International Journal of Agriculture Innovations and Research
Volume 9, Issue 1, ISSN (Online) 2319-1473
Manuscript Processing Details (dd/mm/yyyy):
Received: 02/06/2020 | Accepted on: 03/07/2020 | Published: 17/07/2020

Medicinal and Aromatic Plants in Drylands for Future Livelihood Security

M. Darthiya [1*] and Subbalakshmi Lokanadhan [2]
[1, 2] Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore-641 003, India.
*Corresponding author email id: mano.darthiya@gmail.com

Abstract **– India prevails as one of the richest sources for numerous kinds of medicinal and aromatic plants. It is estimated that the primary healthcare of over 80 percent of the world's populations till depends on plant based traditional medicines (WHO, 1991). Medicinal and aromatic plants have wider adaptability to drought and other adverse climatic conditions and are in great demand in pharmaceuticals industries. A survey done by UNESCO has showed that the arid zones of the old world are rich sources of medicinal plants and old world consists of large tracts of dryland area. The plants rich in secondary metabolites and, are potential sources of drugs are called medicinal plants. These secondary metabolites include alkaloids, glycosides, coumarins, flavonoids, steroids etc. The aromatic plants are those which possess essential oil in them and these essential oils are the odoriferous steam volatile constituents of the aromatic plants. The curative properties of medicinal and aromatic plants are due to the presence of secondary plant metabolites. The cultivation of certain medicinal and aromatic plants under rainfed can fetch price to the range of Rs. 7,150 to 35,000 per hectare. Medicinal plants have higher demand in the market and found to be more remunerative than traditional dry land crops. The suitable medicinal and aromatic plants for drylands are Senna, Periwinkle, Glory lily, Ashwagandha, *Phyllanthusniruri*, *Aloe vera*, Tulsi, Stevia and Mint. The cultivation and economics of these crops under drylands is discussed in this paper.**

Keywords **– Medicinal and Aromatic Plants, Secondary Metabolites, Drylands, Higher Remunerative, Livelihood Security.**

I. INTRODUCTION

The rainfed regions are characterized by erratic and ill distribution of rainfall, low fertility, high temperature, fast blowing dry winds, rapid percolation of water and higher transpiration rate as a result the vegetation is very poor and this causes soil erosion (Rock storm *et. al.*, 2003). It has been projected that by the end of this century, global temperatures are likely to increase by 1.8 to 4.0°C, causing more frequent hot extremes, floods, droughts, forest fires, cyclones and recession of glaciers. The United Nations Intergovernmental Panel on Climate Change (UNIPCC) reported that an overall increase of 2°C temperature and 7% rainfall would lead to an almost 8% loss in net farm level revenue. Moreover the population explosion has extended arable farming to the marginal lands, which has led to their further degradation and farming on such lands is leading to falling factor productivity and profitability of dryland crops and this has widened the socio-economic gap between rainfed and irrigated systems. In the present agricultural scenario, due to poor resource availability, high input cost, abnormal climatic phenomenon, increased pest and disease incidence etc. the productivity and profitability of traditional/conventional agricultural are gradually reducing and plateauing as a result farmers across the globe are looking for better alternatives (Noyingthung and Thejangulie, 2018). These changes put more threats on livelihood security of farmers, thereby, requiring alternative crops, which can withstand the climate abnormalities. This can be achieved by including some drought resistant, efficient water utilizing high value crops like medicinal and aromatic crops in to the drylands production systems. Diversification with high value crops like medicinal and aromatic plants (MAPs), which do not have critical stages, or reproductive stages help in increasing the water productivity and provide stability to dryland agriculture.

II. MEDICINAL AND AROMATIC PLANTS

It is estimated that 80 per cent of the population of developing countries relies on traditional plant based medicines for their health requirements (WHO, 1991). Though the terms medicinal and aromatic sounds similar, both are different. The plants which are rich in secondary metabolites and, are potential sources of drugs are called medicinal plants. These secondary metabolites include alkaloids, glycosides, coumarins, flavonoids, steroids etc., Aromatic plants are those which possess essential oil in them and these essential oils are the odoriferous steam volatile constituents of the aromatic plants. These essential oils are used in perfumery, cosmetic and pharmaceutical industries whereas the essential oils obtained from spices and condiments which impart the flavour and improved the taste of the food are used are several flavor industries.

Economic Potentials of Medicinal and Aromatic Plants

In the report commissioned by the World Wide Fund for Nature, it is pointed out that, the total import in 1980 of "vegetable materials used in pharmacy" by the European Economic Community was 80,738 tons (Lewington 1993). India was the largest supplier with 10.05 tons of plants and 14 tons of vegetable alkaloid and their derivatives. India, Brazil and China are the largest exporters of medicinal plants. Trade of medicinal plants from India is estimated to be worth Rs. 550 crores. Cosmetics and aromatherapy products are two important areas where Indian medicinal plants and their extracts like essential oils can contribute globally. Medicinal and aromatic plants have a high market potential with the world demand for herbal products growing of the rate of seven per cent per annum. Presently, the market for traditional systems of medicine in India is estimated to be about Rs. 4000 crore per year (Sunitha, 2004). The cultivation of certain rainfed herbs could fetch products price anywhere between Rs. 7,150 to 35,000 per hectare. Evidence shows that the total domestic potential for crude drugs and oil extracts in India is worth Rs 3 billion (Planning Commission, 2000).

Medicinal and Aromatic Plantsunder Dryland Condition

Dry land agriculture is characterized by uncertain monsoon resulting in low crop yield. Inspite of irrigation facilities available in the near future, 60-70% of the land shall remain dryland and it needs to be exploited. In India, out of the net sown area of143 m.ha, the dryland accounts for 93.13 m.ha (68.4%). This dryland agriculture 40 per cent population, 60 per cent of cattle heads and contributing 44 per cent to the total food grain production in India. A survey done by UNESCO in 1960 showed that the arid zones of the old world are rich sources of number of medicinal plants (Yaniv and Palevitch, l982).

Why the Medicinal Crops in Dry Lands?

Traditional crops are no more economical to the dry land farmers. In India, it is estimated that the collection and processing of medicinal plants contributes to at least 35 million work days of employment per annum. Medicinal and aromatic plants have higher demand in the market and found to be higher remunerative than traditional dry land crops. Plants are quite suitable to our soils and atmosphere and the crops have got shelf life (Kalaiselvi and Arul Swaminathan, 2009). The curative properties of medicinal plants are due to the presence of complex chemical substances such as alkaloids, glycosides, steroids, essential oils, etc. which are present as secondary plant metabolites. Moreover the water stress may have positive reactions in improving the quality of the crops through biosynthesis of secondary metabolites and this secondary metabolites may improve the drought resistance to plants. The concentration of these secondary metabolites was reported to be higher under

water stress conditions (Yaniv and Palevitch, l982). Therefore the quality of these crops are enriched under dryland conditions (Pratibha and Korwar 2002).

Suitable Medicinal and Aromatic Plants for Dry Lands

Ashwagandha, *Solanum nigrum*, Senna, Periwinkle, Glory lily, *Phyllanthus niruri*, *Aloe vera*, Tulsi, Stevia, and Mint are suitable to cultivate under dry land conditions (Narashima Reddy, 2006). Pareek and Gupta (1993) suggested that psyllium, senna, periwinkle, lemongrass, palmarosa, vetiver, indigo, mesta, henna can be grown over low fertility soil in dry and warmer tracts in the country. Studies at CRIDA suggested that in rainfed areas low water-requiring aromatic grasses like lemongrass, palmarosa etc., medicinal plants like senna, and rographis etc., can be successfully grown. The drought tolerance of these crops helped in cultivation of these crops economically in drylands. They serve as alternatives to traditional crops and help in crop diversification in semi-arid regions.

Economics of the MAP grown in dryland and rainfed regions.

S. No	Crops	Cost of Cultivation (Rs/ha)	Gross Income(Rs/ha)	Net Income Rs/ha
1	Lemon grass	22500	42000	19500
2	Java citronella	19500	33750	14250
3	Mentha	20500	36000	15500
4	Palma rosa	22500	40500	18000
5	Tulsi (basil)	11500	20000	8500

Source: Hanumanthappa et al.,

MAP and its uses.

S. No.	Medicinal and Aromatic plants	Uses
1	Senna	Cures constipation piles and used as natural laxative
2	Periwinkle	Cures high blood pressure, menstrual bleeding and used as an astringent
3	Glory lily	Medicine for arthritis
4	Ashwagandha	Cures stomach ulcers, increases resistance, aphrodisiac, Diuretic and has anti-biotic and anti-bacterial properties
5	*Phyllanthus niruri*	Cures Hepatitis, Eye sight problems, migraine, anemia and Lever problems
6	*Aloe vera*	Used in skin lotions and cures burns
7	Tulsi	Bactericide, Insecticide, digestive and used in treatment of Bronchitis, ear-ache, urinary complaint, coughs and cold
8	Stevia	Alternative to sugar for sugar patients
9	Mint	Digestive, medicine in rheumatic pains, head-ache and used as cough-drops and mouth washes

Cultivation as Inter-Cropping in Various Cropping Systems

Various medicinal plants, keeping in view their growth habits can be inter-cropped in orchards, forests and with major crops. When grown as intercrops, they may also control soil erosion and nutrient loss. Tropical soils

in general and red soils in particular are medium to low in available plant nutrients for growth of the crops. Experiments conducted at CRIDA revealed that cultivation of ashwagandha with green gram is proved to be more profitable than compared to sunflower and sesamum. It is also observed that planting of any alternate high value crop with green gram is more remunerative. Senna also can be intercropped with green gram, black gram and gingelly.

Role of MAPs in Soil and Moisture Conservation, Soil Fertility

Management of water and soil are very important in rainfed regions to sustain the productivity of drylands without much degradation. Medicinal aromatic and dye crops and their wastes can be utilized for conservation of soil and water. Vetiver has received widespread recognition as being an ideal plant for soil and water conservation as well as environmental protection. The lacework of root system of vetiver provides a large surface area for colonization by heterotrophic bacteria that degrade organic materials. Incorporating palmarosa spent material in rainfed palmarosa has contributed substantially to insitu moisture conservation increased the yields of the palmarosa.

Farm residues are very efficient supplements to supply nutrient as well as conserve moisture (Ramesh et al., 2005). The aromatic crops produce lot of distilled biomass these can be used economically for many purposes and reduce cost of cultivation they reduce the weed biomass as well as conserve soil moisture (Prakasha Rao and Puttanna 2000). A number of studies have shown that organic practices reduce the adverse impact of drought and produce significantly sustainable higher yields than the conventional practices. Many metabolites have been found to protect plants against viruses, bacteria, and fungi. Several secondary metabolites such as cyanogenic glycosides, glucosinolates, terpenes, saponins, tannins, anthraquinones and polyacetylenes also act as allelochemicals influencing the growth and development of neighboring plants. Understanding the activity of these chemicals on crops soil and as pesticides is imperative to optimize the yield and quality of the plants in organic farming.

Cultivation and Economics of Medicinal and Aromatic Plants

Vetiver (Vetiveriazizanioides L.)

It helps in soil and moisture conservation, bioengineering, bioremediation and agricultural benefit. Vetiver provides cost effective solutions to soil erosion and slope stabilization problems and the movement of soil and water borne pollutants.

Varieties:

There are basically two main types of the vetiver grass, viz. 1. Seeding type and 2. Non-seeding type.

The one that grows wild in North India is mainly the seeding type while that of the south is the non-seeding type. Besides, differences exist between the North and South Indian strains with regard to yield and aroma of the oil. The oil of some of the North Indian type's viz. Bhartapur, Akila and Musanagar strains generally have an aroma superior to that of oil derived from South Indian grasses.

Climate, Soil and Planting

Vetiver prefers a mild climate but can be grown under both wet and dry or arid tropical conditions. Under temperate or warm winter hill areas, the growth of vetiver remains stunted. The most suitable soil consists of

loose sandy soils, preferably on the sloppy hills. In such soils only, the roots can be easily pulled out without much loss of thin roots. Compact and heavy soils may be avoided. Vetiver can be propagated through tillers and slips. Tillers take long time for growing and therefore, slips are the better planting materials for propagation. One hectare requires 1,50,000 to 2,25,000 slips with 2-3 slips per pit in the commonly adopted system of planting. The best planting time to get higher oil yield under South Indian condition is June-July. Vetiver should not be planted on shaded places as shade will exert an unfavorable influence on the development of root system.

Harvesting and Yield

Harvesting is done during the dry months of the year. In general it is the practice to harvest the roots both for manufacture of articles and for distillation when the plants are about 10-12 months old. Harvesting or uprooting is done with digging forks. To start with the stem portion is cut at a height of 15-20cm and the clumps are then uprooted. About50-60 percent of the roots come away with the clumps leaving the rest in the soil. On an average, one hectare of vetiver plantation yields 5 to 7 tonnes of roots which on distillation yield 15 to 16 Kg of oil.

Senna (Cassia Angustifolia vahl.)

Parts used are leaves and pods.

Varieties

ALFT-2 - Late flowering variety, higher yield of foliage.

Tinney valley senna - Popular variety of Tamil Nadu.

Sonna - Grown in some parts of Rajasthan.

Climate, Soil and Planting

It is usually cultivated as rainfed dry crop and highly sensitive to heavy rainfall and water logging. The crop can thrive on a variety of soils, but is largely grown on red loams and alluvial loams. The average pH ranges from 7 to 8.5. The seeds can be broadcasted or preferably sown at 30*30 cm spacing at a depth of 1.5 – 2.5 cm.

Harvest and Yield

Harvest is done by hand pickings. First, second and third pickings are at 90, 150 and 210 days after sowing respectively. The yield under rainfed conditions is about 10 quintals of leaves and 4 quintals of pods per hectare. It would give a net income of Rs.30,500/ha.

Periwinkle (Catharanthus rosseus Linn.)

Varieties

Rosea - contains more alkaloids, pink colour flower.

Alba - White colour flower.

Occelleta - White with pink or yellow ring in the orifice region.

Parts used:

Leaves, stem and roots.

Climate, Soil and Planting

Tropical periwinkle thrives well in tropical and sub-tropical climates with a well distributed rainfall of 100cm per annum. It can grow luxuriantly under a great variety of climatic and soil conditions except the highly alkaline or water logged soils. It prefers light, well drained, sandy loam. Direct seeding is generally adopted for growing a rainfed crop either through broadcasting (5kg/ha) or by drilling the seeds (3kg lha) at spacing 0f 45*35cm.

Harvest and Yield

The crop is ready for harvest of root after one year. During this period two leaf striping are obtained and third when the whole plant is harvested. The total yield of plant material consisting of foliage, basal, stem and roots from a rain fed crop is 1.0-1.5 tones/ha.

Glory Lily (Gloriosa Superba Linn.)

Part Used: Rhizome.

Climate, Soil and Planting

It grows well in red sandy loam soil, having pH 5.5 to 7 with good drainage. Crop requires hot and humid climate. It can be grown in tropical and sub-tropical regions upto 2400m. It can be grown by seeds and tubers but plants are best raised from tubers. Tubers are planted in the bed during rainy season, maintaining 60x60cm spacing. Plant requires support as it is climber. Approximately 41,500 tubers are required as planting material for one hectare of land. It is a rainfed crop but may be irrigated periodically as and when required.

Harvest and Yield

The fruits are harvested after 170-180 days of planting. The tubers are harvested after 5-6 years of plantation. It yields 250-300kg seeds per hectare annually and 2.5-3 ton/hectare tuberous roots after five years of the plantations. It would fetch a net income of Rs. 2.70 lacs per ha.

Ashwagandha (Withania Somnifera Linn.)

Parts Used: Root, leaf, seed.

Climate, Soil and Planting

It grows well in sandy loam or light red soil, having pH 7.5-8.0 with good drainage. The semi-tropical areas receiving 500-750 mm rainfall are suitable for cultivation of this rained crop. The crop can be sown either by broad casting or in lines. The seedling after 25-35 days after sowing can be transplanted in the field at the spacing of 60 x 60 cm.

Harvest and Yield

The crop is ready for harvest in January-March at 150 to 180 days after sowing. The maturity of crop is judged by drying out of leaves and yellow red berries. The entire plant is uprooted for roots which are separated from aerial parts by cutting the stem 1-2 cm above the crown. About 650-800 kg roots can be obtained from 1ha, on drying it comes to 350 - 435 kg. Berries are hand plucked separately. They are dried and crushed to take

out the seeds.

On an average yield from one hectare land under commercial cultivation is approx 3-5 quintals of dried roots and 50-75 kg seeds. It fetches a net return of Rs.24000 per ha under rainfed condition.

Phyllanthus Amarus

Part Used: Whole Plant.

Climate, Soil and Planting

It is well adapted to variety of soils, at soil pH ranging from alkaline to natural and acidic soil. Plants have also shown preference for calcareous well drained and light textured soils. It grows well under tropical condition, however rarely survives under dry or very low temperature conditions but water logging does not show any lethal effects. The plants are propagated through seeds @ 1kg/ha and transplanted at 15 – 30 DAS at the spacing of 15*15cm.

Harvest and Yield

Since the active constituents are concentrates more in the leaves, production of higher leaf mass is desired for the extraction. Plant in September contain highest amount of leaves and found to be suitable time for harvesting. Average fruit yield is 25-50kg/tree in rainfed, arid, semiarid areas. It fetches a net return of Rs. 20000/ha.

Aloe Vera

Part Used: Leaves.

Climate, Soil and Planting

Naturally occurs in driest and poorest soils and can grow in variety of soils. But most ideal is sandy loam, slightly alkaline with pH upto 8.5. Water logging is completely unsuitable. About 15 - 18 cm long root sucker or rhizome cuttings are planted at spacing 60*60 cm. 15000 root suckers are required for a plantation of one hectare.

Harvest and Yield

Leaving fresh and young leaves from top, older outer leaves are generally harvested. Crop is ready to harvest after 18 months of planting. Economic yields are obtained in 5 years, after it needs replanting. It yields on an average 12 tonnes/ha (fresh weight basis).

Tulsi (Ocimum Sanctum Linn.)

Parts Used: Leaf/whole plant.

Climate, Soil and Planting

Rich loam to poor laterite, saline and alkaline to moderately acidic soils is well suited for its cultivation. Well-drained soil helps better vegetative grown. Long days and high temperatures have been found favourable for plant growth and oil production. Topical and sub-tropical climate (at altitudes upto 900m.) is suited for its cultivation. The plant is propagated by seeds @ 200-300g/ha. and the seedlings are ready for transplanting in about 6 weeks' time. The seedlings are transplanted at40 x 40cm.

Harvest and Yield

The crop is harvested at full bloom stage. The first harvest is obtained at 90-95 days of planting. Then it may be harvested every 65-75 days interval. Harvesting is done usually on bright sunny days for good oil yield and its quality. It is not desirable to harvest the crop if there was a rain in the previous day. About 5 tonnes of fresh herbage can be obtained twice or thrice a year per hectare. It gives a net return of rs. 6000/ha in 2.5 month period.

III. SWOT Analysis for Cultivation of MAP

Strength:

Most of MAPs have wider adaptability (Soil & Climate)

Arid zones have maxi.nos of MAPs species

MAPs get benefited under water stress condition

Less pest and diseases risk.

Could be stored for a long time, and sold at a time when better prices prevail in the market;

Required less maintenance as compared to other conventional crops.

Weakness:

Lack of information in cultivation and marketing.

Market identification

Lack of awareness among the farmers.

Lack of infrastructure facilities.

Opportunities:

Boon for Small/marginal farmers, low fertile and less rainfall areas.

Expansion of MAP global markets.

Pharmaceuticals & Cosmetics

In hilly regions - defaullt organic practices follwed in MAP - organic certificed products.

India has wide biodiversity, and so many MAP are yet to be identified.

Could be raised as inter-crops, along with traditional crops, and also on degraded lands.

Threats:

Land fragmentation will be a threat for large scale commercial production for exports.

Lack of proper marketing channel.

Depletion of natural resources at an alarming rate.

Govt. policies and subsidies continue to be favoring conventional crop cultivation.

IV. CONCLUSION

Many different species and local landraces have been described as 'minor crops' from the point of view of researchers and development workers, often because they have not been the subject of research for development efforts, or because their socio-economic potential is not being exploited by scientists, development workers and policy makers. But, those minor crops can be a key livelihood asset for the rural poor, and are often better adapted to fragile and marginal environments than the major commodity crops that are the focus of so much research.

Due to severe population pressure and meagre cultivable land, the rural poor and extreme poor face the dwindling of diverse means for their livelihoods. We found that the cultivation or production of medicinal and aromatic plants could play an important role in improving the livelihoods of those poor or extreme poor people owning meagre pieces of land. Cultivation of MAPs under drylands or semiarid conditions is thus a feasible diversification enterprise for many small-scale farmers as demand is high, trade opportunities are increasing and the income generating potential is good.

REFERENCES

[1] Noyingthung K and Thejangulie A. (2018). Medicinal and aromatic plants for climate change adaptation: Scope and prospects with special reference to North Eastern Himalayas. Journal of Medicinal Plants Studies; 6(1): 150-155.
[2] World Health Organisation (1991). Traditional Medicine and modern health care, progress report by the director general, forty fourth world health assembly, A44/19.
[3] Lewington, A. (1993), "A review of importation of medicinal plants and plant extracts into Europe", WWF International Plant Programme/IUCN.
[4] Institute for social and economic change (2006), "Cultivation of medicinal crops and aromatic crops as a means of diversification in agriculture", Research Report: IX/ADRT/115, Bangalore.
[5] Suneetha, M.S, (2004), "Economic valuation of medicinal plants in the context of the convocation on biodiversity and intellectual property rights in India", Ph.D thesis, UAS, Bangalore.
[6] Kalaiselvi, K and Arul Swaminathan, A. (2009). Alternate land use through cultivation of medicinal and aromatic plants - a review. Agricultural reviews; 30 (3): 176-183.
[7] Narashima Reddy, K. (2006). Agriculture& Herbal Vision, Feb-March: 13-17.
[8] Yaniv, Z., and D. Palevitch. 1982. Effect of drought on the secondary metabolites of medicinal and aromatic plants. p. l-12. *In* C.K. Atal and B.M. Kapur (ed.) Cultivation and utilization of aromatic plants. Regional research laboratory, Jammu-Tawi, India.
[9] Rockstorm, J. Barron. J and Fox P (2003). Water productivity in rainfed agriculture: challenges and opportunities for smallholder farmers in drought prone tropical agro ecosystems. In: J.W. Kijne, R. Baker and D. Molden editors water productivity in agriculture: limits and opportunities for improvement, CABI Publ., CAB International/IWMI, Cambridge MA/Colombo, SriLanka (2003), pp145-162.
[10] Pareek, S.K., and Gupta R., 1993 Medicinal and aromatic improve profitability of cropping systems in India. In glimpses in plant research (J.W. Govil et al.,) pub Today and tomorrow printers and pub, New Delhi) Vol.11 pp 325-35.
[11] Pratibha G., and G.R. Korwar (2002). Crop diversification through medicinal, aromatic and dye yielding plants for sustainability in semi-arid regions. Proceedings of first national meet on medicinal & aromatic Plants. eds Mathur A.K., S. Dwivedi , DD Patra, GD Bagchi, NS Sangwan, A. Sharma and SPS Khanuja . CIMAP, Lucknow PP: 129-132.
[12] Prakasha Rao, E.V.S. and Puttanna, K. 2000 Role of leaf mulch and FYM in N economy of Java citronella. Proceedings of national seminar on development of soil science Bangalore pp 97.
[13] Ramesh P., Mohan Singh and Subba Rao 2005, A. Organic farming: Its relevance to the Indian context. Current Science; 88(4): 561 – 568.
[14] Planning commission. Report of the taskforce on medicinal plants in India. Planning commission, Government of India, Yojana Bhawan, New Delhi, India, 2000.
[15] Hanumanthappa. M, Jayaprakash. R and Nagaraj. R, 2018. Economic potentials of medicinal and aromatic plants in dryland and rainfed areas of India. Journal of Pharmacognosy and Phytochemistry; SP3: 384-386.
[16] https://www.fao.org
[17] https://www.bioversityinternational.org

AUTHOR'S PROFILE

First Author
M. Darthiya, Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore-641 003, India.

Second Author
Subbalakshmi Lokanadhan, Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore-641 003, India.