

FINAL REPORT

1. Institute Code No. **Agr.IV(131)**
2. I. C. A. R. Code No. **Pl.63/2-ICI F26/2710**
3. Name and Address of Research Institute/Centre: **Central Plantation Crops Research Institute
Regional Station
Vittal 574 243,DK,Karnataka**
4. Project Title: **Inter and Mixed Cropping Trials
b. Arecanut with Pepper**
5. Name and Designation of Project Leader: **1. N.Yadukumar, Scientist S1 from April, 1977 to
Sept., 1980
2. M.Gopalakrishnan Nair, Scientist S1 from Sept. 1980 to April, 1983
3. KB Abdul Khader, Scientist SG from April 1983 to March, 1989 till the
completion of the experiment.**

6. Name(s) and Designation(s) of Project Associates including Project Leader and work to be done:

Sl. No.	Name and Designation	Time spent	Work done
1.	N Yadukumar, Scientist S1, PL	4 man-months 1977 to '80	Layout, planting, maintenance of the experiment, recording observations on the growth characters of both arecanut and pepper, collection of yield both arecanut and pepper and statistical analysis, preparation and submission of annual reports.
2.	M Gopalakrishnan Nair Scientist S1, PL	4 man-months Sept. '80 to Apr. '83	Maintenance of the experiment. Recording of growth and growth components. Recording yield and components and statistical analysis of yield data, recording the incidence of wilt disease under different treatments. Studies of pattern of light penetration under different spacings. Preparation of annual reports.
3.	(separate sheet attached)		
7.	Location of Research Project with complete address (Division/Section/Sub-Centre) Central Plantation Crops Research Institute, Regional Station, Vittal 574243, D.K., Karnataka under Agronomy Section.		

8. Date of start

1977

9. Date of termination 1989

10. (a) Objectives (Not more than 150 words) ;
- 1) To study the performance of pepper in the arecanut garden as an intercrop.
 - 2) To generate informations on the shade requirements of pepper while planting as an intercrop.
 - 3) To screen the best suitable cultivar of pepper for planting as an intercrop.
 - 4) To screen the different pepper varieties for shade tolerance.
 - 5) To study the effect of growing pepper on the growth and productivity of main crop of arecanut also to evaluate the economic viability of such a system.

(b) Practical Utility including background information (Not more than 150 words)

Arecanut, when raised as a sole crop adopting the recommended spacing, does not utilise fully the two natural resources of crop production, viz., soil space and sunlight during their life span. Making use of these under-utilised natural resources in arecanut plantations, a variety of crops can be grown and pepper is one of the such crop.

Pepper being the under forestry growth of humid tropical forest, sufficiently shade tolerant and ideal for inter cropping in arecanut. It can be conveniently trained to the palms, once the stem reaches to a height of about

Nair(1982) and Abdul Khader (1982) have separately stated that pepper is profitable cash crop ideal for intercropping in arecanut gardens. According Singh et al.(1982) pepper can be recommended as an intercrop in the existing areca gardens of North Bengal. Additional production through mixed cropping arecanut garden have been reported by Abraham (1974), Bhat(1974), Roy (1974) Muralidharan and Nayar(1979). However, informations on the effect of growing pepper on the yield of main crop of arecanut, the optimum spacing to be adopted the pattern of light penetrations under different spacing, the best suited variety for choosing as an intercrop etc. are lacking. Therefore a detailed field experiment was laid out at the CPCRI Regional Station, Vittal for generating informations on varietal cum spacing requirements of pepper, its effect on the growth and productivity of main crop of arecanut and also to evaluate the economical viability of such a cropping system.

CENTRAL PLANTATION CROPS RESEARCH INSTITUTE

KASARAGOD-670 124, KERALA

R P F III

Project No. Agr.IV(131)

Date of Start: 1977

11. Technical Programme:

The studies were undertaken at the Central Plantation Crops Research Institute, Regional Station, Vittal(CPCRI), situated at 57 m above MSL and at 12.57°N latitude in a typical tropical climate. The soil is of lateritic in origin texture ly classified as sandy loam.

Arecanut was planted during 1958 with 6 spacing treatments adopting RBD design in six replications. The same garden was utilised for the present investigations.

The present experiment was laid out in a split plot design with six replications. The main plot treatments consists of six spacings and five sub plot treatments consist of four cultivars of pepper and a control where no pepper was grown.

<u>S.No.</u>	<u>Spacings(Main plot)</u>	<u>Cultivars of pepper(sub plots)</u>
1.	1.8 x 1.8 m	Panniyur-I
2.	1.8 x 2.7 m	Uddakare
3.	1.8 x 3.6 m	Malligesara
4.	2.7 x 3.7 m	Karimunda
5.	2.7 x 3.6 m	Control
6.	3.6 x 3.6 m	

Pepper was planted in 1977. Border rows were provided in between both main as well as sub plot treatments.

Main plot size : 233.28 sq m.

Sub plot size : 46.66 sq.m.

The arecanut plants were manured with 12 kg each of green leaf, and cattle manure in the form of organics and 100 g N, 40 g P₂O₅ and 140 g K₂O in the form of urea. Superphosphate and Muriate of potash in the form of chemical fertilizers/palm/year. provided separately with 100 g N, 40 g P₂O₅ and 140g K₂O/palm/year.

During summer (November to May) irrigation was given to a depth of 30 mm of water with IW/CPE ratio = 1.

Plant protection measures against Mahali disease of arecanut and quick and slow wilt of pepper were attended regularly.

Data on growth and growth components and yield and yield components were recorded and statistically analysed. Ancillary data on the pattern of light penetration under different spacings and the incidence of wilt disease were also recorded treatmentwise. At the end of the experimental period an economic evaluation was also made for the different treatments.

Pattern of light penetration

The sunlight falling to the interspaces of arecanut was measured by using quantum meter (Licor). The readings were recorded in Micro-einstein $m^{-2} s^{-1}$ at 8 AM, 10AM, 12 Noon, 2 PM and 4PM under different spacings and also in the open area. From the daily readings, the monthly mean were computed. From the data the percentage of light penetrated to the ground surface after the interception by the crowns of arecanut palms were worked out and the data are given in the Table 1.

The maximum percentage of sun light was available under the spacing of 3.6 x 3.6m (56.38%) and the minimum was under the spacing of 1.8x1.8 m (37.17%). Under the recommended spacing of arecanut i.e., 2.7x2.7m the percentage of light available was 42.89.

Flowering behaviour

Data on the following behaviour were recorded under each treatments. At the third year the vines were started flowering. The percentage number of vines flowered under each variety and the yield of dry pepper/vine obtained in the third year are given on the following Table 2.

Table 1. Flowering behaviour of Pepper

Name of the Cultivar	Percentage of vines flowered	Yield of dry pepper/vine
Panniyur-I	48%	99.3 g
Karimunda	43%	100.4 g
Uddakare	4%	14.2 g
Malligesara	7%	10.3 g

Karimunda and Panniyur-I cultivars have shown earliness in flowering.

Disease incidence

At the third year of planting yellowing was noticed in some of the vines due to slow as well as quick wilt diseases. A study was conducted by assigning indexes to the severity of yellowing. No. yellowing 0, Mild yellowing 1, Moderate yellowing 2 and Severe yellowing 3. The vines were classified on the basis of the above index and statistically analysed. The data are given in the following Table 3.

Table 2. Disease index of Pepper

Spacing/variety (m)	Panniyur-I	Uddakare	Mallige- sara	Karimunda	Mean
1.8 x 1.8	1.34	1.13	1.30	0.83	1.15
1.8x 2.7	1.36	0.27	0.66	0.24	0.69
1.8 x 3.6	0.13	0.00	0.31	0.07	0.13
2.7 x 2.7	0.89	0.33	0.67	0.53	0.60
2.7 x 3.6	0.50	0.11	0.00	0.44	0.26
3.6 x 3.6	0.66	0.00	0.50	0.00	0.29
Mean	0.81	0.31	0.61	0.35	-
C.D. for spacing	0.48				
C.D. for variety	0.32				

In closer spacing significantly more yellowing was noticed. Among the different varieties, Panniyur-I and Uddakare have shown significantly more yellowing as compared to the varieties Karimunda and Uddakare.

From the third year of planting the number of vines showing yellowing were recorded every year under each spacing and in different varieties and the mean data are presented in the Table 4.

The data showed that closer spacing had more disease incidences as compared to wider spacings in all the four varieties tried. The spacing of 1.8 x 1.8m and 1.8 x 2.7m had affected by the highest percentage of wilt disease as compared to 3.6 x 3.6m and 2.7 x 3.6m spacings. In high density of planting there will be more humidity inside the garden and which might have been favoured the Phytophthora disease and caused quick wilt. On the contrary in the wider spacing, the humidity is always less and it had resulted in a lesser percentage of disease incidence.

Among the different varieties Karimunda variety had showed lesser percentage of disease incidence.

YIELD:-

Areca nut Yield

The mean yield of areca nut per plot in terms of ripe nuts for 6 years i.e., 1981-82 to 1986-87 are presented in the Table 5. Among the different spacing treatments, the highest mean yield per plot was obtained from the spacing of 1.8 x 1.8m and which was statistically significant (40.19 kg/plot). The lowest yield was obtained from the widest spacing i.e., 3.6 x 3.6 m. Among the different varieties there was no significant differences in the yield of areca nut between the plots where pepper was planted as intercrop and in the plot where areca nut was raised as a monocrop. This showed that growing of pepper

in arecanut garden did not adversely affect the yield of arecanut. Similarly there was no significant difference in the yield of arecanut between the plots where different varieties of pepper was raised.

When the yield per hectare in terms of chili was worked out, the same trend was obtained. The highest yield of chili per hectare was obtained from the closest spacing of 1.8 x 1.8m (table 8). The lowest yield was from 1.7 x 3.6m and 3.6 x 3.6 m spacings (1121.0 kg/ha and 1133.0 kg/ha respectively). The number of palms per hectare under 1.8 x 1.8 m spacing was 3080 while under 2.7 x 3.6m and 3.6 x 3.6m spacings the number of palms/ha were 1025 and 770 respectively. Though the per palm yield is less in closer spacings, the unit area yield is more because due to larger number of plant population per hectare.

Yield of Pepper:

Among the different spacings, 1.8x2.7m had given significantly more yield per plot (7.09 kg of green berries) followed by 1.8x3.6 m spacing. The lowest yield per plot was obtained from 2.7x3.6m spacing (3.14 kg/plot). Among the four varieties of pepper, Karimunda, gave the maximum yield (5.92 kg/plot) followed by Panniyur-I (6.68 kg). The varieties, Uddakare, and Malligesara had resulted in a very low yield of pepper viz., 2.37 kg and 2.50 kg of green pepper per plot. Among the different treatment combinations the spacing of 1.8 x 2.7m with Karimunda pepper was found to be superior compared to the rest of the treatment combinations. Planting of arecanut at 1.8x2.7m spacings and training Karimunda pepper gave the highest yield of 15.48 kg/plot followed by 1.8x3.6m spacing with Karimunda variety of pepper (10.37 kg/plot).

Yield of dry pepper/ha:

When the yield of pepper was calculated on hectare basis, the highest yield was obtained from the spacings of 1.8x2.7m (860 kg/ha) followed by 1.8x3.6m (842 kg/ha). The lowest yield was obtained from 2.7x3.6m(357 kg/ha).

Among the different pepper varieties the variety Karimunda gave the maximum yield per hectare with a mean yield of 1068 kg/ha followed by Panniyur-I with a mean yield of 768 kg of dry pepper per hectare. The lowest yield was obtained from the Uddakare and Malligesara which gave only 273 and 295 kgs/ha respectively. Among the different treatment combinations 1.8x2.7m spacing with Karimunda variety of pepper gave the highest yield per hectare (1973 kg/ha) followed by 1.8x3.6m spacing with Karimunda variety of pepper (1331 kg/ha). The lowest yield was obtained from the treatment combination of 2.7x2.7 m planted with Uddakare variety of pepper (131 kg/ha).

From the above results, it is evident that for the maximum yield of pepper the optimum spacing appears to be 1.8x2.7m to 1.8x3.6m which accommodates about 1540 to 2050 plants/ha. In the closest spacing though the plant population is 3080, the mean yield of pepper is only 434 kg/ha as against 860 kg/ha from a plant population of 2050 per hectare.

In the case of arecanut the highest yield per hectare was obtained from the closest spacing of 1.8x1.8m having a plant population of 3080/ha which gave 2500 kg of chili nuts/ha as against 1985 kg of chili/ha under 1.8x2.7 m spacing and from a plant population of 2050/ha. Another interesting observation was that planting of pepper did not influence the yield of arecanut.

Economics:

(1) Gross income/ha:-

The economics of growing pepper was worked out. The gross income was calculated taking the market price of pepper as Rs.35/- per kg of dried pepper and the market price of arecanut as Rs.25/- per kg of chili under the different spacings; the highest gross income was obtained from the 1.8x2.7m spacing and with Karimunda variety which gave a total income of Rs.1,33,455/- per ha followed by 1.8x3.6m spacing and with Karimunda variety of pepper (Rs.1,07,664/- per ha). In the treatment combination of 1.8x2.7m with Karimunda variety of pepper the gross income was more from the pepper i.e., Rs.69,055/- as compared to the gross income of arecanut i.e., 64,400/- per hectare. In control treatments the highest gross income was obtained from 1.8x1.8m (Rs.60,550/ha). The lowest income was obtained from the spacing of Rs.27,085/- per ha) with Uddakare pepper variety.

(2) Net income/ha:-

The net income per ha was worked out taking the cost of cultivation for arecanut as Rs.10/- per palm and Rs.5/- per pepper vine. The highest net income was obtained from the treatment combination of 1.8x2.7m spacing and Karimunda variety of pepper and this treatment combination gave Rs.1,02,705/- per hectare out of which Rs.58,805/- was derived from pepper as an additional income, while from the arecanut, the income obtained was 43,900/- . Among the control plots the highest net income was obtained from 1.8x2.7m spacing (Rs.33,875/- per hectare).

From the results it is evident that, in arecanut garden growing of pepper is a profitable proposition and from this field experiment the following conclusions may be drawn:-

1. Pepper is one of the most profitable inter crop in arecanut garden.
2. Karimunda is the most suitable variety of pepper for raising in arecanut garden.
3. The optimum spacing was found to be 1.8x2.7m with a plant population of 2050/ha.
4. Under the spacing of 1.8x2.7m an average of 40.38 per cent of sunlight is available for pepper.
5. Growing of pepper does not affect the yield of main crop of arecanut.
6. Both slow and quick wilt diseases incidences are the major problems to pepper in arecanut gardens. Appropriate control measures are to be taken for disease control.
7. It was found to be possible to increase the unit area income of arecanut garden to almost double by growing Karimunda variety of pepper with a spacing of 1.8x2.7m.
8. The varieties Uddakare and Malligesara are found to be not suitable for growing in arecanut garden.
9. Closer spacings had more disease incidences to pepper as compared to wider spacings.

Table 3. April-VI(131) Inter and mixed cropping trials : Arsenate with Pepper - Light Intensities under different levels of shade - 1984 (Microclimate W² sec⁻² Monthly Mean)

Month	Spring(m) Total	1982.6		1982.7		1982.8		1982.9		1982.6		1982.6	
		Light	pen- traced	Light	pen- traced	Light	pen- traced	Light	pen- traced	Light	pen- traced	Light	pen- traced
March	1165.26	434.40	37.28	496.30	42.59	608.74	52.23	524.48	45.0	695.20	59.75	719.40	59.75
April	1206.74	452.30	38.31	504.69	41.82	634.19	52.56	543.29	45.03	784.40	58.38	726.50	62.55
May	1291.11	467.51	36.21	506.40	39.38	639.19	49.51	542.63	43.03	715.60	55.43	728.40	58.80
June	987.15	389.42	39.45	406.90	41.22	520.16	53.51	439.18	44.49	611.54	61.95	640.50	64.89
July	913.96	352.40	38.56	376.40	41.19	491.70	53.40	430.80	47.14	574.16	62.69	601.80	65.85
August	954.38	380.70	39.89	409.50	42.91	540.60	56.45	470.90	49.34	540.80	56.47	571.60	59.90
Sept.	1123.30	403.80	35.93	429.90	38.28	542.50	48.30	453.90	40.10	821.70	46.45	596.40	49.54
Oct.	1142.51	421.70	36.09	459.60	40.23	567.60	49.68	451.60	40.41	842.40	47.35	578.80	50.60
Nov.	1161.76	410.80	35.33	448.80	38.58	597.80	47.98	452.60	38.93	531.90	45.75	570.30	49.05
Dec.	1153.54	402.70	34.91	441.50	38.28	546.90	47.41	441.80	38.30	520.60	45.13	568.30	48.88
Mean	1110.07	412.56	37.17	448.17	40.38	565.74	50.97	476.12	42.89	595.93	53.69	625.70	56.38

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Table 4. Percentage of paper value affected by wilt disease under different spacings and varieties

Spacing(m)	Paper varieties											
	Pamalya-1			Dokhara			Mulligara			Karlinda		
	1983	1984	1985	1983	1984	1985	1983	1984	1985	1983	1984	1985
1.8 x 1.8	20.45	27.27	29.54	20.45	36.36	32.27	18.18	36.36	-	11.135	22.72	-
1.8 x 2.7	16.66	20.83	25.00	8.33	37.50	50.00	18.75	25.00	-	8.33	20.83	-
1.8 x 3.6	6.25	12.50	25.00	-	12.50	25.00	18.75	20.75	-	25.00	31.25	-
2.7 x 2.7	-	6.25	6.25	6.25	6.25	12.50	-	31.25	-	-	12.50	-
2.7 x 3.6	-	-	-	-	-	-	-	8.33	-	8.33	8.33	-
3.6 x 3.6	-	8.33	12.50	-	-	-	-	8.33	-	-	8.33	-

Table 5. Yield of arcanum for 6 years - 5th to 10th year (1981-82 - 1986-87) - Mean yield (Alpo mta/plot)

Spacing(m)	Family	Mean values					Mean
		Udskere	Mulligera	Karimda	Control	Mean	
S ₁ 1.0x1.0	38.61	37.65	44.79	40.96	36.93	40.19	
S ₂ 1.0x2.7	25.35	29.69	21.14	31.93	26.65	28.15	
S ₃ 1.0x3.6	22.31	20.33	23.00	26.55	20.22	22.90	
S ₄ 2.7x2.7	28.13	22.25	24.85	32.18	21.98	29.08	
S ₅ 2.7x3.6	12.81	11.05	15.55	19.69	14.08	14.75	
S ₆ 3.6x3.6	13.60	14.01	14.80	10.10	33.77	13.26	
Mean	23.47	22.80	24.37	27.57	22.91		

S.E. for spacing 4.08
 C.D. (Dw05) 0.51
 S.E. for variety 2.33

Table 6. Yield of pepper for 6 years - 5th to 10th year (1981-82 - 1986-87)
 Mean Yield per plot (green berries)

Spacing(m)	Varieties				Mean
	Panniyur	Uddakere	Nalligera	Karimunda	
S ₁ 1.8x1.8	7.13	2.09	1.52	7.89	4.56
S ₂ 1.8x2.7	8.15	2.50	2.22	15.48	7.09
S ₃ 1.8x3.6	9.85	2.76	3.28	10.17	6.56
S ₄ 2.7x2.7	6.91	4.01	2.65	7.24	5.21
S ₅ 2.7x3.6	4.78	1.15	2.02	4.59	3.14
S ₆ 3.6x3.6	3.25	1.59	3.32	7.95	4.05
Mean	6.68	2.37	2.50	6.92	

SE for spacing 2.13
 CD(P=0.05) NS
 SE for variety 1.09
 CD (P=0.05) 2.20

Table 7. Mean yield of pepper for 6 years -(5th to 10th year) dry pepper (kg/ha)

Spacing(m)	No. of plants	Varieties				Mean
		Punalpur	Vadakare	Kalligassara	Karimnadi	
S ₁ 1.8x1.8	3080	665	194	142	736	434
S ₂ 1.8x2.7	2050	929	285	253	1973	860
S ₃ 1.8x3.6	1540	1264	354	419	1331	842
S ₄ 2.7x2.7	1370	789	458	302	826	594
S ₅ 2.7x3.6	1025	544	131	230	523	357
S ₆ 3.6x3.6	770	417	217	426	1020	520
Mean		768	273	295	1068	601

Table 6. Mean yield of arecanut for 6 years - 1st to 10th year
(Chall kg/ha)

Spacing(m)	No. of trees/ha	Varieties				Control	Mean
		Panniyur	Udakar	Malligeera	Karimada		
S ₁ 1.8x1.8	3080	2402	2343	2788	2549	2422	2500
S ₂ 1.8x2.7	2050	1925	2251	1757	2576	2175	1985
S ₃ 1.8x3.6	1540	2909	1894	1968	2443	1730	1952
S ₄ 2.7x2.7	1370	2141	1770	1891	2449	1665	1983
S ₅ 2.7x3.6	1025	973	900	1191	1487	1064	1121
S ₆ 3.6x3.6	770	1163	1199	1266	964	1178	1133
Mean		1752	1693	1808	1939	1706	

Table 9. Economics of growing pepper in arecanut garden (Gross Income in Rs./ha)

Spacing(m)	Panna Par-1		Uddalaga		Varieties of Pepper		Kalliyasara		Karlmanda		Gentrol Area- nut alone		
	Per ha	Total	Per ha	Total	Per ha	Total	Per ha	Total	Per ha	Total			
S ₁ 1.8x1.8	60050	21275	83325	58275	6790	65366	69850	4970	74620	63725	25760	89485	60550
S ₂ 1.8x2.7	48125	32400	80605	56275	9975	66250	43925	8855	52791	64400	69055	133455	54375
S ₃ 1.8x3.6	47725	44240	91965	42350	2390	46740	49200	14630	63830	61075	46569	107664	43250
S ₄ 2.7x2.7	53525	27615	81140	44250	1630	45840	47275	10570	57845	61225	26910	90135	41625
S ₅ 2.7x3.6	24325	19040	43365	22500	4585	27085	29525	8050	37575	37175	18305	55480	16400
S ₆ 3.6x3.6	29075	14595	43680	25975	7595	37570	31685	7595	52795	21608	35709	57308	21750

Arecanut @ Rs.25/- per kg
Pepper @ Rs.35/- per kg

Table 10. Movement of mixed cropping of pepper in arecanut garden (net income Rs./ha)

Spacing(m)	Varieties of Pepper				Control								
	<u>Penalty</u>	<u>YPR-1</u>	<u>Yadav's</u>	<u>Mulligetta</u>									
	<u>Areca nut</u>	<u>Pepper</u>	<u>Total</u>	<u>Areca nut</u>	<u>Pepper</u>	<u>Total</u>	<u>Areca nut</u>	<u>Pepper</u>	<u>Total</u>	<u>Areca nut</u>	<u>Pepper</u>	<u>Total</u>	<u>alone</u>
S ₁ 1.0x1.0	29250	7875	37125	2775	6810	36365	32850	10430	49280	32915	10360	43275	29750
S ₂ 1.0x2.7	27615	22250	49865	35775	275	36050	23325	1355	24720	41900	50805	102705	33075
S ₃ 1.0x3.6	42350	36540	78890	36951	4600	41641	43770	6910	50700	55675	30889	94564	27050
S ₄ 2.7x2.7	30765	20765	59530	30550	5220	35770	33575	3720	37205	57525	22060	79585	27925
S ₅ 2.7x3.6	20075	13915	33990	12250	540	13790	13635	2925	16560	26926	13180	53286	25425
S ₆ 3.6x3.6	21375	10745	32120	22775	3745	16020	24005	11660	35005	13908	31650	45758	19500

Rate

Areca nut @ Rs.25/- per kg of shell
 Pepper @ Rs.35/- per kg

Cost of cultivation

Rs.10/- per areca palm
 Rs. 5/- per vine

KV

INTER AND MIXED CROPPING IN ARECA GARDENS

K.B. ABDUL KHADER

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Areca-cacao mixed cropping

INTERCROPPING, multiple cropping, mixed cropping, and relay cropping are some of the terms that are being more widely used in recent years. All these in reality mean an intensive land use to take two, three or even more crops either simultaneously or successively each year. These systems of farming not only increase the productivity per unit area and per unit time but also provide additional work to the agricultural labour.

The practice of intercropping or mixed cropping in arecanut gardens has been in vogue even in early times. But the objective in those days was not intensive cropping. The long pre-bearing age of 5-8 years, the low income in the early years of bearing, the fluctuation in the yield of the crop due to pests and diseases and seasonal conditions forced the planter to take up intercropping. The intercrops when raised can provide additional in-

come during the off seasons. The venetian and orientation of arecanut leaves permit 40 to 60 per cent of solar radiation reaching the crown to penetrate to the crops grown underneath. Rooting pattern of areca palms also suggest that there is considerable scope to exploit the ground surface by growing inter and mixed crops in areca gardens as the total soil mass is not effectively utilised.

Though several crops are grown in arecanut gardens, it is necessary that some selection is made since all crops are not found to come up well under the eco-climates prevailing in the gardens. The crop or crops for intercropping are to be chosen more carefully, especially when one of the partners is a perennial crop like arecanut. The intercrops chosen should not have any problems of soil exhaustion, and pest build-up and at the same time should have maximum production or maxi-



An arecanut plantation in Mysore. Banana is also grown in it

imum returns per unit input to the farmers. Crops which love shade or those which can withstand the canopy of arecanut palms and the heavy drip during the monsoon are to be preferred. They should be able to utilise the filtered light to the maximum. It is also necessary that the crops which go with areca do not have similar requirements of plant nutrients as far as possible. It will also be an advantage if the root systems of the crops are confined to different zones so that competition for moisture and nutrients is minimised. The crops chosen as intercrop or mixed crop also vary from tract to tract, though a crop like banana may be more universally grown. If growers of Sirisi (Karnataka) prefer cardamom and pepper as intercrops, the planters at Dakshina Kannada of Karnataka, select pepper, banana and yam as best suited to the locality. The areca growers of Assam prefer citrus while the growers of Kerala grow *Dioscorea*, yams and tapioca. Thus the kind of intercrop chosen will vary depending upon several factors like the agroclimatic conditions of the region, the demands and preference of the local market and the personal likings and needs of the farmer.

A large number of annuals and perennials have been tried for feasibility studies to evolve different crop combinations with arecanut at the CPCRI, Regional Station, Vittal and in the Research Centres spread over in the States of Karnataka, Kerala, West Bengal and Assam.



Pepper in arecanut

Crops like banana, pepper, elephant foot yam, pineapple, cacao, guinea grass, etc. are found to be best suited for inter and mixed cropping. Elephant foot yam which was grown at the Research Centre, Kannara (Central Kerala) has shown that the same has no adverse effect on the performance of main crop of arecanut. Similarly, growing of banana as an intercrop with arecanut at the CPCRI, Regional Station, Vittal had no adverse effect on the performance of arecanut. In the initial years the shade of banana helped to protect the delicate palm from sunscorching during the summer months. A net return of about Rs 4000/ ha/year was obtained from banana. Guinea grass was found to come up well under the shade of areca. The advantage of growing this fodder is that due to the moisture available in arecanut gardens, a continuous supply of the fodder becomes available. The observations made till now at Vittal indicated that cacao is a profitable mixed crop. Pepper was also found to be another crop suited for the areca gardens. All the intercropping systems increased the job potential in addition to the subsidiary income.

Cultural Requirements

Whatever the crop chosen it is very important that the subsidiary crop is given adequate attention and met with its specific requirements lest the main crop may

suffer. The following cultivation programme for the individual crops may be followed.

Banana. Banana needs a rich, deep soil with plenty of organic matter. Sword suckers of 75 to 100 cm height are planted in pits of 30 to 60 cm cube filled with 10 to 12 kg of cattle manure. Pits are dug at a distance of $2.7 \times 3 \times 4$ metres (when the spacing of arecanut is 2.7×2.7 m) in the same row as arecanut palm. The population of banana will thus be at the rate of one plant to every two areca palms. 250 gm of superphosphate may be applied per plant as a basal dose prior to planting banana, followed by 100 gm of N and 140 gm of K_2O each applied in two equal doses, the first application being done about two to three weeks after planting and the second application four or five months of planting. Other operations like earthing up and providing supports when the plants throw bunches are to be attended to. Another important operation to be attended to is desuckering, only one good sucker should be allowed to grow. Besides the main crop two ratoon crops can be harvested in a three year period at the end of which the entire crop will have to be replanted in pits dug at changed sites.

Elephant foot-yam. The crop prefers loamy soils rich in organic matter. Good and healthy tubers from the previous harvest are cut into bits, each bit having a small portion of ring or bud. Any ordinary sized yam gives six to eight bits and each bit should have a minimum weight of three-fourth to one kg. It is usual to dip these bits in cattle dung slurry to prevent rapid drying of the tuber. Such pieces are planted in pits of 50 cm cube applied with 8-10 kg of cattle manure or compost. It would be preferable to apply 50 gm of superphosphate in each of these pits before the planting of seed material. Three to four pits can be accommodated in the inter spaces between four arecanut palms planted with the normal spacing of 2.7×2.7 m. Planting is usually done in February-March and the crop comes to harvest in October-November. An average of 12,178 kg tuber per hectare fetching a net profit of Rs 4 to 5 thousand per ha can be obtained from this crop.

Pineapple. Pineapple grows in almost any type of soil provided there is adequate drainage. Suckers which arise from underground parts are commonly used as planting material since these produce fruits earlier. Trenches of 60 cm width and depth and about 125 cm length are dug in between two areca palms and filled with 50 gm of cattle manure. In each trench three

suckers are planted. Fertilizers to supply 100 kg N, 100 kg P_2O_5 and 150 kg K_2O per hectare may be applied in two equal doses, once at the time of planting and again six months after planting. As an intercrop in arecanut garden pineapple is estimated to give 8000 kg of fruit per hectare fetching a net profit of Rs three to four thousand per hectare.

Guinea grass (*Panicum maximum*). It is grown under varied conditions of soil and climate and comes up well in drained loamy soils. The grass is propagated by slips. As an intercrop in arecanut gardens it can be planted in two rows about 50 cm apart in the interspaces between rows of areca trees or on the edge of drains. The area to be planted has to be applied with about 10 times of cattle manure per hectare as basal dose, followed by top-dressing with 100 cm of urea in two equal doses at an interval of 6 months. The crop gives 5 or 6 cuttings per year with a total yield of 18 to 22 tonnes/hectare.

Cacao. Cacao is a perennial crop. Seedlings 4 to 6 months old may be planted with a spacing of 2.7×5.4 m when arecanut is spaced at 2.7×2.7 m in the same row of areca palms. The population of cacao should be half to that of areca palms. Cacao plants commence bearing two to three years after planting. A fertilizer application of 100 gm N, 40 gm P_2O_5 and 140 gm K_2O per tree in two equal doses is recommended cacao, when planted as a mixed crop. From a full bearing tree on an average 50 pods may be harvested. Ten to twelve thousand rupees per hectare may be obtained as a net income.

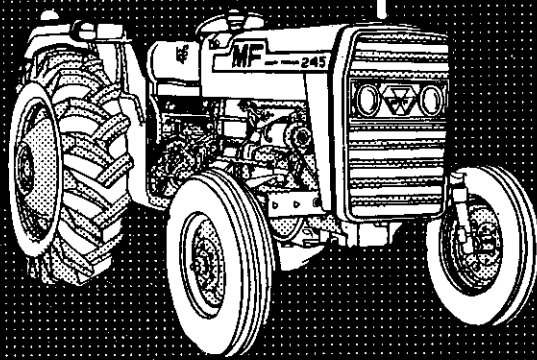
Pepper. Using arecanut palm as a standard pepper may be grown successfully as an intercrop. About 800 to 1000 palms may be used for growing pepper in a hectare. Research results at Vittal have indicated that 'Panniyur-1' and 'Karimunda' varieties are more suitable for growing in areca gardens. A fertiliser dose, equal to the dose recommended to areca palms (100:40:140 gms of N, P_2O and K_2O / palm) may be applied to pepper in addition to 12 kg of green leaf and 12 kg of cattle manure per vine. A grower can get an income of 8 to 10 thousand rupees/ha as net income by pepper alone by growing as an intercrop.

Though several crops, annual and perennial, can go well with arecanut, it is very important that the selection of inter or mixed crop should be based on the moisture availability, soil depth and nutrient status of the soil besides market preference and needs of the farmer.

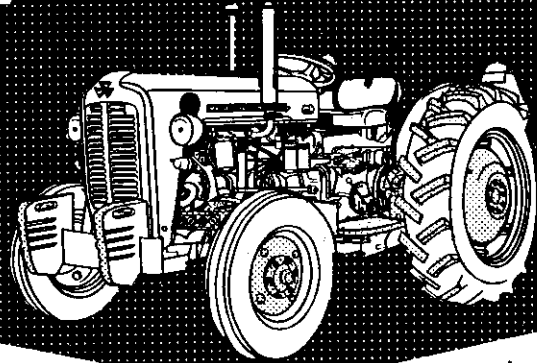
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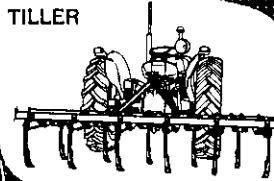


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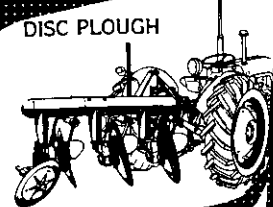


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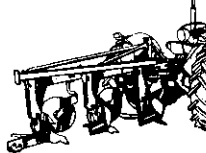
TILLER



DISC PLOUGH



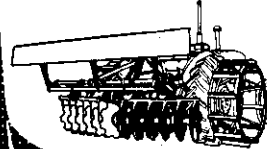
MOULD BOARD PLOUGH



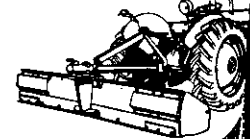
OFFSET DISC HARROW



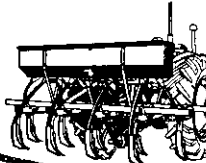
PADDY DISC HARROW



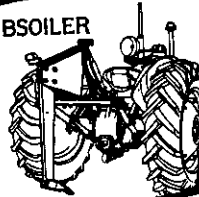
TERRACER BLADE



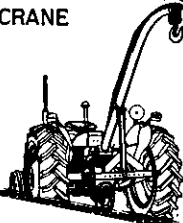
SEEDING ATTACHMENT



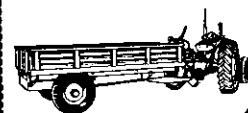
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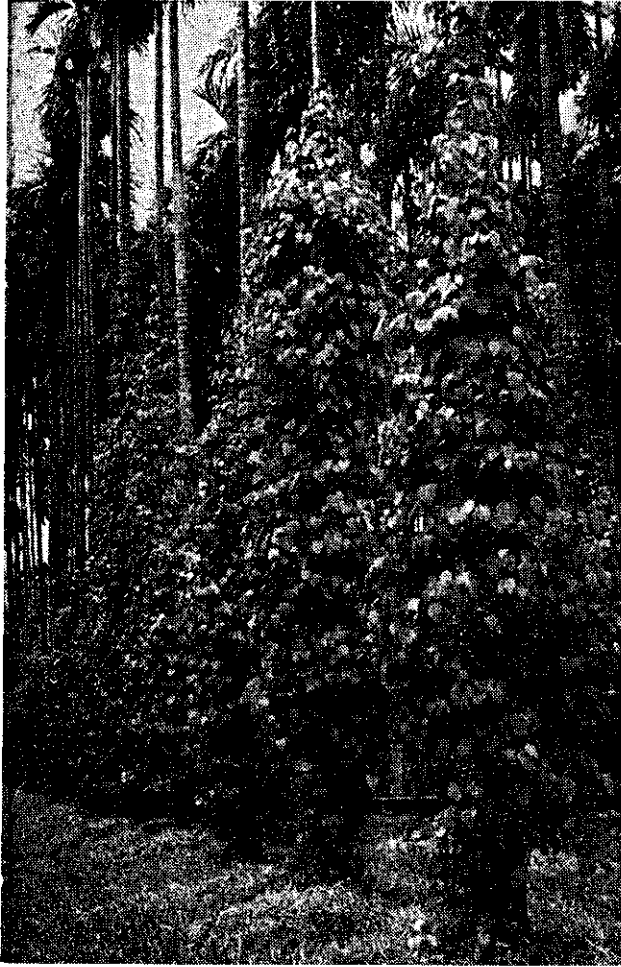


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Pepper intercropped in areca gardens

INTERCROPPING WITH PEPPER

M. GOPALAKRISHNAN NAIR
Central Plantation Crops Research Institute, Regional
Station, Vittal

ARECANUT is a crop cultivated by marginal and small farmers. Hence it becomes imperative to increase the returns per unit area of land to provide a reasonable income. Intercropping is one of the practices followed to meet this end. Fluctuation in market price of arecanut is considerably high. This again necessitates the growing of another cash crop to buffer the effect of low prices. Increasing the cropping intensity also facilitates proper utilisation of farm labour. Arecanut being mostly an irrigated crop, the growth of another crop will also improve the water use efficiency and increase the returns for the amount spent on irrigation. It shall be a boon to farmers in areas where the areca palm is affected by the elusive yellow leaf disease. They will be able to compensate the loss due to the disease by growing suitable intercrops like pepper and thus live with the disease.

There is considerable scope for practising intercropping in an arecanut garden. An areca garden with a spacing of 2.7 m × 2.7 m provides ample space and light for the growth of shade tolerant intercrops. Pepper is a remunerative cash crop ideal for intercropping in areca gardens. Pepper, being the understorey growth of humid tropical forests, is sufficiently shade-tolerant. Intercropping areca gardens with pepper is a practice followed by some of the farmers in the states of Kerala and Karnataka.

Pepper can be grown in the gardens once the palms reach a height of about 5 m. At this stage the trunk acts as a standard for pepper and penetration of sufficient light is also made possible. Pits of size 50 cm cube may be dug 35 cm away from the base on the northern side of the palms with the receipt of summer showers. These pits have to be filled with a mixture of compost (5 kg) and top soil and rooted pepper cuttings planted at the rate of 2 or 3 cuttings per pit. The vines have to be tied to the trunk of the palm as and when they grow. The height of the pepper vines may be restricted to 4 m to facilitate easy harvesting. Climbing the areca palms for purposes of harvesting and spraying has to be done with the help of a ladder to prevent damage to the vines.

Manuring

Adequate manuring has to be done to prevent competition between pepper and areca. Hence the recommended doses of fertilizers for the two crops have to be provided separately. The annual requirement of fertilizers for areca is 100 g N, 40 g P₂O₅ and 140 g K₂O in addition to 12 kg each of farmyard manure and green leaf. The recommendation for pepper is 100 g N, 40 g P₂O₅ and 140 g K₂O over 10 kg of farmyard manure. The organics along with two-third the dose of inorganic fertilizers for the two crops may be applied in trenches 15 cm deep dug 75 cm away from the base of the palm. Lime at the rate of 1 kg may be applied in alternate

TABLE 1. COST OF CULTIVATION OF ONE HECTARE OF PEPPER IN AN ARECA GARDEN (NUMBER OF VINES-1372)

Year	Digging pits and planting		Cost of rooted cuttings		Tying vines		*Fertilizer application including cost	*Plant protection	Harvest		Total cost (Rs)
	Mandays	cost at Rs 15/-day	Rs 0-25/cutting	Number	Cost	Mandays			Cost	Mandays	
First	60	900	3900	975	10	150	1069	—	—	—	3094
Second	—	—	825	207	20	300	2138	1659	—	—	4304
Third	—	—	330	83	30	450	3239	3318	60	900	7990
Fourth	—	—	—	—	30	450	3239	3808	120	1800	9297
Fifth	—	—	—	—	20	300	3239	3808	120	1800	9147
Total	60	900	5055	1265	110	1650	12924	12593	300	4500	33832

Income from sale of 1300 kg pepper at Rs 12 per kg Rs 15,600

*Elaborated in Table 2

Income from sale of planting material 20,000—3 node cuttings at Rs 0.10 per cutting 2,000

Total Rs 17,600

Recurring expenditure 9,500

Net profit Rs 8,100

years. The remaining one-third dose may be applied at a radius of 75 cm during February-March (if the plantation is irrigated) and lightly forked into the soil. The vines may be earthed up at the time of digging the interspace with the cessation of heavy rains.

A cover crop of *Calapagonium mucunoides* can be raised with the onset of summer showers. During summer the crop dries off leaving a thick mulch which will do away with the need for digging the interspace. During subsequent years a self-sown crop is produced from the seeds shed by the previous year's crop. This will help in conserving the soil and improve the organic matter status of the soil. Ring method of irrigation may be preferred to the basin irrigation which is in vogue as this will facilitate earthing up of the vine bases. Adequate soil conservation measures and drainage have to be provided.

At the time of spraying against Mahali disease a spray of Bordeaux mixture is recommended for pepper also. The basal 1 m portion of the vine has to be painted with Bordeaux paste as a precautionary measure against the foot rot disease of pepper. The soil around the vines may be drenched with 5 litres of 1 per cent Bordeaux mixture of 0.1 per cent Ceresan wet. An insecticide spray has to be given if there is incidence of pollu beetle. Dimethoate 0.06 per cent and Dithane Z-78 (0.2 per cent) against fungal pollu. If nematode infection is noticed phorate or carbofuran at 1 g ai/vine may be applied twice a year in May-June and October-November.

Pepper vines usually flower during May-June with the commencement of the monsoon. Harvesting season is from January to March in the hills and slightly early

TABLE 2. COST OF MANURING AND PLANT PROTECTION OPERATIONS

Manuring		Dose for 3-year old vines: 100g N, 40g P ₂ O ₅ and 140g K ₂ O		Rs
		Farm yard manure 10 kg/vine		
Farm yard manure	13 tonnes at Rs 100/ton			1,300
Urea at Rs 2.50/kg	286 kg			715
Superphosphate at Rs 1-04/kg	291 kg			303
Muriate of potash at Rs 1-36/kg	310 kg			421
Application charges (20% of cost)				500
				3,239
Plant protection				
Two sprays of Bordeaux mixture at 3 litres/vine	Copper sulphate at Rs 18/kg	78 kg		1,404
	Lime	78 kg		60
	Spraying charge Rs 0-20/vine			520
Drenching Bordeaux-mixture 5 litres/vine	Copper sulphate			1,170
	Lime			50
	Application charges			180
Painting Bordeaux paste 1 litre for 10 vines	Copper sulphate	13 kg		234
	Lime	13 kg		10
	Application charges			180
				3,808
One spray of insecticide against pollu beetle (0.06% dimethoate at 3 litres/vine)	Rogor 13.5 litres at Rs 90/- litre			1,200
	Spraying at Rs 0-20/vine			260
				1,460
Nematicide-two applications per year	Furadan	86 kg		1,603
Carbofuran at 1 g ai/vine	Application charges			300
				1,903

in the plains. Harvesting is done by plucking the spikes by hand when one or two berries on the spike turn red. It may be done in two or three rounds as all the spikes may not reach maturity at the same time.

Berries are separated from the spikes by rubbing between the hands or trampling them under feet. The berries are to be dried in the sun for 7-10 days until the outer rind turns black in colour and shrunken in size. The moisture content of the berries should be below 11 per cent for safe storage. Extraneous matter, light berries and pin heads may be removed by winnowing. Grading of pepper can be done with the help of sieves of different meshes to obtain berries of required size. Dipping the berries, collected in a basket, in boiling water for one minute facilitates quicker drying, the berries get a shining black colour and reduce the microbial load in the product.

White pepper fetches 40 per cent more price than that of black pepper in the international market. It is prepared by harvesting spikes with fully ripe berries. The berries are filled in gunny bags and steeped under flowing water for about 7 days. Subsequently the outer rind of the berries is removed by rubbing with hands in a bucket of water. Subsequently it is washed in clean water, dried for 3 or 4 days, cleaned by winnowing and polished by rubbing with a cloth. The loss in weight may be about 8 per cent compared to black pepper. The other commercial products of pepper are canned green

pepper, dehydrated green pepper, pepper oil and pepper oleoresin which usually enter the export market. White pepper is a product which can be prepared without any equipment or complicated technology.

One hectare of areca garden with a spacing of 2.7 m x 2.7 m will accommodate about 1300 pepper vines. With good management practices a pepper vine should produce a minimum of 1 kg black pepper in the fourth year. Taking the cost per kg of pepper to be Rs 12 the additional income comes to Rs 15,500 per hectare. The farmer will get an income of Rs 2,000 by sale of planting material making the total income Rs 17,500. The recurring expenditure for the maintenance of an intercrop of pepper has been worked out as Rs 9,500. This enables the farmer to earn a net profit of Rs 8,000 by intercropping his areca garden with pepper. The yield will be doubled by the seventh year. The sale of products shall increase his net returns.

An experiment was laid out at the CPCRI, Regional Station, Vittal in 1977 with four varieties of pepper namely 'Malligesara', 'Uddakare', 'Panniyur-1' and 'Karimunda' as inter crop in an areca garden planted in 1959 under different spacings. The experiment has so far shown the superiority of the latter two varieties for intercropping. The yield of arecanut has also not been affected by the growth of pepper. The green berry yield of the four varieties under spacing of 2.7m x 2.7m during the fourth year is as follows: Karimunda 4582 g, Panniyur-1 3227 g, Malligesara 1652 g and Uddakare 200 g.


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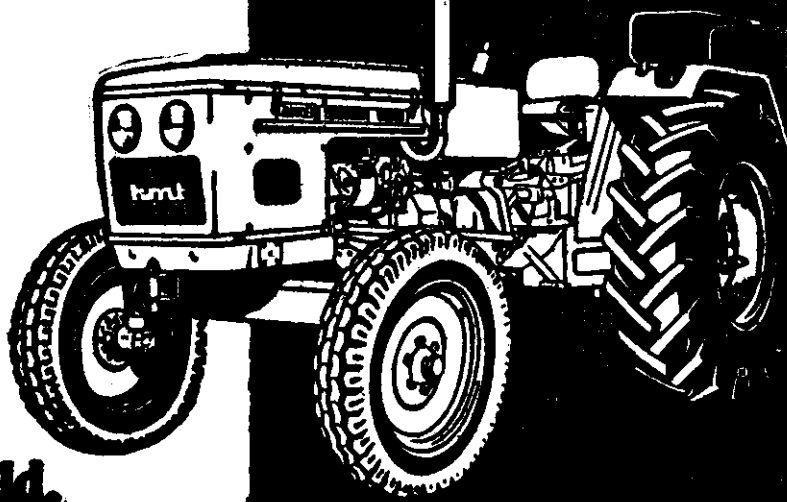
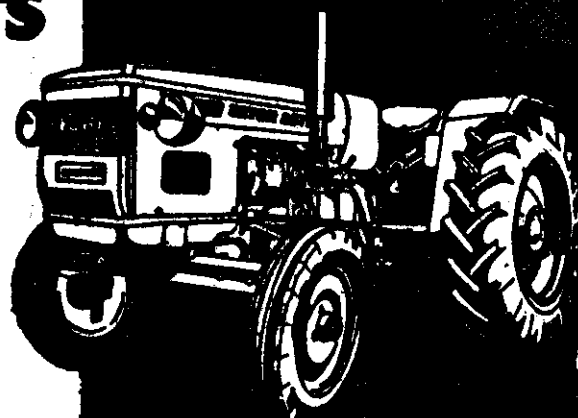
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13. Approximate expenditure incurred in the Project: (Give reasons for variation, if any, from original estimated cost)

Rs. 1,14,506.00 (1,14,506/-)

14. Publications and material (one copy each to be supplied with this proforma)

a) Research papers **nil**

b) Popular articles **Two nos. (copies enclosed)**

c) Reports **10 Nos. (Annual reports from 1978 to 1988)**

d) Seminars and workshops (Relevant to the Project) in which the Scientists have participated:
Nil

e) Material developed (such as new varieties of crops or breeds of farm animals, implements, products, etc.)
(i) Karimunda variety of pepper was found to be the best suited variety followed by Panniyur-I for planting in arecanut garden.
(ii) Growing pepper was found to be highly profitable and it did not affect the yield of main crop of arecanut adversely.
(iii) Closer spacing was found to be not a limitation in arecanut garden for raising pepper.

15. Details (Nos. etc.) of Field/Laboratory Note books and final material and their location

(i) Experimental Log Book

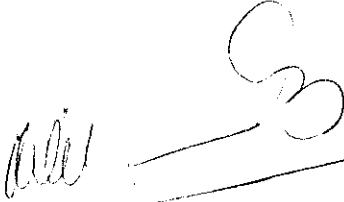
(ii) Project file

16. Comments/suggestions of Project Leader regarding possible future line of work that may be taken up arising of this project:

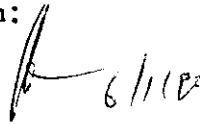
Pepper when raised in arecanut garden, its manurial, cultural and water requirements will have to be standardized. It is desirable to initiate some field experiments to study the above aspects.

Diseases, especially slow and quick wilts, are associated with pepper when raised as an intercrop in arecanut garden and it was observed as one of the major limitations. A suitable control measures will have to be found out to solve the problem.

17. Signatures with name of Project Leader and Associates:

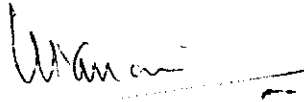

Dr K B ABDUL KADER, MSc (Agri) Ph.D.
Senior Lecturer
Central Plantation Crops Research Institute
Regional Station, YILLAI, Kasaragod, Karnataka.

18. Signature (with comments, if any) of Head of Division/Section/Station:


Optimum spacing for Area + pepper intercropping has been brought out. The superiority of variety 'Kannanda' has been proved. However, disease incidence in pepper was severe and could not be controlled.

Dr. K. Venugopal
Joint Director

19. Signature (with comments, if any) of Director:


Director
Central Plantation Crops Research Institute
P.O.KUDLU, KASARAGOD 670124

Central Plantation Crops Research Institute
Regional Station, YILLAI, Kasaragod 670124