

# Free Bio Energy, Fertility, and Soil/Water Conservation in Tea Plantations

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## Introduction

Tea is the main export based plantation crop in Sri Lanka. It earns about 20 percent of foreign exchange (Rs 74897 million or US\$ 741 million in 2004). At present, the tea industry provides direct employment of about 600,000 people on a total of 188,000 hectares of tea land (three workers per hectare). Estate sector with lands more than 250 ha contributes to 50% of total extent, while the rest smallholdings share is about 50%. With the worldwide increase in energy costs, the cost of production of tea has increased significantly resulting less returns from tea industry. Hence it is important and beneficial to evaluate the cost factors of whole production process considering the renewed scientific developments in the fields of growing nitrogen fixing trees (NFT), fuel wood, dendro-power, coppicing techniques, etc.

Tea industry is heavily dependent on energy sources for its manufacturing process. This mainly for withering and drying and to run the machinery, fuel for transportation, etc. The energy cost is about 30% of the cost of production at the factory level. The fertilizer component of the total cost of production of tea is about 15%. The cost of nitrogen will be about 50% of the fertilizer cost.

The Tea plantations require regular input of fertilizers as 20-50 harvestable young shoots (bud and two leaves) are being plucked from each tea bush at 5-7 day intervals through out the year, where about 8 young shoots are required to produce one cup of tea (2.5 g of made tea for a cup of tea). Due to mining of soil for nutrients, fertility status of many tea lands have declined during the last 140 years of tea cultivation in Sri Lanka resulting low yield levels and about 10% of abandoned tea lands. Land degradation is aggravated due to the sloping nature in most tea lands in the central hill country where soil erosion is common with a loss of about 400 mm of top soil to date.

Tea (*Camellia sinensis* L.) is a C3 plant grow as tree in wild, but trained to be a bush to obtain many apical leaves for frequent plucking, as buds and young leaves contain more theaflavin and other chemical compounds for the production of quality tea with taste, stimulation, aroma, and health benefits.

Tea is generally a shade-loving plant and not grown well under very high radiation. Therefore, tea is grown under shade provided by shade trees. These shade trees are also useful as fuel wood trees. The shade trees are of two types depending on their growth. They are medium shade and high shades.

Further, there are less productive lands in each estate. These lands have two or more interacting limitations. Therefore, tea cannot grow well in these lands.

## Objectives

The objective of this presentation are (1) to estimate the energy requirement for processing tea and (2) to explore the ways and means for supplementing the energy requirement from bio-energy by insitu generation in tea fields. (3) to estimate the N requirements for mature tea to sustain the yield at present levels and explore ways to supplement the part of the requirements

**Energy requirement for processing tea:**

Energy is required for all the process in tea manufacture. The process are withering, rolling, roll breaking, drying and grading. Both thermal and electrical energies are required for the above processes. The thermal energy and electrical energy could be used mainly for withering and drying while the electrical energy is also used for moving machinery such as rollers, roll breakers and shifters. The Energy consumption in tea processing is given in Table 1(De Silva , 1993).

Table 1 Energy Consumption in Tea Processing

Process	Energy (kWh kg Made Tea <sup>-1</sup> )	
	Mid/High Elevation	Low Elevation
<b>Withering</b>	0.46	0.46
<b>Rolling</b>	0.20	0.10
<b>Drying</b>	0.07	0.07
<b>Sorting &amp; Packing</b>	0.09	0.07
<b>Ancillaries</b>	0.12	0.05
<b>Total</b>	0.94	0.75

The thermal energy consumption for withering and drying is presented in Table 2

Table 2 – Thermal Energy Consumption in Tea Processing

Process	Energy (MJ kg Made Tea <sup>-1</sup> )			
	Mid/High Elevation		Low Elevation	
	Actual	Lowest Calculated limit	Actual	Lowest Calculated limit
<b>Withering</b>	9.0	5.6	9.0	5.6
<b>Drying</b>	13.0	10.6	13.7	11.2
<b>Total</b>	22.0	16.2	22.7	16.8

From the above tables 1 and 2, we could conclude that the total energy requirement to produce one kg of made black tea is about 25 MJ (0.7-1.0 kWh of electricity and 1.4 - 2.0 kg of dry Fire Wood), where the main energy sources are imported and expensive petroleum fuel and wood from mature rubber trees. Hence total electricity requirement for all tea factories would be equivalent to a generation from a 35 MW power plant when compared to the present installed capacity of 2172 MW in Sri Lanka

A solar thermal field with flat plate solar collectors had indicated there is a saving of 25-35% saving on fuel and the same system could be used for refiring graded tea without auxiliary source (Koneswaramoorthy and Ziyad Mohamed, 2004)

However, this was found to be uneconomical at present. Therefore, we have to explore the possibilities using fuel wood as a bio-energy source.

The following are the sources of Fuel wood from tea plantations:

1. Fuel wood from diversified tea lands either from fuel wood coupes or social forestry
2. High and medium shade trees
3. Up-rooted tea

Fuel wood from diversified tea lands either from fuel wood coupes or social forestry

In 2002, the tea area was 180,000 ha. This includes marginal tea lands with lower bush stand and productivity. Generally, the marginal tea lands have two or more interacting limitations Eg. Slope and rockiness, slope and depth of soil etc. Assuming 10% of the total tea area is marginal and not suitable for tea cultivation, they could be profitably used for raising fuel wood. About 50% of the marginal lands could be used for fuel wood for processing tea and the rest could be used for raising fuel wood for domestic use. Some of the other tea producing countries had planned their tea plantations with fuel wood area in their plantations to minimize the transport cost. Almost all the tea estates in Sri Lanka have excellent conditions for growing fuel wood.

There are several species available for raising fuel wood. The criteria for selecting fuel wood are (1) easy establishment (2) short rotation coppicing and higher biomass (3) easy to transport and (4) recycling fertility and soil protection. Some of the fuel wood plants available are (1) Eucalyptus species (2) Acacia species (3) Casuarina (4) Paulownia (5) Gliricidia (6) Dadaps (7) Calliandra (8) Leucena (9) Grevillea (10) Albizia and (11) Hakea The calorific value of any woody material ranges from 3500-4900 kcal kg<sup>-1</sup> depending on the moisture content. Gliricidia and Dadaps are also known as green manure crops. Their leaves are a source of ready supply nutrients to the soil due to the faster decomposition rate. Other tree species also supply nutrients but a very slow rate.

1 ha of Eucalyptus plantation could produce 425m<sup>3</sup> of fuel wood at 10 -12 years rotation. However, due to coppicing nature of the fuel wood trees much higher fuel wood could be obtained from the above area. If 9000 ha of diversified tea lands are planted with Eucalyptus, each year, it could produce 0.3 million m<sup>3</sup> fuel wood. The coppicing The anticipated problems with Eucalyptus are (1) harvesting on sloping lands and (2) transport to the factory. Therefore Eucalyptus plantations could be located in the ravines and in undulating lands in close proximity to the tea factories.

Fire wood also could be obtained from Gliricidia, Dadaps Cassia and Calliandra. The planting space could be 2m x 2m. There will be 5000-6000 plant in 1 ha. It was estimated that 8 kg of dried firewood at 20% moisture content could be harvested from each tree at 6-10 months interval after 1.5-2.0 years of planting them. . One liter of diesel oil was equivalent to 3.5 kg of firewood. The fuel wood trees such as Gliricidia and Dadaps also supply leaves which serves as an organic matter input to the tea plantations Further, 150 kg of fresh leaves of these plants will be equivalent to 4 kg of urea. When added to the soil, these leaves will release nitrogen very slowly. The leaves also acts as mulch and protects the soil from erosion and weed growth.

Regular replacement of both medium and high shade trees in the remaining 150,000 ha will give 1.3 m<sup>3</sup> of fuel wood on an annual basis. The up-rooting tea for replanting at a very lower rate of 0.5% will give 0.07 m<sup>3</sup> of fire wood.

### **Nitrogen Requirement:**

The total tea production at present in Sri Lanka is about 300 million kg . The efficiency of N utilization by mature tea is about 33%. Therefore, the total N requirement assuming a replacement ratio (yield/nitrogen) of 10 is about 30 million kg of nitrogen. The main nitrogen source for mature tea is Urea.. Thus 65million kg of urea has to be imported to sustain the above yield. The medium shade trees such as Dadaps and Gliricidia could supply about 1.0 tones of green leaves annually. Assuming 150kg

of fresh leaves supply 4 kg of urea, 1.0 tones of leaves will supply 25 kg of urea. Therefore, from 180,000 ha of tea it is theoretically possible to obtain 4.5million kg of Urea. This is about one sixth of the requirement of nitrogen for mature tea. Apart from green manure trees, other high shade trees will also supply nitrogen but a slower phase. Apart from nitrogen, carbon also supplied by the shade trees. All these will improve the soil fertility and reduce runoff. The reduction in runoff will minimise soil erosion and helps to conserve soil and water.

### **Conclusions**

The foregoing estimates suggests that, Sri Lanka could make substantial savings in foreign exchange and improve the productivity of tea plantations

### **References**

De Silva W C A (1993) Status Review of Energy Utilizatiuon by Tea Industry in Sri Lanka In Energy Perspectives in Plantation Industry (eds C Palaniappan, S Kumar and T M Haridasan) Interline Publishing Bangalore, India

Koneswarmoorthy S and M T Ziyad Mohamed and G Galahitiyawa (2004). Developing and Evaluating solar energy techniques for tea drying Journal of National Science Foundation 32(1&2):49-60