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## Introducing Saffron and a few medicinal and high value plants for small farms and water deficit conditions of northern New Mexico

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### ABSTRACT

This document reviews the potential of cultivating saffron and other high-value medicinal and aromatic plants such as lavender, rosemary, thyme, chamomile, and Damask rose on small farms in northern New Mexico, particularly under water deficit conditions. Medicinal and aromatic plants, rich in secondary metabolites, are crucial to various industries including pharmaceuticals, cosmetics, and food. With an increasing global market for herbal products and a rising interest in traditional medicine, these plants offer economic benefits and sustainability for small-scale farmers. Northern New Mexico's diverse climate and soil conditions are suitable for growing a wide range of these plants, which are more lucrative and adaptable to dryland farming compared to traditional crops. Saffron (*Crocus sativus*), the most expensive herb globally, thrives in arid and semi-arid conditions and requires minimal resources. Its cultivation can enhance farm profitability through the integration of summer vegetable production. Lavender (*Lavandula spp.*), another high-value crop, is well-suited for the region and offers multiple uses in essential oils and personal care products. Rosemary (*Rosmarinus officinalis*) and thyme (*Thymus vulgaris*) are also highlighted for their drought tolerance and medicinal properties. Chamomile (*Matricaria chamomilla*) and Damask rose (*Rosa damascena*) are noted for their medicinal uses and potential in commercial production. The document underscores the importance of proper soil and water management, organic farming practices, and the role of secondary metabolites in enhancing crop quality under stressful conditions. Intercropping and the use of farm residues for soil conservation are also discussed. The review concludes that these high-value crops can diversify farm income, improve land use efficiency, and offer sustainable agricultural solutions for water-scarce regions in northern New Mexico.

**Keywords:** Lavendar; Rosemary; Thyme; Chamomile; Damask rose.

### INTRODUCTION

Chemical investigation of medicinal and aromatic plants leads to valuable resources used in the pharmaceutical, food, beverage, cosmetic, and other industries as well. Traditional medicine and herbal remedies are enjoying a strong revival these days across both Western and developing countries, with an acceleration in popularity witnessed over the past two decades. The rising demands in both national and global markets have added to commercial advantages of medical herbs <sup>[1,2]</sup>.

However, the harvesting of medicinal plants from natural habitats carries a set of problems such as over-harvesting at the global or regional/local levels and which endangers species and disturbs ecological systems. This should also consider the impacts on the environment during cultivation and collection as well as the livelihood of local communities. The secondary metabolites from medicinal plants are also a premium source for pharmaceutical applications including alkaloids, glycosides, coumarins, and steroids <sup>[9]</sup>. Aromatic plants contain essential oils that have fragrant volatile compounds. They are used in different industries such as perfumery, cosmetics, and pharmaceuticals. In addition, flavorings obtained from spices and condiments also serve as basic raw material in the food industry <sup>[3]</sup>.

It is estimated that 80% of the world's population uses traditional medicines for their primary health care needs <sup>[2]</sup>. The 21st-century health consciousness and the side effects of modern-day drugs have led to revived interest in the discovery, development, and application of herbal therapies. The global market for herbal products has been growing at an annual rate of 15% with a projection to value around US\$5 trillion by the year 2050 up from about US \$62 billion in just over ten years (2004) <sup>[4]</sup>. In the United States growers are looking at other crops to diversify their farming operations and increase cash flow. New Mexico has a wide range of ecosystems and microclimates. The advantage of this attribute is that farmers can grow more than 750 varieties of medicinal herbs. Northern New Mexico has a tradition of medicinal herb use in Native American and Hispanic cultures <sup>[5]</sup>.

Most of the irrigated land in northern New Mexico is worked by small-scale farmers and ranchers with fewer than 20 acres. Water scarcity in the region has been further intensified by climate change. As a result, traditional crops become less lucrative which lead farmers to seek more profitable options. Medicinal plants, as a broad class, are worth investigating because of the potential high demand, high value, and adaptation to harsh growing conditions [6].

Breeders have also been working to develop a medicinal botanical range focused on specific varieties of mitigation which could attract buyers to a lucrative market for such crops, than traditional compared to traditional dryland crops. These plants do really well in the dirt climate our Great Taste Kitchen Garden with its low atmospheric humidity which prolongs their freshness for ages. These medicinal properties are generally result phytochemicals that they contain, including alkaloids, glycosides, steroids, and essential oils secondary metabolites. In fact, crop quality has actually been found to increase under water stress due to increased production of secondary metabolites - these could even be responsible for better drought resistance Secondary metabolites are produced in higher concentration under water stress conditions, as shown in numerous studies [3,4,6,7]. Dryland environments also provide better quality crops [8].

Some studies have suggested growing aromatic grasses (lemongrass and palmarosa) and medicinal plants such as (*Senna andrographis*) which needs a minimum water supply to grow in suitable rain-fed regions Their ability to grow in drought conditions offers a unique opportunity for low-cost cultivation in arid lands as an environmentally sustainable alternative to traditional crops. The effect of monoculture rotation in semi-arid regions can diversify crop production [9].

Based on the flora type, medicinal plants might be cultivated alongside orchards as main crops. Cultivating them as intercrops can help manage soil erosion and prevent nutrient depletion. The soils in semi-arid regions usually have low availability of nutrients necessary for plant growth [10].

In rainfed areas, dryland productivity sustained by efficient water soil management of medicinal aromatic dye crops can importantly save soil and water resources. The utilization of medicinal aromatic substances along with their derivatives is very useful. Vetiver is considered a flagship plant for soil water conservation as well as environmental protection due to extremely large fibrous root system, which enables the colonization of heterotrophic bacterial population that degrades organic matter. Residue from the farm is very helpful in retaining moisture and extra nutrients. The large quantities of biomass produced by these crops can be used more affordably for other purposes, such as cutting cultivation costs, suppressing weeds, and conserving soil moisture [11].

Many studies have shown that organic agriculture reduces the negative impacts of drought and provides more healthier crops than conventional methods. Several precursors have been identified that protect plants against viruses, bacteria, and fungi. Furthermore, there are secondary compounds such as cyanogenic glycosides, glucosinolates, terpenes, saponins, tannins, anthraquinones, and polyacetylenes act like allelochemicals and influence the growth process of other plants that grow alongside them. To improve ultimate plant productivity and quality, it is very important to understand the dynamics of materials, crop health, and soil health, as well as the role of natural pesticides [12, 13, 14].

The purpose this review paper is to describe how medicinal high-value plants might be viable for small-scale cropping in northern New Mexico under water-scarce conditions.

## Saffron

Saffron (*Crocus sativus*) considered the most expensive herb globally, is a member of the Iridaceae family and thrives in conditions with

water scarcity, cold winters, and warm summers. It blooms during autumn and is not found growing naturally in the wild; its possible ancestors include *Crocus cartwrightianus* from the eastern Mediterranean region. Prior to blooming, some suspect that cataphylls of *Crocus sativus* may appear when irrigated early in its growth cycle. The plant's floral axes support bracteoles on flower stems known as pedicels. Saffron plants have been sterile for over 3000 years and feature flowers comprising three purple petals, three purple sepals, three golden yellow stamens, and one red pistil made up of three dried stigmas, which yield saffron spice [15].

The major saffron-producing countries are Iran, India Spain Greece with Iran leading production at about 88% worldwide. Saffron cultivation significantly impacts small farm economies primarily in nations like Iran India Afghanistan Greece Morocco Spain Italy among others producing around 418 tons annually across roughly 250000 acres worldwide including newer regions such as New Zealand New England [16,17].

By 1730 Pennsylvania Dutch began cultivating saffron extensively in eastern Pennsylvania trading it successfully with Spanish colonies. War of 1812 led to decline but local cultivation endured mainly within Lancaster County Pennsylvania sustaining American presence till modern times used notably in various dishes like cakes noodles chicken trout recipes among others. Saffron cultivation has expanded to regions like California and west Texas in recent years. The global market size for saffron was valued at USD 589.23 million in 2022, with an anticipated growth rate of 6.4% from 2022 to 2030 driven by increasing demand in medical and cosmetic sectors due to its antioxidant-rich nature and associated health benefits [18,19].

Saffron quality is determined by the concentration of three primary metabolites affecting color (crocin), aroma (safranal), and flavor (picrocrocin). Its active components are known for their potential therapeutic effects on various diseases including Alzheimer's, Parkinson's, depression, cardiovascular issues, respiratory ailments, and digestive disorders as well as properties such as fat reduction and blood sugar regulation along with anti-inflammatory abilities [18].

In the US market, wholesale prices for saffron range broadly from US\$500 to US\$5,000 per pound depending heavily on product grade. The unique characteristics of saffron enable it to thrive even in challenging environments using minimal resources like water irrigation or chemical inputs for pest control due to its distinctive biological traits [18].

As a perennial crop propagated via corms cycle annually renewing mother corms into daughter corms which then mature into potential new mother corms over growing seasons - setting itself apart from traditional crops by commencing flowering cycles around mid-October producing leaves until spring while establishing replacement corms during this period acting both as soil protectors against erosion yet nourishing soil biology till foliar decay occurs typically around May after continuous leaf growth post-cultivation." No cover crop is necessary in areas where saffron is cultivated due to its long vegetative growth period spanning from October through May. This unique life cycle creates an opportunity for incorporating saffron cultivation into summer vegetable production, leading to enhanced land utilization efficiency, prolonged growing seasons, increased biodiversity, and improved farm profitability [20, 21].

Saffron stigmas are dried thread-like parts of the flower used for making spice, food coloring, and medicine with potential mood-altering effects and various health benefits such as anti-cancer properties and antioxidant activity. The leaves can also serve as fodder for livestock [22,23].

*Crocus sativus* flourishes in environments similar to the Mediterranean maquis or North American chaparral characterized by hot dry summers but can withstand cold winters down to -10°C (14°F) with brief snow coverage periods. While irrigation may be necessary

outside moist regions like Kashmir that receive annual rainfall between 1,000-1,500 mm (39-59 inches), Iranian cultivating areas receiving only around 250 mm annually face drier conditions compared to Greece's approximately 500 mm or Spain's roughly 400mm yearly precipitation levels<sup>[23,24]</sup>. Saffron thrives best in friable clay-calcareous soils rich in organic matter allowing easy root penetration while sandy or loamy textured soils are optimal choices according to Nehvi<sup>[25]</sup>. A soil pH ranging from 6.3 to 8.3 and electrical conductivity within 0.09 to 0.30 dSm<sup>-1</sup> are considered favorable parameters for supporting healthy saffron growth<sup>[26]</sup>. Planting of corms should occur between late August till mid-September with denser planting resulting into better flower and corn yield as reported by Koochecki et al.<sup>[23]</sup>.

Mother corms of 4–6 g\planted at 300 (first year) or 200(second year) corms m<sup>-2</sup>yielded the maximum number of flowers. However, the ideal planting density may vary depending on mother corm size. According to Mohammad et al.<sup>[27]</sup> a spacing of 10–20cm was found beneficial in terms of fresh dry stigma yield, flower yield, and average corm weight. Saffron corms in Spain are commonly placed in shallow ditches, organized in two rows with spacing options of either 8-10 cm or 12-15 cm depending on the layout. Planting from July to early September with corms weighing at least 8g and using a planting pattern of either 6×6" or 6×4" can result in increased flower production<sup>[28]</sup>.

Saffron cultivation is well-suited for arid and semi-arid regions as the corms undergo a dormancy period lasting five months starting from early May when spring rainfall diminishes. Irrigation timing significantly impacts saffron yield; mid-June irrigation led to a reduction of about 17% while late August irrigation resulted in approximately a 20% increase in flower yield<sup>[29]</sup>.

Harvesting saffron involves picking flowers and separating the stigmas. Flower collection begins when they first appear, typically between October and November depending on regional climate variations. The picked flowers are separated into stigmas which are then dried under shade for around two to three days before processing further<sup>[30,31]</sup>.

The process of producing dry stigmata requires approximately 78.5 kg of fresh flowers (equivalent to roughly 170,000 flowers) per kilogram produced in Khorasan region. The size of the corm significantly influences flowering capacity where an estimated range spans between 30-50% blooming within the initial year over a 2-4-week period. Harvest time generally falls between mid-October till mid-November with optimal harvest occurring during full bloom phase. Producers may expect to obtain an average of 5-10 lbs. Saffron per acre though top growers have achieved yields up to 15 lbs. Saffron per acre<sup>[30]</sup>.

## Lavender

Lavender (*Lavandula spp.*) a well-known aromatic plant with ancient roots in both medicinal and fragrance applications, remains popular today due to its presence in essential oils, perfumes, and personal care items. There are over 20 significant lavender varieties commercially available, each with unique climate and cultivation requirements. Factors such as low humidity levels, winter temperatures, soil drainage issues, and processing needs for essential oils restrict large-scale lavender farming in Kentucky<sup>[32]</sup>.

Originally hailing from the Mediterranean region of Europe, lavender now thrives globally in regions resembling its place of origin. Key commercial growing regions include France, England, New Zealand Australia while North American states like Washington State host profitable lavender cash crops. In certain Northern New Mexico farms engaged in agritourism ventures could find success cultivating lavender as a specialized crop.

A semi-woody perennial sub-shrub belonging to the mint family (Lamiaceae), Lavender features square stems and distinctive scents that vary depending on location and weather conditions. Two main types suitable for growth in New Mexico are *Lavandula angustifolia* or English lavender - known for blooming twice per season - alongside *L.intermedia* or lavandin which yields larger quantities of oil but inferior quality compared to English counterparts<sup>[32]</sup>.

To ensure successful planting of *L.angustifolia* cultivars it is advised to utilize nursery stock free from Phytophthora & Rhizoctonia fungal pathogens propagated vegetatively rather than through seeds due to potential variations among seed-grown plants.

Research by the Sustainable Agriculture Science Center at New Mexico State University indicates fall-planted lavenders exhibit better survival rates establish quicker producing more flowers next season size selection contingent upon planting timing considerations." Fall-planted lavenders should be placed in pots that are 4 inches or larger to ensure survival during the winter, with an established root system. Watering is essential for their survival over the winter months. On the other hand, spring-planted lavender plants can be smaller since they have a longer season to establish their roots<sup>[33]</sup>.

Lavender thrives in full sun and alkaline soil with minimal organic matter. It may be necessary to amend heavy soils before planting for proper drainage. Utilizing one-quarter inch bark mulch as a soil amendment has proven effective; applying 1 inch evenly tilling it into a depth of 6 to 8 inches is recommended. Sand or gravel could also help alleviate drainage issues when used as soil amendments in clay soils<sup>[3]</sup>.

When cultivating lavender, spacing requirements vary based on the anticipated size of mature cultivars – typically ranging from 2 to 3 feet within rows and between rows at distances of around three to six feet apart. Lavender does not compete well against weeds; hence landscape fabric serves as an ideal weed barrier if grown outdoors organically<sup>[34]</sup>. Polypropylene fabric offers durability lasting up to ten years post-installation despite its initial costly investment per acre which eventually pays off through labor savings according to experienced lavender farmers (Wynne Wright, personal communication). Some growers opt for narrower bands of fabric solely under plants while fostering ground cover growth among rows due to complaints about wire pins coming loose or causing tire mishaps (Ibid.).

While known for drought tolerance, lavender require supplemental irrigation initially along with high-quality landscape fabrics for optimal establishment and maximum production levels. Irrigation needs will differ based on oil type, climatic zone, and weather patterns. Watering once or twice weekly directly after planting until established is recommended, followed by bi-weekly waterings until bud formation. Subsequently weekly irrigations readvised until harvest<sup>[3]</sup>.

It is recommended to propagate lavender plants by taking cuttings right after they have finished blooming. Choose plant stems without flower buds, remove lower leaves from the cutting, and plant it in well-draining soil or horticultural vermiculite. The application of rooting hormones is optional. It's important to label the cuttings with their cultivar name and collection date, water them adequately, and regularly mist them for around three weeks until they root. Once rooted, transfer them to pots sized 2 to 4 inches in diameter before eventually planting them in your garden.

Regular pruning benefits lavender as it flowers on new growth; ideally prune annually once established when green leaves appear at the base during spring by removing about a third of its top part. This practice prevents splitting and woodiness issues while ensuring optimal oil concentration during harvesting when approximately half of the flower buds have opened early morning.

Lavender harvest typically begins in its second year at flowering (June–July) and lasts up to 12-15 years under high productivity conditions post-establishment before declining.

Flowering periods vary geographically; Eastern European silvo steppe areas see earlier blooms lasting around 15-20 days compared to colder temperate regions where flowering occurs later but extends over roughly 25-30 days<sup>[34]</sup>.

### Rosemary

Rosemary (*Rosmarinus officinalis*), a perennial herb with aromatic evergreen needle-like leaves, is indigenous to the Mediterranean region and belongs to the Lamiaceae family. Contrary to its name's suggestion of roses or Mary, "rosemary" stems from the Latin term *rosmarinus* which translates as "dew of the sea." This herb thrives in warm climates such as California where it can grow vigorously into a shrub with woody stems emitting a pine-scented aroma. Not only valued for culinary purposes but also for its attractiveness to bees and reputed medicinal properties like aiding headaches and circulation<sup>[35]</sup>.

Thriving in sunny regions resembling its native Mediterranean habitat, rosemary can reach heights of 5-10 feet when cultivated under ideal conditions requiring regular pruning. It fares well both in-ground and potted environments especially thriving in Zones 7 and above serving as an enduring evergreen shrub surviving harsh winters indoors if needed.

Known for drought tolerance yet flourishing best within specific temperature ranges (20-25°C) receiving adequate rainfall while preferring sandy-clay loam soil types with proper drainage between pH levels of 5.5-8.0 excluding waterlogged soils which hamper growth potential requiring compost additions if necessary<sup>[3]</sup>.

Irrigation aids establishment particularly beneficial until rooted firmly, but waterlogging should be avoided. Harvesting protocols vary depending upon intended use. Younger growth (up to 6 months after planting or after spring greenup) is preferred for fresh markets, but older growth (up to 9 months old is preferred for essential oil extractions).

### Thyme

Thyme (*Thymus vulgaris*), is a small evergreen shrub native to the Mediterranean and belonging to the mint family. It was historically linked with ancient Egyptian embalming practices and revered by the Greeks for its symbolic association with courage, but today is primarily utilized today as a culinary herb cultivated. The plant can be easily propagated through various methods such as division, layering, cuttings, or seeds; among these options, propagation from cuttings is often recommended for novice growers<sup>[3]</sup>.

Delicate tubular flowers ranging in colors of pink, lavender or white that bloom during spring and summer months attracting bees and pollinators alike. Thyme's gray-green leaves remain vibrant year-round making it available for harvesting even during winter months where it thrives perennially within USDA zones 5 through 9<sup>[36]</sup>.

Primarily utilized today as a culinary herb cultivated commercially worldwide on farms and plantations. When propagating thyme via stem cuttings using rooting hormone products may enhance success rates while ensuring minimal contamination risks associated with handling such substances.

Thyme plants require infrequent watering once established—typically every other week or monthly depending on climatic conditions—allowing soil to dry out completely before saturating again due to its drought-resistant nature requiring less water than most herbs especially when well-rooted specimens are present<sup>[37, 38]</sup>.

Once matured thyme plants offer continuous harvest opportunities, retaining their flavor post-flowering stages. Fresh thyme should be stored refrigerated lasting up to two weeks after removing woody stems alternatively dried either traditionally hanging upside down protected from light warmth sources or slowly dehydrated achieving long-term storage usability reaching up till one year if handled appropriately<sup>[38]</sup>.

### Chamomile

Chamomile (*Matricaria chamomilla*) is a widely recognized herb and flower plant that has been traditionally enjoyed as a calming tea. In addition to its culinary use, Chamomile has long been utilized for its medicinal properties attributed to coumarin, an active ingredient known for its anti-inflammatory and blood thinning effects<sup>[3]</sup>.

This annual plant features spindle-shaped roots that spread flatly into the soil with an erect branched stem reaching heights of 10–80 cm. Its bi- to tripinnate leaves are long and narrow while the flower heads - individually placed with diameters ranging from 10–30 mm - boast golden yellow tubular florets ending in glandulous tubes. The white plant flowers are arranged concentrically around the receptacle which lacks paleae - a distinctive feature of *Matricaria*; producing yellowish-brown achene fruits<sup>[3,39]</sup>.

Chamomile's therapeutic benefits extend across various ailments including insomnia, indigestion, toothaches, allergies among others. German Chamomile specifically is commonly used in skincare products due to its soothing properties when dried or fresh flowers are incorporated.

For cultivation purposes whether indoors or outdoors it's advised not to bury seeds entirely but rather expose them lightly given their light germination requirements. Soil preparation involves clearing debris and loosening it before gently pressing down seeds followed by thorough moistening for optimal growth conditions at temperatures between 15-20°C leading up to germination within one-two weeks<sup>[3]</sup>.

Alternatively sowing Chamomile outdoors during autumn allows pre-winter germination necessitating care through colder months using mulch protection against low temperatures facilitating gradual crop growth until early February where significant activity such as height increase bud formation indicates onset of flowering season requiring selective plucking throughout this cycle till seed-setting occurs upon temperature rise inducing maturity signaling subsequent self-germinated crops next year<sup>[39]</sup>.

Harvesting presents considerable labor intensity constituting a substantial portion of production costs crucial during peak flowering seasons spanning March-April demanding meticulous handpicking practices favoring near full bloom stage buds offering premium quality yield whilst maintaining minimal inclusion of extraneous material like stems or leaves ensuring high-quality product outcomes reflecting Singh's recorded maximum yields notably influenced by temperature fluctuations impacting floral weight per unit from late February onwards<sup>[3]</sup>.

### Damask rose, Damascus rose, Rose of Castile

*Rosa damascena*, a rose hybrid originating from *Rosa gallica*, *Rosa moschata*, and *Rosa fedtschenkoana*, is a deciduous shrub with stems adorned with sturdy prickles and bristles. Typically growing up to 2.2 meters in height, this bush bears pinnate leaves consisting of five leaflets (sometimes seven) and light pink to red flowers that cluster together. Known for its informal shape as an Old Rose variety, it holds significance in the lineage of various other rose types<sup>[3,40]</sup>.

The fragrant flowers are harvested for their aroma and used commercially to extract rose oil for perfumes along with producing rosewater and "rose concrete." Additionally, the petals find applications in flavoring food or making tea safely consumable by

humans. Cultivated on a large scale mainly in Bulgaria, Turkey, France among others; it serves as a prime source for concentrates rich in aromatic compounds—recognized as one of the top commercial species amongst fragrant roses [42].

Rich in terpenes, glycosides flavonoids alongside anthocyanins; *Rosa damascena* offers several health benefits owing to its pharmacological effects spanning across different systems including CNS functions like hypnotic analgesic properties while also exhibiting cardiovascular respiratory laxative antidiabetic antimicrobial anti-HIV anti-inflammatory antioxidant activities attributed majorly to lipid-soluble constituents present within [41].

Native to Europe particularly Iran & Turkey regions known historically linked Damascus; key countries facilitating extensive cultivation include Bulgaria, Turkey, French, Morocco, Russia, and India where substantial quantities of oil are produced annually especially by Bulgaria, Turkey, and Morocco accounting collectively about 10 tons yearly. In Central Bulgaria near Balkan Mountains over three centuries, the largest integrated growth area has been established demonstrating significant development. Cultivation recommendations involve full sunlight exposure devoid tree/hedge interference ensuring adequate sunshine preferably during mornings adaptable on leveled fields, hilly terrains or terraces benefiting from mild temperate climates ideal conditions suitable for cultivating *Rosa Damascena* efficiently. Prior to blooming, temperatures ranging from 0 to 5°C for approximately 15 days can enhance both the quantity and quality of flowers. During flowering, it is ideal for temperatures to range between 25 to 30°C with a relative humidity above 60%. A combination of high air humidity exceeding 60% and moderate temperatures of around 15-20°C results in higher flower yields. While *Rosa damascena* can thrive in regions with high temperatures, the yield of flowers is notably lower compared to plants grown in temperate climates. These roses flourish best at foothill locations and are adaptable to soil pH levels ranging from 6 to 8 [3, 40].

Irrigation plays a vital role in rose plantations, requiring watering every 12-15 days during peak periods; however, once plants are well-established after two years, irrigation frequency may be reduced. Adequate field drainage is crucial for removing excess rainwater [3].

The application of fertilizers and manures should be based on soil tests considering factors such as soil fertility level, organic content, texture, moisture availability, and pH balance. *Rosa damascena* propagation typically involves one-year-old stem cuttings or divisions from old plants, lateral sprouts with roots, and seeds. Stem cuttings that are collected during pruning between mid-October and late December—measuring 20 cm long and 0.75-1.50cm thick—are planted into nurseries by burying 2/3 of their length within the soil. Soil preparation includes weed clearance when cultivating new land, dismantling wild bushes, and establishing proper drainage channels. Followed by correct marking at optimal distances, a spacing of 1.5 x 1.5 m<sup>2</sup> is sufficient for promoting optimum plant growth [42].

The most suitable time for translocating rooted cuttings to fields falls between mid-November to mid-January. Nursery plants are transferred to the field on overcast days or even during the rainy season. Inter-cultural operations involve maintaining weed-free surroundings post planting, two-to-three weeding sessions along with hoeing within the first year, coupled with thorough weeding, circle-hoeing around each plant annually alongside winter pruning. Twice-a-year sickling during rainy seasons helps control seasonal weeds and grasses in rose plantations." Pruning is a crucial practice for *Rosa damascena*, requiring a period of dormancy before flowering. In temperate regions, natural dormancy occurs during the winter when the plant sheds its leaves and new shoots emerge in spring to produce flower buds. Conversely, in sub-tropical climates, artificial dormancy is induced through pruning. The primary objectives of pruning include shaping plants, controlling size, eliminating damaged parts, stimulating bushy growth by removing terminal buds and altering growth habits to promote more flowers [3,41].

The Summer Damask rose blooms from early March to mid-April in North Iridium plains, from April 10th to May 20th in Himachal Pradesh's mid hills and early May to June in Kashmir Valley; however exact timing varies based on local temperatures. Autumn Damask roses also flower between September and November but with lower yields compared to the main season; sporadic blooming may occur year-round. Flowering typically spans 25-35 days with peak yield lasting around 15 days [41].

Care commences with gentle plucking without piling large quantities at once; collected flowers should be promptly transferred into well-ventilated wooden baskets after picking to prevent fermentation which diminishes oil content and quality - prolonged storage results in significant oil loss within hours post-harvesting. Annual flower yields vary across countries due to different cultivars involved: Bulgaria/Iran/India (2000-3000 kg ha<sup>-1</sup>), Turkey (2000-2500 kg ha<sup>-1</sup>), Russia (1500–2000 kg ha<sup>-1</sup>). Institute of Himalayan Bioresource Technology (IHBT) developed improved Damask rose cultivars boast higher yields ranging from 4000–50000kg ha<sup>-1</sup> while maintaining linear productivity trends for up-to seven years post-transplantation despite an economic plantation life span of approximately ten-twelve years according Zehtab Salmasi & Dast Borhan [3].

## CONCLUSION

In conclusion, there are a number of herb species environmentally well-adapted to arid conditions like those in northern New Mexico that may be grown sustainably and have long-term economic potential for small-scale traditional growers. The species summarized in this introduction are just a beginning. Further investigation calls for cost-benefit analyses, cost-and-return calculations, methods to integrate with current agronomic and vegetable crop rotations in the area, and local and international marketing research to develop these and other crops for the benefit of all. Further funding for specialty-crop research is called for.

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## Conflict of interest

The authors declare that they have no conflict of interest.

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