TEA CULTIVATION AND ITS ECOLOGICAL IMPACT ON THE ENVIRONMENT

P. Sivapalan

(Director, Tea Research Institute of Sri Lanka, Talawakele, Sri Lanka)

The tropical montane forests, occupying one of the most crucial land areas of the country, were cleared and planted with coffee and cinchona. This pioneering work later led to the development of the once large coffee industry. In the process of clearing these large areas of montane forests, significant extents of the upper catchment areas and vast extents of natural water sheds came to be destroyed and this had its natural effect on the environment with regard to rainfall patterns and the associated moisture status of the soils. Legislation had to be enacted to prevent the clearing of forests and felling of trees, above an altitude of 1,500 m.

Even though the cultivation of coffee and cinchona was initially done with much trial-and-error, these later evolved as efficient agricultural industries. Thus, a natural montane forest environment gave way to organized agriculture. The ecological impact on the environment of such a transformation, though apparently minimal in the initial stages, began to increase steadily with time.

With the complete wiping out of the coffee industry by the rust fungus, *Hemileia vastatrix*, tea came to be substituted in its place. This latter crop was even a much greater labour demanding one and required a complex inputs of diverse cultural practices. On account of the adoption of such intensive cultivation practices, the ecological impact of this crop on the environment was even greater.

The cultivation of tea in Sri Lanka evolved into an extremely efficient agricultural industry, generating a commodity that came to be the single largest foreign exchange earner for the country. In so far as

producing this "green gold", the industry has done extremely well and is continuing to do so.

There is about 120,000 ha of tea lands situated at elevations of over 900 m above sea level, a large proportion of which consists of contiguous estates, covering vast land areas. Beyond an altitude of 900 m most of everything one sees is tea. Being thus a dominant factor in the environment of this critical land area, one should ask the natural question as to what its total ecological influence is on the environment ? We should ask ourselves important questions, including the effects of tea cultivation on the soil, soil moisture and water-table, erosion problems that lead to silting of water ways, streams, rivers and reservoirs, the leaching of minerals into water ways, the effect on the fauna, both in the soil and above, etc.

The introduction of improved technology into such an agricultural enterprise had led to further changes in the environment. Improved technology, introduced with the single objective of maximizing efficiency of crop output, also demands its own price. Innovations in agricultural technology have their benefits as well as disadvantages; unfortunately, most often the latter outweighs the former, leading to even more disastrous situations in the long-term.

Years of cultivation of tea in these mountain slopes has led to varying degrees of degradation of the land area so much that the tea areas of today are categorizable into different groups, including those that are no longer suited for tea any more. Such varying degrees of degradations occurred on account of the varying levels and efficiencies of managerial inputs.

Soil erosion

The all important and single most destructive consequence of tea cultivation, is soil erosion. The original planting of tea itself was wrongly done, by planting the tea up and down the slopes, rather than being planted along the natural contour, as is presently being

done. The importance of arresting this continuing erosion was recognized as early as in the late 1920s, and everything possible within the environs of the tea plantations was done to conserve the soil. It was recognized at that time that even though soil erosion on tea plantations may appear to be a slow process, it is in fact very rapid, when compared with the reverse process of building up soil, in an agricultural sense.

Virgin forest soils opened up for cultivation are the product of many centuries of soil-building, through the agencies of forest and grasslands. It was also recognized that, coupled to the actual loss of soil, is the loss of water supply as well. The construction of leader drains and reverse-sloped lateral drains and the planting of suitable ground covers, are some of the early attempts made to arrest erosion. Later, with a greater emphasis on higher productivity, ground covers were done away with and the estates were kept completely weed-free. A clean weeded estate was the hallmark of 'good management', and consequently, all efforts were made to remove every blade of vegetation by the use of that vicious implement, the weed-scraper, commonly referred to as 'Sorandi'. This implement was used to scrape away the weeds and along with it vast amounts of valuable topsoil too was continuously scraped away. This practice is one of the most destructive cultural operations carried out on tea estates.

It has been proven even in other tea growing areas, that the gradual deepening of gullies caused by continuous erosion, lead to the lowering of the water-table, with consequent harmful effects upon the moisture status of the surface layers of soil, upon which the tea crop depends during periods of drought. This is becoming increasingly evident in Sri Lanka, where the tea is now showing rapid signs of stress with the onset of the dry weather. The crop is now no longer able to withstand droughts, as it once did earlier.

With the removal of shade trees in the mid-1960s, all the consequent reduction in leaf litter on the ground surface has reduced the organic matter content of the soil and its water-permeability characteristics, and this

situation has in turn led to massive sheet-erosion during thunder storms and heavy rains. Such erosion have led to siltation of drains and other water courses and this continuous degradation is threatening our major irrigation schemes with the inevitable silting of such water bodies.

Thus, the continuous scraping away of weeds using the weed-scraper, the neglect to grow appropriate ground covers in exposed sections of the field and the removal of shade and green manure crops, have all led to a deterioration of the soils, not only leading to siltation problems, but also to other associated ones that have made the tea crop more susceptible to droughts. The soil itself has become infertile over the years and the crop is now on a chemical fertilizer tread-mill.

Replanting operations

The greatest soil disturbance occurs during replanting operations, when the old tea is uprooted. Old tea fields that have a definite potential for high yields are uprooted and replanted with high-yielding clones. As the process of uprooting the old tea involves a great deal of soil disturbance and is a very costly operation, land selection for replanting is expected to be carried out with the utmost care. Despite such precautionary warnings, the selection is not always done in the best manner and very poor lands have been uprooted. Such areas are best left undisturbed and if it has become uneconomical to maintain the old tea as such, the area should be interplanted with a suitable timber species, whilst some crop could yet be harvested with minimal inputs. Otherwise, not only would the young replanted tea not survive in such bad lands, but a large amount of valuable soil would have got lost and this again adds to the siltation of water-ways.

History is likely to be repeated unless we take stock of the situation and take immediate meaningful steps to cry halt to such careless operations and arrest the degradation. Ancient irrigation systems that stand abandoned and filled with silt hold testimony to this impending disaster. If we do not pay adequate need to this all important problem, all our large investments made

in the construction of dams, reservoirs and river diversion schemes, may all later prove to be futile endeavours.

Fertilizer use

The next most important factor that is likely to have a significant impact on the environment is the massive use of artificial fertilizers in tea estates. Tea is a crop that is a heavy demander of nitrogen. Very large amounts, ranging from 120-360 kg of nitrogen per hectare per annum is applied in our tea fields. Besides nitrogen, varying amounts of phosphorus, potassium and magnesium are applied in significant amounts each year.

In the early years of tea planting, moderate levels of organic manure, such as oil seed cakes and bone-meal, were applied rather infrequently, not exceeding more than twice a year. Green manure, in the form of loppings from shade trees and leguminuous shrubs were regularly applied. Ground covers were also regularly slashed into the soil and these applications along with the organic manure provided the necessary nutrients for the tea crop.

As part of a progressive programme of research efforts geared towards increased productivity, long years of experimentation with artificial fertilizers later led to the wide scale use of ammonium sulphate as the main source of nitrogen. The tea crop responded to this fertilizer very well and profitable returns were obtained with this change. Increasing amounts of sulphate of ammonia was used from the late 1940s and, with the replanting programme coming into effect from the mid-1950s using very high yielding clones that were heavy demanders of nitrogen, massive amounts going over 360 kg of nitrogen per hectare, per annum are applied in many young tea fields. Due to the continuous erosion and the poor organic matter status of the tea soils, infiltration is retarded with the consequent run-off problems. During heavy rains and thunder storms, there is much sheet-erosion and along with this the fertilizer that is broadcast on the soil surface is also carried away into drains, ravines and water courses. One has to only take a look at some of the very fertile areas that are under vegetable cultivation

in the ravines and valleys below tea fields, to get an idea of the extent of washing down of large amounts of fertilizers broadcast in tea fields.

There is evidence that the continued use of sulphate of ammonia, for a period of well over 40 years, has now led to a decline in soil pH, from an acceptable range of 4.5 to 5.5 to as low as 3.5 to 4.0. Excessive use of sulphate of ammonia and the inadequate use of dolomite following pruning has aggravated this problem in recent times. We do not yet know the full consequence of the large-scale use of not only nitrogeneous fertilizer, but also that of phosphorus, potassium and magnesium, on the ground water and other water courses that feed our streams, rivers and reservoirs, which in turn feed a network of irrigation channels. The heavy use of these fertilizers is likely to cause imbalances in other elements that could be released from bound sites and leached out. We know of very high levels of iron and manganese in some of the water bodies in tea estates. What is urgently needed is a full scale investigation of the displacements and movements of the various minerals in the water courses.

We know from recorded history that great civilizations have vanished as soils were rendered lifeless through the accumulation of salts and as the irrigation systems filled up with silt. We already know of instances where the soil is badly eroded to such a degree, that tea could no longer survive and no other crop as well could survive in such places.

Agrochemicals

We are all aware of the devastating influence the long-persistent organo-chlorine insecticides had on insect pest ecology in tea fields. The disruptive effects of their use resulted in massive outbreaks of hitherto innocuous species of insects as secondary pests, that caused even greater damage than the target pest. Furthermore, the persistence of such insecticides in tea soils and water courses had not been fully investigated. It is, however, reassuring to note that the use of such pesti-

cides is now totally banned in tea plantations since the early 1970s.

Copper-based fungicides are being continued to be used as a prophylactic treatment against the Blister Blight leaf disease of tea. There are yet no other effective and cheap fungicides that could match the performance of such copper-based fungicides. It is time that we investigated our soils and water courses for copper deposits and check their effects on soil micro flora and micro fauna as well as their influence on crops irrigated with water that emanates from these areas.

With the scaling down of the use of soil-disruptive implements for manual weed control, the use of herbicides is on the increase. Even though this latter approach is a more desirable one in respect of soil preservation, we will have to carry out a detailed study of their detoxification in soils and their influence on the flora and fauna in the soils and water ways.

The resourceful earthworm that keeps the soil in good tilth is fast becoming a rare species in our tea fields. The poor organic matter status of tea soils, the increasing acidity of soils on account of the continued use of sulphate of ammonia and the use of various pesticides, including different kinds of herbicides, could all have a detrimental effect on the survival of the earthworm, which could now only be seen near cattle sheds and compost heaps. The fertility status and the tilth of our soils thus stand endangered by the disappearance of this highly beneficial worm. It is time that we undertook a careful study of all the above factors on the survival and population build up of these resourceful worms. In addition, we should also initiate studies on the survival of other beneficial microbes in our tea soils. The association of mycorrhiza in tea roots has been known since 1901. However, no detailed studies have yet been undertaken to ascertain its role on the growth of tea.

The need for a compromise

The inevitable conclusion one comes to is that, despite the enormous prosperity the tea crop has brought

to our country, having occupied one of the most crucial sectors of the land area, the impact of the growing of this crop on the environment has been, on the whole, a harmful one. Being a cash crop with the potential to earn vast profits and foreign exchange earnings, the all important factor of economics of lowering cost inputs and increasing profits played a dominant role. This was particularly so from about the mid-1960s, when world prices for tea began to decline and cost of production increased significantly. Sound agronomic practices that were mindful of conservation came to be neglected and tea growers depended more and more on artificial fertilizers, with very little attention to the soil and the improvement of its fertility.

Yet if we are to start all over again, to select a plantation crop that would benefit the country as a whole in this critical sector of the montane forest regions, we would still select tea as the most desirable one. This would be so, provided we adopt sensible agronomic principles and grow this plantation crop towards optimizing the revenue from its cultivation, whilst at the same time causing minimal effects on the environment.

Yet, it is not too late. The time has arrived for us to take cognizance of the immense complexity of the environment and the interaction of each of its constituents with the others. We have to use our skills and resources to the best advantage to optimize tea production on the one hand, while at the same time coexist with the environment, causing minimal disruptive impacts. Such a situation once existed, during the pioneer days of tea planting. We have to recognize the tea crop as an integral part of the environment, and not simply as a plantation that generates a commodity that is one of our prime foreign exchange earners.

Besides the impact on the environment of tea cultivation itself, an even greater threat is now being posed to the environment by the total abuse of old abandoned tea lands that have not been put to any sensible planned use. *Ad hoc* settlements and cultivations, particularly that of vegetables and potatoes on the steep slopes

of abandoned tea lands is causing massive erosions that is silting our water ways. Immediate action should be taken to prevent such careless use of these lands that could be put to a far better use, with a little amount of planning.

Let us take stock of the situation and be conscious of what lies ahead of us and make every effort to preserve what is left and strive towards improving our tea cultivation practices, with the environment in mind.