

**TRI- IESL (MESC)  
INNOVATION  
COMMITTEE FOR  
TEA INDUSTRY  
DEVELOPMENT**

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## **1.0 History of Sri Lankan Tea Industry**

The Scots planter, James Taylor's experiment in planting tea in his abandoned coffee estate at Loolecondera was the first recorded successful tea plantation established in Sri Lanka. In year 1866 he had withered the first leaves on this bungalow veranda, trying to emulate the process used by tea-planters in Assam, India. Mr. James Taylor started the first tea plantation with twenty acres at Loolecondera and exported his first modest consignment – 23lb to England. Soon, planters from all over the hill country were visiting Loolecondera to learn how to grow and manufacture tea as a replacement to the coffee industry that was established earlier.

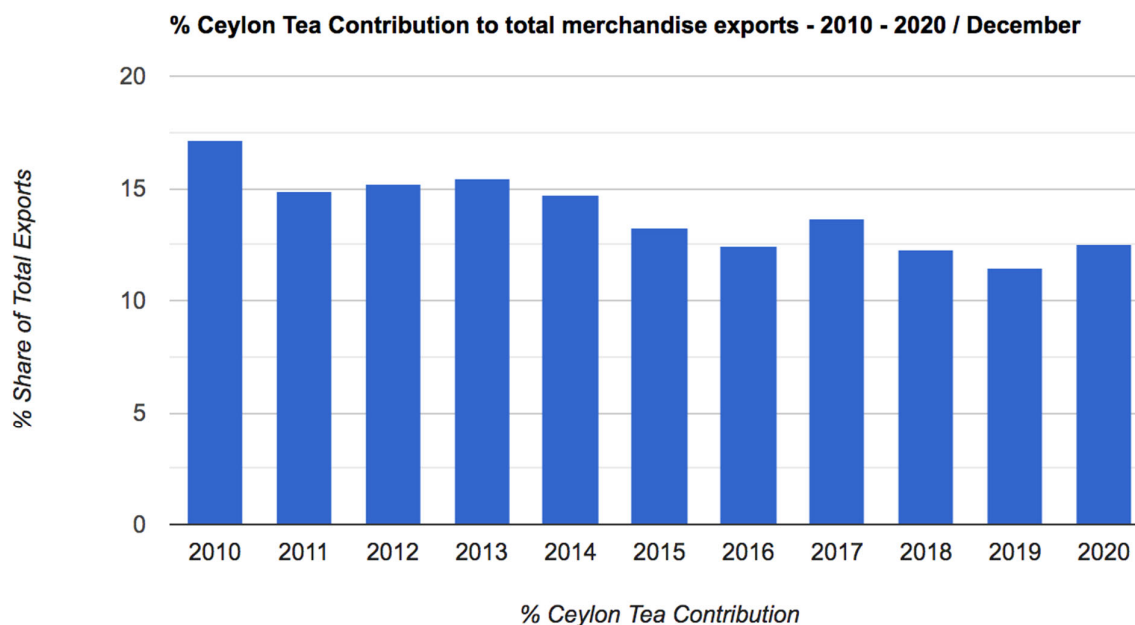
Management of the estates, together with the cultivation, manufacture and sale of tea, was thus left to 'agency houses' or 'management companies' set up in Ceylon for this purpose. Acting on behalf of negligent absentee proprietors and big enough to command both economies of scale and the obedience of planters on their estates, these institutions became enormously powerful, dominating the tea industry.

Work on the estates proceeded according to the well-established methods that were now agreed, to produce the finest black tea in the world. Tea cultivation and manufacture was (and remains) highly labour-intensive; the labour was provided, for the most part, by indentured labourers of South Indian descent whose forebears originally arrived in Ceylon to work the coffee plantations.

In Colombo, the agency houses employed teams of expert tea-tasters to sample and report on the quality of each estate's produce before it was put up for auction in Colombo or London. The brokers and buyers, too, had their tasters, and it was tasters from both sides who attended the auctions, and who in time came to comprise the senior management in mercantile firms connected with the tea industry. Despite the many changes undergone by the industry since the late 1890s, this remains largely true up to the present day.

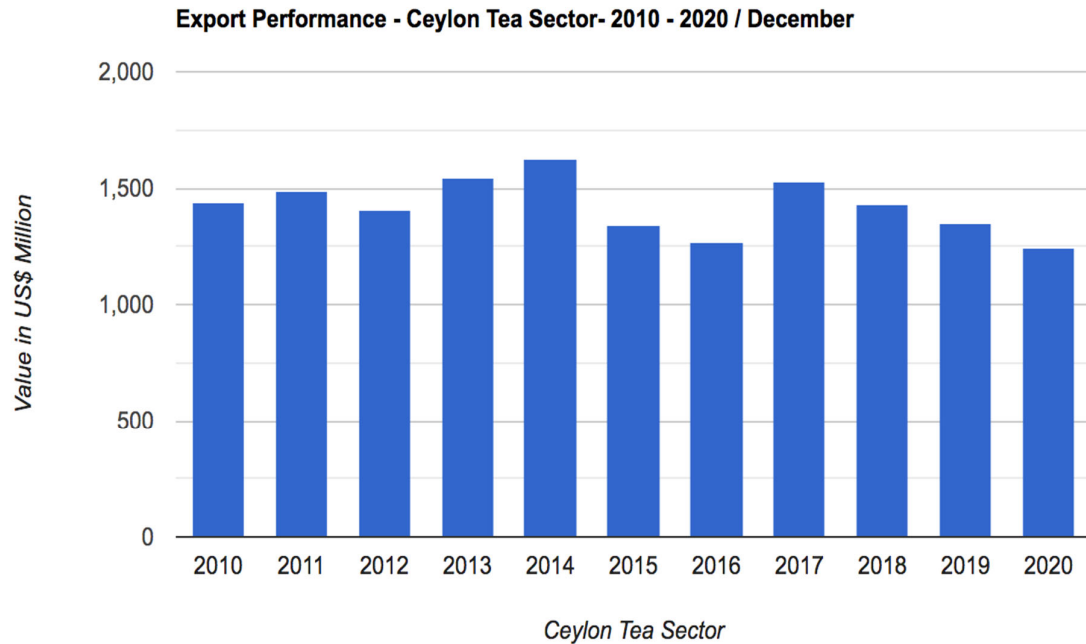
## 2.0 Economic Contribution from Tea Production and Export to Sri Lankan Economy

The tea industry plays a significant role in the Sri Lankan economy in terms of foreign exchange earnings and providing employment opportunities. For more than a century, the tea industry was the main employment provider, the main source of foreign exchange and the main source of government revenue. Nevertheless, recent statistics suggest that the contribution of the tea industry towards the Sri Lankan economy is gradually declining.



**Figure 2—1: Ceylon Tea Contribution to total Merchandise Exports-2010-2020**

It is important as a country to review major contributing factors, including nature of competition in the global tea industry and identify the possible strategies and policies that Sri Lanka should adopt, in order to improve the competitiveness of the Sri Lankan tea industry. The Sri Lankan tea industry faces several problems. The area under tea cultivation is stagnant or shrinking, productivity is low, replanting rate is low, production costs are high and there is a shortage of laborer willing to work in the industry.



**Figure 2—2: Export Performances – Ceylon Tea Sector-2010-2020**

Sri Lanka's share of world exports of tea and production have declined significantly as a result. Hence an integrated approach is essential to identify the possible strategies for the Sri Lankan tea industry to improve the competitiveness

### **3.0 Need for Tea Mechanization**

The urbanization with greater opportunities for a prosperous future, had kept out most of the young generations in the plantation sector and they were migrating to the city for skill/semi-skilled and unskilled job opportunities. Further the perception of a deprived social recognition for tea plantation workers in the society, has also kept many female and male workers out of tea industry. Hence today, most of the small, medium and large tea plantations are facing greater vacuum in labor supply for all of the tea production processes.

The crisis in the tea industry had opened an opportunity for the mechanization of tea manufacturing process. So today a large number of machines has been introduced into tea industry, mainly for plantation processes including harvesting, the most affected by the shortage of labour.

## **4.0 Involvement of IESL**

IESL being the Apex body of engineering professionals in Sri Lanka had decided to contribute to this national task by lending their industrial experience and expertise to save the TEA industry of Sri Lanka. The Mechanical Engineering Sectional Committee having more professionals as members who are closely with mechanization in industry have taken initial steps for the development of tea industry mechanization process. MESC of IESL also invited prominent academics of leading universities of Sri Lanka to be part of this national endeavor, to create the culture at university level, for undergraduates to understand the needs of the industry and thus develop their skills for development of our own TEA industry.

### **4.1 Proposed Strategy for Industrial Cooperation of TRI and IESL**

The Tea Research Institute of Sri Lanka (TRISL) is the apex body mandated to generate and transfer scientific knowledge and technologies for the stakeholders to improve productivity and quality of Sri Lankan tea in a most profitable and sustainable manner. Accordingly, the TRI, had decided to provide series of informative sessions for engineering professionals to understand the activities and processes involved with tea industry. As at today TRI has jointly conducted online presentations and one factory visit for a group of engineering professionals introduced by the MESC to understand the agronomist's view point of the needs of tea mechanization process.

After the initial awareness sessions, and a site visit to the TRI low country station at Karapincha in Ratnapura District, IESL had decided to approach the tea industry's needs in a two-stage approach. The first stage of IESL approach will propose the possible modifications to the existing machines of tea industry to have better efficiencies and productivity within short implementation period. (3 months or less)

The second stage of IESL approach will involve the design of new equipment and processes to enhance the productivity of the tea plantation, harvesting and manufacturing process primarily targeted as a mean of overcoming the labour shortage.



## 5.0 Tea Manufacturing Traditions

Sri Lanka's tea cultivators and manufacturers are the custodians of the traditional, orthodox method of black tea production. This is still agreed by most experts to be the means to produce the best black tea. Even with the technological improvements introduced over the last thirty or forty years, the orthodox method is relatively slow and labour-intensive; but as the tea planters and traders of Sri Lanka have always maintained, good tea cannot be hurried. Nor, oddly enough, can it be delayed. The time devoted to each of the processes of tea manufacture has to be finely judged if a quality product is to be obtained. This is a matter of the tea-maker's judgment, for the right timing depends on the moisture content of the plucked leaf, the temperature and humidity conditions prevailing over the period of manufacture, and a variety of other factors. Although the process of making fine black tea is simple in its essentials, expertise, experience and a 'feel' for the task are absolutely essential to success.

### 5.1 Process of Tea Manufacturing

#### 5.1.1 Plucking



**Figure 5—1: Traditional Tea Plucking Process**

The process of manufacture commences when the leaves are picked or 'plucked'. Plucking calls for discrimination and dexterity and is carried out mainly by women. Only the uppermost foliage on every stem is picked – the famous 'two leaves and a bud' – and the stem itself must be left undamaged. Fiddly work, but a skilled tea-plucker can collect up to 20kg. (44lb.) of leaf daily.

### 5.1.2 Weighing



**Figure 5—2: Traditional Tea Weighing Process**

On arrival at the factory, the raw leaf is weighed. The total weight recorded for the day's batch provides a benchmark for quality assessment at the end of the process of manufacture. After weighing, the tea is laid out for withering

### 5.1.3 Withering



**Figure 5—3: Traditional Tea Withering Process**

Raw leaf is ‘fluffed’ and spread out to dry on racks or troughs in a well lit and ventilated space. It will lie here for 18-24 hours, slowly losing moisture and undergoing physical and chemical changes essential to manufacture. Over-withering can be fatal, so the process is carefully monitored. It is complete when about two-thirds of the moisture present in the raw leaf has evaporated.

#### 5.1.4 Rolling



**Figure 5—4: Traditional Tea Rolling Process**

The withered leaf is now ready for rolling. This is a mechanized process in which the leaf cells are ruptured to release enzymes and bring them into contact with air so that aeration can commence. The bits of broken and rolled leaf are called dhools. The dhools are then broken up and sifted before aeration.

### 5.1.5 Aeration



**Figure 5—5: Traditional Tea Aeration Process**

During this critical stage of manufacture, important chemical reactions take place through the action of air on the leaf tissue. The rolled, broken leaf is spread out on tables and exposed for a period that varies between 20 minutes and five hours, depending on a variety of factors, including what kind of final product is desired. The withered tea leaf is a rusty, coppery orange colour. Again, timing is critical: under-aerated tea tastes raw and green, over-aerated tea is soft and tasteless. Aeration is also sometimes known as ‘fermentation’ or ‘oxidation’.

### 5.1.6 Drying



**Figure 5—6: Traditional Tea Drying Process**

When the right amount of aeration has occurred, the leaf is dried in a desiccator or ‘firing chamber’ at 99-104°C (210-220°F) to prevent further chemical changes. This shrinks and darkens the leaf, resulting in the product known as black tea. This completes the actual manufacture.

### 5.1.7 Grading



**Figure 5—7: Traditional Grading Process**

The size of the leaf particles in your teapot bears no relation to quality per se, but it does affect the colour and strength of the brew. Manufactured tea is graded by leaf size using a mechanical sifter. ‘Leaf’ grades contain the largest pieces, ‘broken’ grades are successively smaller, while the smallest grades of all are known as ‘dust’. Larger grades tend to command higher auction prices.

### 5.1.8 Bulk Packing



**Figure 5—8: Traditional Bulk Packing Process**

To ensure consistency of appearance, flavour and quality, each grade of a particular consignment is thoroughly stirred up and mixed together. After this, the tea is bulk-packed – either in the traditional wooden chests (in former times these were lined with lead) now no longer used in Sri Lanka or in more modern aluminum-lined paper sacks.

## 6.0 Technology Implementation to the Tea Industry

TRI being the only state-owned organization responsible for the development of TEA industry has taken many imitative to identify and promote equipment and processes for the application in small, medium and large tea estates. These equipment are mainly categorized in to four sections

1. Ground Preparation
2. Tea Harvesting
3. Tea Processing
4. Pruning
5. Replanting

The possibility of adaptations of technology in each TEA of the above production area are under consideration by the members of the MESC and the associates under the two-pronged approach discussed earlier. We have invited individual members or teams to develop concepts on such possible adaptations or new interventions.

On receipt of these we will conduct in house preliminary whetting and reviews as the first step. Once any concept is found acceptable, we wish to have a consultation with the relevant experts at the TRI before proceeding further to ensure the compatibility of such proposals with the present practices wherever possible and make suitable adjustments. In case of any novel concept which has the potential of a major impact, we may even seek your help and advice as to how such innovation can be adopted even with some changes in the current practices.

In the meanwhile, we will welcome any suggestions from you on any specific needs identified or even some concepts that you have not been able to move forward due to lack of personnel. This might give us a kick start for our efforts.

We are taking a visionary approach and hope to be of assistance to make a significant change in the industry which is long felt and the TRI has been unable to implement due to inadequate human resources and other constraints. Thus, it is our earnest desire to collaborate with you with a common goal and a vision and hope for success.

We also look forward to the second factory belonging to the private sector which was mentioned as having installed some modern technologies with success. We hope our members would be better prepared to be more inquisitive with the initiation to the industry during the first visit.

## 6.1 Ground Preparation Process

In a TEA estate the ground preparation involves the clearing of land including weeds removals and holing operation. However the holing operation is found to be more time consuming and labour intensive. Hence TRI had looked for holing machine for the drilling of ground for preparation of holes for tea planting activity.



**Figure 6—1: Ground Preparation-Drilling**

The machine has found to be non-popular among workers due to high torque induce on the operator during drilling. It was noticed that during operation when the soil is more of rock and clay mixture, the machine exerts high torque on the operator, which toss him away from the machine. Also, it was informed that the coupling used to transmit power from machine to the drill fails so frequently due to this sudden force exert on the machine due to irregular nature of the soil texture.



## 6.2 Pruning of Trees



**Figure 6—2: Pruning of Trees**

In TEA estates it is common practice that TEA bushes are pruned periodically for several times to improve the harvest from the TEA bush. Generally, this is done using pruning knife. Considering time taken for selective TEA bush pruning process, the TRI had tried the use of bush cutter for TEA bush pruning activity.

Considering the design consideration of bush cutters, it is noticed that the pruning activity using bush cutters is not giving required single action, clean cut to the stem of the TEA bush. So often the rotary cutter crush stem of the TEA stem and damage the tree. Hence even though the bush cutter can improve the productivity, it impedes more damage to the stems of the tree where regrowth is not healthy.

## 6.3 Tea Harvesting



**Figure 6—3: Tea Harvesting Process**

Generally, the TEA harvesting is a selective process where TEA pickers will harvest the tender tea-leaves with buds and leaves. However it is important to leave the small TEA buds in the tree for the next harvest. During application of machine in to the TEA estate had removed the most important selective harvesting requirement of the TEA bush and harvest all buds, leaves above machine operation line. Therefore, the application of machine to TEA harvesting can be identified as counterproductive considering the requirement of selecting the suitable leaves after machine operation.

## 6.4 Tea Weathering, Grinding and Drying Operation



**Figure 6—4: Tea Weathering Operation**

TEA processing within a factory is more of controlled chemical reaction of TEA-leaves. It was noticed that there are a lot of inputs that can be given for the TEA industry for selection of correct heat sources, heat transfer media, and TEA dryer. The initial site visit covered the Colonial type TEA factory where the tradition of TEA manufacturing is continued. However, it was noticed with advancement of electrical/electronic sensing devices, processing equipment and the adaptation of closed loop control system for energy efficient TEA processing technology is wide open for TEA Industry.

## 7.0 Recommendations

1. TRI is willing to work in collaboration with professional institution like IESL who is having adequate professional expertise in identification of suitable technology for TEA and other industry. Hence as a short-term measure, IESL (MESC) recommend to establish a professional panel of experts with participation of TRI, IESL, and Academic institution to identify and conduct trial runs for already available technology for the TEA industry Development as short-term measure.

### EX-1: Holing Machine



**Figure 7—1: Holing Machine**

Modification has been developed to the holing machine including mechanical feeding and anchoring to use it effectively in any terrain.

### EX-2: TEA Pruning Machine



**Figure 7—2: TEA Pruning Machine**

Pruning is a selective operation where the operator needs to select correct stems to be prune in the TEA bush. It was mention that the scissor type-pruning machine could not be applied because the size of the TEA bush branch can be thick as few inches. However today such pruning machine is available with power assistance to operate for more than 8 hours continuously in field.

2. IESL (MESC) would propose to establish access for few student groups from universities to collect data on existing tea processing activities and to develop efficient equipment and processes for tea manufacturing with the factory.
  - University of Moratuwa is willing to undertake the design of efficient heat source for TEA dryer
  - University of Sri Jayewardenepura has endorsed their commitment to develop an efficient tea dryer with CFD modeling
  - University of Peradeniya had endorsed their commitment to develop efficient process through automations
3. It was identified that the Selective harvesters is the most required tool at the tea estate to improve the production capacity and the productivity of the labour. Several participant including representatives from University of Peradeniya have highlighted their interest in developing a selective harvester for the harvesting of tea leaves.
4. Still the uses of new technology in tea estates are at very minimal level. Hence it is recommend establishing a team to look in to the possibilities of adopting latest technologies in to tea states.

**Ex:** Today driving a drone in a predefined path on time schedule and collecting information on field works is very common practice. This process will help the estate management to deploy relevant technical team in time for works to reduce the down time of scheduled activities. Also, this technology will supervise the supervisors in the ground for better output from the filed.
5. The needs for development of in-house technical team for engineering related activities are essential for TRI in their development work. Hence it is recommended to establish special Electro- mechanical engineering division within TRI for continuous development of tea proceSSION industry.