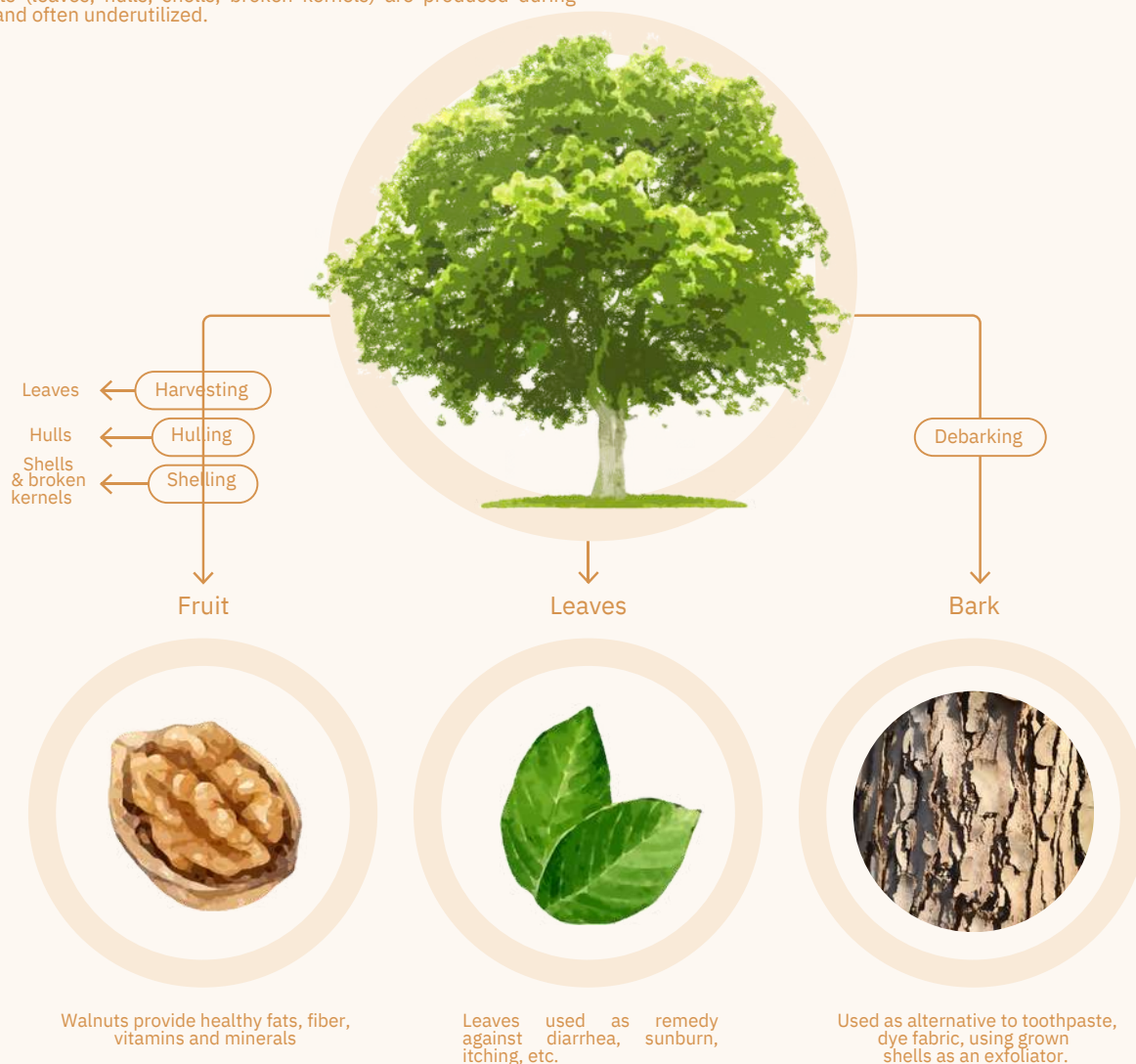
The walnuts kernels selling price in 2019 in the High Atlas was about 50MAD/kg.

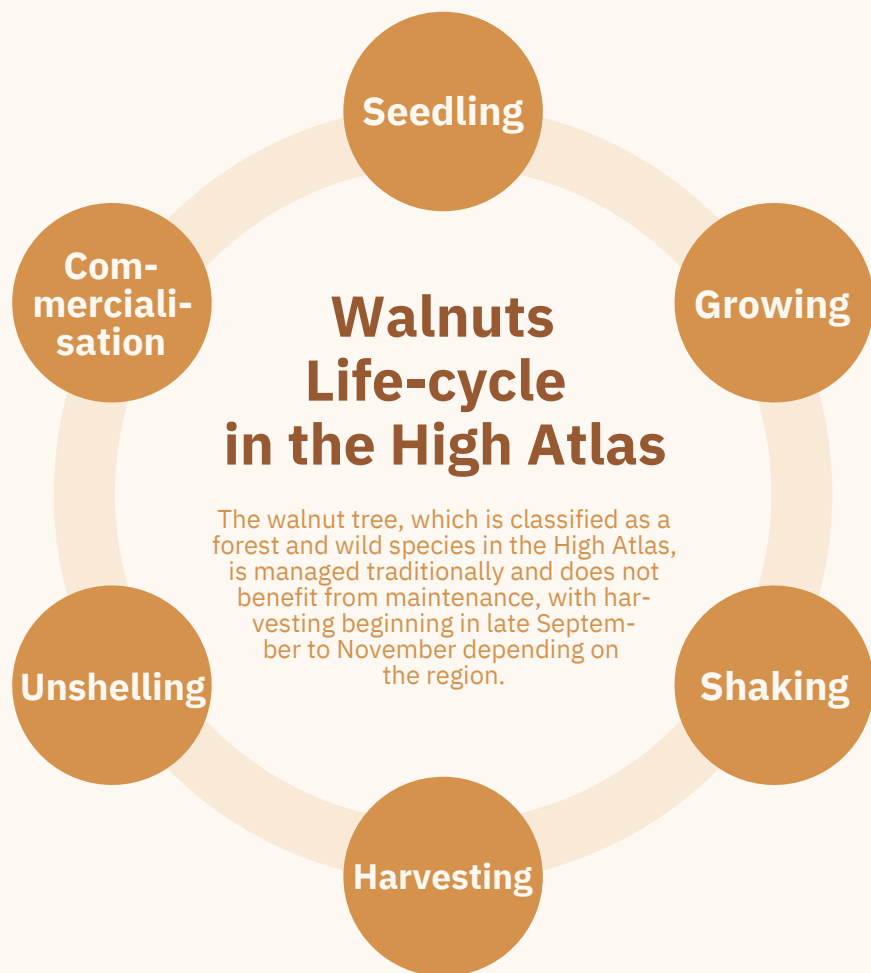


FAOSTAT, 2017

Walnut Tree Multiple Use

To extract the edible part (kernels), walnuts undergo several processing operations such as harvesting, hulling, drying, and shelling. A large quantity of by-products (leaves, hulls, shells, broken kernels) are produced during these steps, and often underutilized.



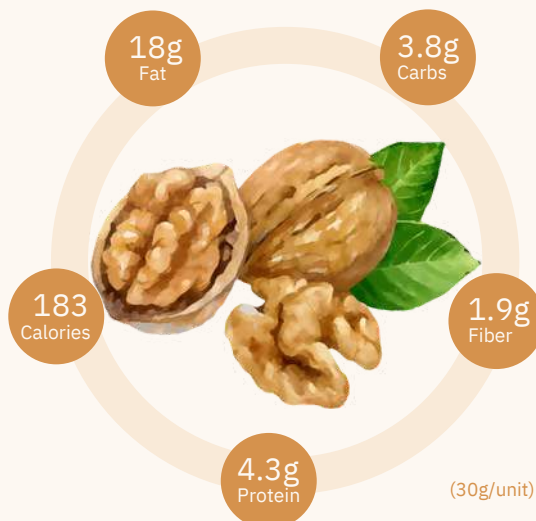


When fields are divided among the community, Azzuwi (harvest) is managed collectively by the population and coordinated by a community guardian (Amchardo), who is paid a percentage of the total harvested amount.

Walnuts, a Nutritional Sweet Snack

According to research, consuming 20 to 30 grams of walnuts daily protects the body from heart disease, certain cancer types, type 2 diabetes, and other health problems (S. Mehmet & K. Turan 2015).

Cholesterol Free
Sodium Free
Rich in Omega-3 and 6
Vitamin E and B6
Potassium and Magnesium



Walnuts Market in Morocco



Evolution curve of walnut production in Morocco from 1961 to 2019 (FAO).

Carob taxonomy tree:
Clade: Rosids
Genus: *Ceratonia*
Species: *Ceratonia siliqua* L.

Carob

Carob in other tongues
In Amazigh: Tikida
In French: Caroubier
In Arabic: Kharroub الخروب



Male carob trees are sterile and unproductive, female trees are the only ones that produce pods

Global distribution

Carob trees originated in the Middle East and are now grown in Mediterranean climates all over the world.



Source: Battle and Tous, 1997

National distribution

Carob trees originated in Carob grows naturally in the plains and middle mountains of the Rif, the Middle Atlas, the High Atlas, and the Anti-Atlas, and it can thrive in arid and semi-arid zones, withstanding dry hot and dry summers.



Source: Fennane et AL, 2007

Traditional Carob tree propagation

The traditional method used in Morocco for Carob tree propagation is slit grafting, begins with a cut to create a clean and smooth surface, followed by a scion from the desired female variety to the rootstock of the host- ing male tree.

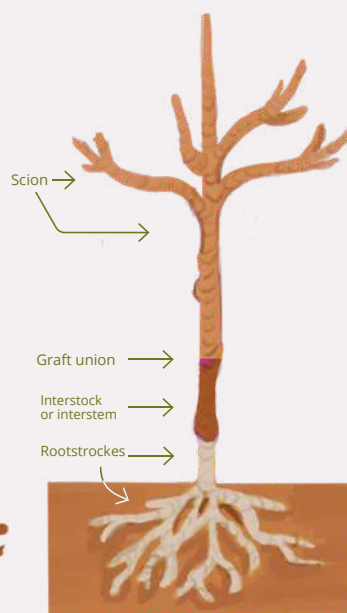
Scion and rootstock should be the same diameter, and the union between them should be held together by a strong but elastic bond that does not strangle the stem.



Cut top off dormant rootstock, slit



Insert dormant softwood cutting



Scion →

Graft union →

Interstock or interstem →

Rootstockes →



Tape (or wax) graft

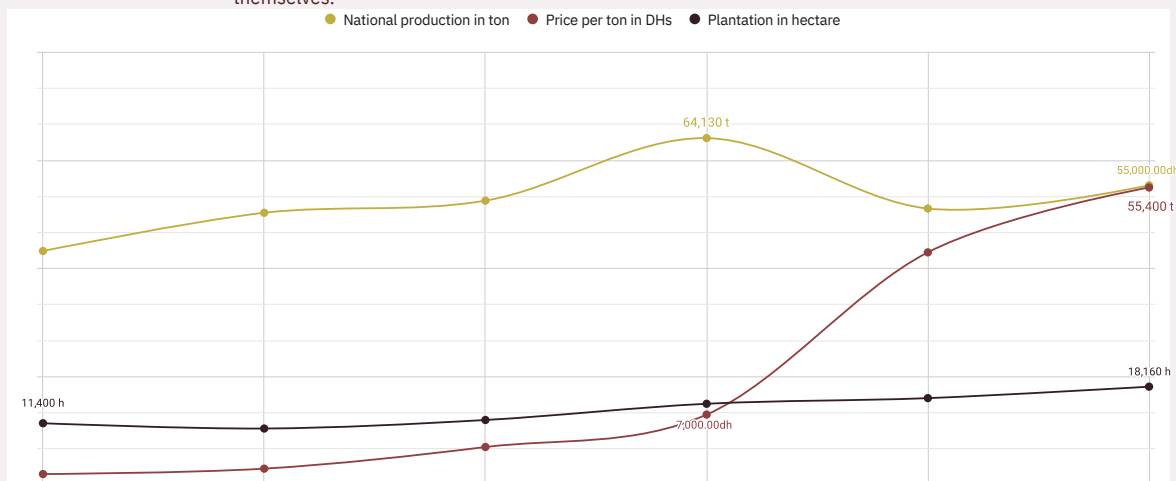
Carob propagation steps trees by grafting

Moroccan Carob sector

The High Commission for Water and Forests puts out a public tender for the carobs grown in the forests every year.

In the forest domain, the pods are harvested by contractors with commission approval, and in the private domain, the farmers harvest the pods themselves.

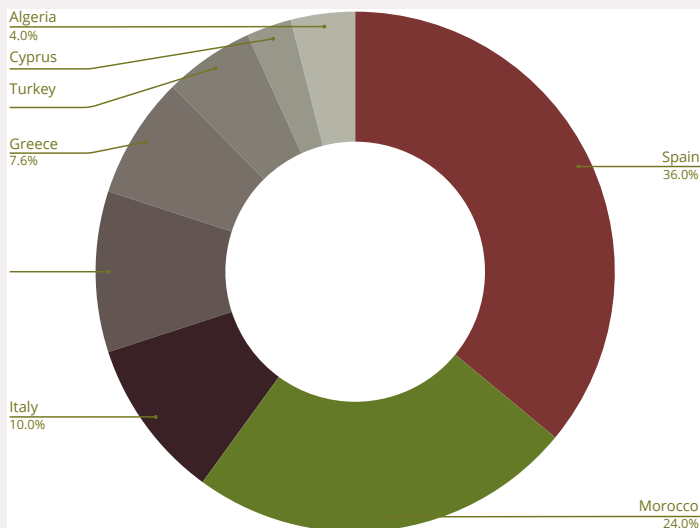
The collection of carob pods takes place in souks by individuals, wholesalers' depots, and cooperatives.



Plantation, price, and national production carob in Morocco

Global Carob production

The global production is estimated to be around 315,000 t per year, produced from approximately 200,000 hectares, with Morocco being the second-largest producer after Spain.



The global carob production of 2017

Carob collectors

The collection of carob pods takes place in souks by individuals, whole-salers' depots, and cooperatives, which transport the products to various industrial processing and export units.

Souk

Cooperatives

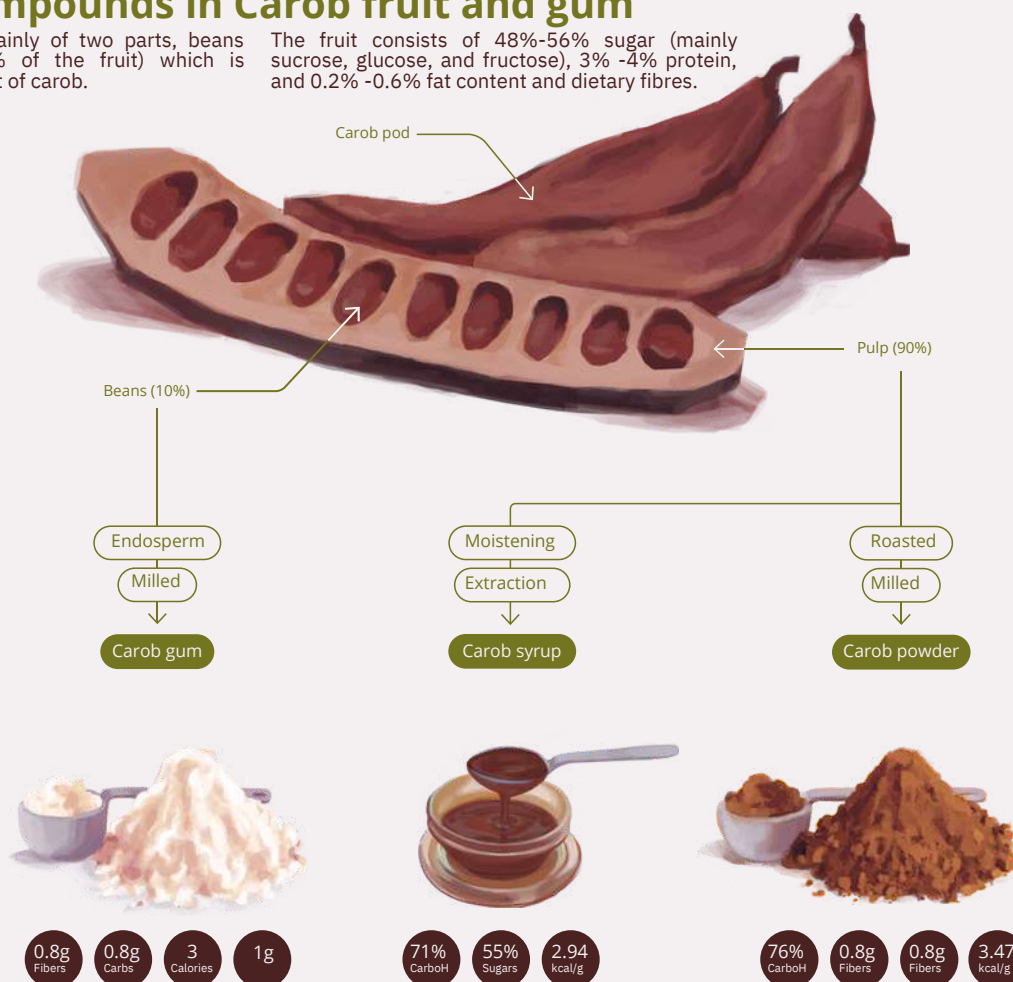
Wholesalers

Individuals

Existing compounds in Carob fruit and gum

Carob fruit consists mainly of two parts, beans (10%) and pulp (90% of the fruit) which is considered a by-product of carob.

The fruit consists of 48%-56% sugar (mainly sucrose, glucose, and fructose), 3% -4% protein, and 0.2% -0.6% fat content and dietary fibres.



Health benefits:

Preventative role against heart disease. A better alternative to chocolate which does not cause insomnia, nervousness, or an increase in heart rate. Suitable for people with celiac disease as it is gluten-free and can be used as flour in baking, cereals, snacks, and more.

Locust bean gum:

Carob gums can be found in ice cream, yoghurt, and sauces. Each gramme of Carob gum contains 3 calories, 0.8 g of carbohydrates and fibre, 3mg of calcium and 1 mg of sodium. Helps in digestion thanks to its water retention properties and improves blood sugar levels when consumed in larger quantities.

The syrup has 71 % of carbohydrates including 55% of simple sugars and an energy value of 294 kcal/100 g. High in d-pinitol, an anti-diabetic agent thus the syrup does not raise blood sugar levels in people with type II diabetes.

Source: Papaefstathiou, E., Agapiou, A., Giannopoulos, S., & Kokkinofa, R. (2018). Nutritional characterization of carobs and traditional carob products. Food science & nutrition, 6(8), 2151-2161. Youssef, M. K. E., El-Manfaloty, M. M., & Ali, H. M. (2013). Assessment of proximate chemical composition, nutritional status, fatty acid composition and phenolic compounds of carob (*Ceratonia siliqua* L.). Food and Public Health, 3(6), 304-308.

Lavender taxonomy tree:
Clade: Eudicots
Order: Lamiales
Genus: *Lavendula* L.

Lavender

Lavender in other tongues
In Amazigh: Wizghyou or Ljersh
In French: Lavande
In Arabic: Khezama الخزامة



Lavandula dentata is an endemic species of Morocco growing spontaneously in the Rif, Anti Atlas, Souss Valley and in the southern part of the High Atlas Mountains.

National distribution

The natural habitat of *Lavandula dentata* is limestone soils in sunny open spaces, pastures, bushes, or low bushes.



Source: Upson Tim & Jury, Stephen. (2002). A Revision of Native Moroccan Species of *Lavandula* L. section *Pterostoechas* Ging. (Lamiaceae). Taxon. 51. 309. 10.2307/1554929

Local use of *Lavandula dentata* and healing properties

What it Can Do for You

Boots stamina and energy
It is great for relaxing
and winding down

Enhance the flavor
of food
Ward off disease

Healing Properties

Relieves spasms,
stress,
headaches, and
rheumatism,

Treating colds,
respiratory conditions,
and stomach upset.

Essential oil,
herbal teas and infusions,
creams and lotions,

Powder and dried flowers
(for culinary and cosmetics
purposes), incense

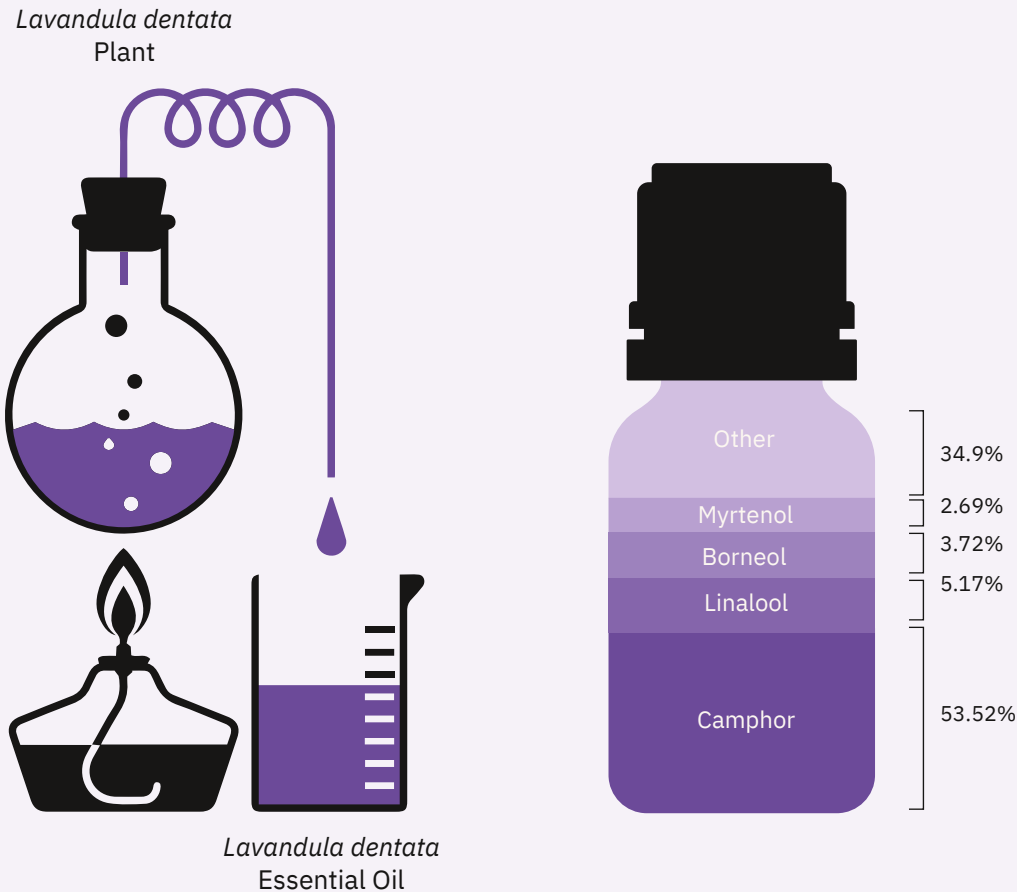
Safety

For people with diabetes, epilepsy, or seizure disorders, use only under the supervision of a physician. Do not ingest its essential oil. To be avoided during pregnancy.

Guittou, Y. (2010). Diversité des composés terpéniques volatils au sein du genre *Lavandula*: aspects évolutifs et physiologiques. (Doctoral dissertation, Université Jean Monnet-Saint-Etienne).

Essential oils as a method of *Lavandula dentata* valorisation

Lavandula dentata to produce 15 ml of its essential oil through

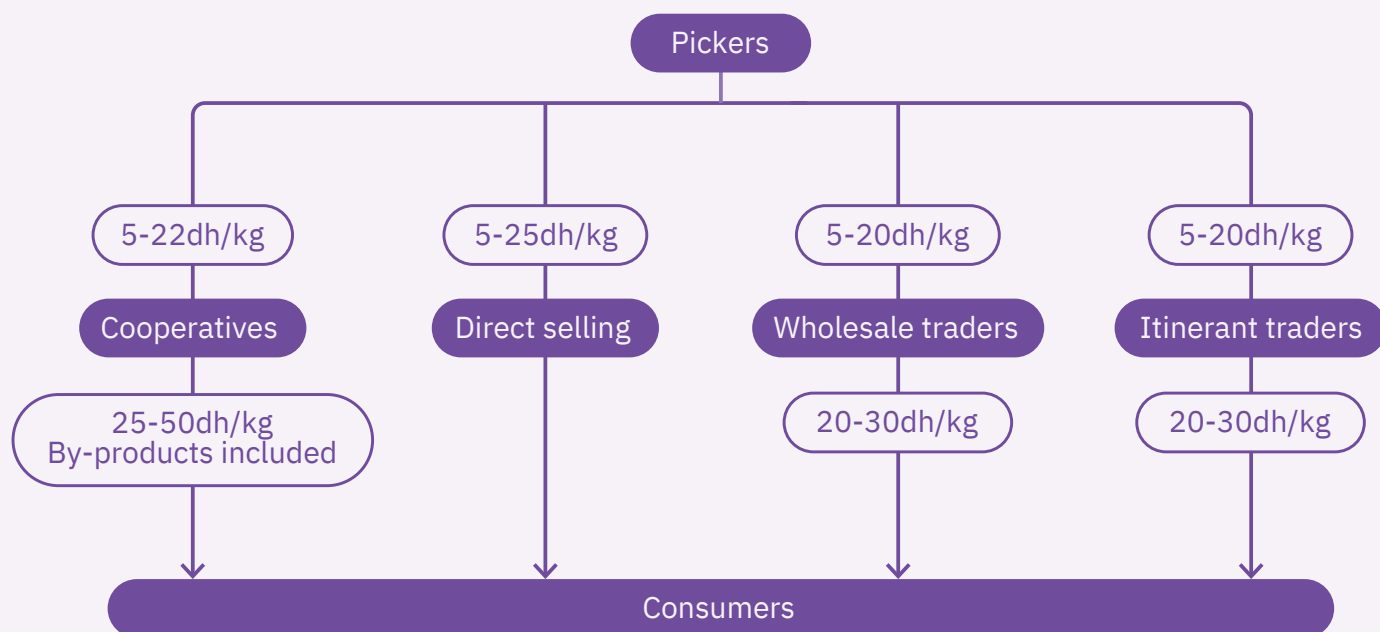


Source: Cavanagh, H.M. A., & Wilkinson, J.M. (2002). Biological activities of lavender essential oil. *Phytotherapy Research*, 16(4), 301-308.

Moroccan *Lavandula dentata* Commercialisation Potential

In 2019, dried lavender flowers were sold in the High Atlas for 9 to 13 MAD/kg, depending on the quality of the flowers. *Lavandula dentata* is regarded as one of the plants that generate significant income for 70% of the local population in the High Atlas.

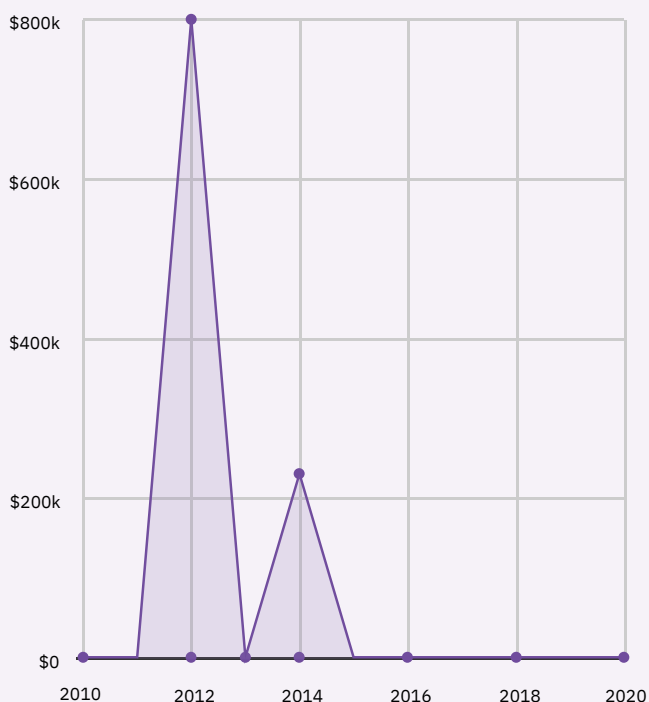
Marketing channels are complex and dominated by intermediaries, resulting in very low profit margins for the initial producers and a non-uniform and varying selling price on the local market.



Source: Cavanagh, H.M. A., & Wilkinson, J.M. (2002). Biological activities of lavender essential oil. *Phytotherapy Research*, 16(4), 301-308.

Moroccan *Lavandula dentata* Commercialisation Potential

Lavender oil exportation from various species has been decreasing since 2012, and it has now completely stopped.

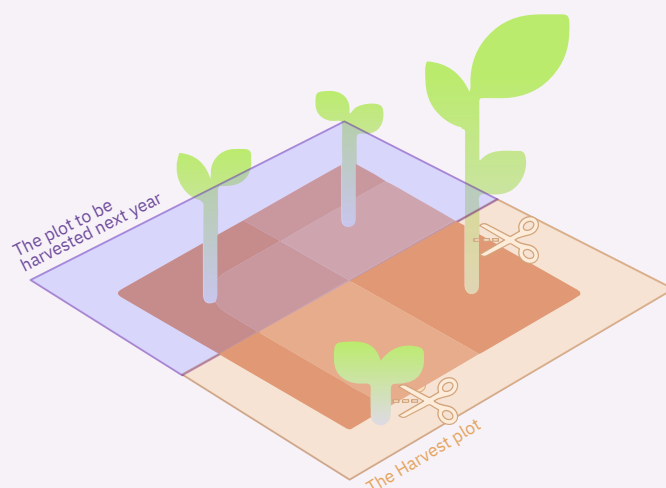


Source: selinawamucii.com

Lavender related harvesting practices

In the High Atlas, well-defined plots are harvested for the regeneration of *Lavandula dentata* in the forest, while other plots are left to be harvested the following year.

Lavandula Dentata blooms from mid-June to mid-July and is harvested during the same time period, yielding 20 to 100 kg of fresh lavender flowers per person.



Source: selinawamucii.com

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