Chapter 5

Original Research Report

DEVELOPMENT OF TEA-HORTICULTURE-SPICES CROP MODEL:

An Approach for Higher Income and Employment Generation for Small Tea Growers

B. C. Ghosh[1], S. Palit[2] and Kanu Murmu[3]

Abstract:
An attempt has been made to develop five tea crop models i.e (1) Tea + Siris + Black pepper + Turmeric (2) Tea + Sapota + Turmeric (3) Tea + Guava + Turmeric, (4) Tea + Amla + Turmeric and (5) Tea + Sandal wood + Turmeric in research farm of Agricultural and Food Engineering Department, Indian Institute of Technology Kharagpur. Fruits crops like Sapota, Guava, Amla and non fruit crops Siris and sandal wood were used as shade tree in a intercropping system. Black pepper and Turmeric were grown as companion crops for generating higher income from unit land resource. Findings on yield and gross income showed compatibility of tea when grown with fruits and spices. Guava, Sapota and Black pepper have shown promise generating faster income than Amla during the reporting years from 2002-2007. There was added advantages in generating additional gross income ranging from 54% to 115% over the income from tea alone. Such crop model would be useful for small tea growers for generation of higher employment and income.

Introduction:
In India, tea (Camellia sinensis (L.) O. Kuntze) crop is traditionally grown on the slopes of hills or high plateau in the Northeast and Southern parts. Tea is a perennial crop grown as a long term monoculture. It is generally grown in deep fertile, well drained and acidic soil. Tea has a habit to grow under partial shade. Inclusion of shade trees particularly woody trees in the tea ecosystem is a common practice. Thus, a unique climax of soil, plant and climate in tea ecosystem exist. Thereby, the resource utilization and income generation from such ecosystem becomes limited and restricted to tea only. So far, little effort has been made to diversify the tea farming by including other economical crops like horticulture and spices etc. for higher productivity and income. Moreover, in last few decades, conventional farming practice in tea and use of associated chemical inputs have resulted deterioration in soil fertility, crop productivity and quality besides environmental contamination. Today there is public concern over environment, health, food quality and safety which have led to an increasing interest in alternative farming practices with adoption of both low input management practice and greater dependence on natural biological inputs.

With increase in demand of tea at home country and worldwide, area expansion under tea is felt necessary. In recent past, tea cultivation has expanded in marginal and fallow lands by small tea growers in non-traditional areas as the scope of area expansion is limited in traditional tea growing regions. As compared to big tea corporate sectors, management of tea crop in smallholder sector is different with respect to

Agricl & Food Engineering Dept, Indian Institute of Technology, Kharagpur, West Bengal- 721302, India
[1]Professor and corresponding author,
Email : bcg@agfe.iitkgp.ernet.in
[2]Research Associate, [3]Research Fellow

PDF created with pdfFactory Pro trial version www.pdffactory.com

man management, resource utilization, processing and marketing. The tea crop management practice in small holdings follows more intensive than extensive agriculture. Efficiency of inputs management particularly water, fertilizers and plant protection chemicals remains always high in small holder tea sector. In diversification of tea farming, besides growing tea, other companion crops like fruits, spices, etc. have immense scope in tea ecosystem for generation of higher employment and income. However, a suitable crop model is required to be standardized where tea and other companion crops should have supplementary or complementary effect each other. This is more so in organic tea production system where a number of botanicals can also be included in tea ecosystem. However, the agronomic management of individual crops has to be standardized and maintained particularly adjustment of crop spacing, fertilizer management, plant protection measures and pruning and training of crops. However, the selection of crops is location specific with respect to soil and climate. In conventional tea growing areas, woody trees are generally used as an integral component as shade tree. In the present investigation, a number of horticultural crops and spices are included to act as a shade tree as well as maintaining a healthy climate in tea ecosystem.

The aforesaid ideas have been conceptualized in developing five crop models considering tea as sole crop and horticultural and spices as companion crops in the research farm of Agricultural and Food Engineering Department, Indian Institute of Technology Kharagpur, India.

Methodology:

The field experiment was conducted in a fallow plain land in an area of 10 acres situated in southern part of West Bengal at an elevation of 44.0 m above MSL. The climate of this region is warm and humid receiving annual rainfall ranging from 1300 to 1500 mm. The maximum and minimum temperature varies from 23.8^{o}C to 41.7 ^{o}C and 10.1^{o}C to 28.9 ^{o}C and maximum and minimum relative humidity from 75 to 99 and 29 to 77 percent respectively. The soil is acid lateritic, sandy clay loam having the following characteristics: pH 5.2, CEC 4.55 (meq/100g), organic carbon 0.28 %, available P_2O_5 3.5 ppm and available K_2O 15.75 ppm, available aluminium 17.65 ppm. The experimental site was divided into five major blocks, two acre each, to accommodate five crop models i.e. (T1) Tea + Siris + Black pepper + Turmeric, (T2) Tea + Sapota + Turmeric,(T3) Tea + Guava + Turmeric, (T4) Tea + Amla + Turmeric and (T5) Tea + Sandal wood + Turmeric. The crop architecture and growth behaviour of Guava (*Psidium guajava*), Sapota (*Manilkara achras*), Amla (*Emblica officinalis*), Sandalwood (*Santalum album*) and Siris (*Albizzia lebbeck*) being different, they were accommodated at varying spacing and fertilizer dose. The Black pepper (*Piper nigrum*) being a climber was grown at base of the tall shade tree like Siris. Turmeric (*Curcuma longa*), having antifungal property was grown as border crop in boundary area of each block (Photo1-5). Organic farming practices were followed in growing the crops. For catering the nutrient need of different crops, an in-situ vermicompost unit was installed with a production capacity of 50 tones per annum from 45 beds (Photo 6). Size of each bed was 12' X 4' X 1'in length, breadth and depth respectively. Organic materials like crop residues, farmyard manure and vermicompost decomposer along with exotic earthworm species were used for vermicompositing. Two major products, solid vermicompost and liquid vermibed wash were generated and used as a major nutrient source.

Plantation:

The land was deep ploughed, leveled with adequate drainage facility. A layout was made with appropriate spacing of tea and horticultural crops. The spacings of various crops

PDF created with pdfFactory Pro trial version www.pdffactory.com

maintained were 1 m X 0.75 m between rows and plants for tea, 10m X 10m for Siris and Sapota, 8m x 8m for Amla and Sandal wood, 6m X 6m for Guava. Tea was grown as intercrop with either Siris or Sapota or Guava or Amla or Sandal wood. The size of the pit for tea, dug manually, was 45 cm in diameter and 60 cm in depth, while for horticultural crops the pit size was 100cm X 100cm X 100cm. The organic fertilizer in the form of vermicompost was applied at the rate of 2 kg/pit in tea crop besides 50 gm each of bone meal and neem cake. In case of horticultural crops, the quantum of vermicompost applied was 5 kg along with 1 kg of each of bone meal and neem cake. The fertilizer materials were well mixed with soil and left in-situ for a period of 2 months. Tea clone TV-25 was transplanted using 8 months old seedlings during July, 2000. The varieties of Sapota, Guava and Amla were Cricket ball, L 49 and NA 7, respectively which were transplanted at the same time as tea. Turmeric variety Pattani was planted in the border area of each block. The rhizomes were planted in furrows by dibbling and covered with loose soil. Before planting turmeric vermicompost was applied @25 t/ha which were placed in the furrows. The crop was mulched with paddy straw after planting. The Black pepper variety KAU- Panniyur-5 was planted at 50 cm away from base of Siris plant. The pit size was 45cm X 45 cm X 45 cm which was fertilized with 5 kg of vermicompost. In each pit 2 to 3 rooted cuttings were planted in such a way that at least one node of the cuttings remained below the soil for proper rooting. As the cutting grew the shoots were tied to plant standards i.e. Siris. The base of the vine was not disturbed so as to avoid root damage. For providing shade to the young tea seedlings, the leguminous crop Sesbania sp. was directly sown in line in alternate tea rows. Growing Sesbania also improved fertility of the soil.

Crop management:

Debudding and pruning of tea was done for developing desired tea bush by following standard schedule of tea crop management. In case of horticultural crops, light pruning was done from 3rd year onwards to allow filtered sunlight as per requirement of tea bushes. From 4th year onwards, a unique canopy architecture of Sapota and Guava was attained by pruning and training of central leader system. Pruning was advantageous to open the tree to light and removal of undesired branches. In case of Amla, it was encouraged to develop a medium-headed tree canopy. The main branches were allowed to appear at a height of 1.5 to 2 m above the ground level. Two to four branches with wide crotch angle, appeared in the opposite direction was encouraged in early stages of two to four years. The unwanted branches were removed during March - April. As per growth habit shreadding of all determinate shoots encouraged new growth in coming seasons. In case of Black pepper, for providing adequate support the standard plant Siris was prunned and lopped carefully from fourth years onwards. As the cuttings grew the shoot were tied to the standard tree. The young vine was protected from direct hot sun during summer with adequate shade provided by the shade trees. From fourth year onwards usually two intercultural operations were given, first during May- June and the other in Oct-Nov. The crop was manured regularly with vermicompost at the rate of 5kg/ pit during April-May of the year.

Both tea and horticultural crops, in subsequent years, received standard fertilizer dose as per crop age. However, the fertilizer dose was crop specific. The fertilizer source was vermicompost and vermibedwash which were applied by broadcasting and fertigation system respectively. Tea being sensitive to either excess or deficit soil moisture stress, adequate drainage during rainy season and supplemental irrigation through sprinkler by fertigation system

PDF created with pdfFactory Pro trial version www.pdffactory.com

(water + vermibedwash) during dry season were provided. All the crops, tea, fruits and spices received water and nutrition through fertigation system from same irrigation source that was the economical advantage of multi-tier cropping system. No severe insect and pest incidence was noticed during the study period and till date.

Harvesting and Yield:

In case of tea, plucking of two leaves and a bud was done at regular interval from 2+ years onwards. The yield of fresh tea leaf is presented from the year 2002 to 2007 in Table 1.

Table 1: Year-wise yield of green leaf of tea (kg/ha) in the five treatments

Treatment	Companion crops with Turmeric +	Y-2002	Y-2003	Y-2004	Y-2005	Y2006	Y-2007
T1	B. Pepper	1260	2362	3240	4720	5850	7200
T2	Sapota	1060	2160	3020	4510	5510	6880
T3	Guava	1150	2245	3110	4680	5225	6990
T4	Amla	1230	2360	3230	4700	5640	7150
T5	Sandalwood	1245	2300	3200	4700	5775	7175

In case of horticultural crops, Sapota began to bear from 3rd year after planting but standard fruiting was observed from 6th year. The yield of Sapota in different years is presented in Table 2. The grafted Guava plant though started fruiting from 2nd year but peak maturity was observed from 7th year. Guava took about five months from the time of flowering to maturity. Peak harvesting period was during July-Aug for rainy season and Dec-Jan. for winter season. The yield of Guava in different years is presented in Table 2.

Table 2: Year wise yield of companion crops in different treatments (Kg/ha)

Treatment	Companion crops	Y-2002	Y-2003	Y-2004	Y-2005	Y2006	Y-2007
T1	BPepper Turmeric	0 0	30 85	65 0	85 95	115 0	160 95
T2	Sapota Turmeric	200 0	1500 80	3500 0	4200 85	5800 0	6500 90
T3	Guava Turmeric	833 0	3324 85	6094 0	8310 80	9695 0	11634 90
T4	Amla Turmeric	0 0	312 80	624 0	1560 85	4368 0	5460 90
T5	SandalWd. Turmeric	0 0	0 80	0 0	0 85	0 0	0 90

The grafted Amla started bearing from 3rd year onward after planting. However, full bearing is expected from 8th years onward. The Amla flowers started bearing late in the spring and the fruits ripened during winter. The yield of Amla in different years is shown in Table 2. The Black pepper showed flowering in May-June and harvested in Jan-Feb. months. The crops took about 7 months from flowering to harvest. During harvesting the whole spike was hand picked when one or two barriers in the spike turned bright purple colors. The barriers were separated from harvested spike and dried in the sun for 7 to 10 days. The yield of Black pepper in different years is shown in Table 2. Turmeric crop was grown as biennial crop harvested every one year interval. The rhizomes were harvested by digging in Feb - March and resown again in June-July. The yield of rhizomes in different years is shown in Table 2.

Table 1 shows that the yield of fresh tea leaves was increased with crop age during the reported year from 2002 to 2007. However, the yield of fresh tea leaves varied when grown under different cropping system ranging from 6.8 to 7.2 t/ha recorded in the year 2007. In Tea + Sapota + Turmeric intercropping system, the tea yield was marginally lower. However, intercropping tea with other fruits crops like Guava, Amla and also with Sandal wood have shown no reduction in yield when compared with intercropping (for shading) with non-fruit crop Siris. The marginal reduction in tea yield was due to heavy shade of Sapota, an evergreen fruit tree, to the tea plants grown in its vicinity.

The growth and fruiting behavior of fruits and spice crops varied when grown with tea. The yield of Sapota and Guava were recorded from the year 2002 and for Amla and black pepper from 2003. It was observed that there was steady increase in yield of these crops during the reporting years, however the growth of Amla was at a relatively slow pace as compared to Guava and Sapota. In the year 2007, the yield was 6.5 t, 11.6 t, 3.5 t and 0.16 t/ha in Sapota, Guava, Amla and Black pepper respectively. Turmeric was grown in all five cropping systems

PDF created with pdfFactory Pro trial version www.pdffactory.com

and was harvested in alternate years. The yield of Turmeric was steady ranging from 80 to 90 kg per plot, harvested from 360 m row length of the border in all the years under different cropping systems. The production potentiality of Siris and Sandal wood could not be presented in the reporting years as the economic yield of these crops would be realized after attaining their full maturity on long term basis.

Tea Equivalent yield: Comparative data on yield of fresh tea leaves and tea equivalent yield is presented in Table 3.

Table 3: Year wise Tea Equivalent yield in different cropping systems kg/ha

Treatment	Tea + Companion crops	Y-2002	Y-2003	Y-2004	Y-2005	Y-2006	Y-2007
T1	Tea+BP+tur	1260	2788	3640	5578	6650	8500
T2	T+Sapota+tur	1193	3373	5353	7536	9376	11453
T3	Tea+Guava+tur	1704	4687	7172	10433	11688	14986
T4	Tea+Amla+tur	1230	2781	3646	5966	8552	11030
T5	Tea+Sandal+tur	1245	2513	3200	4926	5775	7415

BP- Black pepper, tur-Turmeric, Sandal-Sandal Wood

The tea equivalent yield was estimated by converting the total value of other crops except Siris and Sandal wood into yield of fresh tea leaves. The market price considered per kilogram for different crops were Rs. 15 for green tea leaf, Rs. 10 for Sapota, Guava and Amla, Rs. 100 for Black pepper and Rs. 40 for Turmeric. The estimated value of tea equivalent yield varied under different cropping systems. Higher values were observed in Tea + Guava + Turmeric, Tea + Sapota + Turmeric, Tea + Amla + Turmeric cropping systems as compared to Tea + Siris + Black pepper + Turmeric and Tea + Sandal wood + Turmeric. Maximum equivalent yield was however observed in Tea + Guava + Turmeric cropping system in the reporting period. However, the stable equivalent yield of different cropping system may exhibit differential value as per yield, market price and the harvesting time beyond the reporting year.

Gross Income: The gross income per hectare was calculated considering the price of different crops as shown in Table 4. It was observed that the gross income of tea was increased with crop age during the reporting years. In different cropping systems, in the reporting year of 2007, maximum gross income from tea was Rs. 1,08,000 from intercropping with Siris followed by Rs. 1,07,750, Rs. 1,07,625, Rs. 1,04,350 and Rs. 1,03,200 from inter cropping with Amla, Sandal wood , Guava and Sapota respectively. The income from tea was found to be higher than the income from fruits and spices in all the years till 2006 but during 2007 the income from Guava exceeded tea. Both Sapota and

Table 4: Year wise gross income of tea alone and total gross income from cropping systems in Rs. /ha.

Treatment	Income Source Tea&(Tea+Comp-anion crops)	Gross (Rs/ha) Y-2002	Gross (Rs/ha) Y-2003	Gross (Rs/ha) Y-2004	Gross (Rs/ha) Y-2005	Gross (Rs/ha) Y2006	Gross (Rs/ha) Y-2007
T1	From Tea only (Tea+BP+tur)	18950 (18950)	35430 (41430)	48600 (54600)	70875 (83675)	87750 (99750)	108000 (127800)
T2	From Tea only (Tea+Sapota+tur)	15900 (17900)	32400 (50600)	45300 (80300)	67650 (113050)	82650 (140650)	103200 (171800)
T3	From Tea only (Tea+Guava+tur)	17250 (25561)	33675 (70315)	46650 (107590)	70200 (156500)	78375 (175325)	104350 (224790)
T4	From Tea only (Tea+Amla+tur)	18450 (18450)	25400 (41720)	48450 (54690)	70500 (89500)	84600 (128280)	107750 (165950)
T5	FromTea only (Tea +SW +tur)	18675 (18675)	34500 (37700)	48000 (48000)	70500 (73900)	86625 (86625)	107625 (111225)

BP- Black pepper, tur-Turmeric, SW-Sandal Wood

N.B. Figures in parenthesis denote the total gross income from all crop components in each cropping system.

PDF created with pdfFactory Pro trial version www.pdffactory.com

Guava have shown steady increase in gross income from the year 2003 onwards. The income derived from Amla increased considerably in 2007. Black pepper has also shown steady increase in income during the reporting years. In general, the income flow from crops in different cropping systems are shown was steadily increased in the reporting years.

Comparative assessment of income generation from tea alone and total income from the cropping system is shown in Table 4. It is observed that gross income was maximum in Tea + Guava + Turmeric cropping system followed by Tea + Sapota + Turmeric, Tea + Amla +Turmeric, Tea + Siris + Black pepper + Turmeric and least in case of Tea + Sandal wood + Turmeric cropping system. In the year 2007, an additional gross income of Rs. 1, 20,440, Rs.68, 600, Rs. 58,200, Rs. 19,800 and Rs. 3,590 was obtained which was higher by 115%, 66%, 54%, 18% and 3% than income from tea alone under Tea + Guava + Turmeric, Tea + Sapota + Turmeric, Tea + Amla +Turmeric, Tea + Siris + Black pepper + Turmeric and Tea + Sandal wood + Turmeric cropping systems respectively. This shows that fast fruit bearing crop like Guava and Sapota can be considered for growing in tea crop system for generation of quick higher income. However, the compatibility of crops with respect to resource utilization, sustainable crop production and income need to be further investigated on a long term basis.

Conclusion:

It could be concluded from the aforesaid findings that in tea growing regions, there is enough scope to bring diversification in tea ecosystem by introducing the high value crops as a companion crop acting as shade tree or as a border crop. However, the selection of the crop must be site specific considering local soil and agro climatic condition and income generation ability on short (fruits and spices) and long term (Siris and Sandal wood) basis. Tea being a long duration crop the introduction of any crop must have compatibility in maintaining soil fertility and crop productivity. However, crops like black pepper or other creepers can be introduced with minimum competition with tea. Cultivation of border crops like Lemon grass, Turmeric, etc. in the tea field may avoid disease and pest attack particularly when the crops were to be grown organically. In case of non fruit and spice crops like Siris, black pepper and Sandal wood, depending on their economic value, the income will be accrued at some point of time to increase the total income from tea based cropping system. Such multi-tier tea based cropping system can be introduced among the small tea growers where intensive management practice can bring success with higher employment and income generation.

PDF created with pdfFactory Pro trial version www.pdffactory.com

Photo 1-Tea+ Siris+Black pepper +Turmeric as border crop

Photo 2 - Tea + Amla + Turmeric crop model

Photo 3 - Tea + Sapota + Turmeric crop model

Photo 4 - Tea + Guava + Turmeric crop model

Photo 5- Fertigation with vermibed wash

PDF created with pdfFactory Pro trial version www.pdffactory.com

PDF created with pdfFactory Pro trial version www.pdffactory.com