Volume 4, Issue 11
November I 2026

Agri Roots
e- Magazine

www.agrirootsmagazine.in

ISSN: 2583-9071

Aromatic Plants for Climate-Resilient and Low-Input Farming

ARTICLE ID: 0449

Sneha Jha

School of Agriculture and Environmental Science, Shobhit University, Meerut, Uttar Pradesh, India.

Agriculture is increasingly affected by rising temperatures, irregular rainfall, droughts, soil degradation and the growing cost of agricultural inputs. These challenges highlight the need for farming systems that use natural resources efficiently while maintaining productivity and profitability.



Aromatic plants contain fragrant compounds, particularly essential oils, that are commercially valuable in the perfume, cosmetic, pharmaceutical, food and personal-care industries. Important examples include lemongrass (*Cymbopogon flexuosus*), palmarosa (*Cymbopogon martinii*), vetiver (*Chrysopogon zizanioides*), citronella (*Cymbopogon winterianus*) and basil (*Ocimum basilicum*).

Climate-resilient aromatic farming does not mean that all aromatic plants are drought-resistant or require no fertilizers. Rather, it involves selecting crops suited to local environmental conditions and managing them efficiently to reduce production risks and unnecessary input use. When appropriately integrated into farming systems, aromatic plants can contribute to crop diversification, soil conservation and additional farm income.

1. Importance of Aromatic Plants in Climate-Resilient Farming

1.1 Adaptation to Climate Variability

Climate-resilient agriculture aims to maintain agricultural production despite changing weather conditions. Some aromatic plants can tolerate heat, moderate moisture stress or less favourable soil conditions better than certain sensitive crops. However, their tolerance varies among species and varieties and depends on crop establishment and management practices.

1.2 Efficient Utilization of Water

Water scarcity is a major limitation in many agricultural regions. Appropriate aromatic crops can provide diversification opportunities where water resources are limited, particularly when selected according to local rainfall, soil characteristics and

irrigation availability. Efficient irrigation methods, such as drip irrigation, can help reduce water losses where technically and economically feasible.

1.3 Cultivation on Marginal and Degraded Lands

Marginal lands may have low fertility, poor soil structure, salinity, alkalinity or other limitations that restrict conventional crop production. Certain aromatic grasses can tolerate specific adverse soil conditions and may provide an alternative use for selected degraded areas. Nevertheless, crop selection should be based on soil testing and the tolerance limits of the chosen species.

1.4 Soil Conservation and Carbon Management

Perennial aromatic grasses develop extensive root systems that help bind soil particles and reduce erosion. Vetiver is particularly valued for stabilizing slopes, field boundaries, embankments and erosion-prone areas. Perennial vegetation may also contribute to soil organic matter accumulation through root growth and the addition of plant residues.

1.5 Reduction in Production Costs

Some aromatic crops can be maintained with comparatively modest external inputs after successful establishment. Perennial grasses may produce repeated harvests without annual re-establishment, depending on the species and production system. However, costs associated with irrigation, nutrient management, harvesting, distillation and transportation must be considered when evaluating their economic suitability.

1.6 Diversification of Farm Income

Aromatic plants produce valuable raw materials for essential oil extraction and other value-added products. Their cultivation can diversify farm income and create employment opportunities in planting, harvesting, processing, packaging and marketing. Access to suitable processing facilities and reliable markets is essential for realizing these opportunities.

2. Major Aromatic Plants Suitable for Diversified Farming

2.1 Lemongrass (*Cymbopogon flexuosus*)

Lemongrass is a perennial aromatic grass cultivated for its essential oil, which is used in perfumery, cosmetics, soaps and flavouring applications. It grows well in suitable tropical and subtropical environments and can produce multiple harvests under favourable management. Its commercial potential depends on suitable varieties, adequate moisture, proper nutrient management and access to distillation facilities.

2.2 Palmarosa (*Cymbopogon martinii*)

Palmarosa is an aromatic grass valued for its geraniol-rich essential oil, which is widely used in fragrance and personal-care products. It has cultivation potential in suitable warm regions and on certain marginal soils. Its performance depends on local climatic conditions, soil characteristics and crop management.

2.3 Vetiver (*Chrysopogon zizanioides*)

Vetiver is a perennial grass whose fragrant roots are used to extract essential oil for perfumes and cosmetics. Its deep and extensive root system makes it useful for stabilizing embankments, field boundaries and erosion-prone land. It can also be integrated into soil conservation measures, particularly on slopes and along drainage channels.

2.4 Citronella (*Cymbopogon winterianus*)

Citronella is cultivated for its essential oil, which is used in fragrances, soaps and insect-repellent products.

It is suitable for regions that provide adequate warmth, moisture and well-drained soil. Successful cultivation requires proper planting material, timely harvesting and access to suitable oil extraction facilities.

2.5 Basil (*Ocimum basilicum*)

Basil is an aromatic herb grown for its leaves and essential oil. It is used in fragrance products, culinary applications and selected herbal preparations. Depending on the variety and production objective, it can be cultivated as a short-duration crop and integrated into diversified cropping systems.

2.6 Tulsi (*Ocimum tenuiflorum*)

Tulsi is an aromatic herb widely cultivated in India for traditional uses and herbal products. It can provide opportunities for small-scale cultivation, nursery production and value addition. Its suitability depends on local growing conditions, the availability of quality planting material and demand for the intended products.

3. Cultivation and Management Practices

3.1 Site Selection and Soil Preparation

The site should be selected according to the chosen species, local climate, soil texture, drainage and water availability. Soil testing helps determine nutrient status, pH and potential salinity or alkalinity problems. Land preparation should provide a suitable seedbed or planting environment while minimizing unnecessary disturbance of the soil.

3.2 Selection of Planting Material

Healthy, disease-free seeds, rooted slips or other vegetative planting materials should be obtained from reliable sources. Planting material must be suited to the local climate and intended use of the crop. The selection of improved and locally recommended varieties can support better establishment, biomass production and essential oil quality.

3.3 Planting Time and Method

Planting time depends on species, climate and irrigation facilities. In rainfed areas, planting near the onset of dependable monsoon rainfall may support establishment, provided the soil is not waterlogged. Species-specific recommendations should be followed for planting depth, spacing and propagation method.

3.4 Water Management

Water requirements vary considerably among aromatic species and across growth stages. Newly planted crops generally need adequate moisture for establishment, even if mature plants tolerate some moisture stress. Irrigation should be scheduled according to soil moisture, rainfall and crop requirements. Drip irrigation and mulching may help improve water-use efficiency where appropriate.

3.5 Nutrient Management

Balanced nutrient management supports healthy growth and essential oil production. Soil testing should guide fertilizer application, while well-decomposed farmyard manure or compost may be used where appropriate. Excessive fertilizer application should be avoided because it can increase production costs and may not necessarily improve oil yield or quality.

3.6 Weed Management

Weeds compete with aromatic plants for light, nutrients, water and space. Competition is particularly harmful during early crop establishment. Weed management can include manual weeding, mulching, suitable crop spacing and timely intercultural

operations. Maintaining a weed-free crop during critical growth stages helps promote healthy establishment and biomass production.

3.7 Integrated Pest and Disease Management

Although some aromatic crops may experience relatively low pest pressure under particular conditions, none should be assumed to be pest-free. Regular field monitoring, healthy planting material, proper drainage, crop sanitation and timely removal of affected plant parts are important preventive measures. Pest and disease management should follow locally recommended integrated pest management practices.

3.8 Harvesting and Essential Oil Extraction

Harvesting time influences both biomass yield and essential oil quality. The appropriate stage varies according to species, variety, weather conditions and intended product.

Leaves and above-ground biomass are harvested from lemongrass, palmarosa and citronella, whereas vetiver is harvested mainly for its roots. Basil and tulsi may be harvested for leaves, flowering shoots or oil-bearing biomass according to the production objective.

Distillation should be carried out using suitable equipment and recommended procedures. Steam distillation or other appropriate methods may be used depending on the crop and processing facility. Clean handling, timely processing and proper storage help reduce losses and maintain product quality. Essential oils should be stored in suitable, tightly closed containers under recommended conditions to minimize deterioration.

4. Economic and Environmental Benefits

Aromatic plants may provide several benefits when selected and managed appropriately.

4.1 Economic Benefits

- **Diversification of Farm Income:** Essential oil and biomass production can provide additional income opportunities.
- **Value Addition:** Distillation, packaging and the preparation of marketable products can increase the value of agricultural produce.
- **Utilization of Selected Marginal Lands:** Certain aromatic species may be cultivated on land unsuitable for some conventional crops.
- **Rural Employment:** Planting, harvesting, processing and marketing can generate employment opportunities.
- **Entrepreneurship:** Small-scale distillation units and farmer-producer organizations can support local value chains.

4.2 Environmental Benefits

- **Soil Stabilization:** Suitable perennial grasses can help reduce soil erosion and stabilize vulnerable land.
- **Improved Land Utilization:** Selected aromatic crops may provide productive options for certain underutilized agricultural areas.
- **Residue Recycling:** Crop residues and suitable distillation by-products may be recycled through composting or other appropriate processes.
- **Resource-Use Efficiency:** Efficient irrigation and balanced nutrient management can help reduce unnecessary water and chemical inputs.

- **Cropping-System Diversification:** Integrating aromatic plants with other suitable crops can increase diversity within farming systems.

These benefits are not automatic. Profitability and environmental performance depend on local yields, input costs, energy use, land suitability, processing efficiency, transportation and market access. Farmers should assess these factors before adopting aromatic crops on a commercial scale.

5. Future Prospects

The future of aromatic plants in climate-resilient agriculture depends on combining improved crop varieties with resource-efficient cultivation and strong market linkages. Research priorities include developing varieties tolerant to heat, drought and soil-related stresses; improving essential oil yield and quality; and identifying suitable crops for different agroclimatic regions.

Digital weather information, soil testing, efficient irrigation and improved processing technologies can further support farm-level decision-making. Farmer-producer organizations and cooperatives may also help smallholders access quality planting material, distillation equipment, technical advice and reliable buyers.

In India, initiatives such as the CSIR Aroma Mission have promoted aromatic crop cultivation, improved planting material, processing technologies and entrepreneurship. Such initiatives can support the development of aromatic crop value chains and create opportunities for farmers in suitable regions.

Wider adoption should be based on locally verified agronomic recommendations, economic assessment and environmental suitability rather than on the assumption that aromatic crops are universally low-input or climate-proof. Training, extension support and market-oriented planning will be important for ensuring sustainable adoption.

6. Conclusion

Aromatic plants offer valuable opportunities to diversify farming systems, utilize certain marginal lands and support rural livelihoods under changing climatic conditions. Crops such as lemongrass, palmarosa, vetiver, citronella and basil can contribute to essential oil production, soil conservation and additional income when matched to suitable environments. Their success depends on quality planting material, efficient water and nutrient management, appropriate harvesting and processing practices, and reliable markets. Integrating aromatic plants into climate-smart farming systems can support more resource-efficient and resilient agriculture while creating opportunities for rural enterprise.

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