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INTEGRATED MANAGEMENT OF ROOT (WILT) DISEASE AFFECTED COCONUT GARDENS THROUGH CROPPING/FARMING SYSTEM APPROACH

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Introduction

Root (wilt) disease is one of the important diseases of coconut, which is non-lethal, but debilitating. The major symptoms of the disease are inward bending or ribbing of leaflets (flaccidity) of mid whorl or outer whorl fronds as well as general yellowing followed by marginal necrosis of the leaflets. Abnormal shedding of buttons, reduced leaves and crown and gradual reduction in yield are also observed in root (wilt) affected palms. This disease is prevalent in varying intensities in eight southern districts of Kerala and has also been reported from isolated pockets in northern districts of Kerala and in a few districts of Tamil Nadu and Karnataka bordering Kerala as well as in Goa. Root(wilt) disease symptoms are found to be associated with the presence of phytoplasma and so far there has been no therapeutic control measure available for this disease. Often, leaf rot disease is seen superimposed on root (wilt) disease affected palms and if such palms are left neglected without any management, health and productivity of such palms will be considerably lowered. Hence, maintaining health of palms through various integrated management practices including recycling of crop residues and cropping system approach is very important. Disease advanced and uneconomical palms that yield less than 10 nuts per year and that contract the disease early during the pre-flowering stage are to be removed and replanted with disease free plants of high yielding varieties. Seedlings of Kalparaksha and Kalpasree varieties and that of Kalpa Sankara hybrid can be used for planting in disease prevalent tracts. Various integrated management practices that are to be followed in root (wilt) disease endemic areas to improve health of palms and sustain productivity are enumerated.

Root (wilt) disease affected coconut palms

I. Adoption of appropriate cropping/ farming system

Cultivating coconut as a mono crop is only marginally productive and profitable and hence, a cropping system involving inclusion of compatible crops is necessary to enhance the productivity per unit area as well as income of farmers. A well-spaced coconut garden provides adequate inter and intra row space where it is possible to grow a variety of useful seasonal and perennial crops. At least 1.8 to 2 m from the base of coconut palm is to be left and inter/mixed crops are to be cultivated in the interspace available. Raising different kinds of crops will help to meet the nutritional requirement of farm families and also to earn additional income. It also provides sufficient quantity of organic biomass for recycling to partly meet the nutritional requirement of coconut and component crops. Suitable crop rotations are also to be followed while cultivating annual crops in the coconut garden. The following are the cropping systems that can be adopted in coconut gardens:

➢ **Inter/mixed cropping:** A variety of crops can be inter/mixed cropped in coconut garden without affecting the yield of coconut.

- Tuber crops: Cassava (*Manihot esculenta)*, Elephant foot yam (*Amorphophallus paeoniifolius*), Colocasia [Taro] (*Colocasia*

esculenta), Dioscorea (Yams): Greater yam (*Dioscorea alata*) and Lesser yam (*Dioscorea esculenta*)

Elephant foot yam as intercrop

- Vegetables: Brinjal (*Solanum melongena*), Chilli (*Capsicum* spp), Bhendi((*Abelmoschus esculentus*), Amaranth (*Amaranthus* spp.), Cowpea (*Vigna unguiculata*)

Brinjal as intercrop

- Spices: Annuals such as Ginger *(Zingiber officinale)*, Turmeric (*Curcuma longa*), perennials such as Black pepper (*Piper nigrum* using coconut as standard), Nutmeg *(Myristica fragrans)*, and Vanilla (*Vanilla planifolia)*

Turmeric as intercrop

- Fruit crops: Banana (*Musa* spp.), Pineapple (*Ananas comosus*), Papaya (*Carica papaya*)

Pineapple and banana as intercrops

➢ **High density multispecies cropping system (HDMSCS):** Cultivating various types of crops having different stature and rooting pattern in the same field ensures effective utilization of natural resources such as land, water, light and space and provides biomass for recycling and maximum returns per unit area. It will not only ensure regular economic returns to the farmers but also provides more employment opportunities for the farm family. The crops selected should have

Management practices for intercrop in coconut garden:

Intercrop	Time of planting	Method of planting, spacing	Manures	
			FYM (t/ha)	NPK (kg/ha)
Cassava	May-June	Mounds prepared at 90 x 90 cm	9	50:50:100 (for local types)
Elephant foot yam	March-April	Pits taken at 90 x 90 cm	20	50:50:75
Colocasia	April-June	Pits taken at 60 x 45 cm	12	80:25:100
Greater yam	April-May	Pits taken at 90 x 90 cm	9	80:60:80
Lesser yam	April-May	Pits taken at 75 x 75 cm	8	60:30:60
White yam	April-May	Pits taken at 90 x 90 cm	9	80:60:80
Chilli	May-June (rainfed) Sept-Oct. (irrigated)	Transplant in shallow trenches / pits or on ridges 45 x 45 cm	20-25	75:40:25
Brinjal	May-June (rainfed) Sept-Oct. (irrigated)	Transplant in shallow trenches / pits or on ridges 60 x 60 cm for non-branching and 60 x 75-90 cm for branching types	20-25	75:40:25
Cowpea	Any season is ideal	Dibble two seeds per hole at 25 x 15 cm for non-trailing and 45 x 30 cm for semi-trailing types	20	20:30:10
Ginger	First fortnight of April	Small pits 25 x 25 cm in raised beds. Sow to a depth of 4-5 cm.	30	75:50:50
Turmeric	First fortnight of April	Small pits 25 x 25 cm in raised beds	40	30:30:60
Nutmeg	With the onset of southwest monsoon	Pits of 90 x 90 x 90 cm at the centre of four coconut palms	10 kg per plant during first year, increase later on till 15 year old tree gets 50 kg/tree	20:18:50 g/plant during the first year, increase progressively till 15 year old tree gets 500:250:1000 g/tree
Banana	April-May (Rainfed) Aug.-Sept. (Irrigated)	Pits of 50 x 50 x 50 cm Poovan/ Palayanakodan -2.1 x 2.1 mRobusta -2.4 x 1.8 m	10 kg/plant at the time of planting	60-200 : 160-200 : 320-400 (depending on soil fertility) in 6 splits at monthly interval , one month after planting onwards
Pineapple	May-June	Trenches (convenient length and 90 cm width and 15-30 cm depth) Double rows at 60 x 45 cm	25	320:160:320(8:4:8 g/ plant/year)

small, medium and large canopy architecture and are to be planted in a systematic manner to exploit space both in the vertical and horizontal dimensions. Coconut based HDMSCS can be successfully adopted in root (wilt) disease affected coconut gardens by raising a combination of suitable crops. In such a cropping system, care should be taken to follow the recommended package of practices including adequate manuring for component crops. Vegetables, spices (both annuals and perennials), tuber crops and fruit crops mentioned above can be included under HDMSCS.

Banana in HDMSCS

Nutmeg in HDMSCS

Mixed farming system: Fodder crops such as Hybrid Napier, Stylosanthes and fodder cowpea can be raised as intercrops in coconut garden. Co-3 is an ideal fodder grass of Hybrid Bajra Napier, which could be successfully grown in coconut garden. Integrating coconut cultivation with rearing milch animals and raising fodder crops ensures additional income and employment to the farmers. They also provide organic manures for application to coconut and other crops. Installation of biogas plant gives light energy for farm family and slurry for use in the cropping system. Azolla, a floating fern can also be raised in small pits lined with polythene sheets in coconut gardens adopting mixed farming to supplement the feed requirement of dairy animals. Azolla, on dry weight basis, contains 25-35 % protein, 10-15 % minerals and 7-10 % amino acids, and is also rich in vitamins and carotenoids. The rare combination of high nutritive value and rapid biomass production makes Azolla a potential and effective feed substitute for live stocks as it is easily digestable. Azolla can either be mixed with concentrates or given directly to dairy animals.

II. Integrated nutrient management practices

An integrated nutrient management approach using both organic manures and chemical fertilizers is to be adopted for coconut palms showing root (wilt) disease symptoms.

➢ **Application of organic manures**: Application of organic manures helps to improve physico-chemical and biological properties of soil and thereby ensures proper supply of nutrients to crop plants. Apply farm yard manure or green leaves or composted coir pith or vermicompost @ 25 kg per palm per year during September-October in 1.8 m radius from the bole of coconut palms along with the second dose of chemical fertilizers. For effective recycling of biomass,

vermicomposting of all the fallen coconut leaves and other wastes can be done using earthworm (*Eudrilus* sp.) in the coconut garden itself and used.

➢ **Application of recommended and balanced dose of chemical fertilizers:** The recommended dose of chemical fertilizers for an adult palm per year is 500 g nitrogen, 300 g phosphorus, 1000 g potassium and 500 g magnesium. In order to supply these nutrients, 1.1 kg urea, 1.5 kg mussorie rock phosphate, 1.70 kg muriate of potash and 1.0 kg magnesium sulphate are required. The quantity of magnesium sulphate is 3.0 kg for Onattukara sandy soils. Apply one-third of the fertilizers during April-May (pre-monsoon) and two-third during September-October (post-monsoon) for rainfed palms. Application in four equal splits (January, April, July and October) may be made for irrigated palms. Deficiency symptoms of boron in palms could be corrected by applying 150 g borax for palms below five years and 250 g for older palms in two equal splits along with regular fertilizer application.

➢ **Raising green manure crops:** Green manure crops act as cover crop and suppress weed growth apart from supplying leaf biomass. Sow 100-150 g seed of any of the green manure crops such as cowpea *(Vigna unguiculata)*, sunn hemp *(Crotalaria juncea)*, mimosa *(Mimosa invisa)*, Calapagonium *(Calapagonium mucunoides)*, kudzu *(Pueraria phaseoloides)* in the basins of coconut palms during May with receipt of a few showers after applying first split of fertilizers. Uproot and incorporate the plants once they attain maximum vegetative growth (just before start of flowering). Green manure cowpea is easily available and less costly compared to the other types. It can produce around 20-25 kg fresh biomass per coconut basin and on an average can supply N, P and K @ 130, 12 and 115 g, respectively.

Cowpea as green manure crop

III. Water management practices

Water stress during summer period will adversely affect growth and yield of coconut and other intercrops. Considering the availability of water, cropping system adopted in the coconut

Method of irrigation	Age of coconut palms	Frequency	Quantity (l/palm)
Basin	1-2 years	Once in 2 days	25-30
	3-4 years	Once in 4 days	75-80
	Adult palms	Once in 4 days	200-250
Drip	1-2 years	10 l/day through 2 emitters	
	3-4 years	20 l/day through 3 emitters	
	Adult palms	30-35 l/day through 4-6 emitters	
Perfo	For HDMSCS	Irrigate field to a depth of 20 mm once in 4 days	

garden and financial resources of farmer, any one of the irrigation methods mentioned may be adopted. Drip fertigation (application of fertilizers through irrigation water) may be adopted wherever possible as it is found to increase both fertilizer and water use efficiency.

Mulching palm basins using fallen coconut leaves or coir pith or other suitable materials during summer period helps to reduce direct heating of soil surface and evaporation loss of moisture. It is to be done during October-November and retained till April-May. Water logging around coconut palms should be avoided and hence, adequate provision for drainage should be made for ensuring better utilization of applied nutrients and aeration in soil.

IV. Integrated pests and diseases management practices

A number of pests are found to cause damage to coconut palms, the major ones being rhinoceros beetle, red palm weevil and eriophyid mite. Recommended integrated pest management measures are to be adopted at the appropriate time.

Besides, leaf rot disease caused by a combination of fungi is noticed superimposed on majority of coconut palms affected by root (wilt) disease. It causes reduction in photosynthetic area of leaves and yield of palms. Adopt the following integrated plant protection measures for control of leaf rot disease.

- As phytosanitary measure, cut and remove the rotten portions of spindle leaf and the affected parts of adjacent two inner most fully opened leaves.
- Pour 300 ml of fungicide solution containing 2 ml of Hexaconazole (Contaf 5 % EC) or 3 g Mancozeb (Indofil M-45/Dithane M-45) in the innermost leaf axils around spindle leaf.
- As bio control measure, apply a consortium of talc formulation of *Pseudomonas flouorescens* and *Bacillus subtilis* @ 50 g mixed in 500 ml water per palm into the axil of spindle leaf. About 300 to 500 ml treatment fluid is required per palm.
- Treat all the coconut palms in the coconut garden during April-May and October-November.

Various pests and diseases are found to cause damage to different intercrops also. In the case of vegetables, the major pests are fruit flies, jassids and beetle. Adopt mechanical/cultural measures for pest management. Pest or disease affected plant parts are to be completely removed from the field. Application of any insecticide is to be made only when the pest population is on the higher side. Pseudostem weevil and rhizome weevil are the important pests of banana. Select only healthy planting materials and adopt strict sanitation measures by removing pest affected plants from the field. Stem borer and leaf roller are the major pests of ginger and turmeric. Pest affected plant parts are to be cut and removed.

V. Results of experiments conducted at the CPCRI Regional Station, Kayamkulam

An experiment on coconut based high density multispecies cropping system (HDMSCS) by raising banana, pineapple, nutmeg, black pepper, vegetables and elephant foot yam during different years was conducted from 2004 to 2008 at the Regional Station of Central Plantation Crops Research Institute, Kayamkulam, Kerala in root (wilt) disease affected coconut garden with West Coast Tall variety. A schematic representation of crops under coconut based HDMSCS is given in Fig.1 and the year-wise details of the crops maintained in the system are given in Table1.

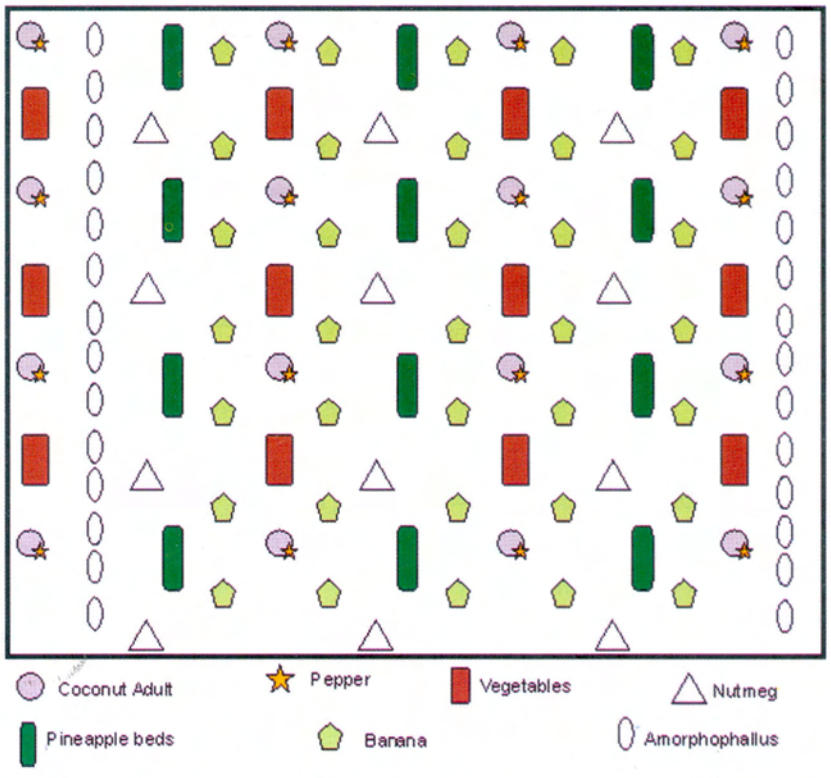

Fig. 1. Schematic representation of crops under coconut based HDMSCS

Table 1. Year-wise population of various crops in HDMSCS

Crops	2004-05	2005-06	2006-07	2007-08
Coconut (WCT)	96	95	90	82
Nutmeg (Local)	70	70	70	70
Black pepper (Karimunda)	108	60	42	35
Banana (Varieties such as Poovan, Njalipoovan, Robusta,Nendran, Red banana)	350	318	250	
Pineapple (Kew)	675	660	500	400
Vegetables (Chilli, bhendi, cowpea, brinjal) 500 plants	-	-	-	4 cents
Elephant foot yam (Gajendra)	-	-	-	700 plants

Spacing adopted for different crops

Coconut: 7.5 m x 7.5 m; Nutmeg: 7.5 m x 7.5 m (in the centre of four coconut palms)

Pineapple: 60 cm x 45 cm; Banana: 2.5 m in between coconut palms leaving about 2 m from coconut basin; Elephant foot yam: 90 cm x 90 cm (planted in pits in between coconut palms after removal of banana); Vegetables in beds as per the recommended spacing of Kerala Agricultural University.

The entire area of the coconut garden was divided into two parts and palms in one portion were applied with 100 % recommended dose of fertilizers (500:300:1000 g NPK/palm/year) and the other half with 50 % fertilizers + organic manures as vermicompost (25 kg/palm/year) prepared in the garden itself using crop residue biomass including coconut leaves by *Eudrilus* sp. of earthworms and incorporation of green manure cowpea (*Vigna unguiculata)* raised in the palm basin. Other recommended package of practices were followed for the inter/mixed crops. The average post-treatment yield of coconut in the plot applied with integrated nutrient management practices was 60 nuts/palm compared to 51 nuts/palm in the pre-experiment period. In the plot where fertilizer alone applied, the yield was 57 nuts/palm compared to 53 nuts/palm recorded during the pre-experiment period. Though there was no significant difference in coconut yield between the treatments at the end of the experiment, 17 % increase in yield in palms receiving both fertilizers and organic manures compared to 7 % increase in palms receiving only fertilizers was observed. Thus, integrated nutrient application through fertilizers and organic manure (vermicompost) improved the productivity of palms. Copra content was also found to be higher in palms applied with both fertilizers and organic manures (175 g/nut) than in palms applied with fertilizers alone (167 g/nut).

The palms in the disease early and middle categories did not show any progression in the disease index during the course of study. Thus, by meeting the nutritional requirement of coconut palms through an integrated management practice of applying recommended dose of fertilizers (50 %), recycling available biomass by vermicomposting and its application and raising and incorporation of green manure crop in basin, the soil health as well as health of coconut palms could be improved over the years or maintained without further deterioration. The overall yield of coconut and other component crops from the HDMSCS is given in Table 2.

The quantity of total crop residues or biomass in the form of coconut leaves (after removing petiole portion), spathe and bunch waste; banana (dry leaves and pseudostem at the time of harvest of bunch); pineapple (crown after harvest of fruit and whole plant while uprooting); nutmeg leaves and other weed materials (collected while slash weeding) obtained during different years from the HDMSCS ranged from 9.10 t during 2007-08 to 18.87 t during 2004-05. The biomass excluding

Table 2. Overall yield of coconut and component crops under HDMSCS in different years (for both the treatments together)

Year	Crop						
	Coconut (nuts/year)	Banana (kg)	Pine apple (kg)	Black pepper (kg)	Nutmeg (kg)	Mace (kg)	Vegetables/ Elephant foot yam (kg)
2004-05	5,092	1,619	114	23	12.7	5.2	-
2005-06	5,428	750	260	29	8.0	1.3	-
2006-07	5,108	1,170	515	21	20.0	7.2	-
2007-08	5,560	-	393	18	9.3	1.4	235*/ 1250**

* Vegetables ** Elephant foot yam

nutmeg leaves, weeds (which were used for mulching plant basins) was vermicomposted and its recovery ranged from 65 to 70 %. The nutrient content of compost produced during each year was analysed and on an average it contained 1.413 % N, 0.112 % P and 0.304 % K and thus, the total nutrient contribution from recycling of biomass through vermicomposting ranged from 86.7 to 180.0 kg N, 6.9 to 14.3 kg P and 18.7 to 38.7 kg K during different years.

The microbial population level in the coconut palm basins was assessed and it was found that in general, the population level of general and function- specific microbial community was higher in the rhizosphere of palms applied with both fertilizers and organic manure except in the case of actinomycetes (Table 3). Application of organic manure in the form of vermicompost helps to improve the microbial population level. Presence of higher number of function-specific microbes in the rhizosphere of disease early palms could be helpful in maintaining soil health and providing better nutrient availability to palms, thereby helping them to give better yield.

improved over the years or maintained without further deterioration, thereby bringing more palms from the disease middle category (2) to (1) or from disease middle category (1) to disease early category. This will in turn help palms to give higher yield in the subsequent years as coconut palms take 3 ½ to 4 years from initiation of inflorescence to harvest of nuts.

The cost economics under different treatments from the HDMSCS was worked out and are presented in Table 5.

The analysis of economics of the HDMSCS in root (wilt) disease affected area indicates that inclusion of various inter/mixed crops in the cropping system helps to obtain higher net income. The net income derived from the plot maintained under integrated nutrient management practice (50% fertilizers + organics) was higher than that obtained from the plot maintained by application of fertilizers alone.

The share of main crop of coconut in the gross return for different years varied between 49 to 70 %, the highest being during the second year

Table 3. Population of general and function-specific microbial communities

Treatments	Disease category	Microbial community				
		Bacteria ($x10^6$)	Fungi ($x10^4$)	Actinomycetes ($x10^5$)	N_2-fixers ($x10^6$)	P-solubilizers ($x10^6$)
50% fertilizers+ Organic manure	Disease Early	40.0	4.0	1.00	52.7	36.7
	Disease Middle	46.0	8.7	0.33	33.3	33.3
Fertilizers alone	Disease Early	26.0	2.0	1.67	45.7	35.3
	Disease Middle	37.0	5.0	0.84	34.0	30.7

An analysis of percentage of coconut palms under different root (wilt) disease intensity categories during each year (2005 to 2008) (Table 4) indicated that through an integrated nutritional management, the health of palms could be

and the lowest during third year, because of lower sale price of coconut during the latter year. The net return/ha increased by 33% during 2007-08 when compared to that of the first year (2004-05) of the experiment. The contribution of inter/mixed

Table 4. Percentage of coconut palms under different root (wilt) disease intensity categories

Treatments	Disease index category	Year			
		2005	2006	2007	2008
50% fertilizers +	Disease Early(Disease Index=0-20)	20.5	23.5	29.5	36.4
Organic manure	Disease Middle 1(Disease Index=21-35)	56.7	53.7	61.4	54.5
	Disease Middle 2(Disease Index=36-50)	22.8	22.8	9.1	9.1
Fertilizers alone	Disease Early	12.1	15.1	42.4	51.5
	Disease Middle 1	78.8	75.8	54.5	47.5
	Disease Middle 2	9.1	9.1	3.1	1.0

Table 5. Economics of HDMSCS under integrated nutrient management system

Item	50 % fertilizers+ Organic manure				Fertilizers alone			
	2004-05	2005-06	2006-07	2007-08	2004-05	2005-06	2006-07	2007-08
Total return(Rs)	32,854	26,195	30,028	35,256	26,826	20,229	18,224	26,309
Total cost(Rs)	15,855	13,432	11,217	13,515	16,255	15,878	10,863	12,667
Net return(Rs)	16,999	12,763	18,811	21,741	10,571	4,381	7,361	13,642
BC Ratio	2.08	1.95	2.68	2.61	1.65	1.27	1.68	2.08

Note: As palms in the experimental field were under varying intensities of root (wilt) disease and with varying number of palms, the economics of the HDMSCS as well as mono cropped garden are worked out based on the expenditure and income derived from the experimental field and not on per hectare basis. (As given in Table 1).

crop in the HDMSCS varied from 30 % during 2005-06 to 51 % during 2006-07 indicating that any fall in price of main crop (coconut) could be compensated to a great extent by other crops of the system. A comparison from an adjoining mono cropped coconut garden with varying intensities of root (wilt) disease during 2004-08 shows that the average yield obtained was only 30 nuts/palm and the net income realisable from such palms works out to Rs. 9,000/- indicating that HDMSCS in root (wilt) disease affected area will be more remunerative. The average Benefit Cost Ratio for application of organic manures+ fertilizers and fertilizer alone was found to be 2.33 and 1.67, respectively. Since positive BCR is obtained, coconut based HDMSCS is economically viable in root (wilt) affected areas, provided the disease incidence is well managed and other production and price related risks are at normal level. These results showed that crop diversification in root (wilt) disease affected coconut garden could help the farmers to realize better returns even if the price of one commodity gets reduced in any year.

Coconut Equivalent Yield (CEY) of the system was worked out and is presented in Table 6. It was found that CEY ranged from 2,294 (2005-06) to 4,466 (2004-05). Banana gave the highest average CEY (2,012) followed by elephant foot yam (514), nutmeg and mace (408), black pepper (303) and pineapple (282). The total yield of the system, based on CEY, ranged from 7,722 (2005-06) to 9,558 (2004-05) due to the higher contribution of banana during that year. The results also indicated that the contribution of inter/mixed crop towards the average total yield of the HDMSCS was about 39 %, indicating the beneficial effects of the

Table 6. Coconut equivalent yield of high density multi species cropping system

Year/Crop	Banana	Pine apple	Black pepper	Nutmeg & mace	EFY*	Total CYE of intercrops	Yield of coconut (no. of nuts)	Total yield of the system
2004-05	3,526	103	230	607	—	4,466	5,092	9,558
2005-06	1,546	223	299	226	—	2,294	5,428	7,722
2006-07	2,848	522	426	584	—	4,380	5,108	9,488
2007-08	129	281	257	213	2,055	2,936	5,560	8,496
Average	**2,012**	**282**	**303**	**408**	**514**	**3,519**	**5,297**	**8,816**

*Elephant foot yam

cropping system in coconut gardens, especially in areas where the RWD is a problem causing reduction in farm family income.

VI. Mixed farming

Greater emphasis is being given on farming system approach as it ensures sustainability both in terms of productivity of crops and long term economic returns. Mixed farming in coconut gardens provides additional income and employment opportunities to the farmers as well as organic manures for recycling in the coconut garden.

Raising azolla in mixed farming

Cow as component of mixed farming

Hybrid Bajra Napier in mixed farming

A field experiment on mixed farming in root (wilt) disease affected coconut garden is in progress at CPCRI, Regional Station, Kayamkulam by raising fodder (hybrid Bajra Bapier-Co-3, stylosanthes and azolla) and component cops such as banana and glyricidia (for green manure); maintaining milch cows (4 nos.); bio gas plant (3 m^3). The details of returns (mean of 2008-09 and 2009-2010) from various components are as follows (Table 7).

The entire bio mass recovered from coconut, banana and prunings from glyricidia as well as bio gas slurry, cow urine etc. are recycled into the production system. The results indicate that the mixed farming in root (wilt) disease affected coconut garden is self-sustainable with respect to nutrient requirement of the system.

Raising stylosanthes in mixed farming

Table 7. Details of returns from coconut based mixed farming

Sl.no.	Item	Quantity
1	Coconut	55 nuts/palm
2	Banana	500 kg
3	Fodder grass (Hybrid Bajra Napier- Co-3)	100 t/ha
4	Azolla production	475 kg
5	Glyricida prunings (two per year)	250 kg (fresh biomass)
6	Cow dung slurry (from bio gas plant)	30,000 l
7	Cow dung	48,500 kg
8	Cow urine	37,250 l
9	Bio gas	650 m^3
10	Milk	7,200 l
11	Biomass from banana	1,000 kg
12	Biomass from coconut	1,000 kg