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Review

PRESENT STATUS AND FUTURE NEEDS OF TEA INDUSTRY IN BANGLADESH

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Summary: World tea production has been showing an annual increment of 3 % while in Bangladesh the production has increased by 1.84 % and contributes 1.37 in export in the word tea trade and earns near about 1775 million Taka (Taka 63 = USD 1.00) every year. The activities of tea industry fall into two categories: production of tea and manufacturing & marketing of tea. Low productivity, poor quality and higher cost of production compared to the dividend in price for tea is the crux of the problem. We have to make quality tea, which must satisfy the prescribed criterion of the of the European countries especially Maximum Residue Level (MRL) value of pesticides to restore its name and fame. This paper attempts at focusing on the present condition and support required of tea industry in the country.

Introduction

Tea is one of the most important non-alcoholic beverage drinks worldwide and has been gaining further popularity as an important 'health drink' in view of its purported medicinal value. It is served as morning drink for nearly 2/3rd of the world population daily. The Bangladesh tea industry is one of the major sources of income for the national exchequer. Presently, this industry is facing a multitude of problems. Lack of capital and modern machinery, lower market value of made tea in comparison to increasing production cost, lower yield per hectare in comparison to increasing domestic need and lack of modern techniques for measuring quality of tea constitute some of the nagging problems. There is also lack of perennial water source for irrigation during dry season or during prolonged drought. In addition, some owners of the tea gardens are not using Government. loans properly. Malnutrition among the children of the labour line, security problems of the executives, deterioration of law and order situation of the tea estates (log stealing, political or outsider influence on their internal arrangements, illegal occupation of land by the outsiders), lack of medical facilities for labour and lack of infrastructure (road, quarter, water supply network etc) are some of the other constraints. For successful tea culture, the above problems facing both the manufacturing and the marketing sector need to be addressed immediately. In Bangladesh, there is thus dire need to focus attention on improvements in the manufacturing sector covering quality of tea, its productivity, cost of production as well as the marketing system. The following account reviews the present status of the tea industry in Bangladesh and its support requirements in order to compete with other tea producing countries in the international markets, particularly the European Union.

Tea: an overview

Tea (*Camellia sinensis* L.) belongs to the family Theaceae. It is the oldest non alcoholic caffeine-containing beverage in the world. The Chinese were

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the first to use tea as medicinal drink, later as beverage and have been doing so for the past 3000 years [1]. The cultivated taxa comprise of three main natural hybrids. They are (1) *C. sinensis* (L.) O. Kuntze or China type, (2) *C. assamica* (Masters) or Assam type, and (3) *C. assamica* sub spp *lasiocalyx* (Planchon ex Watt.) or Cambod or Southern type. Tea is an evergreen, perennial, cross-pollinated plant and grows naturally as tall as 15 m. However, under cultivated condition, the bush height of 60–100 cm is maintained for harvesting the tender leaves for even more than 100 years. The flowers are white in colour and grow singly or in pairs at the axils. The fruits are green in colour with 2–3 seeds. The leaf is the main criterion by which the three types of tea are classified as follows.

– Assam type : biggest leaves,
– China type: smallest leaves, and
– Cambod: intermediate leaves

The original home or 'the primary 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 [2]. Tea thrives well within the latitudinal ranges between 45%N to 34% S, cutting across about 52 countries [3].

Global scenario

In the world, thirty countries are producing more than 2.50 billion kilogram of tea annually (including 0.56 billion kg of green tea varieties manufactured by eight countries) from 2.56 million hectares of plantation. After meeting their domestic consumption, 28 countries export about 1.32 billion kg of tea annually [4]. Production of tea by area, production and export is shown in Fig. 1. Tea production by 12 major tea producing countries of the world is shown in Table 1. Bangladesh is producing more than 54 million kg of tea annually from about 49000 hectares of land. It can earn foreign exchange equivalent to about 1775 million Taka (Taka 63 = US $ 1) annually by exporting about 18 million kg of tea [5]. The world tea production has been showing an annual increment of 3 % [4], while in Bangladesh the production has increased by 1.84 % and contributes 1.37% in export in the word tea trade (Table 2).

Tea cultivation in Bangladesh is spread over the hilly zones on the eastern part mainly in four districts (Sylhet, Moulvibazar, Habibgonj and Chittagong). About 96% annual production (of which 63% is of Moulvibazar district) is contributed by greater Sylhet obtained from 93% (of which 62% is of Moulvibazar district) of plantation area. It is to be noted that Sterling companies produce about 50% of annual crop from about 42% of plantation area [6].

Table 1.
Country wise Productivity of Tea (kg/ha)-2000 AD.

SL No.	Country	Productivity
1	Kenya	1934
2	India	1743
3	Japan	1745
4	Turkey	1494
5	Sri Lanka	1450
6	Bangladesh	1102
7	Argentina	1538
8	China	627
9	Indonesia	1006
10	Vietnam	756
11	Uganda	1381
12	Georgia	382

Source: ITC [4]

Table 2.
Tea production in Bangladesh at different periods.

Year	Area (ha)		Production ('000' Kg)		Yield (Kg/ha)**	
	Total	Increased/ decreased*	Total	Increased/ decreased*		
1947	303533	—	18884	—	62	—
1957	31287	+ 934	25549	+ 6665	817	+ 195
1970	42688	+ 11401	31381	+ 5832	735	– 82
1980	43732	+ 1044	40038	+ 8657	916	+ 181
1992	47781	+ 4049	48930	+ 8892	1040	+ 124
2000	48735	+954	55834	+ 6894	1145	+ 105

Source: BTRI [5]; * Difference from previous total denoted by (+) or (-) sign. ** calculated on the basis of production/total tea area/ha

Economic importance and health benefits

The economic importance of the genus *Camellia* is primarily due to use as tea. Tea was initially used as a medicine and subsequently as beverage and now has proven well to be a future potential as an important raw material for the pharmaceutical industry. Tea is mainly consumed in the form of 'fermented tea' or 'black tea'. However, 'non-fermented' or 'green tea' and semi-fermented or 'oolong tea' are also popular in some countries e.g. Japan and China. Apart from being used as beverage, green leaves are also used as vegetable such as 'leppet tea' in Burma and 'meing tea' in Thailand. Though the oil of tea seeds is used as lubricant, yet extraction from seeds is not economical [7]. Additionally, cakes of tea seed contain saponins, have poor value as fertilizer and are unfit for animal feed due to low nitrogen, phosphorus and potassium content. However, these can be used successfully in the manufacture of nematocide [7]. Tea leaves have more than 700 chemical constituents, among which flavanoides, amino acids, vitamins (C, E, K), caffeine and polysaccharides are important to human health. Importantly, the vitamin C content in leaves is comparable to that of lemon. Tea drinking is now being associated with cell-mediated immune responses of the human body and reported to improve the growth of beneficial microflora in the intestine [8]. Tea also imparts immunity against intestinal disorders, protects the cell membranes from oxidative damages, prevents dental caries due to presence of fluorine, normalizes blood pressure, prevents coronary heart diseases due to lipid depressing activity, reduces the blood-glucose activity and normalizes diabetes [8]. Tea also possesses germicidal and germistatic activities against various gram-positive and gramnegative human pathogenic bacteria such as *Vibrio cholera, Salmonella sp., Clostridium sp.*[9]. Both green and black tea infusions contain a number of antioxidants like catechins and have anti-carcinogenic, anti-mutagenic and anti-tumorous properties. Among the different catechins, epigallo catechin-gallate is the most active component. Several epidemiological studies have also proved that tea consumption plays a protective role against human cancer.

Production of tea

Varieties and improvement

Genome diversity

The genus *Camellia* had 82 species in 1958

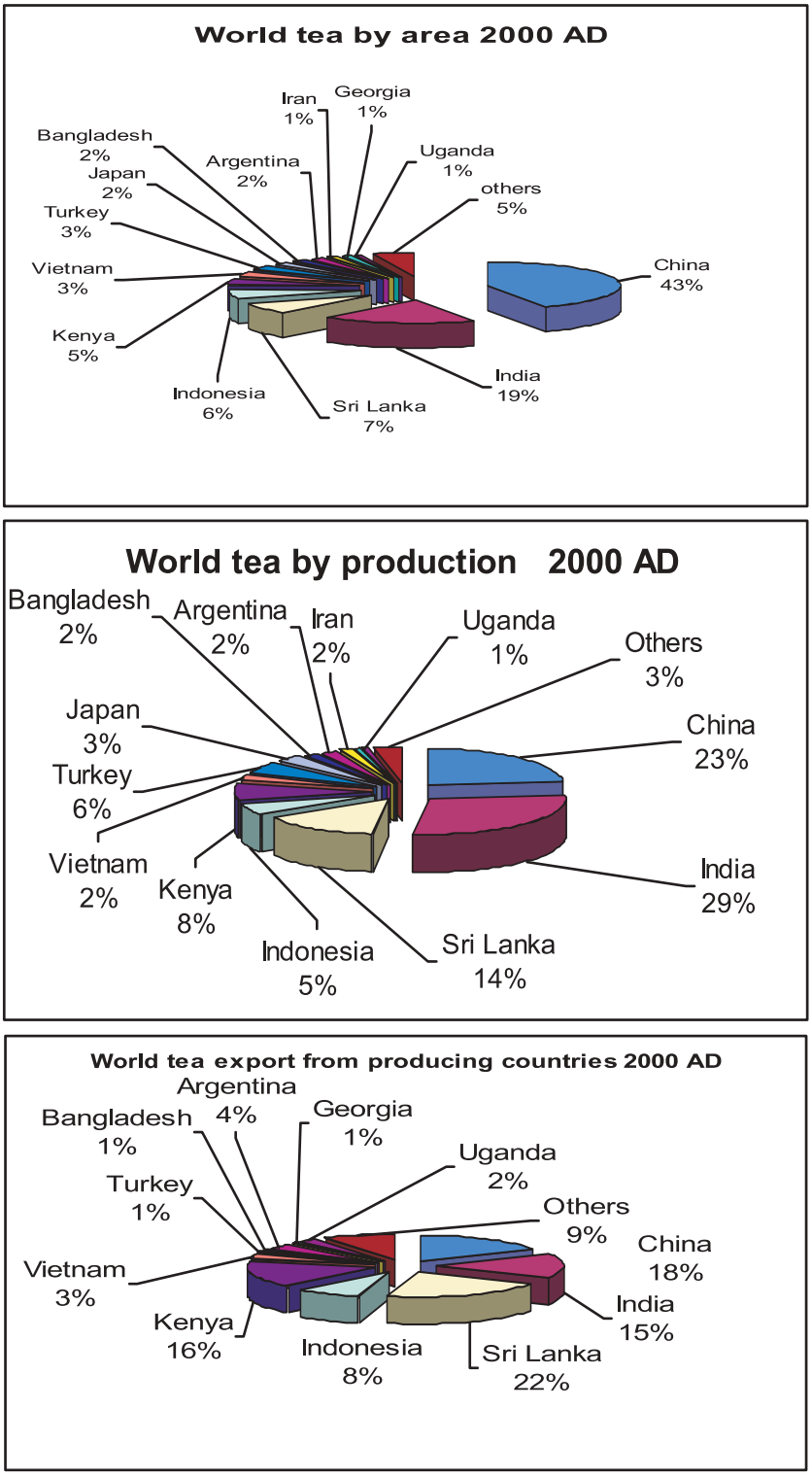

Fig. 1. Top: Country wise percent area under tea cultivation; **middle:** Country wise production of tea; **bottom:** Country wise export of tea.

[10] and accounts for more than 325 species in 2002 [11] that indicates genetical instability and high out-breeding nature of the genus. Presently, over 600 cultivated varieties world-wide are available, of which many have unique traits (Table 3). Owing to extensive internal hybridization between different *Camellia* taxa, several intergrades, introgressants and putative hybrids have been formed. These can be arranged in a gradient based on morphological characters that extend from China types through intermediates to those of Assam types. Indeed, because of the extreme homogenization, existence of the pure archetypes of tea is doubtful [12]. Till date, numerous hybrids currently available are still referred to as China, Assam or Cambod tea depending on morphological proximity to the main taxon [13]. Tea breeds well with wild relatives and thus taxonomists have always been interested in identifying such hybrids due to suspected involvement in tea genetic pool. Two particularly interesting taxa are *C. irrawadiensis* and *C. taliensis* whose morphological distribution overlaps with that of tea [13]. It has also been postulated that some desirable traits such as anthocyanin pigmentation or special quality characters of Darjeeling tea might have been introduced from wild species [14]. Other *Camellia* species, which are suspected to have contributed to the tea genetic pool by hybridization, include *C. flava* (Pifard) Sealy, *C. petelotii* (Merrill) Sealy [15] and possibly *C. lutescens* Dyer [16]. The role of *C. taliensis* is, however, not clear because the species itself is considered to be a hybrid between *C. sinensis* and *C. irrawadiensis* [12,14]. Therefore, it is generally agreed that at least three taxa i.e. *C. assamica*, *C. sinensis*, *C. assamica* sub sp. *lasiocalyx* and to an extent *C. irrawadiensis* have mainly contributed to the genetic pool of tea. The term 'tea' should therefore, cover progenies of these taxa and the hybrids thereof or between them.

Table 3.
Description of tea cultivars with special characters [5,18].

Serial	Special characters	Clone	Originator
1	Wind tolerance	UPASI-2, UPASI-10	UPASI-TRF, India
2	Drought resistance	9 UPASI	UPASI -TRF, India
3	Frost resistance /tolerance	B-26	HPKV-TES, India
4	Smallest leaf	CH-1	IHBT, India
5	Biggest leaf	Betjan	Betjan T.E, India
6	Blister blight tolerance	TRI-2043, DT-1	TRI, Sri Lanka
7	High pubescence content	TRI-2043	TRI, Sri Lanka
8	High anthocyanin pigmentation	TRI-2025	TRI, Sri Lanka
9	High tolerance to pH	TN-14-3	TRF, Kenya
10	Poor fermenter	12/2	TRF, Kenya
11	Mite tolerance	7/9	TRF, Kenya
12	Scale insect tolerant	TN 14-3	TRF, Kenya
13	High polyphenol content (53.7%)	Luxi white tea	TRI, China
14	High amino acid content (6.5%)	Anji white tea	TRI, China
15	Low caffeine content (0.14%),	Guangdong tea	TRI, China
16	High caffeine content (6.96%)	Wild tea at Yunnan	TRI, China
17	Water logged tolerant	TV-9	TES, India
18	Very good pruning recovery and large leaf size	BT-13, BT-16	BTRI, Bangladesh

Conventional propagation and breeding

Tea is propagated either through seeds or cuttings. Usually seeds are collected from orchard, stratified in sand and then sown in polythene sleeves in the nursery where it takes 12–18 months before transferring to the field. Nevertheless, seed-grown plants show a high degree of variability. Therefore, the alternative choice is through vegetative propagation of the elite variety wherein single leaf internode cuttings, with an axillary bud are planted in polythene sleeves under shade for 12–18 months followed by the transfer of these rooted plants to the field. Recently, as an alternative propagation technique, grafting has gained considerable popularity. In this technique, fresh single leaf internode cuttings of both root-stock and scion are generally taken. Scion, commonly a quality cultivar, is grafted on root-stock, which is either drought tolerant or high yielding cultivar. Upon grafting, the scion and stock influence each other for the characters and thus composite plants combine both yield and quality characters resulting in 100% increase of yield with better quality than either of the non-grafted cultivar. Further, a modified improved 'second generation' grafting has been developed where tender shoots are grafted on the young seedlings of tea which have an additional advantage over conventional grafting due to presence of taproot system [17]. Tea breeding consists of hybridization as well as selection. Hybridization can be either natural or hand pollination. In natural hybridization, based on better performance of yield, quality or diseases resistance capability, two parents are planted side by side in an isolated place and allowed to bear fruits. Subsequently seeds (F1) are harvested, raised and planted. If average performance of these plants is found to be better than either parent, then seeds (F1) are released as hybrid seed or biclonal seed. However, some of the outstanding performers among the progenies are marked and verified for multilocational trial and released as clone, if still found suitable. These clones are geographically specific and most of the tea research institutes in the world have generated clones for their own region. Sometimes more than two parents are used and are known as polyclonal seeds. The idea is to introduce more variability among the F1 seeds. Since it is difficult to know about the pedigree of the cultivars (as pollen may come from any male), the chance of reproducibility is low and least preferred presently. Alternatively, pollination or control cross, despite being an important approach, has made a limited success in tea breeding. However, recently, few clones have been released in Kenya and Malawi using this technique. Selection is the most popular, age-old practice in tea breeding. Since commercial tea gardens earlier were established with seeds, lot of variability exits among them. In many instances, the elite plant has been identified in the existing bushes and released as clones. Majority of the tea clones have been developed through selection. However, pedigrees of the clones remain unknown.

Though breeding work is limited up to F1 progenies presently, F2 population holds greater promise for varietals improvement of tea. The advantage of this approach is better segregation of characters and with the help of molecular biology this can be exploited for marker-assisted selections for a particular trait and construction of linkage map which is till not available for tea. Although, conventional tea breeding is well established and has contributed much for tea improvement over the past several decades, the process is slow due to some bottlenecks. Specifically these bottlenecks are:

- perennial nature,
- long gestation periods,
- high inbreeding depression,
- self-incompatibility,
- unavailability of distinct mutant of different biotic and abiotic stress,
- lack of distinct selection criteria,
- low success rate of hand pollination,
- short flowering time (2–3 months),

– long duration for seed maturation (12–18 months), and
- clonal difference of flowering time and fruit bearing capability of some clones.

Similarly, vegetative propagation is an effective method of tea propagation. Yet it is limited by several factors such as:

– slower rates of propagation,
– unavailability of suitable planting material due to winter dormancy, drought in some tea growing area etc.,
– poor survival rate at nursery due to poor root formation of some clones, and
— seasonal dependent rooting ability of the cuttings.

Therefore, micropropagation technique appears to be ideal choice for circumvention of the problems related to conventional propagation. Additionally, transgenic technology has the potential for varietal improvement of tea through means other than conventional breeding. However, central to any successful transgenic technology is an efficient *in vitro* regeneration protocol. While an efficient regeneration protocol is essential for introduction of the foreign gene into plant tissues, micropropagation is important for the transfer of large number of genetically modified plants to the field within a short span of time [18].

In Bangladesh, considerable success has been achieved in the field of clonal selection and tea breeding during the last forty years. Sixteen improved vegetable clones and four biclonal seed stocks and one polyclonal seed stock have been developed and released to the industry [19]. Moreover, some unexplored research areas need to be addressed to increase the relatively low harvest index of tea and the genetic diversity of tea by inducing, recognizing and regenerating chromosomal change through mutation, polyploidy, tissue culture and genetic engineering.

Pruning and Tipping

Pruning is essential in tea to maintain the bush at an operable height as also vegetable vigor. General guidelines on types of pruning (i.e. rejuvenation, hard, medium and light pruning, cut-cross and skiffing) span of time between two pruning and the time of pruning in relation to carbohydrate reserves have been clearly laid out [20] and are adopted with benefit.

Tipping of bush recovering from pruning is an operation aimed at forming a level plucking surface and filling it by a quick production of secondary branches; in other words it is the first round of harvesting young shoots at an operational height and stage [21]. The ideal height of tipping should not only ensure adequate leaf area for maximum photosynthetic efficiency but also fast growth of a mature bush, and in Bangladesh it should be studied for the recommended clones.

Plucking

Removal of young and growing shoots comprising the apical bud and the two internodes immediately below it, which constitute the crop in tea, is called plucking. The tender shoots with growing tips (sinks) and young foliage, which would in normal course have contributed to food reserves (source), are perpetually harvested at short, regular intervals, stimulating a rapid succession of new crop of shoots. There is, thus an intricate relationship between the sink and the source in relation to harvesting in tea which could be altered at will [21]. Plucking system could be designed to determine the severity of the operation as also the amount of maintenance foliage (Source) retained on the bush [23]. The important objective of an efficient system of plucking should be to harvest the maximum possible crop, leaving a minimum period of rest to the buds, while simultaneously ensuring the health of

the bush by retaining adequate maintenance foliage on the bush to meet the carbohydrate requirements of buds in active phase [3]. Too much of maintenance foliage on the bush should be avoided, since it is likely to impose a constraint in obtaining higher yields as pointed out earlier. It has, indeed, been demonstrated that removal of lower layers of mature leaves leads to increased number of shoots per unit area and enhanced size of the harvestable shoot, resulting in increased productivity. This is an indicator of existence of an optimal ratio between the maintenance of foliage and yield, although more critical studies of basic nature are required to determine the precise leaf area that is necessary for higher productivity.

The amount of maintenance foliage retained on the bush could be regulated by optimizing the height of the tipping the bushes recovering from pruning [21] and proper scheduling of plucking system through the pruning cycle [3]. The maintenance leaves retained at the type of tipping should be fully exploited by allowing maximum light penetration during the early part of pruning cycle, when they are photosynthetically most efficient. Further health of the bush should be ensured by retention of new foliage on the bush whenever senility due to aging is suspected to set in among the older leaves. Another away of enhancing the sink activity is to increase the plucking surface area by alternating the canopy architecture into dome or wedge from the conventional flat surface. Such canopies will also facilitate better light penetration and expose more leaf area to the incident light. Yield of 11 and 19 % have been reported due to wedge and dome plucking, respectively [24]. Basic information on the movement photosynthates in shoot and bush is now required for the recommended clone in Bangladesh for a better appreciation of sink-source relationship, so that these operations are further refined to near precision.

Mechanization

True to the situation in the remote, tribal and hilly areas, the plantation industry (particularly tea) relies completely on manual labour. Even a wheelbarrow has not made its appearance in tea estates; the crop and agricultural inputs are still carried on head-loads in the field. A survey of cultural operation reveals the possibility of partial mechanization of at least certain operations like manuring, pruning and plucking 25]. Mechanization, where possible, is necessary not just to reduce the costs in the context of increasing wage-bill, but also to lighten burden of the worker and to make the work more interesting to him. Motorised mechanical aids to prune and skiff, developed in Japan, have been found to be useful [26], but are not available in Bangladesh. Use of hand-operated share shears for harvesting tea has been found to increase the productivity of workers and yield in tea [21], [24]. However they could be used only in high cropping seasons to cope with the labour-shortage. In other seasons, it is not favoured because of the fear of its non-selective harvesting and possible drop in quality. This problem could, perhaps, be overcome by collaborating with the agro-engineering industry.

Tea processing and marketing

Processing

The Engineering industry is more active in the area of tea manufacture than in the field. The machinery required for both orthodox and CTC (Cut, Tear and Curl) manufacture has been developed and standardized 25]. Usually, the tea maker is left with the discretion of deciding whether or not a particular process has been completed, thus leaving scope for an error of human judgment. Sample tests should be formulated to determine, at different stages of manufacture, the biochemical parameters of quality as understood in terms of appearance, color, brightness, briskness, aroma and creaming down, so that uniform standard of the produce is ensured. Measures should be devised to increase the cuppage (number of cups of liquor

Table 4.
MRL Value (ppm) of Various Pesticides in Made Tea [25].

Sl. No.	Technical name of the pesticide	EPA	Codex commission	European Union	German law	Remarks
1	Dicofol	45	8	0.1	2	very very restricted
2	Ethion	10	5	2(proposed 0.1)	-	-do-
3	Sethion	10	5	2	-	-do-
4	Bromopropylate	-	5	-	-	-do-
5	Dimethoate	-	-	0.2	-	-do-
6	Endosulfan	24	30	30	30	Restricted
7	Fenvelerate	-	-	0.1	-	very very restricted
8	Cypermethrin	-	-	0.1	-	-do-
9	Deltamethrin	-	-	5	-	-do-
10	Chlorpyriphos	-	-	0.1	-	-do-
11	Propargite	-	-	0.1	-	-do-
12	Malathion	-	-	0.1	-	-do-

MRL: Maximum Residue Level, EPA: Environmental Protection Agency

per unit weight of made tea) by enhancing the solubility of made tea and manufacturing methods developed for reducing waste.

Marketing

Consumer acceptance of tea as a drink for all times cannot be taken for granted because of the changing tastes and the availability of wide range of aroma of beverages in the market. Incisive market research into consumer preferences and testes would facilitate the introduction of tea in convenient packs, instant tea powder, value added teas, carbonated tea beverages and other consumable packs[27]. Such a generic promotion in conjunction with specific promotion of Bangladesh tea in brands can sustain tea consumption at increasing levels. Still in Bangladesh there is no instrument to measure Maximum Residue Level (MRL) of various pesticides. It will create a serious problem on export volume or sales promotion, since European countries (especially the west European countries) are very conscious about their health and hygiene.

Conclusion

Tea industries in Bangladesh are facing numerous problems. Some of these problems concern security problems of the executives, unexpected natural calamity, deterioration of law and order situation of the tea estates, log stealing, political or outsider influence on their internal arrangements, illegal occupation of land by the outsiders, lack of medical facilities, unhealthy atmosphere in the labour lines, over consumption of wine by the labourer, lack of infrastructure (road, quarter, water supply network etc), lack of capital and modern machineries, lower market value of made tea in comparison to increasing production cost, lower yield per hectare in comparison to increasing domestic need, lack of instrument for measuring MRL value, improper use of Govt. loans by some owners of the tea gardens, lack of perennial water source for irrigation during dry season and also in prolonged drought, lack of

educational institutions, malnutrition among the children of the labour line. For successful tea culture the above problems must be solved. To reduce production cost we have to produce quality tea with eye catching bright orange-red colour liquor with flavour or have to increase yield. We have to make clone tea with high yielding variety having good quality. We must remove the screen of distrust and suspicion of the European countries by establishing a clean image such as achieved by the Sri Lankan Tea Research Institute.

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