# Overharvesting medicinal and aromatic plants in rural Moroccan communities

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Morocco is a biodiverse nation providing a rich source of medicinal and aromatic plants that contribute to health care of and income for rural communities. Unfortunately, collection of the plants is currently done chiefly through unsustainable foraging practices. This article analyzes the impact of these practices on rural economies and offers solutions for better harvesting and business practices.

## Introduction

Morocco is in the Mediterranean Basin and has a wide-ranging geography of mountains, valleys, plains, and coastal areas that allows for a diverse mixture of flora and fauna (Taleb, 2017). The Mediterranean Basin is recognized as the third most richly endowed region in the world for endemic plant species; with more than 10,000 endemic species, it ranks just behind the tropical rainforests of the Andes and the Sundiac region of Southeast Asia in terms of biodiversity (Mittermeier et al., 2004). High levels of biodiversity are important for healthy, functioning ecosystems wherein species' connectedness and abundance increase resilience by reducing the impact of stressors, such as drought and disease, by spreading them among species. Along with that resilience, a higher variety of species increases the likelihood of plants with pharmacological qualities (Relyea & Ricklef, 2018). Among the unique flora of Morocco is a rich concentration of medicinal and aromatic plants (MAPs). Medicinal plants are those containing chemical compounds with pharmacological properties for humans. Aromatic plants are those used in cosmetics; as essential oils; or in food as oil, flavoring, or spice. In Morocco, there are more than 4200 species and subspecies of vascular plants; 22% are endemic. Of those species, 800 are used medicinally or as aromatics. These plants are used by rural communities for health care or are sold for profit to retailers and exported. Loss of biodiversity is a growing concern for Morocco. Threats from climate change lead to drought; and human influence, such as overharvesting and habitat destruction, plays a significant role in threatening vulnerable species. Greater global market demands for MAPs lead to overharvesting and unsustainable foraging practices that put species at risk (Bouiamrine et al., 2017). The International Union for Conservation of Nature has developed the Red List of Threatened Species, which has identified Morocco as a high-priority site for conservation, specifically in the Atlas and Rif mountain ranges, with many species classified as critically endangered (Rankou et al., 2015).

The loss of endemic species and other important MAPs threatens traditional health care for many rural Moroccans. Folk medicine, also known as traditional medicine, herbal medicine, or indigenous pharmacopeia, is a centuries-old practice in the rural communities of Morocco (El-Hilaly et al., 2003). Rural communities and indigenous tribes have little access to Western medicine and rely on herbal medicine as their primary source of health care (Bouiamrine et al., 2017). According to the World Health Organization (2023, January 30), over 80% of the world is partially or entirely reliant on indigenous pharmacopeia as a form of health care. In rural communities in Morocco, multiple generations, including extended families, often live in a single household. In these households, the eldest woman acts as the head of the family and is the inheritor of many generations of traditional ecological knowledge of medicinal plants (Lamrani-Alaoui & Hassikou, 2018). Although the head woman is responsible for passing traditional ecological knowledge on to the younger generations to help ensure the practice continues, many tribes also have herbalist healers and witch doctors who have this knowledge (Taleb, 2017); they know how to identify plants, what function they serve, how to prepare and utilize them, and where to find them naturally. This knowledge is not science based but rather culture based, from centuries of experience. Even so, many of these plants have been scientifically proven to have healing properties and are functional as a form of health care. Over generations, Moroccan

 doi:10.18275/pbe-v042-009 

rural communities have built a medical system around this knowledge and trust this way of life. When communities are given access to Western medicine, they are more likely to trust herbal medicine and prefer it to Western medicine (El-Hilaly et al., 2003).

Because of the complex ecosystems in Morocco, it is difficult to cultivate many MAPs outside those regions where they are endemic. This creates a reliance on local communities to forage these plants. About 61% of MAPs in Morocco are wildly sourced and not cultivated and 37% are actively farmed (El-Hilaly et al., 2003). Cultivated MAPs, such as *Capparis spinosa* (capers) and varieties of the genus *Thymus* (thyme), are exported frequently, but wild MAPs provide a wider range of species with different and important medicinal properties and are preferred to their cultivated counterparts because private land or other agricultural resources are not needed (Schippmann et al., 2006). This puts emphasis on conserving wildly sourced plants to continue the practice of traditional medicine in Morocco as well as maintain the supply for export, providing income to the rural communities.

Besides contributing to health care, MAPs provide an important avenue for jobs and income for rural populations, and that potential is growing as a result of global demand (Bouiamrine et al., 2017). In 2022, the worldwide MAP market generated almost $150B in revenue, with an estimated projection reaching $387B by 2032 (Gotadki, 2021). Income from MAP exports can increase, if rural communities are informed of sustainable harvesting techniques and trained in making good business decisions (US Agency for International Development [USAID]: Morocco, 2012). Due to the importance of MAPs to traditional practices and health care and the expected revenue from the MAP sector, it is critical that Morocco implement more sustainable practices to ensure these plants are not exploited as they are today.

## Medicinal plants in rural health care

About 64% of Moroccans live in urban areas, which has led to a localization of health care within cities. There is subsequently a disproportionate allocation of resources and funding in favor of urban areas, leaving rural communities vulnerable to health issues and without modern health care. As of 2023, it is estimated that 48% of Moroccans have no health coverage. Even those who may have access to health care but no health-care insurance need to pay for their health care out of pocket (Mahdaoui & Kissani, 2023). These out-of-pocket expenses can create financial distress for those in lower socioeconomic classes in rural areas. To explore the presence of medicinal plants as health care in Morocco, El-Hilay et al. (2003) interviewed and surveyed the Taounate people of North Morocco, and Kachmar et al. (2021) studied the people in the Taza region of Morocco. Both studies reveal the lack of health care in the rural regions and the increased reliance on medicinal plants for health care. The researchers found that Western medicine was unavailable to most of those populations, and, when it was available, many reported greater trust in folk medicine. They also found that in the 47 rural communities they surveyed, almost every family used or knew about medicinal plants and incorporated them in their daily lives (El-Hilaly et al., 2003). Their findings emphasize the importance of preserving medicinally used plants in Morocco as health care.

El-Hilay et al. (2003) identified 102 medicinal plants commonly used by the indigenous Taounate. In terms of applications, 24.9% were for gastrointestinal distress, 12.2% for urogenital purposes, 9.8% for bronchopulmonary issues, and 9.2% for skin-related health issues. Many of these plants have been tested scientifically and demonstrate medicinal properties. For example, *Trigonella foenum-graecum*, *Ammi visnaga*, and *Nigella sativa* are herbs with antidiabetic properties and are valued by rural populations for these purposes. In fact, many of the plants identified by El-Hilay et al. are used in modern medicine. More broadly, greater than 25% of modern medicines are derived from uncultivated plant species (Bouiamrine et al., 2017).

The study by Kachmar et al. (2021) looked at the region of Taza. They interviewed 200 people to understand the distribution of plant uses in the region. Examples included *Mentha pulegium*, for alleviating symptoms of the common cold as well as treating digestive ailments based on the plant's antioxidant and antimutagenic properties. The study recorded endemic plants, such as *Artemisia huguetii*, for gastrointestinal infections, and the most used plant in the study, *Origanum compactum*, for treating nausea but which also has antibacterial effects. The researchers found that those interviewed attributed the frequency of their usage to how easy the plants were to harvest and the richness/concentration of medicinal substances in the plants.

## The market for medicinal and aromatic plants

MAPs are becoming more popular worldwide as consumers in Western countries integrate more ho-

listic health care into their daily lives with herbal supplements, tinctures, and salves (Bouiamrine et al., 2017). Measuring the value of the MAP market is difficult due to the conflicting definitions of what makes a plant aromatic or medicinal. Additionally, the informal MAP trading market in Morocco (i.e., trading between local merchants and small sellers) is not tracked or taxed by the government, making it difficult to estimate the market's true size; as a result, various sources provide differing values of the MAP market.

Analysis of a comparable figure of a defined trade item is one way to attempt to quantify the MAP market. The UN Comtrade database (2022) recorded figures on trade item 121190, defined as "plants and parts (including seeds and fruits)...of a kind used primarily in perfumery, pharmacy, or for insecticidal, fungicidal, or similar purposes, fresh, chilled, frozen or dried, whether or not cut, crushed or powdered." In 2010, Morocco exported $24.82M of item 121190 to the global market. The exported amount grew to $40.57M in 2015. Recent data (2022) show that Morocco nearly tripled their 2010 MAP export of item 121190 to $64.93M. These numbers may not represent all the trade occurring during these years but are strong evidence of the expanding Moroccan MAP market.

Relatively speaking, Morocco plays an important role in MAP production on a global scale. Although the export dollar value of MAPs is modest by comparison with other products, given its overall size, Morocco has a high production of MAPs that are extremely valuable in that marketplace (United Nations, 2022). Market reviews indicate a steady growth in demand and value in the MAP market overall. Morocco is listed as the twelfth biggest exporter of MAPs in the world, and their potential is only increasing. As of 2022, the global trade value for MAPs was estimated to be $150B per year, with an estimated growth rate going forward of ~11%, reaching a total of as much as $386.07B by 2032 (Gotadki, 2021).

Given the projected expansion of the MAPs market, the opportunity for profit in Morocco is likewise expanding. Demand for MAPs could introduce new flows of income to those living in Morocco's rural, low-economic areas (Taleb, 2017). In the northern region of Morocco in 2003, the Taounate people, with a population around 30,000, had an annual income of approximately $1.83M from medicinal plant exports (*City Population: Taounate*, 2014; El-Hilaly et al., 2003). MAPs are a valuable part of rural incomes; however, the profit from medicinal plants is largely tied to wholesalers who buy local products cheaply and resell them for higher prices, leading to exploitation of the local producers of MAPs. Many foragers have connections with intermediaries who purchase the product at a very low price and sell it higher to industrial wholesalers for export. Although the final value of the plants is high, foragers get paid minimally for their product. Because there are no other options but to sell to the intermediaries, damaging harvesting continues and profits are small (El-Hilaly et al., 2003). This issue requires governmental regulation and education for collectors and cooperatives to implement good business practices with the growing market and prevent further exploitation (Taleb, 2017).

## The threat of plant exploitation

MAPs are not regulated for collection. Foraging for these plants occurs primarily on public land and is generally accessible to whoever wishes to harvest them. As a result, the market is treated similarly to mining rather than agriculture, that is, harvesting a supply until it is gone and then moving onto the next source rather than protecting the original supply. It is difficult to report on individual behaviors in this sector because of lack of national control and observation of foragers. Plant collectors may know where to find plants and how to use them, but many collectors do not engage in sustainable practices, threatening the future of MAPs in Morocco (Lamrani-Alaoui & Hassikou, 2018). Plants often are not harvested with the intention of utilizing every part. Entire plants can be uprooted, when only the leaves, fruit, stems, seeds, or bark is needed (Schippmann et al., 2006). Uprooting the entire plant makes it difficult, if not impossible, for the plant to propagate again, reducing the chance of reproduction for many species (Bouiamrine et al., 2017). Plants respond differently to the removal of parts, and what is removed can threaten the life cycle of the plants. For example, Lamrani-Alaoui and Hassikou (2018) reported that annual plants have a high risk for reproduction loss when their roots or fruits are taken, whereas shrubs or trees have a medium risk when using the root and a low risk when losing the fruit or seed of the plant. This assessment emphasizes the importance of educating the people gathering the MAPs on sustainable practices and conservation techniques. Knowing which part of the plant to harvest can reduce the threat of overexploitation by giving plants a chance for regrowth.

There are many MAP species listed on the International Union for Conservation of Nature Red List that are at threat of extinction in Morocco

(Bouiamrine et al., 2017). An example is *Anacyclus pyrethrum*, the Atlas daisy, for joint pain, indigestion, diabetes, rheumatism, and Alzheimer's disease (Zahra Jawhari et al., 2021). This herbaceous plant is listed as vulnerable to extinction because of "ruthless collection for domestic uses and for trade, collection practices, overgrazing, agricultural intensification, deforestation and soil erosion" (Rankou et al., 2015, p. 506). It has a severely fragmented population, and the number of mature plants is also rapidly declining. Habitat fragmentation leads to likelihood of population loss due to lower reproduction rates (Lienert, 2004). This is but one example of a plant that plays an important role in medicine for rural Morocco and is declining due to exploitation and unsustainable harvesting practices.

An example of an endangered aromatic plant that is highly treasured in Morocco is *Sideroxylon spinosum*, the argan tree, which produces oil for cooking and for cosmetics and medicine, with dermatologic benefits and cholesterol-reducing properties (Heuzé & Tran, 2020). This tree is currently cultivated to meet demands, but wild argan is endangered by overgrazing and overexploitation, resulting in a density drop from 100 to 30 trees per hectare from 2000 to 2017 (Green Climate Fund, 2023). At the beginning of 2024, the market size of cultivated and wild argan oil in Morocco was recorded at $290.3M and is projected to reach $600.8M by 2031 (Verified Market Research, 2024; Ismaili et al., 2017). Due to the reduction in wild *Sideroxylon spinosum* and its importance to the national economy, the Moroccan government initiated a rehabilitation project through the Green Climate Fund that plans to plant about 43,000 hectares of argan trees (Green Climate Fund, 2023). This project is intended to not only promote sustainable agriculture but also support co-ops of women who rely on arganiculture in rural communities. Despite this effort, the wild argan population is still severely fragmented and declining.

## Solutions

The MAPs industry harbors several significant problems that need to be addressed. These include identifying sustainable harvesting practices and implementing them in communities, establishing cooperative organizations to support plant harvesting and processing in indigenous communities to ensure their fair share of profits, and finally, a national plan for managing the public lands where most foraging occurs.

**Introducing sustainable harvesting practices**

Growing demand is threatening endemic species, but by shifting how plants are harvested, the reproduction potential, survival, and quality of plants can increase. Ismaili et al. (2017) studied sustainable practices in Morocco to prevent the overharvesting of *Rosmarinus officinalis*, also known as rosemary. The study examined how to best avoid overharvesting and sought to improve quality by maximizing essential oil quantity and leaf biomass production with different harvesting practices. These practices included the cutting method and adjusting the season of harvest. The study authors hypothesized that different combinations of these two factors would result in more productive collections. They found that changing harvesting practices based on time of year would allow for optimal plant growth and essential oil production. Spring showed the highest essential oil yield when clear-cutting was practiced (the act of cutting the entire plant but leaving roots intact). It was advised to not harvest in summer because of negative effects on essential oil production and growth. Harvesting only half the plants in the fall would let the remaining rosemary plants flower at the end of the fall to ensure seed production and pollinator attraction, and they suggested the plants should be clear-cut again in winter to allow for full regeneration. The results of this study suggest that the methods of foraging plants should be planned according to their growth habits and that it is detrimental to harvest without this information.

These harvesting methods demonstrate success limited to rosemary, but they can be applied to other plants. A suggested technique of conservation is identifying the plants at highest risk of exploitation and running similar experiments to test the best harvesting practices. Plants that are in the same genus should show similar characteristics; thus, results can be applied across multiple species without running excessive experiments. To prevent overharvesting and promote conservation, it is critical that those harvesting these plants understand how to harvest in a sustainable manner. This type of research is conducted by universities, including the National Forestry School of Engineers and Mohammed V University, that assisted with the Ismaili et al. study and with partnerships in government organizations, such as the Department of Soil and Water Biodiversity. These projects are funded by both private and public partners; most recently, the World Bank allotted $300M for scientific research to Moroccan universities. This loan intends to support higher education and is primarily for research in Morocco's

ecosystems to promote a sustainable future (World Bank, 2023). This loan emphasizes the support for projects promoting sustainable practices. Following the experiments, foragers must be educated on sustainable practices. This can be done by educational visits from Moroccan university scientists in rural communities or, alternatively, by partnering with programs such as the Morocco Country Fund, a collaboration with the Peace Corps that aims to engage with and educate communities on issues such as the environment, economic development, water, and agriculture (Peace Corps, n.d.). These visits are led by volunteers who walk through the practices and discuss immediate consequences of them. Not only will these practices sustain the availability of the plants but also add to the yield of the product and improve its quality.

**Supporting cooperatives for increased and fair profits**

Cooperatives are an important part of the Moroccan economy and help increase jobs and decrease poverty, specifically for women. They are businesses that generally craft handmade, local products and goods and are controlled by their members democratically. The democratic nature of co-ops gives each member a voice in the business and a sense of independence (International Center for Agricultural Research in the Dry Areas [ICARDA] Communication Team, 2022). Aid to cooperatives from governmental and nonprofit organizations would help spread awareness of sustainable harvesting practices of MAPs while promoting business practices to boost profit and preserve the environment. Supporting cooperatives also increases female participation in agricultural practices and, subsequently, the economy. This reflects a modern transition that recognizes and promotes gender equality in Morocco.

In 2004, USAID Morocco drafted the Integrated Agriculture and Agribusiness Program (IAA) with the goal of increasing profits and jobs from agricultural products and supporting the competitiveness of agricultural value chains. One of the value chains identified as a key focus on the project was MAPs. The Beni Yâala Zkara rosemary cooperative is an example of the benefits cooperatives have for sellers and in protecting the environment (USAID: Morocco, 2012). The IAA program worked by educating collectives and established cooperatives on sustainable harvesting practices, such as rotating harvesting sites and cutting less than half of the plant. In addition to education, they provided financial support and trained cooperatives on new production, marketing, financial, and administrative techniques and supplied cooperatives with modern equipment and processing locations. The Beni Yâala Zkara cooperative was able to create 200 jobs in collecting and processing rosemary. They also increased national and international rosemary sales and were able to grow profits from Dh200 per liter, about $20, to Dh1000 per liter, or approximately $100 (USAID: Morocco, 2014). Along with these profits, the rosemary products were certified organic, indicating that the products are free from chemicals, genetically modified organisms, and pesticides, reflecting a more environmentally beneficial agricultural practice. The IAA model was able to transform the production system from inefficient and unprofitable into a modern and active part of the medicinal-aromatic production chain. The same results have been seen with olives, capers, and argan oil, but the IAA program has been criticized for not making enough effort to continue connections between cooperatives and aggregators, a reason many of their programs fail to continue. Aggregators, such as supermarket chains and food distributors, are essential for helping develop the value chain and providing marketing and financial support to encourage production. Without these key players, the IAA program became weaker and is now not represented in Morocco as strongly as it was in 2012 (USAID: Morocco, 2012).

The IAA program presents a guideline of impactful steps for integrating rural communities into business decisions and plant processing, but its shortcomings resulted from a lack of financial resources from the USAID. Thus, there is a need for reliable funding, such as from the National Human Development Initiative created by King Mohammed VI and other donors that fund cooperatives. Specifically, the High Atlas Foundation is an organization that supports agricultural cooperatives for women in Morocco. It supports ideas for cooperatives by providing information about financial support, planning, and understanding the workings of cooperatives (Joke, Rakia, & Lynn, 2018).

Health and sanitary precautions are other limitations to expanding the MAP market. Since 2004, cooperative funding from the USAID has continued, but the COVID-19 pandemic put intense stress on rural communities, forcing many cooperatives to shut down or limit processing. Many rural communities do not have certifications that assure quality and sanitation, but a recent collaboration between Oxfam (a global charity organization that works to prevent injustice and poverty) and ICARDA is providing solutions. Since the COVID-19 pandemic, Oxfam

and ICARDA have been training rural cooperatives on leadership, engagement, and marketing as well as certifying health and food safety through ONSSA, the Moroccan public office in charge of food safety. With new confidence and entrepreneurial skills from training and health and safety certifications, cooperatives can confidently sell their products outside their local markets, increasing profit (ICARDA Communication Team, 2022).

**Regulating foraging**

One of the biggest reasons overharvesting occurs is lack of regulation of public lands, which results in a tragedy of the commons (Lamrani-Alaoui & Hassikou, 2018). In that scenario, proposed by Garrett Hardin, the constructed social system encourages individuals to acquire as much as possible without considering the effects on others and the community (Hardin, 1968). His example is a communal sheep-grazing pasture: each herder who uses the pasture takes advantage of the abundant shared resource, allowing their sheep to eat as much as they can. Because each herder has this same mindset, the resource is ultimately completely used up, with no grass left for any of the herders. Hardin's tragedy of the commons reflects foraging practices seen in Morocco and around the world. Foragers see the plants as resources that bring income and that the more that are harvested, the more money they can make.

Regulating collection amounts from harvesters would allow for the regrowth of MAPs to occur sustainably. In US national parks, regulations are established to limit the number of wild plants that can be taken, allowing the gathering of wild plants and at the same time encouraging regrowth and reproduction. As an example, the US National Park Service (USNPS) established rules and guidelines for foraging in Shenandoah National Park in Virginia. It is prohibited for any of the rare or dangerous plants to be collected, but other plants, including most fruit, berries, and nuts, are allowed to be foraged, with limits. For example, maximum collections of eight gallons of apples and one gallon of hickory nuts per person per day are allowed (Shenandoah National Park, 2022). There are exceptions to these regulations for people indigenous to the land. Tribes can apply for a plant-gathering agreement for species important to their cultural practices (USNPS, 2023). Such exceptions allow for the recognition of traditional practices.

The guidelines laid out by the USNPS are examples of what could be adopted in Moroccan national parks. The USNPS has partnered with Morocco to help support the establishment of multiple national parks, including the Great Basin National Park and Toubkal National Park. This partnership allows the United States to share knowledge and resources for drafting harvesting regulations in Moroccan parks (US Embassy…, 2016). In Morocco, this could mean placing maximums on certain species and preventing collection of others on public or protected land. These regulations, as in the USNPS, would be seasonal, and decisions based on which foraging practices would promote optimal regrowth for each species. The National Agency for Water and Forests (n.d.) is responsible for management of much of the public and protected land. This agency has the power to draft regulations for protected land, similar to those seen in the USNPS. Because access to traditional medicine is a concern in rural areas, allowing for cultural exceptions for medicinal purposes would be an important component in these regulations. Ultimately, the number of plants sourced in the wild would be limited for industrial resale, even though allowed for traditional uses. Difficulties in enforcing these regulations on a large scale, however, cannot be ignored. Adding park rangers or staff to periodically survey natural areas would ensure regulations are enforced. This approach limits the potential for profit in rural communities and emphasizes the importance of reducing environmental impact.

## Conclusion

The diversity of landscapes in Morocco allows for a rich concentration of plants unique to the region. Included in these plant species are copious MAPs that are important to rural health care and income. Because of inadequate modern resources, rural communities rely on medicinal plants as a primary means of health care, and a threat to these plants is subsequently a threat to rural health care. With growing demand for MAPs around the world for medicine, cosmetic products, supplements, and seasoning, harvesting of these plants is increasing as rural communities rely on them as a major source of income, and these unique species are becoming threatened.

To prevent exploitation of the land, collectors and cooperatives can be educated on sustainable harvesting practices, such as only taking the part of the plant they need and always leaving enough of the plant behind to promote reproduction. These practices can also improve the quality of the forage, in turn increasing potential profit. Many rural communities are not knowledgeable concerning business practices; as a result, collectors are exploited by wholesalers and earn a fraction of the money they should from their

harvests. By educating collectors and cooperatives, rural residents can acquire knowledge, strengthening their confidence in negotiating and adding to their profits, without excessive harvesting. Finally, to limit overharvesting, government regulations can put a cap on foraging specific plants that can be taken from public land. These regulations would also prevent harvesting of rare and endangered species, to allow them to reproduce sufficiently. For culturally necessitated medicinal needs for plants, exception permits could be requested. These solutions are possible, and although implementing them on a wide scale might be difficult, doing nothing will result in land depleted in biodiversity. Morocco is already a competitive player in the MAP market, and, as demands continue to rise, so will tensions in rural communities. It is important to protect the biodiversity of the land and prevent overharvesting to ensure ecosystems remain functional, so that Moroccans will have access to their country's resources for a long time to come.

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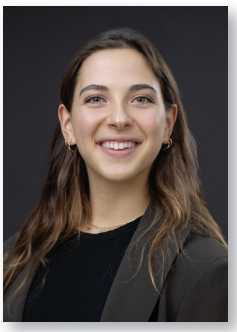

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