

TEA IN INDIA¹

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Abstracts.

This is the first of the draft country reports prepared for compilation into the proposed book "Tea Growing Countries of the World", which will be edited by Nigel Melican, Ashok Kumar, V.S. Sharma, Wilson Ronno, Zeno Apostolides, K.L. Mughogho and N.K. Jain as series Editor of ISTS books.

The British started organised tea plantations in India in 1839 with seeds brought from China. Although indigenous tea *Camellia sinensis* var *assamica*, was grown since times immemorial by the tribals in forests of Upper Assam, but its quality, was not recognized until 1839, when it was first sold at London auctions. Today India is the largest producer of tea, averaging 842 million kg or 26% of global production, grown in 129,027 holdings, 92% of which are less than 10 ha. North India contributes 3/4th of total production with 1/4th coming from South India. However, India consumes 77% of its own produce, leaving only 200 m kg for its ever-shrinking share of exports. Plate 1 shows landscapes in different regions. The decennial average of climatic parameters are graphically presented in plates 2,3. The impact of development on changing landscape is illustrated in plates 4 and 5.

India has strong tradition of R&D in tea. Tocklai, established in 1911, is the oldest and largest tea research institute in the world. The next, UPASI was founded in 1926, DTRC in 1976 and IHBT in 1984. Their impact on their member tea growers is quantified.

Global supply of tea is 3% more than the demand, which has depressed prices by 25%. Combined with spiraling costs of production, the un-remunerative prices have thrown Indian tea industry in an unprecedented economic crisis, which would leave ugly pugmarks on the face of the organized tea industry in India. Its impact will certainly linger for a long time. This paper suggests strategies for scientific management of the Crisis.

INTRODUCTION

The British introduced tea cultivation in India in early 19th century when Opium Wars threatened the "Home" tea supplies. The first tea plantation was established in 1839 with seeds brought from China. Though the indigenous tea *Camellia sinensis* var *assamica* was grown since times immemorial, by the tribes in North East India, it was (re)discovered in 1823 by Robert Bruce but

rejected by Dr. Wallich, an authority in Botany, who declared it as a wild plant and unsuitable for making tea of commerce. The quality of tea made from these "wild" *assamica* bushes was established in 1839 at London Auctions. Tea plantations spread very quickly in Brahmaputra valley, Darjeeling and other Himalayan hills in North India. In the equatorial South tea cultivation was taken up in the Nilgiris, Karnataka and Highlands of Kerala. In 2005 India recorded a production of 929 million kilo tea, grown on an area of 523,000 hectares in 1,29,027 units, of which over 92% were less than

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10 ha and only 8% (1661) were large estates in corporate sector. Tea industry employs 1200,000 workers, most of whom are women and belong to underprivileged groups. India drinks 3/4th of its produce, leaving about 200 million kilos for export, which is only 13% of global export.

GLOBAL STATUS (2000-2005):

More than 32 countries spread over all the continents grow tea in 2.8 million ha area. Asia accounts for 89% of the world tea area, followed by Africa with 9%. The top 6 producing countries account for 82% of world's tea. During the last 5 years 2001-2005 India averaged the largest world production with 26.2 % share from only 18.5 % of the tea area (Table 1).

Countries	Area	Prod.	Export	Consumption (% of own production)	Yield (Kg/ha)
Global Total	150.6 th. Ha	3214 m kg	1468 m.kg	1746 m.kg 55%	1145
India	18.5%	26.2%	13.0%	77.2%	1695
China	43.5%	22.2%	16.2%	66.7%	652
Sri Lanka	6.7%	9.3%	19.2%	6.0%	1729
Kenya	4.8%	8.5%	17.0%	8.2%	2264
Indonesia	5.4%	5.1%	6.7%	39.6%	1136

Table 1: Status of Indian Tea in the Global Context (Average of 2001-2005)

India and China are the leading tea growers, together accounting for about 2/3rd of the world acreage, producing almost half of the global crop and consuming 70% of the volume of tea. The global export is 45% of the world production. Five countries account for 78% of the export. Kenya and Sri Lanka who are the leading exporters with 36 % combined share, produce only 18% of the world crop and consume merely 6-8% of their own tea.

PROFILE OF INDIAN TEA

Amongst Indian teas, Darjeeling is known for its unique muscatel flavour, Assam for cup character while Nilgiris have a characteristic taste & Flavour. The area, production and productivity of Indian tea recorded (fig 1) a consistent rate of growth between the years 1950 and 2000, after which there was a slow down. Internal

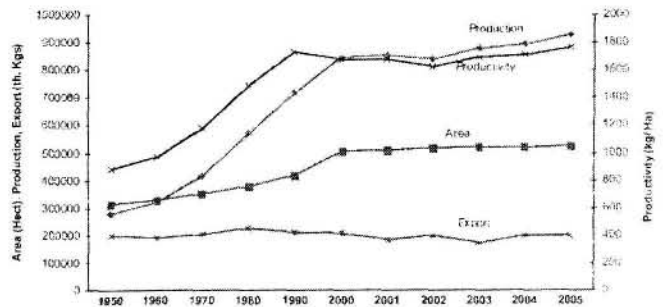


Fig 1 : Area, Production, Exports and Productivity of Indian Tea

consumption of tea absorbed all the increase in crop, leaving only about 200 million kilos for exports, that gradually dwindled as a percentage of production, from 80% in 1950 to only 20 % now. Tea exports during 2005 earned \$430 million in Foreign Exchange.

REGIONAL SPREAD OF TEA IN INDIA

Of the two major tea producing regions of India, North India contributes 3/4th of the total tea production while South India produces only 1/4th, although the tropical South India harvests more yield per hectare than North India. (Table2)

Region	Area under tea (Th ha)	Production (Million Kgs)	Yield (Kg /ha)	Number of Holdings
North India	407.5 (78%)	700.97 (76%)	1720	60629
Assam	272.0	474.14	1743	43293
West Bengal	114.5	214.66	1875	8709
Others	21.0	12.17	580	8627
South India	115.5 (22%)	227.01 (24%)	1965	68398
Tamil Nadu	76.3	154.6	2030	62213
Kerala	37.1	67.03	1802	6153
Karnataka	2.1	5.38	2527	32
All India	523.0	927.98	1774	129027

Table 2: Regional Spread of Tea in India (2005)

North India has approximately 1400 large estates in corporate sector, against only 200 in South India. Interestingly, half of India's production is contributed by Assam with over 1200 estate while within North India provides 2/3rd of the crop. Smallholder growers (of <10 ha) numbering 127,366 contribute 25% of the Indian tea production and predominate the South Indian tea scenario, where 2/3rd production comes from Tamil Nadu, which is dominated by over 60,000 small growers but also has about 200 large tea estate.

LAND SCAPE

Climatic parameters of different regions in North (Plate 2a-h) and South India (Plate 3a-g) are reflected in the landscape of tea fields. Sometimes the landscape is modified by application of science and human effort (Plate 4a-h & 5a-h) as happened in Kangra.

The flood plains of Brahmaputra are covered with vast flat tea fields, shaded with leafy albizzias to protect against sunburn in windless summers (Plate 1a). Landscape of tea fields in Dooars is like Assam but in older plantations, shade trees and tea bushes are not as well kept. Tea pluckers are tribals and majority of them are women. They wear protective aprons and boots and often carry plucking baskets, supported by head band (Plate 1b). In the adjoining cool and steep hills of Darjeeling, little or no shade tree are needed (Plate 1c.). Their pluckers are reputed to be gifted with the most nimble fingers to pluck the tiniest shoots (4000 shoot per kilo tea leaf).

Tea in Nilgiris (Plate 1d) and Anamalais (Plate 1e) in tropical South is protected against Ultraviolet radiation with thin foliage of silver oak trees (cf discussion on climate) and is distinguished by spraying lanes, cut between every 7 rows of tea, to facilitate frequent spraying to control devastating blister blight. Pluckers carry plucking cloth on their backs. The steep landscape of High Ranges in Western Ghats, Kerala are cool enough to obviate the need of (Plate 1f) shade trees. However, the pluckers carry the usual plucking bag and also a leveling stick called as *Mattam* to maintain the level of the plucking surface of the bush on a steep ground slope.

IMPACT OF CLIMATE

North India: The climatic parameters of the seven stations in North East and one Station in North West India are graphically presented in Plate 2 – a to h. The similarities are striking. Maximum monthly rain occurs in June and July, the peak

ranging from 500 mm to 1000 mm. Maximum temperatures range from 30 to 33°C except in Darjeeling and Kangra where they are 5-7° lower. Annual rainfall of 800 – 1500 mm is received during almost all the months except in North West India (2h) where there is a distinct period of drought in April, May and June, sometime interspersed with hailstorm. Humidity is almost always 95 to 100% during the rainy season. Interestingly, a favourable combination of temperature, rainfall and humidity leads to harvesting of 1-1.5% of the annual crop on a single day: this occurs on 4 days during this period of peak crop.

High rainfall and poor drainage necessitates drainage channels in tea plantations. In the plains of North East, the temperature on the flat leaf surface during the windless summers can be as high as 40°C, necessitating leguminous shade trees to cut incident sunlight on the bush surface by 30-35% and even planting a nurse crop to protect the young tea. In Darjeeling the temperature is lower which obviates the need of shade trees on the steep slopes. In the North West is Kangra Vally, peak rain is received in August and July but the distribution is very poor with a distinct drought which begins as early as October. The damage is compounded by high summer temperatures in April, May, June. Sometimes hailstorm batters the new flush in the beginning of the plucking season.

South (tropical) India: The Climatic parameters of the 7 Stations are depicted in plates 3 a-h. Tea in south India is grown in western ghats on slopes at gradients between 15 and 35 per cent; tea fields are dotted with grevillea trees, pollarded or un-pollarded, at varying spacing depending upon the aspect (facing the sun) of the fields.

A scrutiny of the graphs presented in Plate 3 a-g reveals that there are two distinct monsoon zones in tea area of south India: one with predominant south-west monsoon and weak north-east monsoon such as Anamalais

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(Valparai) and the other with predominant north-east monsoon and weak south-west monsoon as in Coonoor area of the Nilgiris. A greater tea area in south India falls into the first category as in the case of Gudalur, Waynaad, Munnar area of the High Ranges and Vandiperiyar; there is hardly any north-east monsoon in Koppa region of Karnataka, while the higher reaches of the Nilgiris and High Range experience predominant north-east monsoon and weak south-west monsoon. Rains tail off in early/mid-November in s.w. monsoon zones with occasional showers during December-March. Drought in these areas usually breaks with the summer showers during mid-March to April. In Coonoor and other such regions. Drought* may occur twice: March/April and August. In Waynaad and Koppa regions drought may extend even up to 120 days as in the latter case. Even in other areas, drought once in four years or so, extends, as for instance during 2003-2004 Anamalais experienced drought for 147 days.

Mean maximum temperatures, as per the figures, generally remain below 30°C in all the regions except Waynaad and Koppa where they soared even up to 35.5°C; lowest mean minimum temperatures recorded are around 10°C.

The averages of climatic parameters projected in the graphs do not reveal the true picture obtaining on the ground: often, maximum temperature crosses 30°C between February and May, in all areas, even if it is for a single day, On such days relative humidity drops steeply, at times, even below 30% as has, indeed, happened in Anamalais in 2004. The optimum ambient temperature falls within the range of 18 to 30°C. The day temperatures in excess of 30°C and night temperatures below 14°C reduce the rate of shoot extension (Carr, 1972**)

*Venkataramani - rainless period: a month with less than 66mm is considered as dry, with 66 to 90mm as transitional and 91mm or more as humid.

** Carr, 1972 climatic requirements of tea. Experimental Agriculture

At an ambient temperature of 30-32°C leaf temperature in full sun reaches 40-45°C. Usually after the air temperature reaches 24°C. The Leaves fully exposed are 8-13° warmer than air temperature. Shade reduces the leaf temperature nearer to ambient temperature, with a variation of only ± 2 degree (Carr, 1972).

Net photosynthesis increases steadily up to 35°C and then both rate of photosynthesis and growth decline sharply. Both the physiological activities cease as the leaf temperature reaches 39-42°C. But, respiration continues to rise until leaf tissue is irreparably damaged at and above 48°C. (Carr, 1972).

Tea grows well at a cell-sap concentration of eight to nine per cent and above this the rate of growth declines; cell-sap concentration of tea shoots increases by 0.6% for a fall of each ten per cent in relative humidity. Tea plant seems unable to maintain a favourable water balance in its leaves even if the soil profile is at field capacity (18% soil moisture in lateritic sandy loams as in the Anamalais), if the saturated vapour pressure deficit of the air exceeds 20 millibars (Carr, 1972). In simple terms, tea plant suffers if R.H. falls below 52% at a temperature of 30°/57% at 32°/63° at 35° and so on.

This would show the need to provide regulated, dappled shade for tea in south India even though it is cultivated in ostensibly hospitable climes! Additionally, shade absorbs the harmful UV-radiation that is high as the altitude increases. Grevillia with its finely dissected leaves, is admirably suited for the purpose.

IMPACT OF DEVELOPMENT ON KANGRA TEA LANDSCAPE

That a thriving Kangra tea in 1904 (before the Great Earthquake) could be ruined by decades of mismanagement, is illustrated by pictures from Kangra tea landscape in 1984 depicted in Plate 4 a-h. The efforts to develop it to its pristine glory and the results of development efforts

achieved in 2007, are shown in a series of pictures in Plate 5a-h. The extremes of transformation of dilapidated tea in 1984 (plate 4 h) to the same site of Banuri farm after transformation in 2007 (Plate 5 g) appear like the ultimate possible. The data in plate 5 e show the impact of development work on participant farmers' demonstration fields during the first 6 years while data in 5 f depict the average yield in plots starting with different stages of ruination due to mismanagement indicating development need which received varying intensity of development attention, during the first 6 years. Graphic representation of production for the entire 2000 hectares of Kangra tea in fig 2 (of which only 50% area received the benefit of development) show that tea production tripled in 1997. After 2000 AD it drastically dropped due to neglect and mismanagement of the tea fields as a result of declining tea prices. Plate 5 h shows that old habits die hard and tea growers can revert back to the former mismanagement during periods of economic distress, with disastrous consequences.

TEA R & D:

Value of research for tea as an agro based industry was recognized in India at the turn of the 20th century. Four tea research institutes setup in India are: Tocklai, UPASI, DTRC and IHBT.

Tocklai Experimental Station, "Tocklai" set up in the year 1911, is the oldest and the largest tea research institute in the world. TRA's 760 member estates, in North East India are served by seven substations and a staff of 339, including 64 scientists. Tocklai gave vegetative propagation to the world and developed many clonal varieties and bicultural seed stocks. These varieties occupy 48% of the area under tea in North East India. With major research breakthroughs in drainage, weed & pest control, shade regulation, standardization of nutrient application. The average yield of North East India, which was 400 kg/ha in 1900 AD went up to 1800 kg/ha in the year 2000. Tocklai has

developed all the black tea processing machinery and process control systems in use. However, with the paradigm shift from crop yield to quality and value addition, research in biotechnology has been strengthened. R & D expertise in leaf processing machinery has been transferred to process control. Tocklai research is estimated to yield 200 fold returns on investment. For special development of Tocklai, celebrating its centenary in 2011, a special fund of \$ 5 million has been set apart.

UPASI Tea Research Institute: founded in 1926, serves its 143 member estates and 12000 small holder growers from its seven regional stations, with a strength of 42 scientists and advisory officers and 45 supporting staff. UPASI has released 29 clones and 5 bicultural seed stocks. Its unique contribution to vegetative propagation is the pre-nursery grafting technique for composite plants, against the biotic and abiotic stresses. Amongst its major R&D contributions in improving the productivity of South Indian tea are the heavy rejuvenation pruning to replace the entire upper hamper affected by severe stem canker, replanting with minimal period of soil rehabilitation, ratio-manuring of high yielding crop sections, correction of soil acidity with dolomite, bio-fertilisers, phytohormones for regulating crop management, effective phyto-sanitary practices for control of, *inter alia*, severe blister blight & shot hole borer, and rational introduction of shear plucking during rush crop periods to increase labor productivity without affecting quality of plucking. Biotechnology has been emphasized in crop improvement. A major achievement is use of crop regulation with growth regulators for crop control. The impact of UPASI advisory services is reflected in the crop increases in South India (table 3)

Year	Area in hectares	Production M. Kg	Productivity Kg/ha
1960	73,998	77,7775	1.051
1970	74,007	101,169	1.367
1980	75,047	131,095	1,747
1990	75,559	173,207	2,292
2000	1,13,199	204,522	1.807
2004	1,15, 211	230,781	2003

Table 3: Impact of UPASI on Tea Production in South India.

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CSIR Institute of Himalayan Bioresource Technology: "IHBT" was established in 1984 as a multidisciplinary regional resource development institute. For resuscitation of 2000 hectares of dilapidated micro tea plantations in Kangra Valley, community participation of 1600 smallholder growers was modeled on demonstration of known technologies on farmers' fields. The impact on productivity and value was immediate with participants recording 400% to 4300% increase in production in six years (plate 5 f). The long term impact of IHBT on productivity and valuation of Kangra tea with development (covering only 50% of the area) is recorded in fig.2.

Production & price of Tea
In Himanchal Pradesh

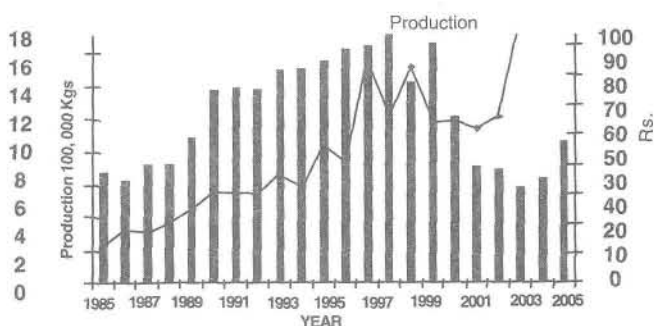


Fig. 2: Production and Price of Kangra Tea

IHBT developed techniques of consolidation by replanting 130 years old bushes and rejuvenation pruning at ground level called as *danther* (Plate 5a) to build up a new productive bush in one season (Plate 5b). In due course, tissue culture protocols were developed for micro-grafting, hardening and transgenic plants. Genes for biosynthesis and dormancy were characterized. Protocols for determining pesticide residues were standardised. Rhizosphere bacteria were isolated for growth. Technique for fixed PPO enzyme was determined for theaflavin production. Several value added products were developed like RTD, extraction of catechins and theaflavin, wines with herbals were patented. Green leaf manufacture was standardized. Preconditioning machine was designed and patented.

IMPACT OF R&D ON TEA PRODUCTIVITY FOR OVER A CENTURY:

The impact of tea research is hard to quantify. An attempt was made to compare the productivity of tea for over a century 1880-1990 in research-starved and research-served tea growing regions of North India located within a few degrees of latitude (fig 3). Impact of R&D on research served and research-starved area on tea yield over a century is shown in fig. 3.

The differences between the three regions were very small in 1880 but they widened with major breakthroughs in tea research-served area of North East India.

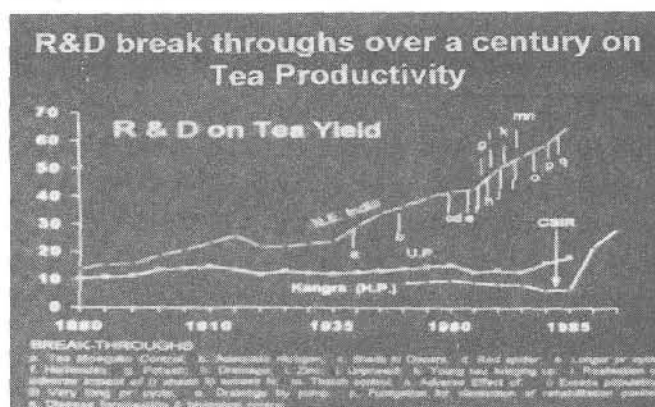


Fig 3: Impact of R&D on Research-Served and Research-Starved areas on Tea Yield Over a Century.

It proves if proof is needed, the value of applied research in achieving the objectives of research.

CHALLENGE FACING TEA INDUSTRY OF INDIA: THE ECONOMIC CRISIS

Cost Price Squeeze: During the last decade, the widening difference between the rising costs of production and declining tea prices led to an unprecedented economic crisis due to the cost-price squeeze. A loss of Rs. 33/- per kilo (Fig 4)

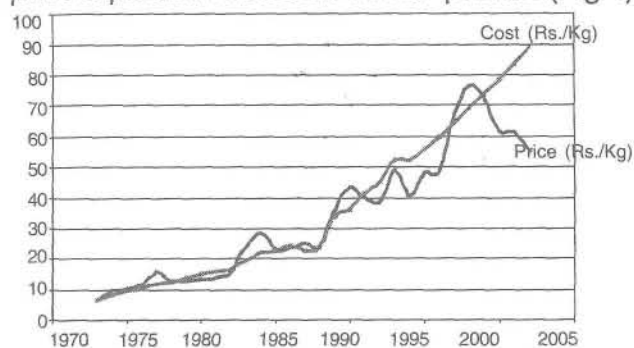


Fig 4: Cost Price Squeeze Faced by the Indian Tea Industry.

(Estimated in 2003), threatened the very existence of the tea industry. Several loss-making estates were hived off or sold by tea producing companies. Closure of many tea gardens led to malnutrition and even starvation deaths amongst the affected workers. Smallholder growers were even worse off.

GLOBAL TEA PRICE AS A FUNCTION OF SUPPLY - DEMAND BALANCE:

The laws of supply and demand determine the global prices of tea, like any other commodity. Tea production is 3-5% more than the consumption (fig 5). As a direct result of this supply-demand imbalance, the global tea prices are depressed by 25% which is reflected in Indian tea revenues.

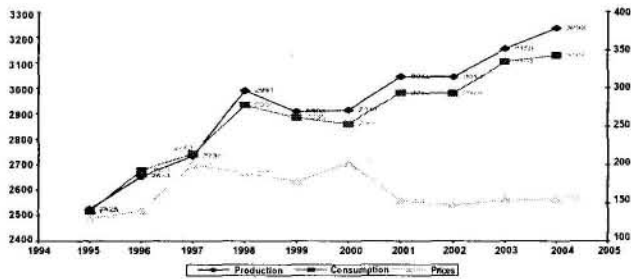


Fig 5: Global Tea Prices as Affected by Production-Consumption Balance.

Source: International Tea Committee ITC: Bulletin of Statistics 2005 quoted from Mbadi & Owuor, in ISTS Book 4, (Under Publication)

FUTURE PROSPECTS:

The long term projections by FAO (fig 6), of tea production trends suggest that the prices are expected to stay low due to supply exceeding demand even in the foreseeable future. Unless contained, the crisis will linger for a while and will certainly leave ugly pugmarks on the face of the Indian tea industry.

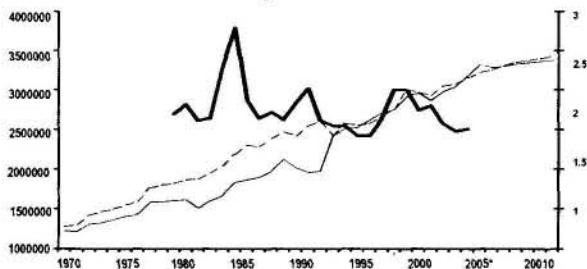


Fig 6: World Trends in Production and consumption of Tea and tea prices (Source FAO)

Strategies of Scientific Management:

A 4-pronged approach to scientific management of the economic crisis is suggested, which comprises of Cost reduction, Improving realization, Value addition and Information sharing, as discussed in the following text:

1. Cost Reduction

- Field – Plucking labor & pest control costs
- Factory – Fuel costs

Several avenues are available for cost reduction in field and factory. In field, plucking labor wages account for 50% of the cost of Production(C.O.P.), and can be reduced without affecting quality, in improving leaf fine-ness by implementing time and motion studies for deployment of pluckers and by rational introduction of machanized plucking at peak crop periods. In factory, energy costs can be reduced by proper maintenance of motors and integrated working of machines. Fuel, which accounts for 40% of processing costs, can be economized to the extent of 75% by introducing biomass gasification.

2. Improving Realisation

- Elimination of substandard tea to reduce beverage supplies by 3-5%
- Upgrading Quality in
 - Field: Fine plucking & leaf handling
 - Factory: Process control, new processing technology
- Reducing Pesticide Residues by
 - Rational phytosanitary measures - IPM
 - Biological control Microbials, Semiochemicals, Botanicals
- Organic tea

If elimination of substandard tea from global trade or the industrial use of low quality tea for value added pharmaceuticals and industrial products, can reduce tea supplies by 3-5%, the products will yield higher income and the global tea prices will be stabilized.

Pesticides residues depress realization and can be minimized by rationalizing phytosanitary measures and substitution with bio-control

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agents, particularly by adopting organic tea growing, which adds to the value of produce.

3. Value Addition:

- Pharmaceuticals: for health effects
- Industrial products
- Cosmetics and nutraceuticals

Japan and China Language are leading the world for research in value addition to low quality tea. The ultimate products are of higher value. By reducing market supplies of quality tea, prices in the beverage market also tend to stabilize.

4. Information sharing network

Information sharing is *sin qua non* of progress in research. However, more than 50% of tea research literature is published in Chinese and Japanese, which is not accessible to readers of English. Methods must be devised to share information across the language barrier/s. One such system devised by ISTS is to share information with Institutional network and publish the abstracts of research in a special section of the International Journal of Tea Science (IJTS). Example are the special issues of IJTS on OCHA 2004 & 2007 containing the abstracts of all the papers presented at OCHA international Conferences held in 2004 and 2007, respectively.

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Plate 1: Landscape of tea India (photographs showing pluckers in the inset) impact of climat

North India



a. Brahmaputra flood plains (Assam)
 (Note the heavy shade of closely planted)



b. Teesta flood plains, Dooars (W. Bengal)
 (Note all-women work force, the protective boots and plucking baskets)

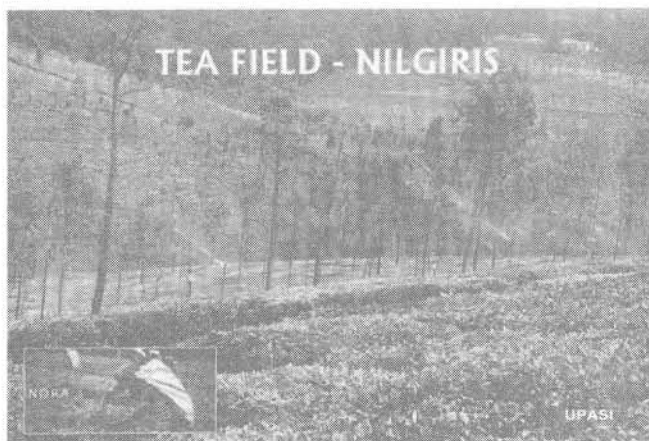


c. Darjeeling Hills
 (Note the steep slopes and pretty pluckers with baskets suspended on their heads)

South India



d. Anamalais (Tamil Nadu)
 (Note Silveroak shade tree)



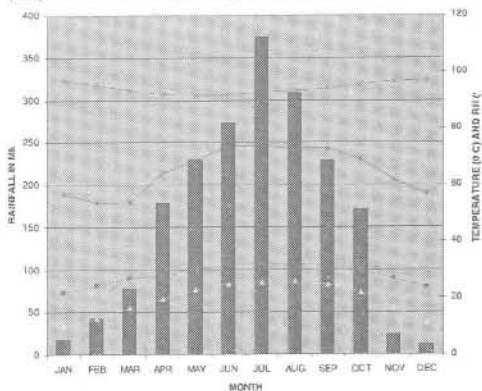
e. Nilgiris (Tamil Nadu)
 (Note the pluckers with plucking cloth supported on head and the pollarded silver oak trees for providing critical shade)



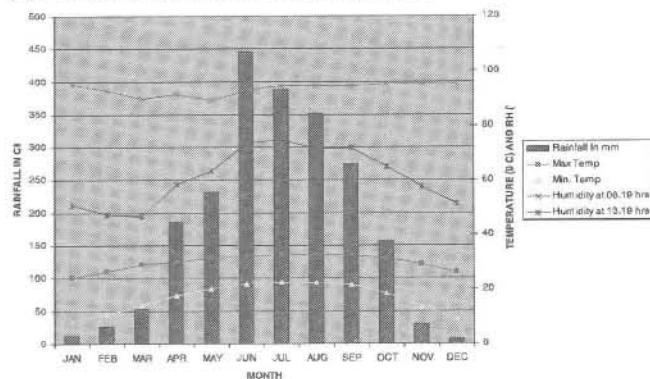
f. High Ranges (Kerala)
 (Note the absence of shade trees and steep slope where the plucking level on the bush surface is maintained with levelling sticks called "mattam")

PLATE 2 : Climatic Conditions of North India

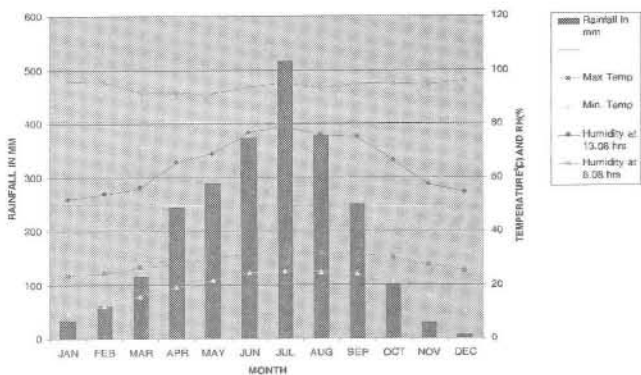
(2A) DECADENIAL AVERAGE (1997-2006) OF CLIMATIC VARIABLES : TOCKLAI



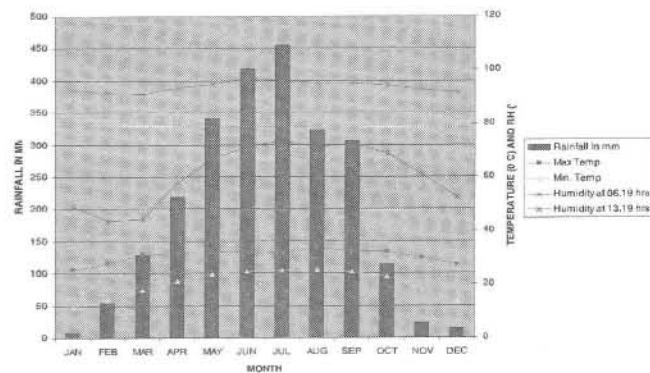
(2c) DECADENIAL AVERAGES (1997-2006) OF CLIMATIC VARIABLES : NORTH BANK



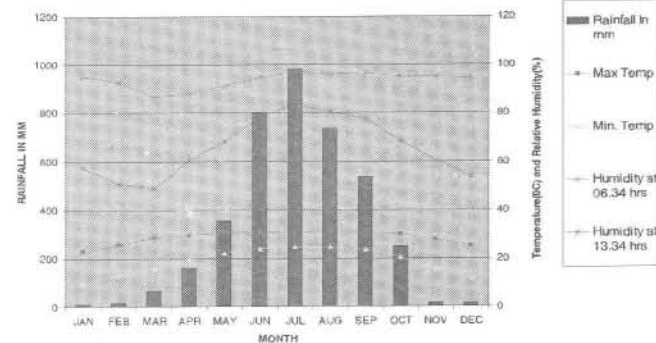
(2B) DECADENIAL AVERAGE (1997-2006) OF CLIMATIC VARIABLES : DIKOM



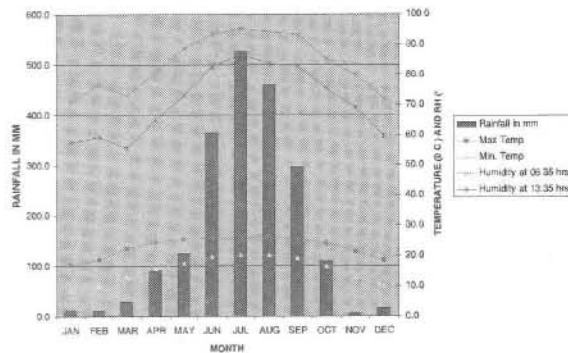
(2f) DECADENIAL AVERAGE (1997-2006) OF CLIMATIC VARIABLES : CACHAR



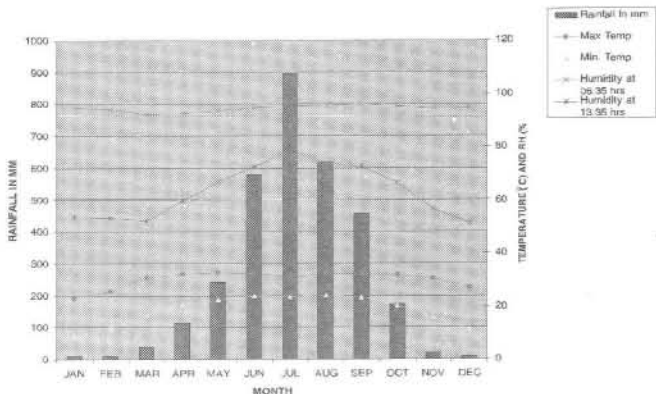
(2c) DECADENIAL AVERAGE (1997-2006) OF CLIMATIC VARIABLES : NAGRAKATA



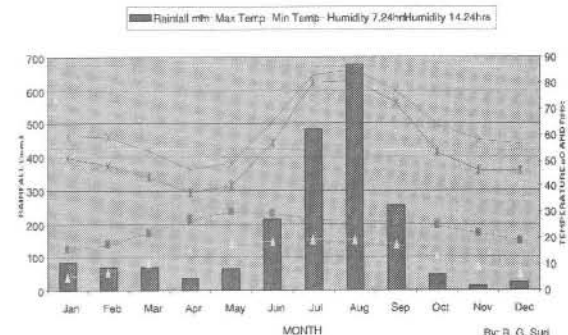
(2g) DECADENIAL AVERAGE (1997-2006) OF CLIMATIC VARIABLES : GING (DARJEELING)



(2d) DECADENIAL AVERAGE (1997-2006) OF CLIMATIC VARIABLES : GUNGARAM



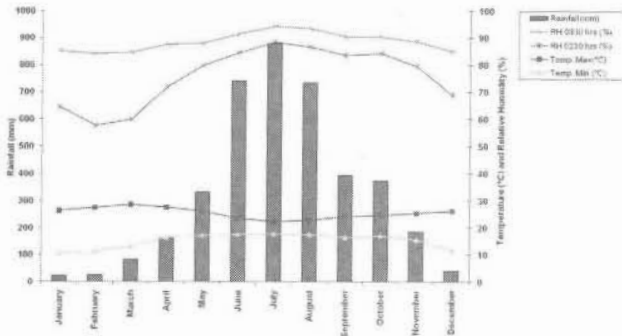
(2h) DECADENIAL AVERAGES (1997-2006) OF CLIMATIC VARIABLES : PALAMPUR



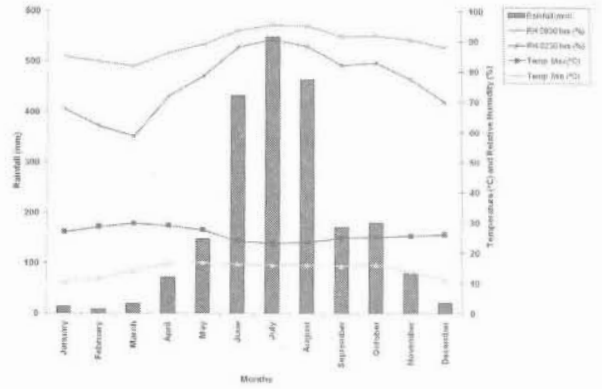
By: R. G. Sud

PLATE 3 : Climatic Conditions of Tropical (South) India

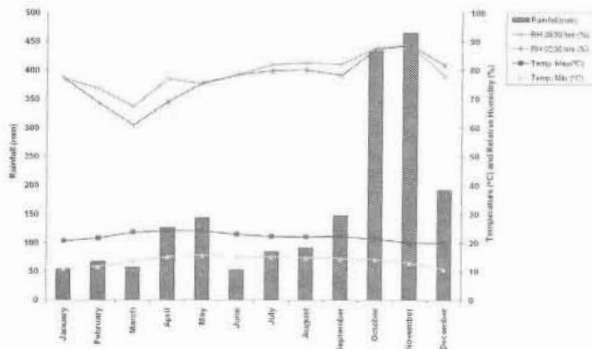
(3a) Decennial Average (1957 - 2006) of Climatic Variables - Valparai



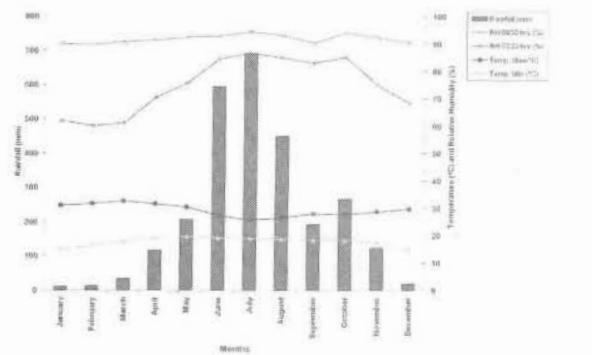
(3e) Decennial Average (1957 - 2006) of Climatic Variables - Gudalur



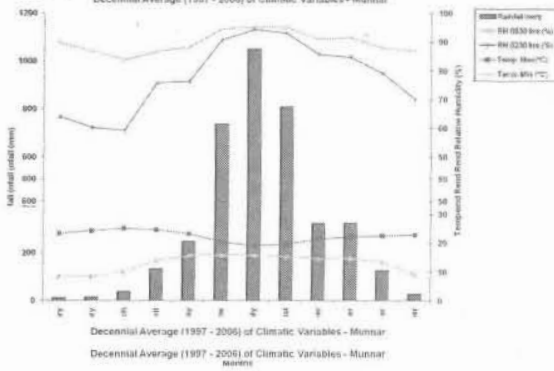
(3b) Decennial Average (1957 - 2006) of Climatic Variables - Coonoor



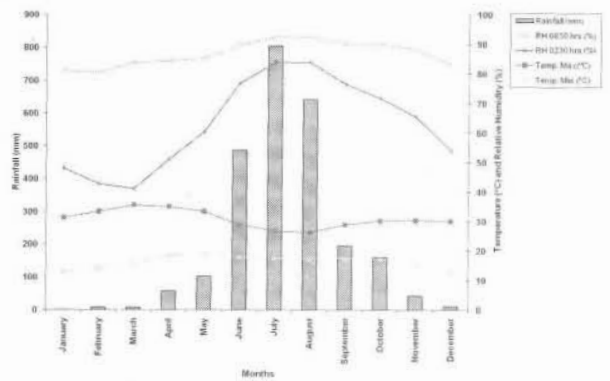
(3f) Decennial Average (1957 - 2006) of Climatic Variables - Wayanad



(3c) Decennial Average (1957 - 2006) of Climatic Variables - Munnar



Decennial Average (1957 - 2006) of Climatic Variables - Koppa



(3d) Decennial Average (1957 - 2006) of Climatic Variables - Vandiperiyar

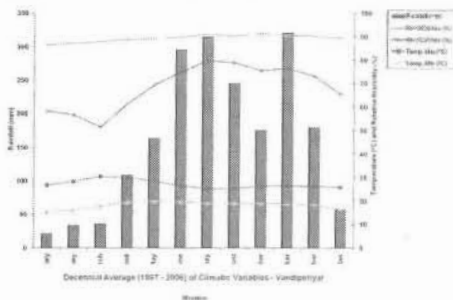
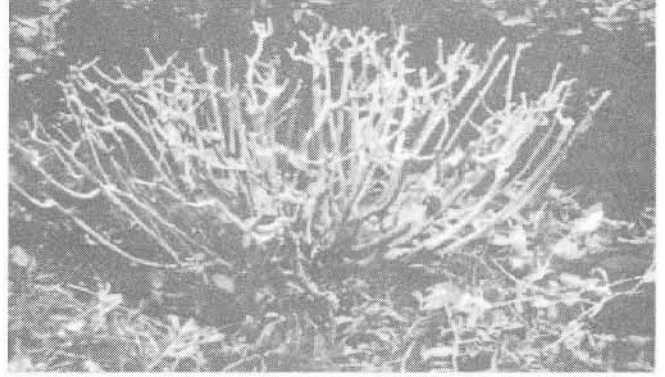


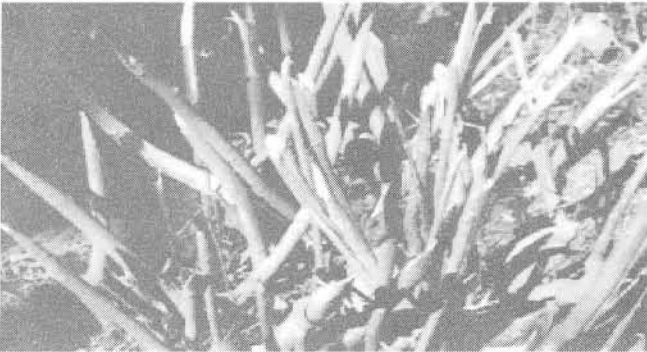
PLATE 4: Kangra Landscape (1984) before development



a. Pruning equipment in use



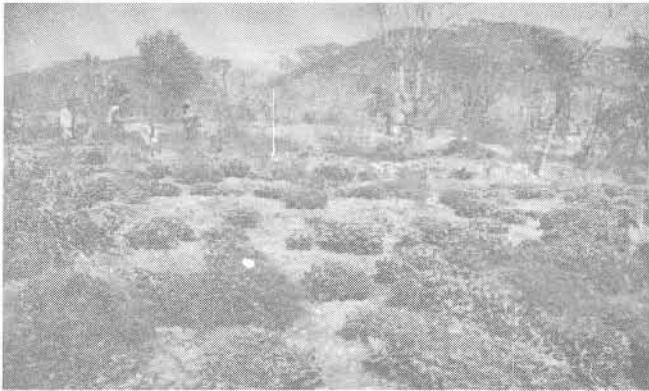
b. Knotted bush frames



c. Split stems after pruning



d. Cabbage shaped bushes.



e. Nutrient deficiency, vacancies, no shade



f. Grass between bushes for dairy cows



g. Grab plucking (wrong)

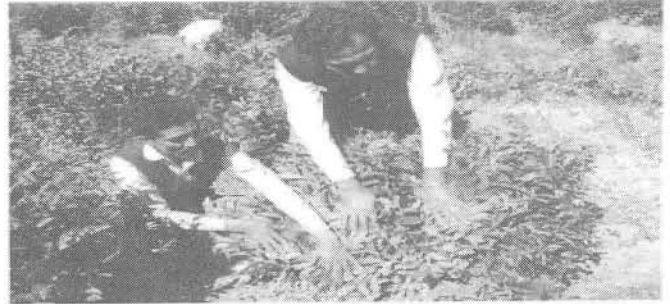


h. Banuri farm - original tea plantation run over by weeds

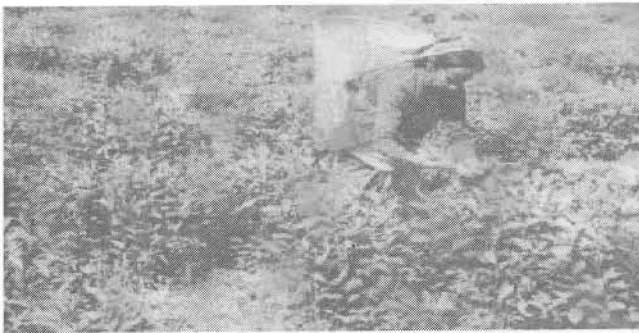
PLATE 5: Kangra landscape during (1984 onwards) and after development (2007)



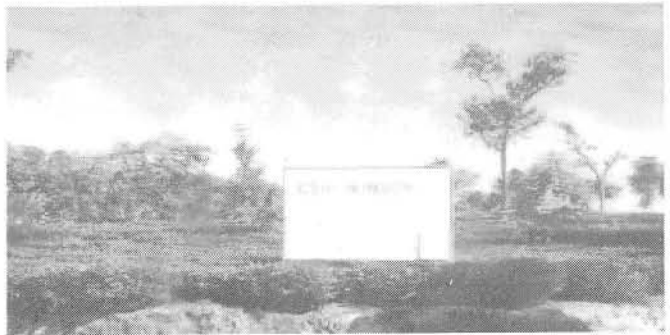
a. Danther or ground level purning + pre-emergence herbicide spray



b. Regenerated bush frame after one year



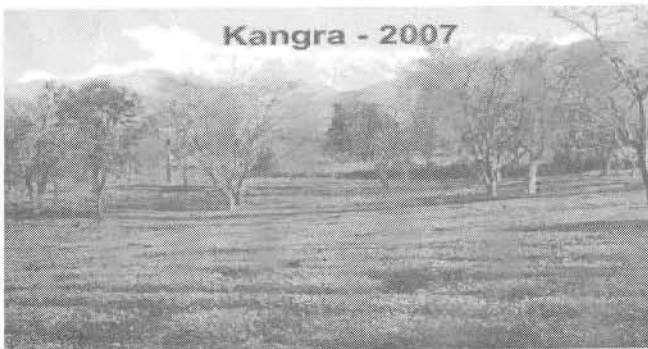
c. Correct plucking by Darjeeling plucker



d. Farmer's field demonstration

Kangra Small Holder Demonstrations								
Tea Estate	Yield (in Kg Made Tea/Hectare)							
	1984	1985	1986	1987	1988	1989	1990	1991
Pathar	266	245	1852	3525	3207	1695	2707	2819
Sitoliari	525	863	2744	3889	2128	2748	2807	1171
Khatpat	914	279	1064	1532	2650	2084	2877	1263
Kelua Singh	N.A.	727	897	2257	2368	2652	2381	2441
Randi Paul	-	368	65	2267	2141	2709	1816	2845
PunPohra	-	517	87	1222	1424	1436	1983	872

e. yield record of Farmers' field Demonstration during the first 6 year plots starting in 1984 with various levels of mismanagement/damage,



g. Removated field site on Banuri farm in 2007 after rejuvenation, consolidation and replanting. (Compare with plate IV h 1984)

Last Beneficiary – Kangra Valley

Programme	Area ha	Starting Standard	Scientific Support	Yield in 1984	Kg/ha 1990	Increase % of 1984
Model Farm	8.82	Abandoned	Innovative	74	1106	1494%
23-demonstrator	9.39	Abandoned	Weekly Supervision	704	1926	273%
Tea Estate	117.55	Abandoned	All levels	744	1911	257%
Enlightened Farmers	26.20	Better	Advices	649	1862	287%
Overall	162.86	Abandoned	Intensive	350	901	257%

f. Impact of management intensity for the 6 years on plots starting in 1984 with various levels of mismanagement/damage.



h. Reversion to old mismanagement of developed tea fields during economic depression.