

REVIEW OF TEA INDUSTRY IN SRI LANKA FOR CLIMATE ANALYSIS

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PREFACE

Tea is sensitive to climate and the geography, management, economics and production are shaped by it. Tea plantations of Sri Lanka are found in varying climatic conditions. This report provides a review of the Tea industry of Sri Lanka for Climate analysis.

These compilations and findings serve as a baseline for the analysis of climate impacts on the tea industry, sector and ecosystem. The sections of the report provide review on History of tea, Scientific classification of tea, Tea growing areas in the world, World tea production, World tea export, World tea consumption, World tea prices, Tea in Sri Lanka, Institutional and policy history, Impact of climate factors on tea production; quantity and quality, Phenology and physiology of tea plant, Tea production, Area and yield histories in Sri Lanka and Tea growing regions in Sri Lanka.

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INTRODUCTION

Tea, *Camellia sinensis* (L.) O. Kuntze (Theaceae) is an evergreen, perennial, cross-pollinated plant and grows naturally as tall as 15 m. The tea plant has an economic life span of 50-60 years. However, some of the existing tea plantations are over 80-100 years. Tea is the manufactured drink and the second most consumed after water in the world. Discovered about 2700BC, it is one of the oldest beverages in the world. The genus *Camellia* includes some 82 species which are mostly indigenous to highlands of south-east India an indefinite area to the south-east of the Tibetan plateau, including Sze-chuan, Yu-nan, Burma, Siam and the Assam variety in north-east India, (Robert Sealy 1958; Weatherstone 1992). Tea is the most important of all *Camellia* spp. both commercially and taxonomically. Today it is available for consumption in six main varieties, based on the oxidation and fermentation technique applied (Kaison Chang 2015). Young leaves of camellia plant after wither and crushed and in hot water drink as refreshment. All *Camellia* spp. do not produce the brew that goes into the cup that cheers (Banerjee 1988). Taxonomy plays a major role in the identification of true teas among the *Camellia* spp. for commercial exploitation (Banerjee 1992). Many non-tea species of *Camellia* are used as ornamental plants.

SCIENTIFIC CLASSIFICATION OF TEA

In Linnaeus' Species Plantarum, two genera, *Thea* and *Camellia* were recorded. At the time only *Thea sinensis*, the tea plant of China and later two other species *Camellia japonica* and *Camellia sasanqua* were known. In 1762, Linnaeus named two varieties of tea as *Thea viridis* and *Thea bohea*. *Thea viridis* thought to be the plant making green tea and *Thea bohea* for black tea. Later it was shown that green and black tea was made from the same plant. Later Botanists have combined two genera *Thea* and *Camellia* in to one species and given the name *Camellia sinensis* under the International Code of Botanical Nomenclature. The correct name for the tea is considered as *Camellia sinensis* (L.). O. Kuntze. L. indicates that Linnaeus first published epithet *sinensis* and O. Kuntze indicates that this Botanist was the first to combine the two names (Harler 1964).

Kingdom - Plantae – Plants

Subkingdom - Tracheobionta – Vascular plant

Superdivision - Spermatophyta – Seed plants

Division - Magnoliophyta – Flowering plants

Class - Magnoliopsida – Dicotyledons

Subclass - Dilleniidae

Order - Theales

Family - Theaceae – Tea family

Genus - *Camellia* L. – camellia P

Species - *Camellia sinensis* (L.)

The cultivated taxa comprise of three main natural hybrids. They are (1) *C. sinensis* (L.) O. Kuntze or China type, (2) *C. assamica* (Masters) Wight or Assam type, and (3) *C. assamica* sub spp *lasiocalyx* (Planchon ex Watt.) or Cambod or Southern type. (Islam 2005)

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Assam type: biggest leaves
China type: smallest leaves,
Cambod: intermediate leaves
The center of origin of tea was South-East Asia

i.e. at the point of intersection between the 29° N (latitude) and 98° E (longitude) near the source of the Irrawaddy river at the confluence of North-East India, North Burma, South-West China and Tibet provinces (Weight 1959). Tea thrives well within the latitudinal ranges between 45°N to 34° S.

HISTORY OF TEA

Tea has been using since prehistoric time in north western China as medicine and food (Sheng 2001, in (Weatherstone 1986; Modder 2002). According to one of the Chinese legends, the Emperor of China and inventor of agriculture and Chinese medicine, Shen Nung, was drinking a bowl of just boiled water due to a decree that his subjects must boil water before drinking in sometime around 2737 BC when a few leaves were blown from a nearby tree into his water, changing the colour. The emperor took a sip of the brew and was pleasantly surprised by its flavor and restorative properties. A variant of the legend tells that the emperor tested the medical properties of various herbs on *himself, some of them poisonous, and found tea to work as an antidote. The emperor came in to believe that tea had beneficial effects on health and recommended it as remedy for various ailments as kidney trouble, fever, chest infection and tumors (Fernando 2001). The recent research has amazingly confirmed these findings.

Tea has been used in China in 500 A.D. primarily as medicine and used as a beverage in China upper class society in 598 A.D. more than three centuries later the practice spread to the lower classes. In Japan in 951 A.D. tea was used against the plague. Tea ceremony was initiated in Japan about 1159 A.D., the ceremony reached to Japanese middle class over four centuries later about 1582 A.D. Tea used as a therapeutic measure in Far East and then for many centuries as a drink for emperors and rich class later it became a drink for normal people. Tea was discovered by Europeans traveling to Far East during 1500s and early 1600s restricted to nobility and rich due to its great cost. In 1600 and 1700, tea was imported from Far East and highly prized. Tea drinking became a fashion in London soon after 1662 when the new queen of Charles II, the Portuguese Catherine, insisted on tea rather than beer (Young 2001, in (Modder 2002). The British East India Company began to import tea on a large scale in 1678 (Weatherstone 1986) (Toung 2001 In Modder 2002). A pound of tea then cost more than a skilled craftsman might earn in a week. Both black and green tea were drunk, black being much cheaper. Tea became a symbol of wealth and lavish hospitality and developed formalized social and domestic tea rituals of their own in the late 1600s and early 1700s. British tea ritual survived to this day as in Morning and Afternoon tea, Tea Breaks etc.

TEA GROWING AREAS IN THE WORLD

Tea crop require specific agro-climatic conditions that are only available in tropical and subtropical climates, while some varieties can tolerate marine climates of British mainland and Washington area of the United States. The tea plant needs a hot, moist climate. Its specific requirements are: temperatures ranging from 21-30 °C, and annual precipitation of 1500 - 2500

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mm, preferably acidic soils, ideally 0.5-10 degree slopes and elevations up to 2000 meters. Tea production therefore is geographically limited to a few areas around the world (Figure 1) and it is highly sensitive to changes in growing conditions. Importantly, Change of ideal growing conditions under climate change will severely effect on tea production.

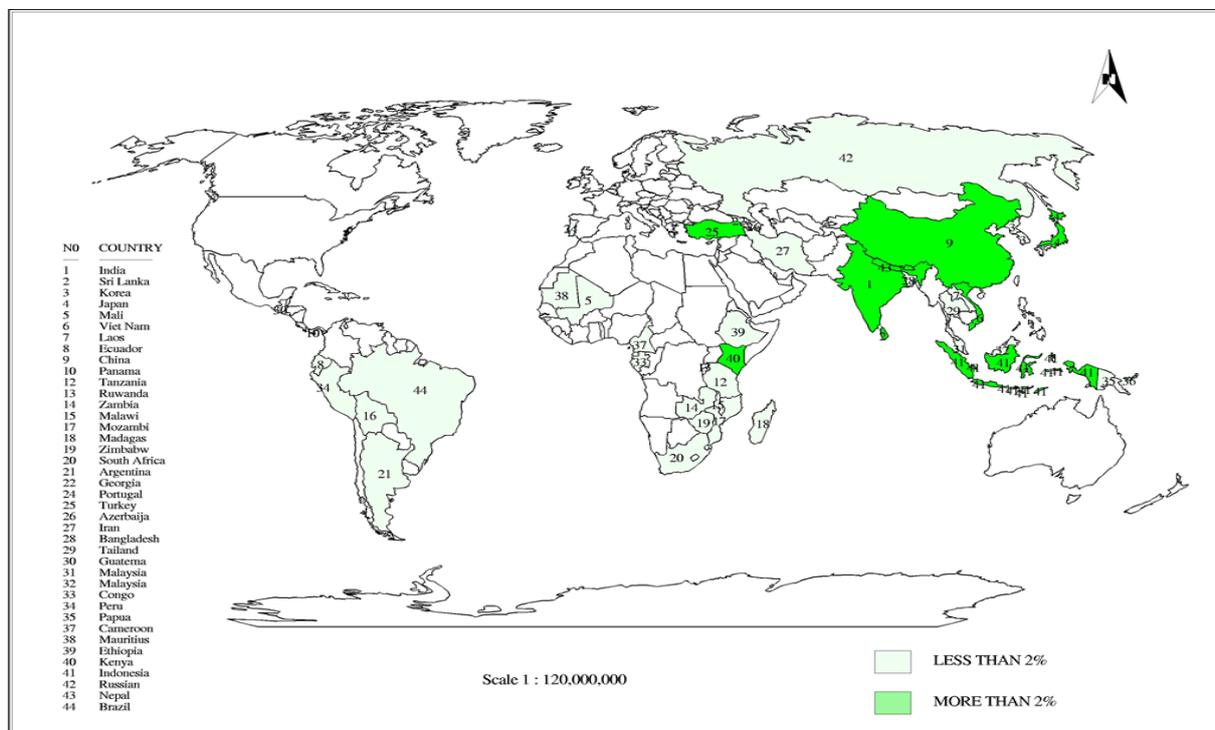


Figure 1. Tea producing areas in the world

Source: Climate Change and Variability and Tea and Coconut Plantations in Sri Lanka, tropicalclimate.org

WORLD TEA PRODUCTION

Table 1. World tea production (thousand tons)

	2006 - 2008	2009	2010	2011	2012	2013
World	3891.2	4040.0	4364.7	4627.0	4784.5	5063.9
Asia	2892.3	3089.7	3280.3	3579.1	3753.3	3965.6
Bangladesh	56.8	60.0	60.0	59.6	62.5	66.2
China (Mainland)	1150.5	1344.4	1475.1	1623.2	1789.8	1924.5
India	986.4	982.1	970.3	1119.7	1129.0	1200.4
Indonesia	150.3	156.9	156.6	150.8	150.9	152.7
Sri Lanka	311.3	291.2	331.4	327.5	328.4	343.1
Vietnam	158.0	177.3	192.0	202.1	200.0	185.0
Others	78.9	77.8	94.8	96.2	92.7	93.8
Africa	535.9	520.5	616.1	591.7	580.2	649.5
Burundi	6.6	6.7	6.9	7.0	8.7	8.8
Kenya	345.2	318.3	403.3	383.1	373.1	436.3

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Malawi	44.9	52.6	51.6	47.1	42.5	46.5
Rwanda	19.1	20.5	22.2	24.1	24.7	25.2
South Africa	3.5	2.0	2.1	2.2	2.2	2.5
Tanzania	32.6	32.1	31.6	33.0	32.3	32.4
Uganda	42.4	51.0	59.4	56.3	57.9	58.3
Zimbabwe	12.4	7.3	8.6	8.4	8.5	8.5
Others	29.0	30.0	30.2	30.6	30.4	30.9
Latin America & Caribbean	97.7	89.8	107.4	107.8	98.3	95.0
Argentina	79.6	73.4	90.7	91.2	81.3	78.9
Brazil	8.5	7.6	7.7	7.7	7.8	7.0
	9.7	8.8	8.9	8.8	9.2	9.1
Middle East	255	238.2	262.0	251.1	251.5	253.5
Iran, Islamic Rep.	41.4.2	39.6	27.0	29.5	26.5	26.5
Turkey	213.7	198.6	235.0	221.6	225.0	227.0
Oceania	7.1	7.2	7.2	6.6	6.4	6.5
Japan	94.7	86.0	83.0	82.1	85.9	84.7
CIS	8.3	8.4	8.4	8.5	8.6	8.9
Developed	113.7	101.0	103.8	99.5	103.3	102.9
Developing	3777.5	3936.2	4263.6	4527.5	4681.2	4961.0

Source: Committee on International Group on Tea, Twenty-second Session Naivasha, Kenya, 25-27 May 2016

Globally tea production continues steady increase, doubling in the past 20 years from 2,525 Mt in 1995 to 5,305 million Mt (5.3 billion kgs) in 2015 (Figure 2). Tea is grown commercially in more than 35 countries but production remains concentrated in a few with the top seven producers accounting for 90% and the top 10 growing 94% of the world's tea (Figure 3). Production continues to outpace consumption with Kenya, China and Vietnam showing significant increases. The gap between production and consumption is widening. Production in 2015 was estimated at 5,306 MT with consumption at 4,999 MT resulting in a 307 MT surplus. In 2014 the surplus was 351 MT. Five years ago (2010) the surplus was 127 MT and 10 years ago surpluses were less than 100 MT. Nearly 50% of world tea production is coming from China and India (Table 1).

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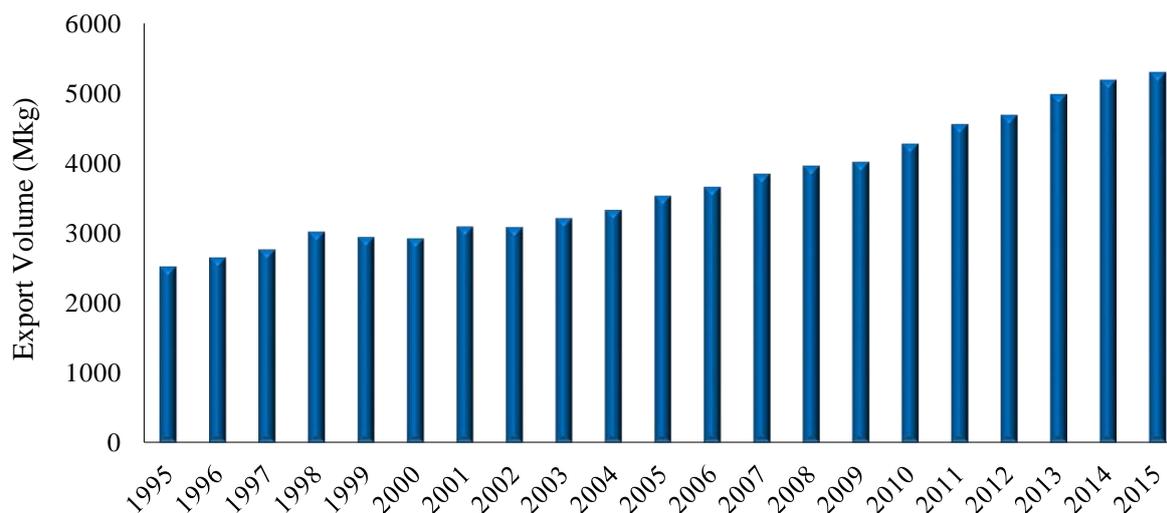


Figure 2. World tea export

Source: <http://worldteanews.com/news/global-tea-production-2015>

WORLD TEA EXPORT

Kenya remains the global leader of tea export with a 25% share (mainly black tea) and China is accounting for 18% of global exports (mainly green tea). Sri Lanka follows China in third place at 17% market share with India at 13% and Vietnam now 7%. Argentina rounds out the top 5 with 4% market share. Once listed among the top five, Indonesia's 3% share continues to slide as tea growers there switch to food and other cash crops, primarily palm oil and Arabica coffee (Figure 4).

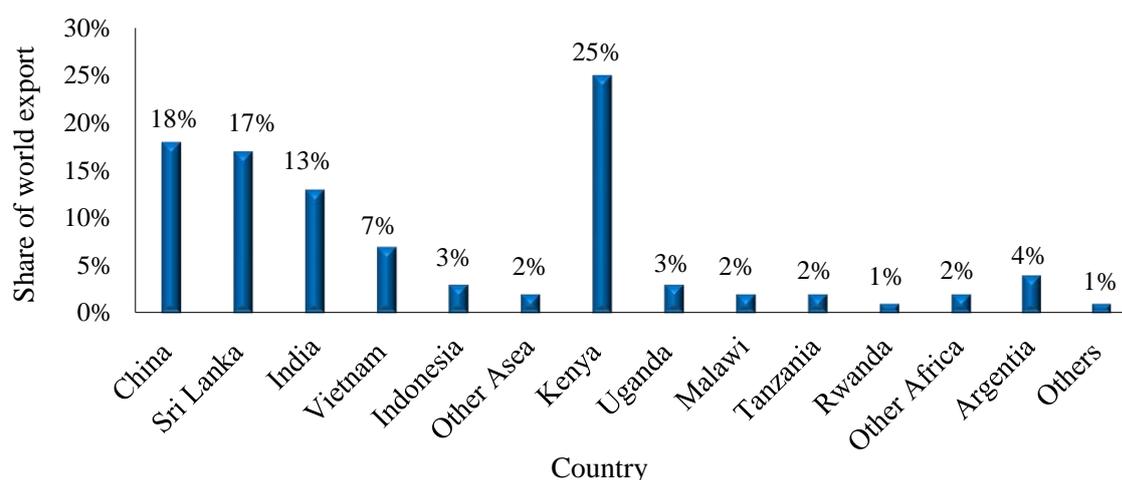


Figure 3. Share of tea exports in producing countries, Source: <http://worldteanews.com/news/global-tea-production-2015>

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Table 2. World tea exports (thousand tons)

	2006 - 2008	2009	2010	2011	2012	2013
World	1570.7	1544.7	1683.0	1674.8	1684.0	1768.5
Far East	1014.0	1008.8	1036.4	1051.9	1064.8	1077.9
Bangladesh	7.9	2.1	0.9	1.5	0.6	0.5
China	291.0	303.0	302.4	322.6	321.8	329.7
(Mainland)	200.2	180.5	182.7	205.3	199.1	209.2
India	91.7	92.3	87.1	75.5	70.1	70.8
Indonesia	303.5	279.9	305.8	303.2	306.1	311.0
Sri Lanka	108.2	134.1	138.4	122.6	145.0	133.5
Vietnam	11.5	17.0	19.1	21.4	22.1	23.1
Others	462.8	449.1	542.9	519.4	525.7	596.4
Africa	301.0	281.1	362.3	347.5	349.9	415.9
Kenya	42.9	46.8	48.9	44.9	41.8	40.5
Malawi	17.4	18.8	21.5	23.2	23.0	23.5
Rwanda	5.6	5.3	5.0	2.7	2.8	5.2
South Africa	26.4	24.4	26.1	27.1	27.8	26.2
Tanzania	39.6	47.9	53.7	47.9	52.3	56.7
Uganda	9.1	4.5	5.1	5.7	5.9	5.9
Zimbabwe	20.8	20.3	20.3	20.3	22.3	22.5
Latin America and Caribbean	79.7 7.0	72.7 7.8	89.2 7.4	89.0 6.7	79.3 6.1	76.2 6.6
Oceania	16.7	17.5	17.2	14.5	13.7	18.1
Developed	1554.0	1527.2	1665.7	1660.2	1670.3	1750.4

Source: FAO IGG Secretariat

[www.teausa.com/teausa/images/International Tea Committee Ian Gibbs.pdf](http://www.teausa.com/teausa/images/International_Tea_Committee_Ian_Gibbs.pdf)

WORLD TEA CONSUMPTION

Tea consumption is gradually increasing in the world. China, India, and Turkey together drink more tea than rest of the world's consuming nations combined. In 2015 China consumed 1,812 MT of tea while India, which is experiencing significant demand from a growing middle class, consumed 948 MT. Turkey, which has the largest per capita consumption in the world, drank 253 MT in 2015.

Three-year average consumption per country in kgs found that per capita average of 3.14 kgs per person is consume in Turkey accelerating while tea consumption in the Republic of Ireland has declined from a similar average in 1993-95. Last year Irish tea drinkers consumed a three-year average of 1.6 kgs, falling from first to fifth in per capita rankings. Turkey is now followed by Afghanistan at 2.4 kg, Libya at 2.19 kg the United Kingdom at 1.74 kg and Morocco at 1.73 kg per person. Tea consumption in China is on the rise at 1.22kg. Russia, another major tea consuming country and the world's largest tea importer, has also shown a strong trend during the past decade with a per capita three-year average rising by a quarter to 0.88 kg in 2015. The United States and Canada are coffee nations. The three-year per capita average consumption

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for Canada is 0.47 kg down during the past five years while tea consumption in the US is on the rise to 0.41kg in 2015.

Table 3. World tea consumption (thousand tons)

	2006- 2008 (Average)	2009	2010	2011	2012	2013
World	3714.9	3916.0	4180.3	4449.6	4626.8	4842.1
Developed	826.0	792.1	818.8	834.4	827.8	814.8
South Africa	18.8	24.0	25.1	23.5	23.5	22.8
EU	259.7	228.5	230.3	246.6	238.0	242.0
France	14.6	13.9	15.3	14.9	15.1	15.2
Germany	23.2	19.0	24.9	25.9	29.9	28.9
Ireland	9.2	10.7	10.2	8.6	6.7	7.0
Netherland	13.8	11.8	10.9	14.2	7.0	12.2
Poland	23.7	15.8	17.2	19.8	19.9	15.0
UK	134	121.0	119.8	129.3	125.2	116.2
Other EU	41.2	36.2	31.9	33.9	34.2	47.5
Japan	139.4	124.1	124.0	121.9	121.9	119.1
USA	109.6	108.2	123.8	124.6	122.7	127.4
Russian Federation	172.4	176.2	177.8	182.2	173.3	159.1
Others	114.7	107.1	112.7	112.1	125.0	121.6
Developing	2889.0	3123.9	3361.5	3615.1	3798.9	4027.3
China	867.0	1045.3	1188.5	1314.5	1481.7	1614.2
India	786.9	822.1	818.3	922.2	939.2	1001.4
Turkey	214.6	202.4	241.9	227.4	227.2	228.0
Egypt	81.1	82.3	68.5	95.7	95.4	99.0
Pakistan	107.3	85.7	120.3	126.2	131.3	126.6
Iran	76.8	86.1	89.6	80.2	80.3	83.4
Indonesia	56.1	56.8	59.9	61.1	63.3	64.9
Bangladesh	46.4	53.7	57.3	59.3	59.5	61.9
Vietnam	25.5	27.5	27.9	29.3	30.3	31.7
Morocco	51.4	54.8	53.9	65.0	54.1	56.7
Kenya	17.3	18.1	18.7	20.0	23.0	26.6
Others	558.6	589.0	616.6	614.2	613.7	632.9
Total	11118.9	11952.3	12745.9	13571.7	14094.9	14745.5

Source: FAO IGG Secretariat - <http://www.fao.org/3/a-i4480e.pdf>

WORLD TEA PRICES

World tea prices shows increasing trend over the past decade (Figure 4). Sri Lankan tea or popularly known as Ceylon in the world fetches the highest price due to its unique flavor and aroma (Figure 5). Even within the country, Sri Lanka produces tea with different aroma and flavors due to its geographical and climatic variation in its tea growing districts.

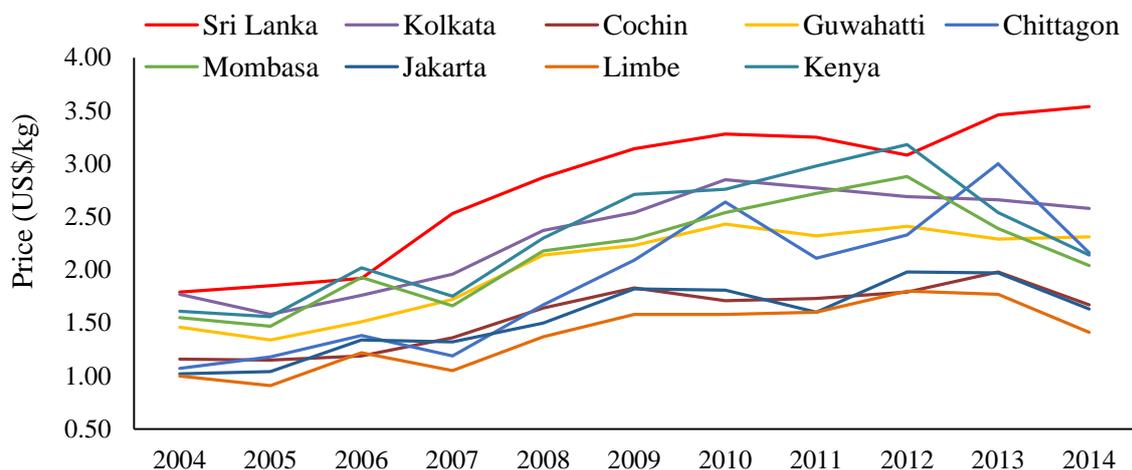


Figure 4. Tea prices at the world market, Source: Dept. of census and statistics, National accounts of Sri Lanka 2014

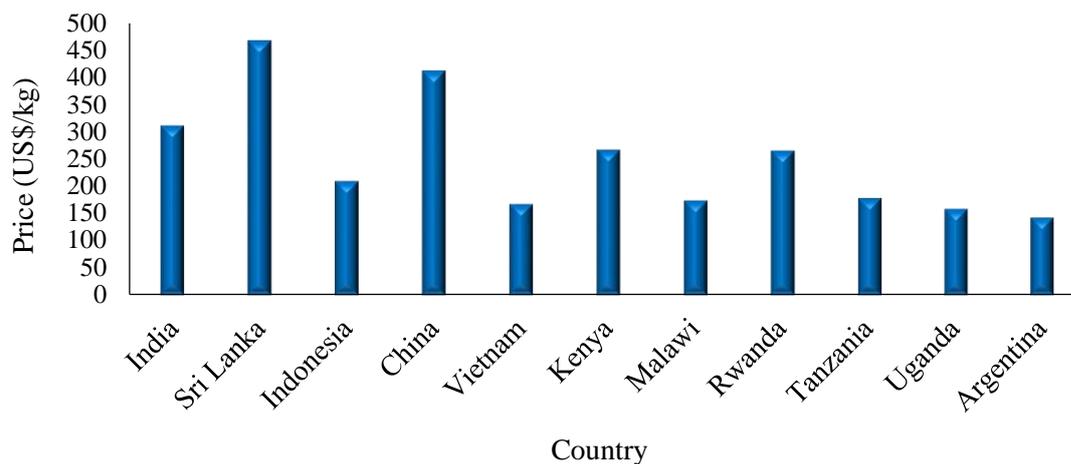


Figure 5. World tea prices in 2014 Source: www.teausa.com/teausa/images/International_Tea_Committee_Ian_Gibbs.pdf

TEA IN SRI LANKA

History of Tea Cultivation in Sri Lanka

Coffee cultivation may have begun by 1824 during the colonial era. The coffee plant had already been found growing naturally among in the central hill country. During that era land in

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the central hills was sold for a few pence an acre, official funds were dedicated to research and experiments in coffee growing, planters and merchants were provided with incentives and support. Most important of all, the Governor Edward Barnes provided the infrastructure, a network of roads and Railways lines, including the all-important trunk route from Kandy to Colombo that enabled coffee planters to get their produce to Colombo, and then to market in England. (History Sri Lanka Tea Board).

By 1831 the coffee industry occupied much of the Kandy area and was spreading southward and upward into the formerly virgin forests of the central hills. Then, in 1838, the abolition of slavery in Jamaica caused the collapse of that country's coffee industry. This led to a big demand for coffee from Sri Lanka resulting coffee cultivation expanded in hill country by clearing natural forest cover of the hill country. Thus, a natural montane forest environment gave way to organized agriculture. The coffee rust disease caused by fungus *Hemileia vastatrix*, reached Sri Lanka in 1875 where nearly 160,000 hectares of coffee trees were infected. There were no effective chemical fungicides available in that era to protect the foliage, thus the fungus was able to colonize the leaves until nearly all the trees were defoliated and destroyed the entire coffee industry in the country.

Then tea came to be substituted in its place. Tea was first introduced to Sri Lanka in 1839 when a batch of tea seeds were planted at the Royal Botanic Gardens at Peradeniya (Weatherstone 1986). The first commercial tea plantation was undertaken by James Taylor in 1867 on nineteen acres of land on Loolkandura estate, Hewaheta (Nathaniel, 1986). Taylor visited India in 1866 to learn the basics of growing tea on plantations. Following his return, he started tea plantation in Loolkandura estate. The plantations surrounding Loolkandura such as Hope, Rookwood and Mooloya began transforming into tea plantations and were amongst the first tea estates established on the island. Taylor set up his own tea 'factory' probably the first in the country in the verandah of his bungalow in Loolkandura Estate. Here the leaves were rolled by hand on tables and the firing done on clay stoves over charcoal fires, with wire trays to air the leaves. The end result was a delicious tea, probably the first commercial cup to be brewed. Taylor started a fully equipped tea factory in Loolkandura estate in 1872. In 1875 Taylor managed to send the first shipment of 23 pounds of tea to London tea auction. Taylor continued to develop the tea industry with his innovative thinking until he died in 1892 at the age of fifty-seven. From that point on Ceylon tea arrived regularly in London and Melbourne. Its success led to the opening of an auction market in Colombo in 1883, and to the founding of the Colombo Tea Traders' Association in 1894.

Coffee stores were converted to tea factories to accommodate the first "Sirocco" tea dryer by Samuel C. Davidson in 1877 and the first tea rolling machine by John Walker & co in 1880. In addition to the newly installed machinery, many new tea factories which included Fairy Land Estate (Pedro) in Nuwara Eliya were constructed along with the introduction of innovative methods of mechanization brought from England. With the popularity of tea growing it soon began selling at the tea auctions. The first such public auction was held at the premises of Somerville & Co. in July 1883 under the auspices of the Ceylon Chamber of Commerce. One million tea packets were sold at the Chicago World Fair in 1893, with tea establishing a record price of £36.15/pound at the London Tea Auctions. In 1894 the Ceylon tea Traders Association was formed and today most of the tea produced in Sri Lanka is vended through it and the Ceylon Chamber of Commerce. Adding further value to the industry, in 1896 the Colombo Brokers Association was formed. By 1926 there were about 200,000 ha of tea in Sri Lanka (Peebles 1982).

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Tea production dramatically increased growing to nearly 400,000 acres in around 1899. Tea crop was a much greater labour demanding and required a complex input of diverse cultural practices. The cultivation of tea in Sri Lanka evolved into an extremely efficient single largest agricultural industry. British personalities such as Ranolph Trafford, considered a pioneer planter with vast knowledge on tea cultivation arrived in the country to work closely with the numerous tea estates.

INSTITUTIONAL AND POLICY HISTORY

Tea cultivation after colonial era

Tea plantations started by the British were initially taken over by the government in 1960s, but have been privatized and managed by plantation companies. The total extent of land under tea cultivation has been assessed at approximately 221,969 hectares.

Sri Lanka celebrates 150 years in Tea in 2017 and has a market share of 17% in the world and offers all types of pure Ceylon Tea unique to this Island in the form of Bulk Tea, Tea Packets, Tea Bags, Instant Tea and Green Tea etc. Sri Lanka is the world's third largest tea exporter and number one supplier of Orthodox Black tea. Export earnings in 2016 was USD 1.2 billion. Tea industry employs over 1.5 million persons throughout the island and dominated by smallholder producers which produce over 70% of tea production (Perera 1990).

After first commercial field of tea (19 acres) established in 1867 field in 1873, 23 lbs of tea exported to London. By 1883 there were about 30,000 acres of tea established and 1,665,768 lbs of tea exported. In 1900, 384,000 acres were established and by 1965 a peak of 590,000 acres were under tea. By 1997, 44 billion S.L. Rs. worth over 90 % of the total production was exported to the U.K. who today takes less than 3 million kgs of tea from Sri Lanka. In 2006, Total production reached 310.8 Million kgs. After 150 years of tea introduction into Sri Lanka in 2017 there are 221,969 ha of tea in Sri Lanka.

The commonly growing tea cultivars of Sri Lanka were derived from two original varieties of *Camellia sinensis* (China type) and *Camellia assamica* (Assam type). In addition, some populations of tea have been derived from another variety known as *Camellia assamica* sub species *lasiocalyx* (Anandappa 1986). In commercial plantation, tea plants are generally trained as a flat-topped bush of about 60-90 cm in height. Although under humid tropical condition the production of tea shoots is more or less continuous throughout the year, shoot growth and harvesting is seasonal under temperate climatic conditions

Institution and Organizations

Tea Research Institute was established in 1925; they commenced work on vegetative propagation in 1938 at St. Coombs Estate in Talawakele, and by 1940 it had developed a biological control (a parasitic wasp, *Macrosetus homonae*) to suppress the Tea Tortrix caterpillar, which had threatened the tea crop. By 1927 tea production in the country exceeded 100,000 metric tons produced entirely for export. In 1932 the Tea Propaganda Board was formed and in 1958 the State Plantations Corporation was established. By 1960 the tea production and exports exceeded 200,000 hectares and 200,000 metric tons respectively. In 1966 the first International Tea Convention was held to commemorate 100 years of tea in Sri Lanka. In 1996, Sri Lanka's Tea Production exceeded 250,000 metric tons, increasing to 300,000 metric tons by year 2000. It was followed with the establishment of The Tea Museum in Kandy and in 2002 the Tea Association was formed.

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During the 1971–1972 period, the government of Sri Lanka nationalized estates owned by Sri Lankan and British companies, taking over some 502 privately held tea, rubber and coconut estates, and in 1975 it nationalized the Rupee and Sterling companies. Land reform in Sri Lanka meant that no cultivator was allowed to own more than 50 acres (202,343 m²) for any purpose.

In 1976, the Sri Lanka Tea Board was founded. Institutes such as Janatha Estate Development Board (JEDB), Sri Lanka State Plantation Corporation (SLSPC) were established to manage and supervise the state owned plantations. Tea Small Holding Development Authority (TSHDA) was established to promote increasing productivity and quality of tea smallholdings sector through provision of support services creation of an economically and socially sustainable tea small holdings community. In 1976, the export of tea bags commenced. In 1980, Sri Lanka was the official supplier of tea at the 1980 Moscow Summer Olympic Games, in 1982 at the 12th Commonwealth Games in Brisbane and again in 1987 at Expo 88 in Australia. In 1981, the country began importing teas for blending and re-exports and in 1982 commenced the production and export of green tea. In 1983, the CTC tea method was introduced. In 1992, the industry celebrated its 125th anniversary with an international convention in Colombo. On December 21, 1992, the Export Duty and Ad Valorem Tax were abolished and the Tea Research Board was established to further research into tea production. In 1992–1993 many of the government-owned tea estates which had been nationalized in the early 1970s were privatized to mainly Indian Companies. The industry had experienced heavy losses under state management, and the government made the decision to return the plantations to private management, selling off its remaining 23 state-owned plantations. The list of present Regional Plantation Companies and their contact details are given in Table 4. By 1996, Sri Lanka's tea production had exceeded 250,000 metric tons (275,578 short tons), and by 2000 had grown to over 300,000 metric tons. In 2001, Forbes & Walker Ltd. launched the country's first on-line tea sales at the Colombo Tea Auctions. A Tea Museum was established in Kandy and in 2002 the Tea Association of Sri Lanka was formed. The association, which works with those that preceded it in Sri Lanka, represents tea producers, traders, exporters, smallholders, private factory owners and brokers, and is funded largely through Asian Development Bank.

IMPACT OF CLIMATE FACTORS ON TEA PRODUCTION; QUANTITY AND QUALITY

Many climatic parameters such as rainfall, maximum and minimum temperature, sunshine hours, relative humidity and wind velocity affect the tea yield, quality and growth of pruned tea.

According to Tea Research Institute of Sri Lanka, the most suitable regions for tea cultivation are Nuwara Eliya, Ratnapura, Deniyaya/Kotapola, Kalawana and moderately suitable areas are Galle, Matara and Kalutara districts and some parts of Ratnapura, Kandy and Matale districts. These regions are coming under the AEZ of Wet Zone and Intermediate zone. These areas receive monthly average RF which is suitable for tea cultivation (Table 9). The study conducted by TRI Sri Lanka revealed that optimum rainfall required for tea varied from 223 - 417mm/month in different tea growing regions and reduction of monthly rainfall by 100mm

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could reduce productivity by 29-81 kg/ha/month. Optimum yields were recorded at temperatures around 22°C under that study (Abeyasinghe 2014).

Table 4. Agro ecological zones and their optimum RF for tea yield

Agro Ecological Zone	Optimum Rainfall (mm/month)	Yield drop due to 100 mm reduction in rainfall per month (kg/ha)
Up Country Wet Zone	350 ± 20	29 ± 3
Mid Country Wet Zone	417 ± 49	36 ± 6
Low Country Wet Zone	223 ± 38	55 ± 7
Up Country Intermediate Zone	303 ± 34	39 ± 3
Mid Country Intermediate Zone	227 ± 10	81 ± 11

Source Premathilake 2004 TRI

PHENOLOGY AND PHYSIOLOGY OF TEA PLANT

Tea is grown for the production of young shoots. The factors effect on high productivity are suitability of soil and climate, choice of proper variety/ cultivar, planting at the right time, adequate supply of water at different stages of growth, proper nutrition of the crop, protection from pest, diseases and weeds and proper harvesting at appropriate time (Barua 1993). Three well marked flowering periods occurred in February to April, July and in November. Nonetheless, major flowering period coincided February and March in all the genotypes allowing free crossing between the different genotypes. Profuse mature fruit crop was obtained in February to May.

TEA PRODUCTION, AREA AND YIELD HISTORIES IN SRI LANKA

The climatic requirements of tea fulfilled by wet zone and several parts of intermediate zones (Watson 2015). More suitable AER are as follows;

Wet Zone – WU1, WU2a, WU2b, WU3
 WM1a, WM1b, WM2a, WM2b, WM3a, WM3b, WL1a, WL2a

Intermediate Zone- IU1, IU2, IU3a, IU3b, IU3c, IU3d, IU3e
 IM1a, IM2a, IM2b, IM3c

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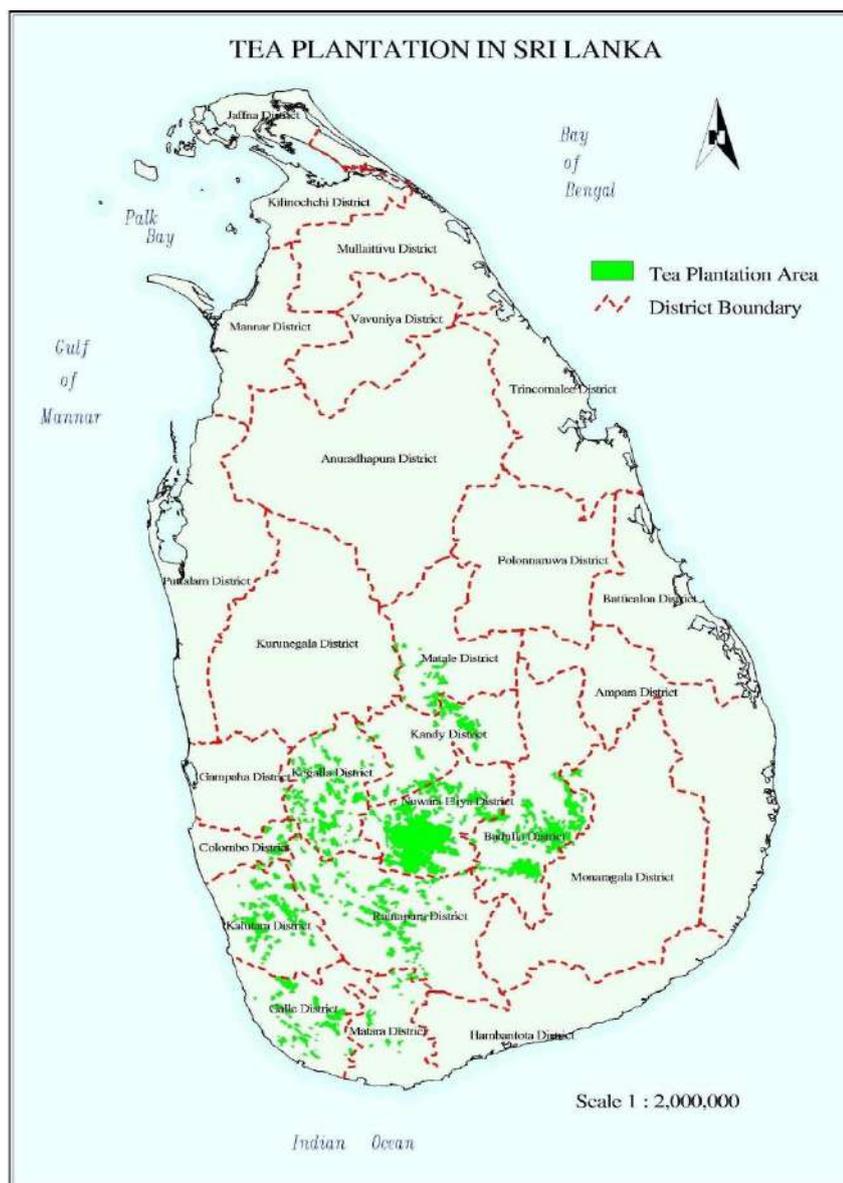


Figure 6: Tea producing areas in Sri Lanka

Therefore, commercial tea cultivation is confined to the Wet and Intermediate Zones of Sri Lanka and do not grow in low country Intermediate Zone (Ratnasiri 2007; Watson 2015) (Figure 6).

Agricultural Seasons and Regionalization Agro-ecological regions (AER) of Sri Lanka are the main representatives of different climatic zones of the country (Domroes 1974). According to the annual rainfall Sri Lanka has divided into three major zones namely wet zone, intermediate zone and dry zone (Forestry Inventory of Ceylon, 1961) (Figure 7 Left). There is a bimodal seasonality to the rainfall across Sri Lanka in keeping with its equatorial location. Dry zone gets most of its precipitation during the October to December season and less during *Yala* season (April to July). Wet Zone receives higher precipitation in *Yala* season. Further, these zones had been divided in to 24 Agro-Ecological Zones according the rainfall, temperature and soil types (Panabokke 1996). Availability of more spatial and temporal data, and advancement

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of GIS technology have led to the sub-division of 24 agro-ecological regions of Sri Lanka into a map with 46 agro-ecological sub-regions on an enhanced scale in 2002 (Punyawardena, Bandara et al. 2003), (Figure 7).

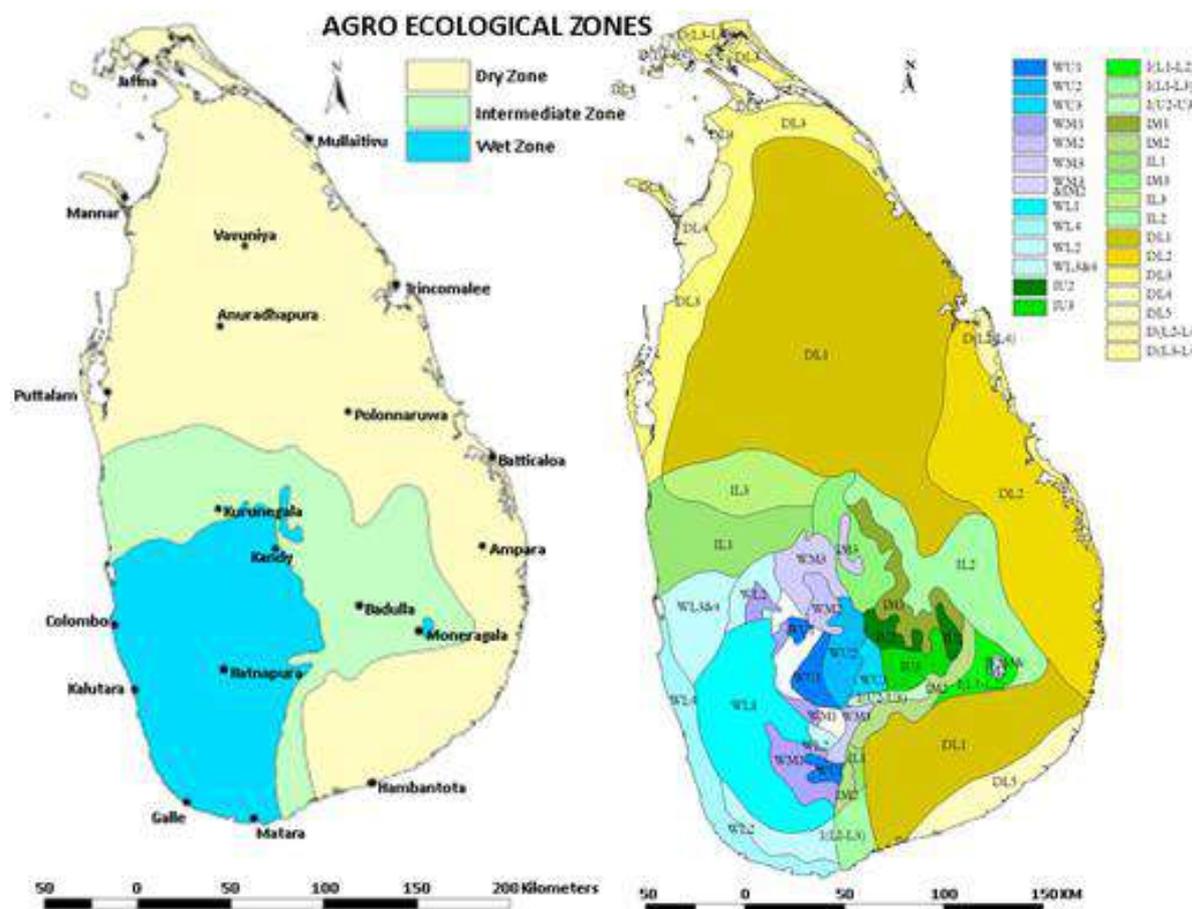


Figure 7. Climate regions (Left)— Cook (1935), Agro-ecological map of Sri Lanka (Right) Source: Panabokke and Punyawardena (1996)

Tea has been mainly grown in central hilly areas and southern inland of the island. Sri Lanka is the fourth largest tea producer in the world and contributes 8% of the world tea production. However, being the 3rd largest tea exporter Sri Lanka, contributes 17 percent of the world exports (Anon, 2010) Ceylon tea from Sri Lanka, acclaimed as the best tea in the world has its inherent unique characteristics and reputation running through more than a century. The influence of climatic conditions of its plantation imparts to the product a variety of flavors and aromas, synonymous with quality. Sri Lanka is renowned for its high quality tea and as the 2nd biggest tea producing country globally, has a production share of 10% in the international sphere, and one of the world's leading.

TEA GROWING REGIONS IN SRI LANKA

Tea plantations in the country have been classified in several ways according to their elevation, holding size and climatic condition.

Elevation

Tea growing regions have been divided into three regions viz; High grown, Medium grown and Low grown based on elevation with clear temperature variations. The regions below 600

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m above mean sea level (amsl) fall into the low country (L). Those between 600-1200m amsl are identified as the mid country (M) and those above 900 m amsl belong to the up-country (U). The tea crop is grown mainly in agro ecological zones of Up Country Wet Zone, Mid Country Wet Zone, Low Country Wet Zone, Up Country Intermediate Zone and Mid Country Intermediate Zone. Up- country Wet Zone and, Mid country Sri Lanka are clustered mostly among the mountains of the island's central massif and its southern foothills. The, flavour and aroma of teas from each elevation are influenced by the conditions particular to those regions. Low grown teas, where it receives long periods of sunshine, dry and somewhat warm and moist conditions, exhibit burgundy or reddish brown colour and strong taste, heavy note with black leaf appearance. Whereas High grown teas grown on an elevation of around 900m would be dramatically different depending on the time of year, influenced by the chill winds, dry and cool conditions these teas are likely to be extraordinarily light, with greenish, grassy tones in honey golden liquors.

Holding size

A tea holding of 20 ac (8.9ha) or more in extent and under the same unit of management is considered as an estate. In the instances where different parcels of the holding may add up to 20 acres or more if so it is not considered as an estate. Estate should have at least one lot of which the extent should 20 or more in acres. All other holdings, which do not fall into the category of estates were defined as small holdings. Basically they are the holdings below 20 acres in extent. With the time extent of tea estates was decreased while smallholding extent was increased. Nationalization of private tea companies and distribution of large scale tea lands among people leads to reduction of extent of estate sector. At the same period Establishment of Tea Small Holding Authority and providing of subsidies and free advocate resulted the expansion of number and extent of small holdings.

Climate condition

The complex topography of tea growing areas in the country results in complex microclimatic conditions, with different areas receiving varying patterns of wind and precipitation from the two weather systems (Yala and Maha) throughout the year. According to climatic parameters tea growing areas has been categorized in to six tea growing districts (these districts are different from administrative districts) Viz; Nuwara Eliya, Westerns, Mediums, Uda Pussellawa, Uvas and Low Grown (Table 5). Thus, the climate of each tea growing district differs more or less from the others. Even within a single district, the variation between small areas can often be marked. These climatic variations are reflected in the diversity of quality characters that is one of the principal and most prized features of Ceylon Tea. In the process, they helped establish the character for which each region and subdivision of the tea-growing districts is known. The discovery of effect of the diverse climate on tea production has resulted in manufacture of an array of fine teas which are unique to each agro climatic district and also are not found anywhere else in the world.

Since 1975, the award and usage of regional 'appellations' has been administered by the Sri Lanka Tea Board, the central administrative and regulatory authority for the Ceylon tea industry. The Board sets the standards and regulations with which all tea exported from Sri Lanka must comply. Among these are minimum standards of quality and purity; additionally, to qualify for a district appellation, the tea must conform to the specifications and standards pertaining to that region.

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Tea Research Institute of Sri Lanka has been recommended several tea varieties for different tea growing districts considering their ecological differences, growth and yield performance, pest and diseases resistance etc., (Table 6).

Table 5. Tea growing district and areas in Sri Lanka

Tea District	Elevation category	Area
Nuwara Eliya	High grown	Nuwara Eliya
Westerns	High grown	Ramboda, Pundaluoya, Agarapatana Nanuoya/Lindula/Thalawakele Patana/Kotagala Hatton/Dickoya Bogawantalawa Upcot/Maskeliya Kotmale
Mediums	Medium grown	Watawala/Ginigathhena/NortonBridge Pussellawa/Hewaheta, Kotmale, Gampola/Nawalapitiya/Dolosbage, Nillambe/Hantana/Galaha, Kadugannawa, Madulkelle/Knuckles/Rangala, Hunnasgiriya/ Matale/ Yakdessa, Balangoda/ Rakwana
Udapusellawa	High grown	Udapussellawa/ Halgranoya Maturata Koslanda/ Haldummulla Haputale Bandarawela/ Poonagalla Malwatte/Welimada Demodara/Haliella/Badulla Ella/Namunukula Passara/Lunugala Mdulsima
Low grown (Ruhuna)	Low grown	Deniyaya Galle Kalutara Kegalle Kellanivalli Kandy/Matale/Kurunegala Matara Morawaka Ratnapura Balangoda

Source: Sri Lanka Tea Board Annual Report 2013

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Table 6. Recommended tea varieties/cultivars in Sri Lanka

Variety/ Cultivar	Low country	Mid country	Uva	Up country	Nematode prone areas	Blister blight	Drought prone areas
TRI 4042	X	X	X				X
TRI 4006	X	X		X	X		
TRI 4053	X	X	X	X	X		X
TRI 4049	X						X
TRI 4046		X	X				
TRI 4071		X	X	X			X
TRI 4052			X	X	X	X	X
TRI 4078			X	X			X
TRI 4004					X		
TRI 3014	X				X		
TRI 3025	X						X
TRI 3055	X						X
TRI 3069	X	X			X		
TRI 3019		X	X	X	X		X
TRI 3013		X	X				
TRI 3035			X				
TRI 3015				X			
TRI 3016				X			
TRI 3072				X	X	X	
TRI 3073					X	X	
TRI 2025	X	X	X	X			X
TRI 2026	X	X					
TRI 2027	X		X				X
TRI 2043	X			X	X	X	
TRI 2023		X	X	X			
DN		X	X	X			X
DG7	X	X	X				X
DT1				X	X	X	X
N2		X		X	X	X	X
K145		X	X	X	X		
CY9		X		X			X
PK2				X		X	
KEN 16/3			X			X	
S106	X						X
H1/58	X						X

Source: Tea Research Institute, Sri Lanka

Tea Extent in Sri Lanka

Since first introduction of tea in 1839 and the first commercial tea plantation undertaken by James Taylor in 1867 on nineteen acres of land on Loolkandura estate, Hewaheta, by late 1890s there were 558,775 ac (205842 ha) of tea in the country (1917) Government Administration Report (1917) Ceylon Blue Book 1916). Until present days the total extent of tea in the country has not changed much but extent in Medium Grown and High Grown areas has reduced dramatically while that in Low Grown has been increased (Figure 8). Since 1956, the extent of Sri Lanka's tea cultivation has continuously been reduced by an overall amount of 20%. Political, economic and agro-ecological reasons are responsible for this reduction which, however, has proved to be far from uniform in the different regions of tea cultivation of the country. The southern Galle and Matara districts have experienced a significant increase of area cultivated with tea (mostly by smallholders) (Humbel 1990). Other areas, especially those with tea cultivations in the midlands, are characterized by decreases ranging from 20 up to 50% of the formerly cultivated area. Higher producer prices continued for the low grown tea has attracted many small landowners for tea planting in low country area. Large plantations also have increased production under the private management. Tea prices for Sri Lanka have been sustained at an attractive level over the time due to the global supply changes and currency depreciation. Industry has responded positively to the price improvement by increasing production continuously over the time.

Also large scale estate extent has reduced while smallholding extent increased (Figure 9). This occurred due to government policy during 1970 to 1977 of limiting private owned land maximum up to 50 acres and establishment of Tea Small Holding Authority to enhance small holding tea growers. The other reason for reduction of estate area was after privatization of management of large estates to Plantation Management Companies in 1983 unproductive estates were diversified with other crops and forest trees.

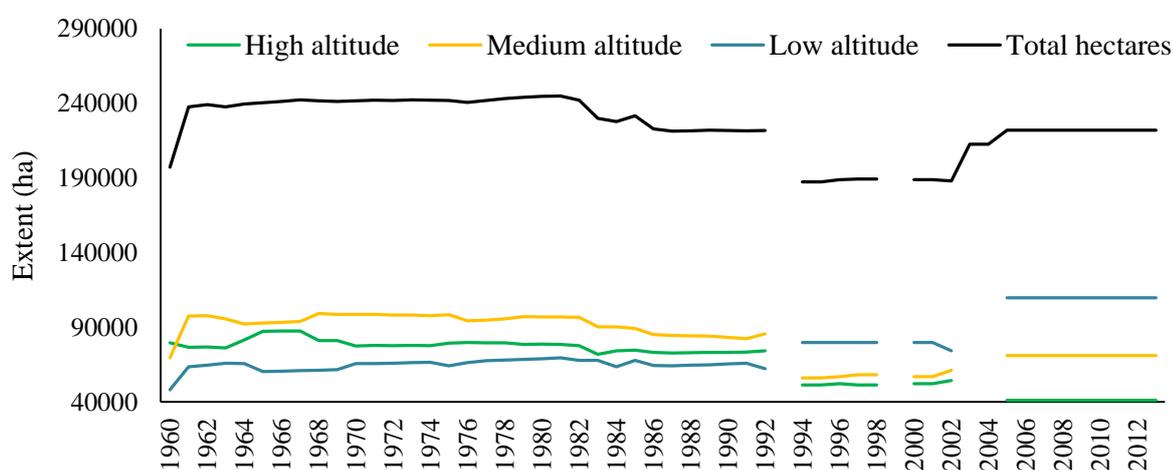


Figure 8. Elevation wise tea extent over the time (Elevation wise data on 2004 and 2005 data are not available)

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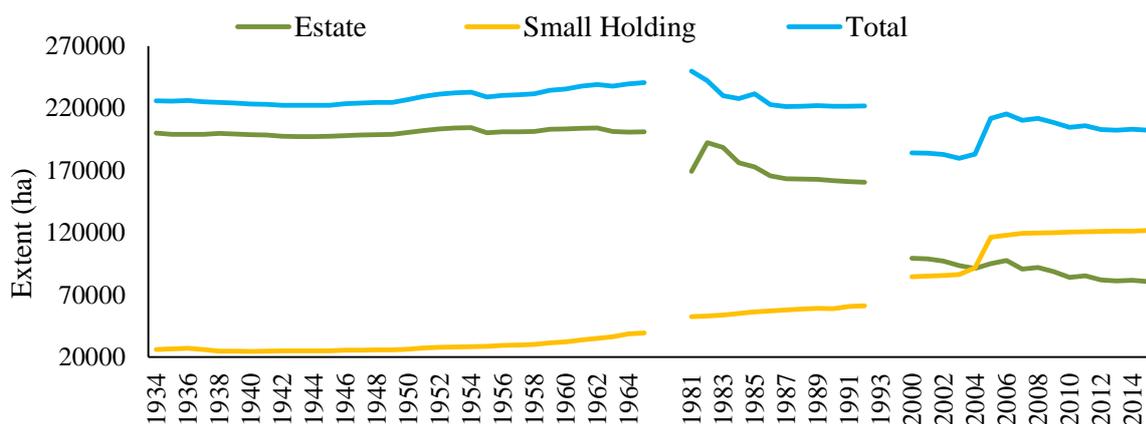


Figure 9. Area of tea small holding and estate sector over the time (Data from 1958 to 1985 and 1994 to 2001 are not available)

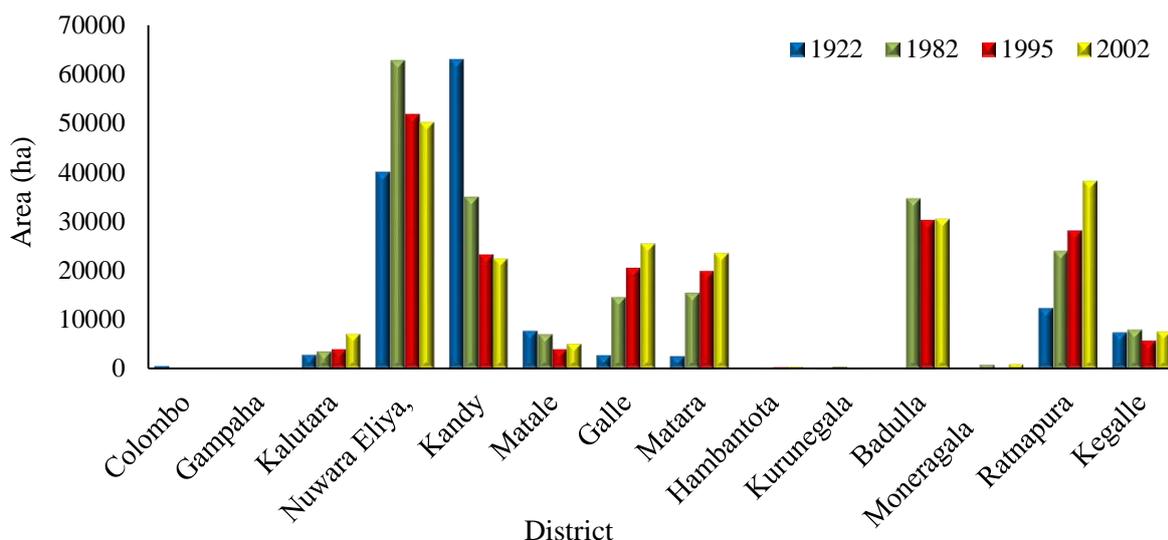


Figure 10. District wise tea extent Source: Ceylon blue book 1922, 1925, and Statistical Information on Plantation Crops 2012, Ministry of Plantation Industries 55/75, Vauxhall Lane, Colombo 2.

At the beginning of tea cultivation in Sri Lanka in the 19th century tea extent in the districts of Nuwara Eliya, Kandy and Matale and Badulla (Hill country) were prominent but by 20th century extent of those districts started to reduce while Kalutara, Galle, Matara, Ratnapura and Kegalle districts started to increase (Figure 10). The main reasons for this increase are due to high price of low grown tea in the world market and government incentives for small holder tea sector.

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Table 7. Extent under Tea by Administrative Districts 2002, 1982

District	2002			1982		
	Small holding	Estate sector	Total	Small holding	Estate sector	Total
Colombo	93	60	154	161	89	250
Gampaha	12	-	12	-	-	-
Kalutara	6117	1054	7170	539	3047	3586
Kandy	7609	14990	22599	7947	27135	35082
Matale	356	4774	5130	660	6445	7105
Nuwara Eliya	4,045	46,222	50266	3112	59710	62822
Galle	22,062	3,568	25,629	8213	6396	14609
Matara	17,326	6,378	23,704	8,025	7,515	15,540
Hambantota	440	0	440	142	0	142
Kurunegala	31	10	41	134	286	420
Badulla	5,616	25,024	30,639	3196	31545	34741
Moneragala	70	852	922	11	786	797
Ratnapura	25,433	12,918	38,352	4,881	19,183	24,064
Kegalle	4551	3,107	7,658	1570	6,417	7,987
Sri Lanka	93761	118955	212716	38519	168626	207145

Source: Statistical Information on Plantation Crops 2012, Ministry of Plantation Industries 55/75, Vauxhall Lane, Colombo 2.