

Crop diversification in arecanut plantation through intercropping of medicinal and aromatic plants

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Abstract

The experiment was conducted in 2004 to 2006 in 18 year old arecanut plantation at Central Plantation Crops Research Institute, Regional Station, Vittal, Karnataka, with intercropping of medicinal plants like Shatavari (*Asparagus racemosus*), Vetiver (*Vetiver zizanoides*), Long pepper (*Piper longum*), Brahmi (*Bacopa monnieri*), Nilagirianthus ciliatus, periwinkle (*Catharanthus roseus*), Aloe (*Aloe vera or barbadensis*), Aswagandha (*Withania somnifera*), senna (*Cassia angustifolia*) and safed musli (*Chlorophytum borivillianum*) and aromatic plants like lemon grass (*Cymbopogon flexuosus*), Palmarosa (*Cymbopogon martinii*), Basil (*Ocimum basilicum*), Davana (*Artemisia pallens*) and Patchouli (*Pogostemon cablin*) and geranium. All the medicinal and aromatic plants tried in arecanut plantation except senna, safed musli and geranium performed better. Shatavari produced fresh root yield of 14.3 t/ha of arecanut garden and contributed maximum chali equivalent yield (2045 kg ha⁻¹). The net return accrued by intercropping of shatavari per ha of arecanut plantation was highest (Rs. 80,000) followed by Nilagirianthus ciliatus (Rs. 42,000) bramhi (Rs. 39,380) and vetiver (Rs. 31,000). Aromatic plants like lemon grass, patchouli, davana, palmarosa and basil performed better with chali equivalent varying between 406 kg ha⁻¹ in case of basil to 1286 kg ha⁻¹ in lemon grass. All medicinal and aromatic crops contributed to productivity increase of 10.7% in basil to 53% in shatavari in terms of chali equivalent per hectare of arecanut garden. Aromatic plants like lemon grass, patchouli davana and palmarosa found highly profitable with net returns of Rs. 22700-58387 per hectare of arecanut plantation. In terms of net profit per rupee investment, all medicinal and aromatic plants were found superior.

Key words: Arecanut, medicinal plants, aromatic plants, intercropping, net returns

Introduction

Arecanut (*Areca catechu* L.) is grown in 3.35 lakh hectares in Karnataka, Kerala, Assam and West Bengal. Studies on light interception carried out at CPCRI, RS, Vittal indicated only 43 per cent light interception by arecanut, while it can be increased to 95 per cent with mixed crops in arecanut (Balasimha, 1989). The root distribution studies in arecanut have revealed that at the recommended spacing of 2.7 m x 2.7 m, arecanut uses only about 35 per cent of the space (Bhat and Leela, 1969). Thus, it provides 65 % of the area available to other crops. Crop diversification in arecanut garden is essential as arecanut farmers are facing recurring problems. Of late, medicinal and aromatic plants are looked up on as a source of income. The recent study indicated that herbal drug market continues to grow at the rate of 7-30 % annually. The potential returns to the farmer from cultivation of medicinal and aromatic plants

are reported to be quite high. Kamla Singh *et al.* (2000) and Rao *et al.* (2000) also reported the relative economic advantage of medicinal and aromatic plant cultivation in South India. However, these crops have not been tried so far as intercrops in arecanut plantation and require standardization of agro-techniques. The congenial climate available in arecanut plantations offer great scope for cultivation of medicinal and aromatic plants, which in turn would increase resource use efficiency and generate supplemental income. Besides, arecanut is an irrigated crop and there is scope for growing medicinal plants as intercrops throughout the year without any provision for additional irrigation facilities. A few studies indicated that kacholam (*Kaempferia galangal* L.), arrowroot (*Maranta arundinacea* L.), greater galangal (*Alpinia galangal*), *Coleus aromaticus*, *Coleus vetiveroides*, periwinkle (*Catharanthus roseus*), *Ocimum* (*Ocimum sanctum*), *Costus speciosus*, *Plumbago rosea*,

Rauvolfia serpentina, mango ginger (*Curcuma amada*), *Andrographis peniculata* and *Sida retusa* are well suited to grow under shaded conditions in coconut plantations (Nair *et al.*, 1991; Rajagopalan *et al.*, 1992; Viswanathan *et al.*, 1992; Maheswarappa, 1997). In this context, an experiment was conducted to screen suitable market oriented medicinal and aromatic plants as intercrops in arecanut plantation with organic farming approach and to find out their economic feasibility.

Materials and Methods

The experiment was initiated in June, 2004 in 18 year old arecanut plantation spaced at 2.7 m x 2.7 m at the Experimental Farm of Central Plantation Crops Research Institute, Regional Station, Vittal, Karnataka, India. The place is located 58 m above MSL with an average rainfall of 3800 mm, and mean maximum and minimum temperatures of 36°C and 21°C, respectively. The soil of the experimental site is laterite with a pH of 5.6, organic carbon status of 1.98% and pre-experimental nutrient status 10.1 ppm P and 53 ppm K at 0-25 cm. Medicinal plants included are Shatavari (*Asparagus racemosus*), Vetiver (*Vetiver zizanoides*), Long pepper (*Piper longum*), Brahmi (*Bacopa monnieri*), *Nilagirianthus ciliatus*, periwinkle (*Catharanthus roseus*), Aloe (*Aloe vera or barbadensis*), Aswagandha (*Withania somnifera*), senna (*Cassia angustifolia*) and safed musli (*Chlorophytum borivillianum*). Aromatic plants included lemon grass (*Cymbopogon flexuosus*), Palmarosa (*Cymbopogon martinii*), Basil (*Ocimum basilicum*), Davana (*Artemisia pallens*) and Patchouli (*Pogostemon cablin*) and geranium. The intercrops were accommodated in interrow interspace accounting for 45% of 1 ha of arecanut plantation. The experiment was laid out in Randomised Block design with 5 replications. The schedule followed for cultivation of different crops is

given in Table 1. Agro-techniques for each crop were followed as standardized for sole crop. FYM @ 5-10 t/ha was applied to all crops as per the requirement of sole crop recommendation. As crops vary in their growth habit, the harvesting period also varied. The economic products were harvested as and when ready and quantified per hectare of arecanut garden. Farm gate and local market rates were considered for computing net returns (Table 1). Intercrop yields were converted to chali equivalent i.e., base crop yield in order to test for statistical significance. The chali equivalent of intercrop yield was estimated using the following formula.

$$\text{Chali equivalent of intercrop yield} = \frac{\text{Yield of intercrop (kg ha}^{-1}\text{)} \times \text{Price of intercrop (Rs. kg}^{-1}\text{)}}{\text{Price of chali (Rs. kg}^{-1}\text{)}}$$

Results and Discussion

Performance of medicinal and aromatic plants as intercrops in arecanut plantation

The results revealed that all the medicinal plants tried in arecanut plantation except senna and safed musli performed well as intercrops in arecanut plantation and increased productivity per unit area and net income (Table 2 and 3). Shatavari produced fresh root yield of 14.3 t from one hectare of arecanut garden and contributed maximum chali equivalent yield of 2045 kg ha⁻¹ among all medicinal and aromatic plants. *Nilagirianthus ciliatus* produced root yield of 1191 kg/ha and shoot yield of 7423 kg ha⁻¹, which was equivalent to chali yield of 1715 kg ha⁻¹. Due to intercropping of medicinal plants, the productivity per unit area in terms of arecanut equivalent increased considerably by 34% in case of shatavari and *Nilagirianthes ciliatus*, and 21% in vetiver in first year.

Table 1. Agro-techniques adopted for medicinal and aromatic plants as intercrops in arecanut plantation

Crop	Spacing(cm)	Planting material	Crop duration (months)	Prices of economic products (Rs/kg)
Medicinal plants				
Vetiver (<i>Vetiver zizanoides</i>)	45 x 30	Root slips, KS 1	15	45 (dry roots)
Shalavari (<i>Asparagus racemosus</i>)	60 x 60	Roots, CIMAP	18	10 (fresh roots)
Long pepper (<i>Piper longum</i>)	60 x 60	Rooted cuttings	Perennial	80 (dry spikes)
Brahmi (<i>Bacopa monnieri</i>)	20 x 10	Rooted cuttings	Perennial	20 (dry herbage)
<i>Nilagirianthus ciliatus</i>	60 x 60	Cuttings	15	35 (shoot & root)
Periwinkle (<i>Catharanthus roseus</i>)	30 x 20	Seed, cv. Nirmal	12	10 (dry leaves)20 (dry roots)
Aloe (<i>Aloe vera or barbadensis</i>)	60 x 45	Suckers		2000/t fresh leaves
Aromatic plants				
Lemon grass(<i>Cymbopogon flexuosus</i>)	45 x 45	Root slips,	Perennial	300 (oil)
Palmarosa (<i>Cymbopogon martinii</i>)	45 x 30	Seed	Perennial	450 (oil)
Basil (<i>Ocimum basilicum</i>)	45 x 30	Seed	3	350 (oil)
Davana (<i>Artemisia pallens</i>)	30 x 15	Rooted cuttings	Perennial	8000 (oil)
Patchouli (<i>Pogostemon patchouli</i>)	45 x 45	Rooted cuttings	12	10 (fresh leaves)

Table 2. Yield of intercrops obtained per hectare of arecanut garden, chali equivalent of intercrop yield and yield of arecanut

Crop	Yield of intercrop (kg ha ⁻¹)			Chali equivalent of intercrop (kg ha ⁻¹)			Mean yield of arecanut (kg ha ⁻¹) (2 years)
	1 st year	2 nd year	Mean	1 st year	2 nd year	Mean	
Medicinal plants							
Vetiver (dry roots)*	1262	-	-	944	-	944	3571
Shatavari (Fresh roots)*	14310	-	-	2045	-	2045	3934
Long pepper (Dry spike)	171	272	221.5	225	358	291.5	4333
Brahmi (dry herb)	2504	2788	2464	729	796	792.5	4024
<i>Nilagiriathus ciliatus</i> *							
a. Dry leaves							
b. Dry roots	7423	1191		1715	-	1715	3299
Periwinkle							4259
(Leaf)	2125	2631	2378	590	570	580	
(root)	671	394.6	532.8				
Aloe (Fr.leaf wt)	13580			453	562	465.5	
Aromatic plants							
Lemon grass							3454
(Dry leaves)	8581	8810	8695	1286	1409.5	1348	
(Oil yield)	257	282	269.5				
Palmarosa							3667
(Fresh leaves)	14840	6821	10830	625	345.6	485	
(Oil yield)	89	41.4	65.2				
Basil	8128	8456	8292	406	422.8	414	4029
Davana	7662	9722	8692	817	1036.7	926.8	3820
Patchouli	5756	5248	5502	822	749	786	4346
S.Em±	-	-	-	176	27.936		373
CD (0.05)	-	-	-	352	80.7		NS
Sole Crops							
Lemon grass (Dry)	18432	19077	18754				
Palmarosa (Fresh)	33577	18157	25867				
Basil	18262	18891	18576				
Davana	16027	19804	17915				
Vetiver	2270	-	2270				
Shatavari (Fresh roots)	26333	-	26333				
Arecanut	3855						

* Only one crop cycle was completed due to long duration and not considered for statistical analysis in second year

The dry spike yield of long pepper was less as yield levels would be generally less in first year. The study revealed that Senna (*Cassia angustifolia*) and safed musli did not establish due to their sensitivity to fungal infection, while Aswagandha established and performed better as intercrop in post monsoon season. The economic products of aswagandha are yet to be quantified.

Similarly intercropping of aromatic plants like lemon grass, patchouli, davana, palmarosa and basil also performed well with respect to chali equivalent, varying between 406 kg ha⁻¹ in case of basil to 1286 kg ha⁻¹ in lemon grass. All aromatic crops as intercrops increased the productivity per unit area contributing to productivity increase of 9 to 27% in terms of arecanut equivalent yield. All medicinal and aromatic crops contributed to productivity increase of 10.7% in basil to 53% in shatavari in terms of chali equivalent per hectare of

arecanut garden. The better performance of medicinal and aromatic plants as intercrops in arecanut plantation might be attributed to congenial microclimate in the plantation and better soil fertility status. The research findings by Bavappa *et al.* (1986) also revealed congenial microclimatic conditions in arecanut based cropping system. Earlier reports also suggested that mixed cropping of coconut with cocoa had a buffering effect against drastic fluctuations in microclimate (Varghese *et al.* 1978). Improved microbial activity and soil fertility was reported earlier in arecanut based cropping system (Bopaiiah 1991). The chali yield of arecanut was not affected adversely due to intercropping of medicinal and aromatic plants in first year i.e., 2004-05 (Table 2). When sole and intercrop yields were compared on actual area basis, yield advantage was noticed in intercropped vetiver (23%) and shatavari (20.7%) over sole crop. Yield

Table 3. Economic feasibility of intercropping of medicinal and aromatic plants in arecanut garden

Crops	Cost of cultivation (Rs ha ⁻¹)		Net returns (Rs ha ⁻¹)			Net return per rupee investment		
	1 st year	2 nd year	1 st year	2 nd year	Mean	1 st year	2 nd year	Mean
Medicinal plants								
Vetiver	15000	-	31,000	-	31,000	2.07	-	2.07
Shatavari	30000	-	80,000	-	80,000	2.67	-	2.67
Long pepper	7500	5000	6,180	16760	11470	0.82	3.35	2.09
Brahmi	13000	10000	35,000	43760	39380	2.69	4.38	3.54
<i>Nilagiriathus ciliatus</i>	15000	-	42,000	-	-	2.40	-	2.40
Periwinkle	10000	10000	24,670	24204	24437	2.47	2.42	2.44
Aloe	18350	8350	8810	25338	17074	0.48	3.03	1.76
Aromatic plants								
Lemon grass	19800	11000	57,300	59472	58387	2.89	5.4	4.14
Palmarosa	11800	11000	23,800	20740	22270	2.02	1.88	1.95
Basil	5000	5000	14,000	20156	17078	2.80	4.03	3.41
Davana	15000	13000	38,000	49600	43800	2.53	3.81	3.17
Patchouli	15000	15000	42,560	37480	40020	2.84	2.5	2.67

advantage was 2.6-3.4% in intercropped lemon grass over sole crop in two years. Basil yields were comparable in both cropping situations in both years. However, yield of palmarosa was reduced by 2% (2004-05) and 17% (2005-06) in intercropping situation over sole crop. The establishment of brahmi was very poor as sole crop indicating its preference for shade.

Kamla Singh *et al.* (1985) also observed that medicinal and aromatic plants like *Mentha sps.*, *Cymbopogon martini*, *Cymbopogon flexuosus*, *Rauwolfia serpentina*, *Vetiveria zizanoides* and *Piper longum* performed better as intercrops in agroforestry system with Eucalyptus, Subabul and poplar.

Economic feasibility

As arecanut is an irrigated crop, there was no need to provide separate irrigation facilities, which in turn would reduce cost of production. Similarly, the cost of planting material of these plants was high amounting to 30-50% of cost of production during first year (Table 3). The cost of production was reduced in the second year due to reduction in cost on planting material. The net return accrued by intercropping of shatavari per ha of arecanut plantation were highest (Rs. 80,000) followed by *Nilagiriathus ciliatus* (Rs. 42,000), brahmi (Rs. 39,380) and vetiver (Rs. 31,000). In terms of net profit per rupee investment, all medicinal plants were found superior. Among aromatic plants, lemon grass, patchouli davana and palmarosa registered net returns of Rs. 69000, 42560, 38000 and 23800 per hectare of arecanut plantation, respectively.

With regard to net returns to rupee invested, the highest was found in lemongrass (4.14) when averaged over two years. This was followed by brahmi (3.54) and basil (3.41). All the crops except palmarosa and

periwinkle had more than Rs. 3.0 per rupee invested in the second year. Crops like aloe and long pepper which had less than one rupee return per rupee invested in the first year recorded more than Rs 3.0 return per rupee invested. This indicates the crops are highly profitable under arecanut system.

Overall the results indicated that crop diversification in arecanut plantation through intercropping of value added medicinal and aromatic plants not only results in increased productivity per unit area but also contributes to increased net income due to higher resource use efficiency. The advantages observed were absence of pests and diseases, less or no irrigation requirement, reduced cost of cultivation from second year onwards and high returns.

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