

Tea Research Association

[www.tocklai.org](http://www.tocklai.org)

# VISION

---

## 2030



Tea Research Association  
Tocklai Tea Research Institute, Jorhat - 785 008,  
Assam



# Vision 2030

## CONTENTS

<b>Topics</b>	<b>Page No.</b>
Introduction, About Tea, Tea Growing Regions, Challenges & Opportunities	1
Tocklai's Role in Development of the Tea Industry, Mission, Vision, Goals	2
Focus Areas, SWOT Analysis, Major Achievements	3
R&D Targets	4
Innovations for Transformational Changes	10
Human Resource Targets, Budget/Finances, Infrastructure	12
Networking, Transfer of Technology	13

## Introduction

**T**ocklai Tea Research Institute of Tea Research Association has been the pioneer R&D organization globally in the field of tea research and engineering since 1911. Prior to 2014, the institute was known as Tocklai Experimental Station, set up by the Indian Tea Association with the help of the Governments of Assam and Bengal. Through its wide range of R&D activities, Tocklai has made significant contributions to growth of the tea industry by developing more than 200 tea cultivars, suitable agro-techniques and location specific package of practices for nutrition, crop protection, tea processing equipment and methods for sustainability of tea plantations. The Association also provides crucial extension services as well as accredited analytical support to the industry for ensuring effective transfer of technology and quality of tea. Regular training on tea technology is also offered to various stakeholders from tea nursery to factory management.

This vision document is prepared keeping in view the needs of a sustainable research support and continuous innovations in order to bring about transformational changes for sustainability of the Tea Industry of Assam, West Bengal, Tripura and other northeastern states of India which together produces more than 75% of the tea in the country in view of the emerging sustainability challenges. The intended activities includes are aligned with the United Nation's Sustainable Development Goals (SDGs) 2 (promote sustainable agriculture), SDG 13 (climate change), SDG 14 (conserve water), SDG 15 (Sustainable use of terrestrial ecosystems, halt and reverse land degradation and halt biodiversity loss) and the institute plans to achieve the targets within 2030.

## About Tea

Tea is grown as monoculture under varying agroclimatic conditions. Tea cultivation demands a moderately hot and humid climate, which influences its yield, crop distribution and quality. It is generally accepted that tea grows best on well-drained fertile acid soil on high lands. Assam tea is well known globally for its unique strong liquor, rich body, taste and colour while the Darjeeling tea is world famous for its distinct delicate floral aroma and mellow taste with light colour. Darjeeling tea became the first Indian product to receive a GI tag.

## Tea Growing Regions

The primary tea-growing regions of the country are situated in Northeast India and in North Bengal (Darjeeling and the Dooars region). About 51% of the country's production and 62% of north Indian tea production is attributed to Assam. Assam's four primary tea-growing regions are Upper Assam, South Bank, North Bank and Cachar. A large chunk of the tea in South India is grown in the States of Tamil Nadu and Kerala, while in North India, Dehradun and Kangra, situated in the foothills of the Himalayas, are the major tea producing areas.

The State of Assam is the single largest tea growing region in India. The State has about 3.08 lakh hectares under tea which is 54.19% share in total area under tea in India, with 767 big tea estates, 473 estate factories, estimated 1 lakh small tea growers and 233 Bought Leaf Tea Factories. About 7 lakh workers are directly employed in the tea gardens and twice the number are employed in ancillary activities. Assam alone produces about 606 million kg of tea annually which is around 50.69% of India's production. The share of the small tea growers in the total production is about 38%.

Assam tea is well known for its quality especially the strong liquor and rich body, taste and colour. In order to provide a distinctive identification mark in the international market, Tea Board has introduced a logo for Assam tea and registered Assam orthodox tea as a GI product. The State has witnessed a spurt in the growth of small holdings during the last decade. A detailed Tea Board census of small growers is nearing completion and as of now (2016), 90164 small tea growers have been enumerated of which 90% are with holding size less than 2 Ha. This adds another dimension to the industry with both challenges and opportunities.

## Challenges and Opportunities

The Indian Tea Industry is in a state of decline. Several factors ranging from escalating production costs, paucity of labour, climate change challenges, increased incidence of pests and diseases and a gradual reduction in the consumer base have threatened the sustainability of the industry.

Stagnant productivity has been noticed particularly in the organized sector in the recent years. Increase in Labour cost, shortage and absenteeism are other challenges which warrants looking for Mechanization of field operations and mechanical aids for improving work efficiency.

Adverse effect of climate change manifested in prolonged droughts as well as shorter spells of heavy rains, hails and increasing cost of pest control due to incessant pest attacks adversely impact productivity and cost of production.

The quality of green leaf outsourced from the growing Small Tea Growers have taken a hit which may lead to regulatory non-conformances as well as oversupply, creating a supply-demand mismatch resulting in low price realization.

The Tea Board has notified the Plant Protection Code for delivering a safe and better product for the consumers of tea. Adoption of Quality Management Systems and Food Safety Management Systems is imperative and the Tea Board is providing financial incentives for quality certifications like ISO / HACCP and other Food Safety Certifications including those from International bodies. The only facility available in Assam for testing the teas is at the TRA, Tocklai currently.

## **Tocklai's role in development of the tea industry**

The beginning of a new era of tea research in India was marked by the establishment of the Scientific Department of the Indian Tea Association (ITA) in the year 1900. This was consolidated with the creation of the Tocklai Experimental Station in 1911. The formation of the Tea Research Association (TRA) in 1964 with Tocklai at the centre of all activities further expanded the horizon of tea research to cover the entire Northeast India. Research on all aspects of tea cultivation and processing is carried out at the Tocklai Tea Research Institute, Jorhat, the oldest and the largest research station of its kind in the world. Transfer of technology to its member estates is carried out through its advisory network covering 1,076 tea estates occupying 341,049 hectares (1,317 sq mi) of land spread over The South Bank, North Bank, Upper Assam, Cachar, Tripura, Dooars, Darjeeling and Terai. TRA's regional R & D Centre is located at Nagrakata, West Bengal.

Today, TRA is regarded as a pioneer in the research and development of tea and an innovator in providing extension services to the tea industry. The research findings of the institute has helped in the growth of the tea industry in India and abroad. The vegetative propagation method given by Tocklai is widely practised globally. The CTC manufacturing process is another globally accepted contribution from this institute. All agrotechniques required to raise and sustain a commercial tea plantation have been developed at Tocklai.

## **Mission**

To support the tea Industry through research, innovation, technology and training at the highest levels of excellence to bring about transformational changes to achieve the sustainable goals.

## **Vision**

Providing technology led innovative solutions to the tea industry, ensuring production, quality and environmental sustainability while addressing the issues faced by the industry for smooth tea trade globally, taking advantage of scientific and innovative technology and emerging scopes for transformational changes and move towards self sufficiency by 2030.

## **Goals**

- Promoting research on innovative technology development through use of ecologically sound modern tools for sustainable production and quality tea.
- Ensuring effective transfer of technology and services to all stakeholders.
- Skill development on various aspects of tea cultivation, processing & diversification.
- Ensuring conformance to standards through accredited laboratories.
- Positioning strategies for marketing and moving towards self-sustainability.

## Focus Areas

- Soil Health restoration and Climate change adaptation
- Development of stress tolerant cultivars with high quality
- Improvement of tea quality and production of speciality teas
- Mechanization of field practices
- Reduction in costs of production
- Precision agriculture - drip irrigation & fertigation
- Ecological pest & disease management
- Mitigating regulatory & emerging challenges
- Leveraging International Networks
- Diversification
- Training for small growers

## Strengths, Weaknesses, Opportunities and Threats (SWOT) Analysis of TRA

### Strengths:

- Domain knowledge gained from a century of research on tea
- Highly skilled scientific personnel
- Infrastructure
- Organized structure
- National and international collaborations
- Literary archives
- Reputation – Tocklai is well known globally

### Weaknesses:

- Reduced Govt. funding
- Ageing manpower
- Perceived over-reliance on Tocklai's celebrated past
- Perceived disconnect with industry demands

### Opportunities:

- Adoption of technological advancements in tea cultivation
- Adoption of Artificial Intelligence (AI) based interventions
- Leveraging Information and Communication Technologies (ICT) for training and education
- Marketing and Promotion
- Entrepreneurship opportunities from diversified/innovative tea byproducts
- Training of industry stakeholders
- Skill development of the growing Small Tea Growers (STG) sector

### Threats:

- Declining importance of tea as a favoured beverage amongst younger generations
- Declining importance of R&D amongst policy makers
- Turmoil in the tea industry leading to questions about its long-term sustainability
- Acute shortage of budgets to fund research activities

## Major Achievements

- The technique for vegetative propagation of tea by internodal cuttings.

- Released 33 TV (Tocklai Vegetative) clones, 15 bicalonal seed stocks and 154 region specific garden series clones.
- Invention of the following tea machineries:
  1. MacTear Rotorvane
  2. Borbora Continuous Leaf Conditioner
  3. Continuous Tray Drier
  4. Continuous Fermenting Machine
  5. Borua Continuous Roller
  6. Tea Breaker-cum-Stalk Separator
  7. Green Leaf Storage Device
  8. Continuous Withering Machine
  9. Electronic Monitoring and Control System for Withering
- Introduction of extended pruning cycle in lieu of annual prune for higher productivity and better distribution of the crop.
- Optimisation of plant population.
- New techniques of bringing up young tea reducing the gestation period from planting to full bearing.
- Land planning, drainage and balance manuring for higher productivity. Soil Amendment techniques.
- Establishment of the necessity for a light even canopy of shade for tea plantations in the plains of N.E. India.
- Introduction of safer pesticides for effective pest and weed control with emphasis on Integrated pest management.
- Introduction of bioagents - Trichoderma and Bacillus for control of certain tea diseases and their formulation for commercial application.
- In situ Conservation of tea germplasm
- Introduction of improved pest control methods through IPM
- Introduction of the VAM technology for tea nurseries
- Standardisation in installation of low cost sticky traps to control thrips and jassids
- Development of low cost light traps to control red slug and loopers
- Development of Neem Kernel Aqueous Extraction technology for pest management
- Development and release of nutrient management packages for organically tea.
- Accredited pesticide residue & heavy metal testing laboratory
- Database on pesticide residues and heavy metals & fixation of maximum limits.

## R&D TARGETS

Research priorities are attuned to the needs of the industry as well as future challenges. The multidisciplinary R&D activities at Tocklai are carried out through its nine scientific departments and at North Bengal Regional Research & Development Centre at Nagrakata and the DBT unit of Excellence set up at TRA Upper Assam Advisory Centre at Dikom.

### Climate Change Research - Impact and Mitigation

It is well known that the climate change triggered by global warming is impacting almost everything in this world. In the same way agriculture will be affected round the world. Already symptoms of the impact of climate change have appeared in many crops. In the process, it is believed that the most vulnerable will be the one to be becoming extinct first. It may also happen that while some crops may become extinct and may give way to new crops; many may change places as areas may become unsuitable for their survival. Tea will thus be not an exception. Not only the crops, but climate change may trigger a series of various other phenomenon like increase in the frequency of floods and droughts, periodicity of extreme events increasing as temperature rises, rainfall recedes

and carbon dioxide levels shoot up. Visible symptoms may not appear quickly, but surely long term impacts will be disastrous. Research efforts should not be aimed at stopping the phenomenon of climate change, because



as of now there are no tools available to stop climate change. But best practices to reduce it and adapt to climate change must be developed. TRA's future research agenda will have a special focus on the research on climate change - some efforts have already been initiated. It seems as of now there is one green light that can help us to some extent combat climate change and that is the carbon management. Soil carbon has a definite role to play in the crop production as well managing soils. Efforts must be aimed at enhancing soil carbon pools, but aiming at enhancing the stable pool. Research efforts are necessary in this regard. Ever dwindling sources of organic matter like farm yard manure may would necessitate to look for alternate sources of



*Open Top Chamber experiment at Tocklai*

organic manures or quality manures. Research efforts need to be focused on the issue of developing quality manures. Carbon sequestration research in tea needs immediate attention. It can be argued that roughly tea production imitates agro-forestry system, because tea grows below shades. Experts believe that there is a vast scope of carbon sequestration in tea systems. Future research efforts' will definitely accommodate carbon sequestration as one of its agenda. Carbon credits can be attained on vast tea plantations in the North Eastern region, but it needs intervention and a closer look by TRA scientists. Clean development management (COM) in tea production is another related area in the carbon research under climate change. It may be related more to the planters' level, but a strong intervention of TRA scientists is necessary and will be a research area in the near future.

### **High rainfall and humidity**

The high rainfall and humidity of the region not only creates favourable environment for the better growth of tea but also help to sustain wide range of pests, disease and weeds in various proportions. Changes in precipitation patterns may impact the tea production adversely as well as influence the pests and diseases. Emergence of new pests and diseases, never heard of before may impact tea. Besides the sudden changes in precipitation patterns may need more thinking on water management practices. Tea is considered to be largely grown as a rain-fed crop, however, the climate change may bring about the need for irrigation in this crop.

### **Water logging/Drought:**

It is known that tea grows better on well drained soil. Survey showed that more than 50 per cent of tea area in the North Eastern India suffers from either water logging or drought or from both. The magnitude of moisture deficit varies from 8 mm to 300 mm in Upper Assam and Terai respectively. It has been observed that improvement of drainage results in significant crop yield. With more areas becoming vulnerable to alternate flooding and droughts, more emphasis has to be laid on drainage and water conservation practices.

### **Soil health and Managing soil as a resource for sustained productivity**

The tea industry in the region has been in operation since the last 150 years with monoculture. Large parts of tea lands have been subjected to erosion by rivers. Natural drainage for the tea areas have also been affected due to development activities outside the tea areas. A sound policy on soil and water management for long term sustainability of the industry is therefore of paramount importance.

Managing soil as a resource for sustained productivity is one of the greatest challenges in tea plantations where prolonged monoculture is a typical feature. Originally, the tea plantations in this region have been established after clearing forest lands having fertile soil. Well-managed tea plants normally remain productive for decades

and the yields tend to stagnate or decline in older plantations. In one of our older studies on nutrient status and physical conditions of soil in relation to cropping period, it was observed that the nutrient status decreased with the progress of cropping period and prolonged cultivation usually brings about deterioration of physico-chemical as well as biological properties of the soil. However, in another study, surprisingly a decline in productivity was observed in a large number of commercial tea plantations with a clear turning point of 17-



*Strands of deep-rooted Guatemala grass in an uprooted old tea field*

21 years after planting, irrespective of cultivars and regions in Assam and North Bengal. This is a matter of great concern as the youngish mature tea plants at that age should have been at their best and expected to sustain high yield for 16 another 25-30 years more. It therefore calls for a closer look at the soil beneath to ensure whether the five basic principles of soil management, viz., replenishment of nutrients continuously removed by the plants over the years, maintenance of adequate soil physical conditions and optimum soil acidity, adoption of proper soil conservation measures to minimize erosion and prevention of build-up of toxic elements, weeds, pests and diseases, which are essential to sustain productivity have actually been followed or not. Soil degradation is the major threat to long term sustainability and may very well be a factor for stagnating or declining yield in an input intensive farming system as in tea plantations.

### **Forest Cover & Water Bodies**

Forest Cover & Water Bodies in Tea Garden Land use pattern offers much scope to enhance the micro climate as well as the forest cover of the state. The marginal lands not fit for tea cultivation can be used for creating patches of forest cover and water bodies within estate areas. Planting trees of ecological importance as well as economic value in the additional areas in the plantations or allotting an uprooted bad patch of existing tea fields and using for an alternative crop is a food for thought.

### **Tea physiology**

Studies have shown that a tea leaf retains its photosynthetic activity to about six months, and about 70 per cent of photosynthates is used up in respiration and the rest 30 percent is only utilized for growth. Photosynthesis is inhibited at temperature above 3°C and hence shade is essential for tea in North Eastern India. Experiments have demonstrated that a light canopy of shade permitting 30-50 per cent of light is essential for growth of tea in North Eastern India, except in higher elevation areas in Darjeeling. A good stand of shade also contributes to about 80 kg N/ha. Futuristic growing environments may would need further assessment of shade as well as the behaviour of tea plan under water logged and water stress conditions.

### **Effect of elevated level of CO<sub>2</sub> on crop production**

It has been observed that increase in carbon dioxide concentration in the atmosphere will cause increase in biomass of crop and non crop plants. Consequently weeds may continue to be a bigger problem. It is also predicted that nitrogen fixing plants will respond more readily to CO<sub>2</sub> enrichment than non nitrogen fixing plants. It is also argued that CO<sub>2</sub> acclimatization varies depending on the plant species and the positive response starts after attaining certain limit. Controlled studies under elevated carbon dioxide conditions need to be carried out to study the behaviour of current tea clones. Elevated temperature studies coupled with carbon dioxide may form the basis of many studies concerned with defining the tea growing environments.

Tea plants respond differently in different geographical location. Tea plants grown near equator do not have dormancy period, and dormancy increases in region away from equator. Tea in North Eastern India is grown within 24° and 27° N latitudes and 88° to 95° E longitudes. Tea plants in North East India enter into dormancy



from November. Development of region specific tea cultivar and seed stocks has been a priority area of tea research. Tocklai has evolved so far 35 TV series cultivar, 26 seed stocks and 154 garden series clones. Biotic and abiotic stresses have been identified to be significant threat to sustainability of tea. Pest and disease organisms continue to be more powerful and some clones suffer more seriously than others. It is therefore predicted that losses due to pest

attacks will increase in near future in the face of harsh environmental variable and increase availability of some tea cultivars susceptible to pests. There is therefore a need to develop new tea cultivar which are tolerant to major pests and diseases. Strategic research to develop tea cultivars tolerant to biotic and abiotic stresses will be major thrust areas of research and will have to be intensified in near future. Biotechnological interventions may be needed to enhance the process of plant improvement, which otherwise is a time consuming process.

### **Plant improvement using conventional and biotechnological tools**

Discovering the functions of 25000 genes from *Arabidopsis thaliana* and success of Human genome project has paved the way for better understanding of genes and their inheritance and functions. The future of genetic transformation in plants, therefore, looks promising. Research has revealed that tea plant is amenable to genetic transformations. Genetic manipulation in tea may lead to development of golden clones that have ability to tolerate drought, water-logging, pests attack etc. The genetically modified clones may acquire altered metabolic pathways yielding valuable secondary metabolites, which may have significant and desirable agronomic traits. However, the work on conventional breeding will have to be continued with more intensive emphasis on integration of both conventional breeding and biotechnological intervention.

### **Non conventional pest and disease management to reduce chemical load**

Insect pests, pathogens and weeds cause significant losses (20-25%) to tea production. Pesticides form an important input to control insect pests, which may create undesirable environmental organisms in the long run. Pesticides cause reduction in natural enemies of pests, which induce resurgence in pest population, secondary pest outbreak, ground water contamination and lastly the build up of residues in made tea. Reduction of pesticide use, by introducing eco-friendly technologies for control of pest and diseases and weeds is a great challenge ahead. Concerted efforts will have to be made to generate knowledge on epidemiology of pests, diseases and weeds with appropriate control measures. Good agricultural practice may have to be developed and pest may need to be controlled under the ambit of IPM to reduce the chemical load. International and national regulatory bodies will be taken into consideration in every step of functioning. As world tilts towards chemical free foods, tea will be not be an exception, hence aforesaid measure will be implemented in the future research efforts at TRA.



*Insect pests of tea getting stuck on yellow polythene sheets coated with HMPSA*

### **Tocklai as a hub for organic tea**

Organic tea is yet another area where Tocklai has been conducting long-term experiments. Through a series of investigations, Tocklai has developed a package of practices for organic tea in North East India and this package is now available to the tea gardens. Vermiculture is another subject of contemporary interest and here too Tocklai has researched and published the method for vermicomposting in tea gardens.

Organically grown economic crops in India occupy about 5,27,800ha of land. Demand for organically grown tea is increasing slowly but steadily and its demand is expected to increase even further. Tea grown organically remains free from residues of pesticides, fertilizers, and weedicides. The general protocol for cultivation practices for organic tea in North Eastern India is not available at present. The research results for such studies are unfortunately missing in North Eastern India. About 41 tea Estates in Darjeeling and some in the plains

are practicing organic tea cultivation in North Eastern India. Indian tea currently adopts principles of "GOOD AGRICULTURAL PRACTICES" for its growing. In view of the declaration of Darjeeling and Assam tea under geographical Indicator (GI), the place of Indian tea occupies a unique position in international markets. There is therefore an urgent need to develop socially acceptable, eco-friendly, cost effective organic tea growing protocol in North Eastern India that meet the demands of consumers, but must be backed by sound research data.

### **Precision farming practices in tea production : use of drones and AI**

Indian agriculture faces a stiff challenge of meeting the demands of fertilizer required by growing crops. Currently more than 12 million kg of fertilizer is used and crop removal is found to be more than 18 million. A net deficit of 6 million or more is thus observed; tea may not be an exception in this scenario. The problem can be tackled by introducing precision farming in tea cultivation, which may include a laser leveled tea fields at planting, fustigations etc. But this would need a serious research effort in tea, where this might not have been tried earlier anywhere in the world. In tea production, series of technologies are needed to raise a tea plant from seed or cutting. e.g. (1) nursery technique, (2) young tea management, (3) pruning and plucking, (4) manuring, (5) pests control, (6) shade, (7) drainage etc. Before going for introducing precision farming in tea, it may be worthwhile to first study the economics of a/l available agro-technologies required at various stages of tea cultivation. Precision farming practices may be developed but may need to be evaluated for its economic viability. New research efforts are therefore a necessity in this direction.

### **Developing GIS and satellite based monitoring networks**

Tea grows in about 3.50,000 ha of land in the North Eastern India. These areas include both plains as well as hilly and comparatively inaccessible areas. Manually it may not be easy to monitor these areas quickly as ground tracking may take long time. By the time the ground tracking is done by manual means, the problem may assume alarming proportion. Geographic information system (GIS) using remote sensing data may be a quick method of monitoring the entire tea plantations of North Eastern India. The plantations can be monitored by using satellite imageries varying in resolution, depending on the objective of monitoring. GIS is a very strong tool that can be utilized for various purposes of monitoring e.g. floods/drought assessment, insect pest/disease assessment, uprooting/replantation assessment etc., besides it can also be used for various analysis as well as tracking changes occurring in land use pattern of an area. An effort has been initiated at TRA to develop infrastructure as well as human resources in GIS to initiate research in this frontier area. However, a major emphasis need to be laid down in this area in future, because these tools are extremely helpful in developing decision support system frameworks in many areas.

### **Developing AI based customized decision support systems for all management practices**



*Unmanned Aerial Vehicles (Drones) in Tea Crop Management*

At the moment, most decision making at the farm level is done by using available records in the shape of hard copies, personal communication, local discussion and available knowledge. There is hardly any intervention of any computer aided decision making or any effort to develop a decision support system framework using a supportive platform. Developing customized applications for making quality decisions using the large datasets will go a long way in improving decision making at farm level. Computers have the distinct advantage of using and integrating large datasets developed over the years from a particular region or area. It also has the advantage of choosing variables and using them to meet certain objectives in decision making. Developing quality

decision support system frameworks will form the core of the future research agenda of TRA. These will

involve both macro as well as micro level decision making, both at farm level and the region level. Introduce simulation studies for forecasting - yield, disease, pests infestation forecasts. Pests and diseases activities are dynamic and continuously under selection pressure due to change in the environment and growing conditions. New biotypes with altered behaviour evolve and caused at times extensive damage to agricultural crops. Simulation studies are helpful to know about the possible time of occurrence of pests and natural calamities and therefore will be helpful to take appropriate precaution. Such studies will be encouraged. Process simulation models world wide have helped to predict things in advance. There are so many models that are currently used in simulation studies. Tea is thus no exception. The environmental impacts and tea yield predictions can be made using simulation models if there are databases available to validate the models. All effort in this direction has already been initiated, but it needs to be put on a still faster mode. It is a fact that tea models are not very common; hence, initially the existing models may need to be calibrated. But eventually, capacity building should be undertaken to develop a robust simulation model which can simulate the crop behaviour under a given set of environmental conditions.

### **Introduce simulation studies for forecasting - yield, disease, pest infestation forecasts**

Pests and diseases activities are dynamic and continuously under selection pressure due to change in the environment and growing conditions. New biotypes with altered behaviour evolve and caused at times extensive damage to agricultural crops. Simulation studies are helpful to know about the possible time of occurrence of pests and natural calamities and therefore will be helpful to take appropriate precaution. Such studies will be encouraged. Process simulation models worldwide have helped to predict things in advance. There are so many models that are currently used in simulation studies. Tea is thus no exception. The environmental impacts and tea yield predictions can be made using simulation models if there are databases available to validate the models. All effort in this direction has already been initiated, but it needs to be put on a still faster mode. It is a fact that tea models are not very common; hence, initially the existing models may need to be calibrated. But eventually, capacity building should be undertaken to develop a robust simulation model which can simulate the crop behaviour under a given set of environmental conditions.

### **Assuring food safety and product quality**

Tea is an economically important crop in India and Good Agricultural Practices are pre requisite for its growing. Agrotechnology developed by Tocklai are largely based on GAP principles and implemented through strong net work of Advisory services spread throughout North Eastern India. Fertilizers are checked for presence of hazardous substances before application and recommended pesticides are sprayed on tea bushes to ensure that no pesticide exceeds permissible limit of MRL. Optimization of process parameter for black tea processing is one of the areas of research. ECM (Environmentally Controlled Manufacturing) and Model tea manufacturing is functioning in this direction to achieve the objectives. Meeting the regulatory requirements in domestic as well as global markets under Sanitation and Phytosanitation (SPS) measures under WTO is one of challenges which are to be dealt appropriately in the coming years. TRA research efforts need to be continuously focused on ensuring quality at farm gate. Research data to be updated to help develop quality standards for conformance.



### **Bio-security and genetic resource conservation programme:**

Biosecurity is broadly a set of preventive measures designed to reduce the risk of intentional removal (theft) of a valuable biological material. North Eastern region is recognized to be one of the 18 biodiversity hot spots

of the world. Its rich diversity of flora consists of forest plants, medicinal plants, horticultural plants, flowering plants and wild relatives of crop plants. Tea plants were discovered in Assam in 1823 by Bruce brothers and subsequently many wild species of tea were discovered in Nagaland, Manipur and other forests. But for initial years of tea cultivation, tea seeds were brought from China. Subsequently Chinary tea plants were found to be susceptible to pests and suffer more than the Assam or Assam hybrids. These materials, however, are now serving as valuable germplasm for undertaking a conventional breeding programme involving Chinary tea. In course of time Tocklai has evolved 30 TV cultivars, 14 seed variety and 154 garden series clones. All these now along with parents of tea cultivars or wild cultivar need to be preserved. Some progress has been made in this direction, and action will be taken to register tea germplasm having desirable characteristic tolerance to biotic and abiotic stress. In addition to all this, it is most important that illegal or willful loss of these highly valuable germplasm is prevented from this region. TRA needs to evolve a suitable mechanism to prevent this loss of germplasm from this area.

### **Post harvest processing - stress on processing hygiene and quality - developing new tools - alternate factory fuels to reduce carbon emission and automation**

Food safety and hygiene has become the prime objective of tea processing units. Meeting the consumers' demands for hygiene and safe products will be a great challenge for tea industry in the coming years. This challenge has to be addressed by adoption of HACCP, in the tea processing factories. HACCP (Hazard analysis and critical control points) ensures identification of microbiological and chemical hazards at the processing lines and provides remedial measures so that end products remain safe for consumers. Establishment of a model tea factory at Tocklai, marks the beginning of automation in tea industry. Tea processing like withering, rolling, fermentation etc. are accomplished at one step without manual handling. The ideal and appropriate process parameters which are associated with quality tea processing, need further research and testing. Energy consumption measures are important issues for future and efforts will be made to undertake research on alternate fuel for factory. It may be added at this moment that ideal fuel for factory must address the requirement of clean fuel also. TRA research agenda needs a special focus on factory automation, clean fuel and packaging to enhance the shelf life.

## **Innovations for transformational changes**

### **Soil condition monitoring using IOT enabled devices**

Soil condition monitoring sensors allow planters to collect data about rainfall, temperature, and other metrics over time to track trends and predict irrigation needs. Such technologies allow planters access to real-time information on parameters such as soil humidity/moisture levels and soil/air temperatures, which makes decision making easier without having to make educated guesses and estimates. With better data being fed to them live from their own crops, planters can be empowered to take the best call on planting, watering, and pest control measures.

In a nutshell, these are the best possible reasons for the industry to strive for the adoption of such sensors in tea-

- There is better management of the land through data (which is more accurate than manual testing)
- Planters can combine outside data (like weather forecasts) with their own land parcel data to optimize crop watering and maintenance
- There are less associated costs for labour, water, and crop care
- Planters have healthier crops by optimizing water and soil care
- IOT-enabled sensors take very little time to set up and the battery life is healthy, which leads to less maintenance costs.

### **Artificial Intelligence (AI) based solutions for tea quality assessment**

- NIR based sensors for tea quality assessment during manufacturing: In a collaborative work with Jadavpur



University a rapid NIR spectroscopy based method for estimating caffeine and polyphenol was developed which correlated very well with the conventional methods.

- Biosensor based pesticide detection kit: In a TRA- CDAC Kolkata-BITS Goa collaborative work carried out at Tocklai a prototype of a pesticide detection kit was developed that could detect very low levels of monocrotophos.
- Drone based precision agriculture – In an TATA GTIO | APPL | TRA collaboration study
- Unmanned Aerial Vehicle (Drone) was successfully utilized for aerial spraying against sucking pests in tea indicating its potential use in tea plantations.
- TRA-Agnext Tea Leaf Profiler: The machine makes use of AI to instantly analyse tea quality and to help planters determine appropriate pricing for their produce. It is also helps to bring about accuracy and reduce the time involved in Fine Leaf Count (FLC). Development of the machine is currently underway.

### Upscaling of Diversification efforts

Diversification of tea products through value addition is a promising formula for boosting profits. A diversified range of tea-based by-products could potentially capture both national and international markets and assure high economic returns. Such products could also be the answer to the receding appeal of tea amongst the younger generations. While efforts to produce a wide array of diversified by-products are currently underway, in the long term, it is expected that the range of products and the production capacity will be increased manifold for commercial viability.

Some notable tea by-products (both current and ones reserved for the pipeline) are -

- Tea premixes
- Green and black tea concentrates
- Flavoured tea from locally available natural sources
- CTC Green tea
- Black tea with high EGCG by blending and process modification.
- Matcha tea from quality Assam jats.
- Pu'er tea from quality Assam jats
- Catechin based products
- Carbonated soft drinks and confectionaries fortified with tea bioactives.
- Tea bioactives based pharmaceutical products.

### Online Information channels, virtual classrooms and Digital Library services

Advances in Information and Communication Technologies (ICT) have led to wider use of portable devices due to their ability to access high speed data networks. Round the clock connectivity has created a demand for readily available information on different domains, including tea. Initiatives have already been made to tap into this ever increasing demand by channeling information through digital publications, online videos and instant messaging. Going forward efforts will be made explore other avenues for information dissemination such as online podcasts and interactive virtual classrooms. Virtual classrooms have evolved as a practical alternative to conventional classrooms using tools such as videoconferencing, instant messaging, participation controls, breakout rooms etc. In the short to medium term, TRA intends to select, engage and train its scientific personnel to carry out such virtual sessions by leveraging these new-age technologies and solutions.

A closed-access digital library with online cataloguing services is critical for the preservation of old and rare





bibliographic resources. While numerous digitization initiatives have been already undertaken, the long term goal is to create an institutional repository of books, papers, theses, maps and all other available bibliographic resources and to make this repository online and available on demand to the scientific personnel of TRA.

## HUMAN RESOURCE TARGETS

### **Staff diversity - National and international heterogeneity in human resources**

Human resources in an institution form the back bone. Trained and dedicated human resources are a/ways an asset to an institution. TRA considers human resource development as its prime focus in its agenda. TRA human resources consist of a diversity of cadres and positions in its two distinct categories of scientists and the support staff. TRA has initiated efforts to bring about heterogeneity in its staff by recruiting persons from cross section of the country. However, quality of human resources will be the prime criterion for the recruitment. The staff will be highly qualified and most suited to the position for which recruited. Scientists of eminence across all disciplines will be recruited as Scientist Emeritus to provide new dimension to the scientific programmes. Experienced scientists in different aspects of tea technology will also be engaged as mentors to guide the young scientists.

### **Long term staff welfare - skill development (on the job trainings), benefits and best paid and post retirement benefits**

TRA's efforts have always been focused on long term staff welfare. There have been various initiatives for on the job trainings and skill developments for both scientific staff as well as the support staff. TRA has been embarking on policies of providing the best benefits of working with TRA which includes best paid service and post retirement benefits. Various schemes of health insurance, employee welfare schemes etc. have been introduced from time to time.

## BUDGET/FINANCES

### **Performance related budgets**

TRA is currently funded by the tea industry and Govt of India grants through Tea Board. The institution basically works on a deficit government funding. TRA, in future will make a strong effort to develop self sustaining projects, which are run on long term basis and can partially meet the deficit. Long term self sustaining projects will form an integral part of the TRA R&D agenda.

The Association has recently identified specific verticals for generating income and seeks to be self sufficient in the long run:

- Training & skill development
- Sale of bio formulations & products
- Educational courses on tea
- Conferences, seminars, workshops
- Testing services
- Sale of seeds and plants
- Tourism & hospitality
- Tocklai Tea Awards in various categories
- Overseas Collaborations & Certifications

## INFRASTRUCTURE

### **Modern facilities for Research**

TRA needs to improve its infrastructural facilities as many of the laboratory are very old. Some improvement is already on its way as part of its centenary celebrations to construct new laboratories and procure new and additional equipment. More laboratories and other facilities will be required in future. TRA is focussed on this

need to expand and accordingly future plans have been laid out.

#### **Two major infrastructure development projects announced by the Govt of Assam for Tocklai:**

- A Training & Research Centre for Small Tea Growers Assam will be established at Tocklai. The set up will house a state of the art Quality Assurance laboratory with advanced sophisticated equipment, and three other labs for tea tasting, biocontrol and mechanization and classrooms for basic and specialized training of small tea growers.
- Another Assam Govt project to set up a “Tea Tourism Hub at Tocklai” is being planned. This project will offer scope for major renovations of the heritage buildings, premises with water bodies and landscapes as well as set up a Tea Museum. After completion of this work the entire sprawling campus of Tocklai would be a centre of attraction for tourists which will generate revenue for research

### **Complete transfer to digital records, communication and paperless institution**

TRA is committed to completely shift to e-governance. It has already started to transfer all its record in digital form. But it has to be undertaken more vigorously. The institution intends to shift to a paperless mode as quickly as possible. All records and communications need to be made digital and effectively implemented in all its offices.

### **NETWORKING**

TRA has, already involved in networking with some of the world tea institutes like Tea Research Institutes in Sri Lanka, China, Kenya and other institutions like ITC, The Netherlands, Kyoto University Japan, Cranfield University, UK Tea & Infusion Association, European Tea & Herbal Infusion Association, Germany, University of Braunschweig, Germany, CABI UK, University of California, Davis USA, University of South Africa, etc. But it needs to be expanded to more institutions for collaborative projects and staff exchange programme with these institutions.

TRA will not work in isolation. Its research findings need to be shared and communicated with the world. Besides TRA's horizon must expand beyond North Eastern India. It should work for the world tea communities. This is possible only through its co-operation with the other. R&D institutions in the Asian region and the world. Already TRA is making efforts to open up dialogues with much institution in this regard, but it will be taken up more seriously in the near future.

More of multi- institutional, multi-regional and multi-country projects can fulfill this unique goal of TRA's new agenda. Some recent outcomes of such regional and international co-operation are creation of a policy document entitled “Guidance Document on Risk Assessment Using Brew Factor For Fixation of MRLs of Pesticides in Tea” for CCPR/JMPR evaluation, a report “Impact of Climate change on Tea and adaptation strategies” and “climate modelling maps for Assam”. A more recent collaboration of Tocklai with Pasteur Institute, Little France has given the indication of anti hepatitis-C activity of black tea theaflavins convincingly.

### **Transfer of Technology**

Advisory services of TRA are unique and second to none. However with the increasing level of awareness and demand for increasing information by planters, sometimes it is becoming difficult to meet their demands due to limited resources both human and infrastructural. Many a times various programmes envisaged for planters at different levels cannot take off due to non availability of resources. However, the introduction of new communication techniques in extension services like tele-communication, modular communication etc may ease out TRA's stress. Introduction of direct telecast via satellite communication system to gardens can go a long way in this direction. Besides, if various extension modules (audio and video) are made for tea production technology with FAQ, then it can help the planters in a best way. These will be a core area of activity in TRA's new extension agenda.

--- X ---

---

THE DIRECTOR  
Tea Research Association,  
Tocklai Tea Research Institute  
Jorhat-785008  
Assam, India  
Tel: 91-0376-2360467, 0376-2360972  
Fax: 91-0376-23600974  
director@tocklai.net

THE SECRETARY  
Tea Research Association,  
113, Park Street, 9th Floor  
Kolkata-700016  
Tel: 91-033-22291815, 22293813  
Fax: 91-033-22294271  
secretary@tocklai.net

---



Tea Research Association  
Tocklai Tea Research Institute, Jorhat - 785 008,  
Assam