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Medicinal and Aromatic Plants for Soil and Water Conservation in Nilgiris, Tamil Nadu, India: An Economic Analysis

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Abstract This study was carried out to examine the economics and soil and water conservation value of prominent medicinal and aromatic plants in the hilly areas of Nilgiris, Tamil Nadu during 1998-99 to 2004-05. The six species of medicinal and aromatic plants were planted in 15m × 5m plots on 15% land slope to assess the relative soil and water conservation efficiency and economics. The Geranium recorded highest average green biomass yield followed by Digitalis, Cineraria, Mentha and Rosemary. Runoff and soil loss was maximum under Thyme followed by Cineraria because of their poor canopy cover. The lowest average annual soil loss and runoff over the year was observed from Digitalis followed by Mentha and Geranium due to their quick establishment and higher canopy cover. The soil and water conservation efficiency varied from 39.1 to 97.2%. Whereas, relative soil and water conservation efficiency (RSWCE) of 97.2,90.5,90.0,91 and 39.1% in Digitalis, Mentha, Geranium, Rosemary and Cineraria, respectively and observed almost zero in the case of Thyme. Based on economic criteria order of medicinal plants profitability it was observed that Digitalis, Cineraria, Rosemary had 1:9.4, 1:4.2 and 1:2.5, respectively higher benefit cost ratio (BCR) where as Geranium has given higher internal rate of returns (IRR). However, IRR for Thyme and Mentha was almost negligible. Thus, RSWCE and Economic criteria does not follow the same pattern of preference of medicinal and aromatic plants. Eight years of the study suggest that Digitalis, Mentha, Geranium and Rosemary cultivation could be the viable proposition for a diversified land use system as well as for cover crop, intercrop and vegetative barrier in the Nilgiris for effective natural resources conservation. The economic analysis also found to be viable for cultivation of these plants in Nilgiris.
Keywords Aromatic; Economics; Medicinal; Runoff and Soil conservation; Soil loss

1 Introduction

India is endowed with rich wealth of medicinal and aromatic plants, but despite the rich heritage of knowledge on the use of plant drugs, little attention had been paid to grow them as field crops in the country till the later part of the nineteenth century. The folk medicine is based on empirical knowledge and utilizes a large proportion (25-60%) of local plant species in the various regions, as well as many animals and some minerals (Singh et al., 2008). Though India has been a pioneer in the production of several essential oils, the Indian herbal industry faces problems in the procurement of raw material. A solution to the problem could be achieved by the cultivation of medicinal and aromatic plants (Vijaya Lakshmi, 1999). The 960 traded medicinal plant species, 178 species are consumed in volumes exceeding 100 million tons per year, with their consolidated consumption accounting for about 80% of the total industrial demand of all botanicals in the country. Analysis of these 178 species by their major sources of supply reveals that 21 species (12%) are obtained from temperate forests, 70 species (40%) are obtained from tropical forests, 36 species (20%) are obtained largely or wholly from cultivations/ plantations, 46 species (25%) are obtained largely from road sides and other degraded land uses and the remaining 5 species (3%) are imported from other countries. According to the report of the World Health Organisation (WHO), a large population of the world relies on the traditional systems of medicines, largely plant based to meet their primary health care needs.

India at present exports herbal materials and medicines to the tune of Rs.3000 crores during 2005 and expected to doubled. The Chinese export based on plants including raw drugs, therapeutics and other is estimated to be around Rs.18,000- Rs.22,000 crores. In view of the innate Indian strengths which interalia include diverse eco-systems, technical and farming capacity and a strong manufacturing sector, the medicinal plants area can become a huge export opportunity after fulfilling domestic needs.

All India production of medicinal and aromatic plants has shown an increasing trend from 2001 to 2011 (Figure 1) and recorded more than 300% over the period in terms of total area and production. However, in the case of Tamil Nadu state area under medicinal and aromatic plants was very small (10000 ha.) with an annual production of about 61100 tons (2011, GOI, www.data.gov.in). A part from requirement of medicinal plants for internal consumption, India

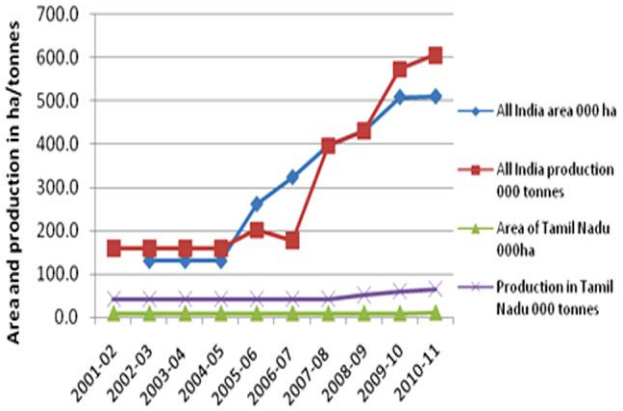

Figure 1 Area and production of medicinal and aromatic plants

exports crude drugs mainly to developed countries, viz. USA, Germany, France, Switzerland, UK and Japan, who share between them 75 to 80% of the total export of crude drugs from India. The annual demand of botanical raw drugs in the country has been estimated at 3,19,500 MT for the year 2005-06. (Ved and Goraya, 2007). An import has been found to be a major grey area as adequate record keeping mechanism is not in place. Consolidation of species-wise data in respect of raw drugs harvested from wild (forest areas) obtained from 9 states, representing more than 52% of the forest area of the country, adds up to 1,20,000 MT of botanicals per annum. There are hundreds of valuable species of herbs growing in Nilgiris (Magesh and Vanya, 1999; 2008). Since the Nilgiris is subjected to major land degradation process of soil erosion due to steep land slope (Singh et al., 2000; Subhash et al., 2011), information on the extent of soil erosion, occurring due to the cultivation of medicinal and aromatic plants is important and alternate land use system or component of diversified land use system should address this problem. The natural resource degradation is the serious problem in the Nilgiris (Anonymous, 1988) due to steep slopes and high intensity of rainfall and this leads to accelerate the runoff and resulted in enormous soil erosion. Thus it is high time to check the land use and alter it in such a manner, which can provide more cover to land mass. Therefore, this study was aimed to test the natural resource conservation efficiencies and economics of different medicinal and aromatic plants on marginal and small land holdings of hilly areas.

2 Materials and Methods

2.1 Study locale

The geographical area of the state is 13.6 million ha constituting 4% of the country. The Nilgiris District, Tamil Nadu, with a geographical area of 2549 km^2 is one of the smallest districts in the State. The Niligris hills consist of great plateau, up-heaved at the junction of ranges of the Eastern and Western Ghats and run southward at a converging angle. It is elongated in the East-West direction and is bounded by 11° 0′ and 11° 55′ North Latitude and 76° 13′ and 77° 0′ East Longitudes. The State bound the district on the west by Kerala, on North by Karnataka and South by Coimbatore district of Tamil Nadu. The blue mountains of South India, is one of the magnificent and oldest ranges in the world, lying at the junction of Eastern and Western Ghats of Indian Peninsula. Botanically, as well as zoologically and ethnologically, the Nilgiris forms a distinct ecological realm of its own and enigmatic affinities to Himalayan flora and fauna. The District is mostly hilly, located on the fragile environment of Western Ghats with an elevation ranging from 300m in the Moyar Gorge to 2634m above MSL at Doddabetta peak. Nilgiris, The main activities of Dodabetta Medicinal Plants Development Agency include raising of medicinal plants nursery, planting medicinal and aromatic plants (rosemary, thyme, parsley, oregano, sage, citronella, *Acorus calamus*, *Elaeocarpus oblongus*, *Rhodomyrtus tomentosa*, *Laurus nobilis* etc) in forest area allotted to

it, distillation of essential oils, simple processing of medicinal plants and marketing of essential oils and medicinal plants products. The income generated from different activities over 1994 to March, 2000 was; sale of distilled oil, Rs 2.22 million; sale of herbs, Rs 0.138 million; sale of seedlings, 0.154 million; miscellaneous, 0.062 million; total Rs 2.574 million. To handle distillation and marketing of oils, the village community established a separate enterprise called Dodabetta Essential Oils and Herbs (Meghesh and Vaniya, 2008).

2.2 Experiment Design

This study was carried out at Indian Institute of soil and Water Conservation (IISWC) the than Central Soil and Water Conservation Research and Training Institute, Research Centre, Nilgiris, Tamil Nadu during 1998- 2004-05. The six species of predominant medicinal and aromatic plants viz., Geranium (*Pelargonium graveolens*), Rosemary (*Rosmarinus officinalis*), Cineraria (*Ceneraria maritime*), Thyme (*Thymus vulgaris*), Mentha (*Mentha piperita*) and Digitalis (*Digitalis purpurea*) were selected for detailed study. Thus experiment was laid out on a natural slope of 15% in plots of 15m x 5m each. Initial bench mark soil fertility status was analysed by taking composite soil samples from each plot at two depths (0-20 and 20-40cm). A result reveals that the soil has a medium level of overall fertility status (Table 1).The pH ranges from 4.52 to 4.72 at 0-40 cm soil depth which indicate the acidic nature of the soil. The electrical conductivity was observed to be 0.1 to 0.3 dsm^{-1} with high organic matter carbon contents. The available nitrogen varies from 605.2 to 676 kg/ha at 0.20cm depth and it was decreased at 20-40cm of soil depth. Similarly phosphorus availability was found to be in the range of 299 to 556.8 kg/ha and it decreased with the depth of soil. The available potassium varied from 394.8 to 500.08 kg/ ha. The Planting was done during June, 1998 at a uniform spacing of 40cm x 30cm except in case of Mentha where it was kept as 40cm x 20cm. A basal dose of 10 t/ha FYM was applied before planting. Uniform dose of 40 kg/ha each of N, P and K was applied in furrow after 100 days of planting (Singh et al., 2000). Observations on canopy and plant height were recorded after 150 days of planting at different periods, for which five representative sites and plant were selected in each case. Runoff and soil loss were quantified by installing runoff tanks and multislot divisors at the outlet point of each plot. Relative soil and water conservation efficiencies were computed on the basis of highest observed value of the product of soil loss (t/ha) and runoff (%) under thyme.

2.3 Analytical procedure

The relative soil and water conservation efficiencies were worked out on the basis of highest observed values of soil loss and runoff under different medicinal plants and same is given below:

Soil and water conservation efficiencies (%) = (Max (S*R) Obs. (S*R) I / Max (S*R)*100.

Where, Max (S*R)= Maximum observed value of the product of soil loss (t/h) and runoff (mm).

Obs. (S*R)i= Product of soil loss (t/ha.) and runoff (mm) under particular species.

The scoring technique on the scale of 1-3 was designed. Where 1 indicated low benefit/effect, 2 medium benefit and 3 high level benefits (Suneetha et al, 2006). Further, scores were converted into percentage to draw the logical conclusions. To compute the comparative economics of medicinal and aromatic plants a cost/ benefits stream was derived. Standard procedure, cost benefit analysis assuming project life 10 years @10% discount rate was worked out. Benefit Cost Ratio (BCR), Internal Rate of Return (IRR) and Pay Back period (PBP) economic criterion measure were employed.

3 Results and Discussion

3.1 Estimation of yield

The yield obtained from each treatment was recorded at the time of harvest. It was observed that Geranium (28.7 tones/ha/year), Cineraria (18.45 tones/ha/year) followed by Digitalis (16.9 tones/ha/year) have produced biomass. It is obvious that higher vegetative growth, higher biomass production and more canopy coverage. However, other treatments were also produced the biomass in the range of 1.5 to 10.2 tones/ha/year.

3.2 Runoff and soil loss estimation

The mean soil loss and runoff for the project period (1998-2001) is presented in Figure 2. It was observed

that the soil loss under the cultivation of Digitalis, Mentha, Rosemary and Geranium is below the permissible limit (5 t/ha) in the study area. However, soil loss was maximum under Thyme (16.4 t/ha) followed by Cineraria (9.5 t/ha) which is due to the

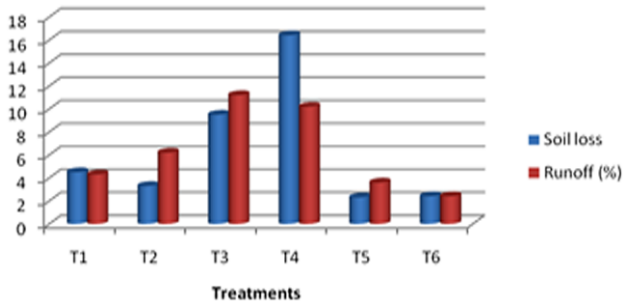

Figure 2 Soil loss (t/ha.) and runoff (%) in the treatments

fact that poor canopy cover and long-time taken for establishment. The lowest average annual soil loss and runoff was observed from Digitalis followed by Mentha, Geranium and Rosemary due to their rapid establishment and better canopy cover. It is interesting to note that in case of Mentha even with poor canopy and less biomass production due to frost effect during third year onwards, soil loss and runoff was towards minimum side due to effective soil binding by runners over the soil surface. In general, harvesting of these crops was done at the onset of North-East monsoon (October) which produces high runoff but less soil loss since no soil disturbance occurred due to weeding and hoeing operations. During the South-West monsoon, soil disturbances are more due to weeding and hoeing which induce more soil loss. Less runoff during South-West was attributed to less intensity storms during the study period. Therefore, among the six treatments digitalis, cineraria, rosemary and geranium was found to be best in terms of soil erosion and runoff control in the study area. Further the The economic value of Geranium is better than Mentha because of its very high oil price and wider uses in perfumery industry. The nutrient loss was low and fertilizer uptake also was less as compared to other crops grown in the study area.

3.4 Cost and benefit stream

The actual expenditure incurred from land preparation to sale of produce was taken into account while generating of cost stream. The farm gate price was multiplied with total production of each species and nutrients loss was decreased from second year onward due to low soil loss and run off. The pH not affected and EC also did not shown very much difference across the treatments at the end of the project.

3.3 Relative soil and water conservation efficiency

Relative soil and water conservation efficiencies of selected species are depicted in Figure 3. The Soil and Water Conservation Efficiency varied from 39.1 to 97.2%. Whereas Relative Soil and Water Conservation Efficiency (RSWCE) in the case of Digitalis, Mentha, Geranium, Rosemary and Cineraria was observed viz. 97.2,90.5,90.0,91 and 39.1%, respectively. Almost, zero in the case of Thyme medicinal plant. Based on economic criteria order of medicinal plants profitability was observed that Digitalis, Cineraria, Rosemary had 1:9.4, 1:4.2 and 1:2.5, respectively higher BCR followed by Geranium, Thyme and Mentha. However, IRR for Thyme and Mentha was almost negligible. Thus, RSWCE and economic criteria does not follow the same pattern of preference of medicinal and aromatic plants. Runoff and soil loss under Geranium was very high in the first year due to late establishment of the plants while during the second and third years, it was less and comparable to runoff and soil loss under Mentha.

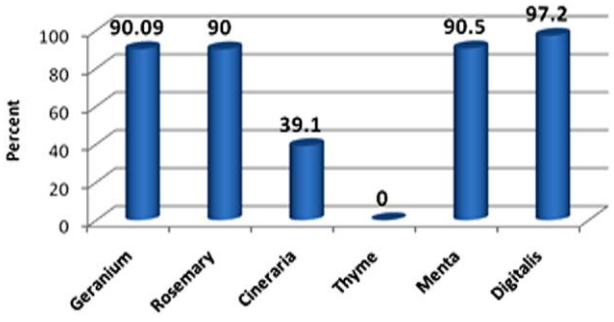

Figure 3 Relative soil conservation efficiency

gross return was worked out. The project life was assumed eight year and accordingly cost benefit analysis was carried out. The economic analysis assumes the economic values of the medicinal and aromatic plants to be a function of investment, market value, non market value benefit sharing measure.

3.5 Economics of selected medicinal plants

The economic analysis was carried out by assessing the project life 12 years and at different rate of discounts, BCR, NPW and IRR were calculated

(Table 1). Based on economic criteria NPW and BCR of different species were observed to be T6>T3>T2>T1 order. The T4 and T5 were found to be uneconomical in the experiment carried out. Based on payback period also same trend was observed and at the same time these were also less effective interims of soil conservation. The IRR again has depicted the same picture as T6>T3>T2>T1. This has indicated the T6>T3>T2>T1 species were economically viable and has established the relationships that higher the yields, higher the economics returns. Therefore, digitalis, Cineraria, Rosemary and Geranium may be the viable proposition for sloppy area of Nilgiris, Tamil Nadu.

Table 1 Economics of different medicinal and aromatic plants (1999 to 2007)

Treatments	Discount rate (10%)			IRR
	BCR	NPW	Payback period (Yrs)	(%)
T1 Geranium	1.5	40534	2.2	35.0
T2 Rosemary	2.5	154101	1.5	73.8
T3 Cineraria	4.2	845456	0.9	90.5
T4 Thyme	0.8	-13527	-	-
T5 Mentha	0.7	-35774	-	-
T6 Digitalis	9.4	860946	0.6	95.6

3.6 Scoring of usefulness of medicinal and aromatic plants

The index was developed using 0-3 point scoring. This index helps to the farmers, policy makers and researchers to make investment decisions and policy for medicinal an aromatic plants in the study area. Therefore based on the table 2, it was revealed that Rosemary (26.37%), Digitalis (26.22), Cineraria (25.35, followed by Mentha (25.24%) and Geranium (23.37%) and Thyme (17.76%) scores obtained and indicating the usefulness of the respective species. The result clearly demonstrates the ranking of the species predominantly preferred by the stakeholders.

Table 2 Scoring of usefulness of medicinal and aromatic plants (1-3 Scale)

Beneficial attributes	Medicinal and aromatic species					
	Geranium	Rosemary	Cineraria	Thyme	Mentha	Digitalis
Food	0.58	0.97	0.80	1.00	1.40	1.10
Medicine	2.80	2.40	2.60	1.50	2.10	1.80
Cultural	1.60	2.30	1.50	1.00	2.10	1.50
Benefit sharing	1.40	1.00	1.20	1.50	1.20	1.40
Conservation function	2.10	2.15	1.42	00	2.17	2.45
Domestic market	1.80	1.70	2.60	1.20	1.80	1.70
Overall Score	11.58 (23.63)	12.92 (26.37)	12.42 (25.35)	8.70 (17.76)	12.37 (25.24)	12.85 (26.22)
Mean	1.65	1.85	1.77	1.24	1.77	1.84
Std	0.80	0.63	0.72	0.75	0.38	0.63

Note: Figures in parenthesis indicate the percent score in respective species

Policy Implications and conclusions The valuation exercise highlights that the inclusion of the perceptions of various stakeholders while valuing medicinal plants helps to prioritize species based on a broader framework of utility of the plants. The Soil and Water Conservation Efficiency varies from 39.1 to 97.2 percent, suggesting that all medicinal plants were not effective from conservation point of view. Whereas Relative Soil and Water Conservation Efficiency (RSWCE) in the case of Digitalis, Mentha, Geranium, Rosemary and Cineraria was observed viz. 97.2,90.5,90.0,91 and 39.1 percent, respectively. RSWCE was almost, zero in the case of Thyme medicinal plant. Based on economic criteria order of medicinal plants profitability was Digitalis, Cineraria, Rosemary had 1:9.4, 1:4.2 and 1:2.5, respectively higher BCR followed by Geranium, Thyme and Mentha. However, IRR for Thyme and Mentha was almost negligible. Thus, RSWCE and Economic criteria does not follow the same pattern of preference of medicinal and aromatic plants. It is desirable for a country to have an equal emphasis on conservation and market appropriation of medicinal plants. The results of this study show that the soil conservation values of medicinal plants increase when benefits are shared with a community. Some of the measures to encourage benefit sharing are promotion of contractual agreements between indigenous communities and the pharmaceutical industry that will ensure an assured market for the indigenous

community and assured quantum and quality of resource to the end user; designing and implementing in situ and appropriate *ex situ* conservation activities that promote development of endemic medicinal plants (Mollik et.al 2010). Digitalis, Geranium and Rosemary are the good options for alternate/diversified land use system as well as a cover crop, intercrop and vegetative barrier in Nilgiris among the selected species as regards to their soil conservation value and economic values. Mentha also could be the option for cover crop / intercrop for initial two years of establishment of any perennial plantation in the area. These species may hold promise in rehabilitating degraded / waste lands and will provide a value added land use system in watershed management programmes.

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