Technology Management in India's Plantation Sector: Structural Infirmities Perspective

Overview of Tea & Coffee, Indigenous Machinery, Effects of Climate Change, Production Management, Quality & Safety, Trans-disciplinary R&D and Conclusion

V.G. Dhanakumar

Introduction

The plantation sector in India has experienced major changes over the years in terms of global competition, tariff structure, price volatility, innovations and technology, ownership pattern and management structure. Such changes have exposed the sector to a new operational setting. This setting is subjected to certain challenges, viz. structural infirmities, which should be appropriately addressed for the sector to perform adequately.

> A structure gives stability and standing to a system. An infirmity results in instability in the system and its environment, and all infirmities need to be addressed from time to time. Infirmities in the plantations will harm the sector and associated industries. The Indian economy is on the move and international trade in plantation commodities is very important. At this critical juncture, tea and coffee constitute important commodities and it is crucial to ensure strength of the value chain.

Thus, there is a need to evolve a policy framework to tackle the infirmities and to guide the future growth. Structural infirmities are the inherent weaknesses or limitations within the structure of the industry that inhibit performance and growth of the sector and reduce efficacy of the policy intervention. It is, therefore, imperative to address the major structural and functional rigidities faced by the industry presently to better equip it to face the challenges and become competitive in the global arena.

In discussing the relationship between technology, competitiveness and economic growth at the macro level, the OECD (1992) conclude that 'the proposition that investment in R&D and technological progress are essential for future economic growth has not yet been conclusively empirically demonstrated'. The difficulty of demonstrating this relationship is understandable as R&D is just one component of innovative activity that takes place within enterprises, albeit within the context of its

V.G. Dhanakumar (✉)
Production & Operations Management, Indian Institute of Plantation Management (IIPM), Bangalore, Karnataka, India
e-mail: vgdkumar@vsnl.net

K.B. Akhilesh (ed.), *Emerging Dimensions of Technology Management*,
DOI 10.1007/978-81-322-0792-4_3,

external linkages and government policies. For an enterprise, competitiveness refers to the capacity to create and sustain cost and/or product advantages to gain or maintain strong positions in the markets for its products and a high level of profitability. In general, the advantages are based on the ability of a firm to:

(a) Successfully define its scope
(b) Manage and coordinate the core functions and operations within the enterprise as well as relationships with suppliers and customers
(c) Market demand characteristics and respond to them appropriately. In advanced technology sectors, technology and the ability to innovate are key aspects of the organizational knowledge of a firm that give it distinctive capabilities and competitive advantages

The Ministry of Commerce and Industry, GOI, has assigned the study on the Structural Infirmities in Plantation Sector (SIPS) to IIPM focusing on five critical issues such as productivity, labour issues, quality, R&D structure and competitiveness. The study has discussed elaborately the above-mentioned issues with appropriate recommendations. The report also provides an international perspective on the best practices of coffee and tea sector in comparison with competing countries.

An Overview: Coffee and Tea Sector in India

Coffee

Indian coffee production is dominated by the 'traditional' plantation areas of Karnataka, Kerala and Tamil Nadu with contributions of 71, 20.5 and 6.7% to national production, respectively. The remaining contributions are from the 'nontraditional' areas of Andhra Pradesh and Orissa as well as the northeastern states. There are mainly two types of coffee cultivated: Arabica and Robusta.

The planted area under coffee in India has grown from 0.92 lakh hectares in 1950–1951 to approximately 4 lakh hectares in 2009–2010, and the bearing area grew from 2.21 lakh hectares in 1989–1990 to 3.56 lakh hectares in 2009–2010. The planted area under coffee in the traditional and nontraditional areas during 2009–2010 is tabulated below:

It is seen from the above Table 1 that out of the 4 lakh hectares of coffee plantation, Karnataka has the major share of plantation (56.9%), followed by Kerala (21.2%) and Tamil Nadu (7.8%). Other regions contribute approximately 14% share of the cultivated land. Of the total planted area, Robusta occupies 51.5% of area and Arabica the balance.

Robusta, the less labour-intensive variety, constitutes approximately 67% of national production in 2009–2010 (Coffee Data base, Coffee Board of India, Jul–Sept, 2010). Coffee is an export-intensive sector with around 70% of the national production exported. India is the sixth largest producer of coffee (FAO STAT 2010) but contributes only around 3.53% of the world exports (Coffee Board

Table 1 Planted area by states – 2009–2010 (In hectares)

State	Arabica	%	Robusta	%	Total	% to India
Karnataka	110,023	27.5	117,317	29.4	227,340	56.9
Kerala	3,711	0.9	81,085	20.3	84,796	21.2
Tamil Nadu	25,708	6.4	5,636	1.4	31,344	7.8
Nontraditional areas	50,518	12.6	268	0.1	50,786	12.7
Northeastern region	4,035	1.0	1,382	0.3	5,417	1.4
Total (India)	193,995	48.5	205,688	51.5	399,683	100.0

Source: Database on Coffee, Coffee Board of India, Jul-Sept 2010

Table 2 Number, area and share of production under different sizes of coffee holdings in India – 2007–2008

Size of holdings (in hectares)	No. of holdings		Area under coffee		Share of production (%)
	Number	% to total	In hectares	% to total	
Small holdings					
<2	178,585	80.9	144,196	37.1	*70*
2–4	27,731	12.6	71,905	18.5	
4–10	11,800	5.3	73,642	19.0	
Subtotal	218,116	98.8	289,743	74.6	
Large holdings					
10–25	1,789	0.8	29,829	7.7	*30*
>25	920	0.4	68,623	17.7	
Subtotal	2,709	1.2	98,452	25.4	
Total (India)	220,825	100.0	388,195	100.0	*100*

Source: Database on Coffee, Coffee Board of India, Jul-Sept 2010

of India 2009). In the domestic market, consumption is currently growing at 5–6%, and only a very small portion is sold through auction.

Evident from Table 2, coffee production in India is predominantly a small grower's phenomenon who contributes approximately 70% of total national production. In terms of number of holdings, almost 99% of planters are under <10 ha category, and in terms of acreage, approximately 75% fall under this category. Under this category are small growers who are mostly affected by fall in yield, adverse price movements, productivity loss and other socio-economic constraints.

Coffee cultivation is shaped largely by the ecological system, and coffee is cultivated within shaded multi-crop ecosystems rich in biodiversity. Productivity is low compared to sun-grown monocultures in competing countries such as Brazil and Vietnam. Coffee production in India is vulnerable to a variety of pest and disease threats, specific to the agro-ecological conditions. The most pressing problem currently for Arabica is the white stem borer, which kills the host plant leading to significant crop losses.

Aged plantation is another important factor influencing productivity adversely. Many of the plantations have crossed the prime yielding age thereby necessitating replantation. While the need for replantation is well recognized, growers are financially incapable of meeting the replantation costs due to the recent crisis faced by the industry. With the objective of extending financial support, the Coffee Board of India has introduced Replantation Development Support. However, it is important to note that the performance of the scheme in terms of targets and achievements has been rather poor during the XI plan period. This calls for revisiting the provisions of the scheme and appropriate technology to explore avenues for improvement.

The annual labour requirement per hectare is around 400 man-days for Arabica and 300 man-days for Robusta. In the main coffee-growing areas, manual labour has been significantly short in supply. The sector is more associated with migrant seasonal labour. Labour costs constitute half of the total cost of production, which has increased by 30% over the last 5-year plan period.

An Overview: Tea

Tea industry has witnessed significant structural changes during the recent years, which include emergence of small tea growers and private bought leaf factories (BLF). In addition, there are some inherent weaknesses due to poor yield arising out of poor condition of the gardens (bushes above the economic threshold age limit), old factory setup (which affects tea quality and price realization thereof), poor garden management, ownership disputes and strained relationship between management and garden workers and labour shortage.

During the last decade, overall increase in *production* has been 134 million kg with an average annual increment of 13 million kg. Out of the total world production of around 3,750 million kg, India produces nearly 1,000 million kg, of which 200 million is exported and the rest consumed domestically. The Indian situation is different from that of the major tea-producing countries like Kenya and Sri Lanka, where nearly 95% of tea is exported (in India nearly 80% is consumed domestically). Indian tea exports today constitute only about 0.5% of total commodity exports and about 5% of total agro-export. Indian tea has been losing overseas market, and current share in global exports is around 12%.

Domestic *consumption* has increased by 166 million kg during the past decade with an average annual increment of 17 million kg. However, the growth in domestic consumption is primarily through population increase, and very little could be attributed to increase in per capita consumption.

Worldwide increasing *consumer preference* exhibits an upward movement along the value chain from loose to package to tea bags and ready to drink tea such as instant tea and tea concentrates. In addition, there is a growing awareness of consumers regarding traceability and the country of origin. Hence, value realization and margins earned would be higher from value-added exports. Exports of tea bags and instant tea constitute a very small percentage of the value-added exports. It is, therefore, necessary to explore the constraints that hinder value addition activities (viz. lack of technical infrastructure and innovation, R&D). Besides, the production in India is focused mainly on CTC due to heavy dependence on domestic demand

and the need to produce more cups a kilogramme (adverse product mix). In other words, response by the industry towards catering to the shift in consumer preferences in terms of types of tea is inadequate. Tea Board has introduced incentive scheme to induce more production of orthodox tea, which needs to be continued at least until the end of twelfth plan period.

The tea industry is associated with the livelihood concerns of a large section of its population, many of whom are indigenous tribal. The tea industry has an estimated number of 1.2 million of permanent *labour*; of these, more than 6 lakh are women workers. The industry generates income and livelihood directly and indirectly for more than 10 million. The labour force primarily belongs to deprived and disadvantaged sections of the population.

The output from the *small tea growers* (*STGs*) over the last 10 years has increased by 160 million kg from 97 to 257 million kg. The number of holdings has significantly raised. Presently, there are 1,57,000 holdings covering 1,60,000 ha. The share of small sector in all India tea production has increased from 11 to 26% over the last 10 years, mainly resulting from the new planting carried out from mid-1990 onwards. On the contrary, production of organized sector has declined by 53 million kg due to old age of bushes and manpower shortage. There is a scope for increasing the production of the small sector through higher productivity and introduction of appropriate institutional framework for advisory and extension services.

Mechanization needs to be introduced to deal with the lack of timely availability of labour and enhance labour efficacy. There is a need to provide impetus for mechanization through attractive package of incentives and subsidy to (1) induce planters to modify plantation to suit machinery, (2) train workers for proper operation of upgraded machineries and (3) ensure win-win situation for both workers and planters.

Analysis and Discussion

The analysis section discusses identified structural infirmities in coffee/tea to enhance linkages that add to the value and capability of each sector. Further, the study proposes a research programme to integrate natural science and engineering investigations with social science and policy research from the outset – what we call 'real-time technology assessment' to enhance the societal value of research-based innovation for India's plantation sector.

Trends in coffee area and productivity over the last two decades in India have been declining (decline being more significant in case of Arabica). Four-yearly compound annual growth rate (CAGR) since 1990 shows that coffee production has declined significantly during 2000–2004 due to prolonged price crisis and severe drought conditions. Four-yearly and decadal trends of productivity since 1990 have been estimated for Arabica and Robusta based on the compound annual growth rate (CAGR). Estimated CAGR during the last two decades reflects that productivity has declined, more in case of both Arabica and Robusta especially during the period of global crisis in the sector. However, continuing efforts for replantation could improve coffee productivity in the future with strategic interdisciplinary approach.

Technology for Indigenous Machinery for Different Operations Within Ergonomic Aspects of Coffee

Coffee cultivation is highly labour intensive; nearly 60–70% of the total input costs account for labour wages particularly for cultural operations like weeding, pruning, fertilizer application and harvest. In the recent years, labour unavailability and increasing labour wages have become major constraints in the plantations. The migration of labour force, especially the educated young generation, from the plantation areas to the city is the major reason for scarcity. To retain the labour force in the plantations, there is a need to develop appropriate technology with ergonomic aspects, which would reduce the drudgery involved due to estate operations and enhance labour productivity/unit area.

CCRI has already taken initiative to introduce mechanization in coffee plantations, viz. coffee mass raker, weed cutter, pit digger, bark scrubber and evaluated utility of machinery developed by the industry. Improvement of labour productivity through appropriate mechanization efforts is proposed as an important component in the EFC memorandum (X1 Plan-2007/08-2011-12) with the budget allocation of ten crores.

A status report on mechanization in Indian coffee (Raghuramulu 2010) has indicated the performance of machines developed in collaboration with the Mechanical Engineering Research Development Organization (MERDO), Chennai and various imported machinery. The study reveals that the weed cutters are able to ensure a saving of 5 man-days per acre with a cost saving of Rs. 325/- per acre. The pit diggers are capable of saving up to 50% in terms of labour and 25% in terms of costs. Similarly, some of the harvesters available in the market have shown good promise for introducing mechanical harvesting especially in Robusta coffee. This critical evaluation and field-based observations highlight that the mechanization to some extent reduces the dependence over labour with certain shortcomings like available spacing and planting design. It implicates the importance of multidisciplinary research that consists of agronomists, agri-engineering and other departments to evolve appropriate implements and machineries.

Infirmities

- Non-existence of separate R&D division for design, development and evaluation of appropriate tools and machines within ergonomic aspects for coffee estate operations
- Unsuitability of existing planting designs/terrain conditions for usage of larger machinery

Recommendations

- Design of indigenous and ergonomic dimensions of machinery for weeding and harvester by the multidisciplinary scientific team to suite the existing and proposed field design.
- It is therefore proposed to establish a separate R&D group for mechanization at CCRI within the existing PHT Division comprising of at least one agri-engineer, one scientist (postharvest technology) and 2 senior assistant specialists for providing impetus on mechanization efforts.

Technology for Tea Mechanization

Acute shortage of manpower and absenteeism are the major challenges faced by the Indian tea industry. Aspirations for better jobs and urban life have induced garden workers to switch over to alternative occupations. The NREGA 100-day scheme of the government has further aggravated this problem. Mechanization could be a solution to the problem of labour shortage. Mechanization is essential for timeliness in field operations and precision in placement of costly inputs to increase productivity and reduce unit cost of production and drudgery in farm operations.

The rigid specifications of *the tripartite Labour Agreement (1969)* between the Union, concerned state government and plantation management prevalent in *North India* mandate maintenance of a stipulated strength of workforce (as on 1.1.69 plus additions through subsequent agreements).

Since a decade, the South Indian tea industry is facing an acute shortage of workers. Data reveal that the percentage of reduction in labour strength as compared to 1999 varies between 21.4 and 56.2% with an average reduction of 25% across the region. Such reduction in labour may increase further due to non-availability of workforce in the estates.

The problem of non-availability of adequate workforce is severe during the two high cropping seasons, that is, April–May and June–September and October and November. During these high cropping seasons, about 10–11% of the total crop is harvested in a month itself. Many fields are abandoned during the high cropping seasons due to shortage of pluckers leading to crop loss. Hence, mechanization in all operations, especially harvesting, is essential. During these periods, even though harvesting is done with help of hand-operated shears resulting in a plucker productivity of 70–80 kg of green leaf/day/plucker, the estates are unable to harvest the crop completely. Indian Tea Association (ITA) during its presentation in Committee on Commodity Problems, Rome, June 2010, had emphasized on concerns over availability of labour, particularly during the peak plucking season, and resultant need to look at mechanization in tea estates.

Infirmities

- Non-availability of indigenous mechanization for harvesting and other field operations.

- Non-existence of separate R&D division for tea mechanization.
- Imported tea-harvesting machines from the developed countries are not suitable for the steep terrain of South India. Moreover, all these harvesting machines are highly expensive.

Recommendations

- Development of indigenous mechanization within ergonomic dimensions to overcome the acute shortage of labour in tea sector for pruning, plucking and spraying.
- Activities related to mechanization in tea were started by UPASI/TRF in late 1990s when labour problem started. Major activities of UPASI/TRF with respect to mechanization in tea are as follows:
  - Evaluation of machinery imported
  - Designing planting style and spacing suitable for different types of machinery
  - Development of cost-effective indigenous machinery in collaboration with other agencies
- Evaluation of plucking machines like *one-man-operated Ochiai harvester*, *two-men-operated Ochiai harvester* and *Microlete harvester* reveals that one-man-operated Ochiai harvester covers an area of *0.2–0.5 ha* and *120–137 kg G.L/worker w*ith requirement of 3 labours to operate. Two-men-operated Ochiai harvester covers an area of *0.6–0.8 ha* and *100–220 kg G.L/worker* with requirement of 5–7 labours (hand-operated shears also should be used to complete the plucking surface). Microlete harvester is an indigenous developed harvester, but area coverage is only 0.08–0.09 ha and 80–100 kg G.L./worker.
- Different planting style and spacing are designed for different machines. However, *120×75×75-cm* spacing of Jat/done for one-man-operated Ochiai harvester (60-cm blade length) yielded 80% good leaves. Similarly, spacing of *135×75×75 cm* for two-men-operated Ochiai harvester (120-cm blade length) yields 85% good leaves.
- During 2008–2009, UPASI/TRF made a joint effort with private manufactures to develop prototypes of indigenous harvesters. However, the effort was not successful due to lack of fund and human efforts. Therefore, there is a need of separate department for mechanization in UPASI/TRF.
- Establishment of mechanization unit at TRA/TRF.

Mitigation Effects on Climate Change and Impact on Coffee

Historically, numerical prediction of impact of climate/weather events has been linked to mesoscale models run over limited areas. Recent trends however indicate that there is a demand for comprehensive global, national and regional predictions of climate. This fact suggested a new approach to derive radar information to forecast from local agro-climatic locations.

Infirmity

- Vagaries of monsoons and change in climate induce existence of severity of pests and disease and overall climatic conditions which affect production system.

Recommendations

- CCRI research should focus on development of varieties to cope with adverse climatic conditions, especially on development of suitable varieties for heavy rainfall, drought and high temperature.
- Establishment of at least one weather station in each region of Liaison Office representing agro-climatic region and linking all these stations telemetrically for short-term forecasting of weather conditions to all growers.
- These weather stations should be linked to the Forecast Systems Laboratory at CCRI for providing cumulative and accurate meteorological data by a network of global positioning system monitoring stations for effective location-specific research. Additionally, CCRI may use the service of ISRO/NRSA/Department of Earth Science, GOI, to provide agro-meteorological data to predict climatic conditions to facilitate sustainable research.
- Revisiting the critical field operations suiting climatic change.
  - Research on the potential impacts of climate change needs in-country support to enable information into language and timescales relevant for policymakers.
  - Research and selection of varieties resistant to climate change for different agro-ecological zones.
  - Specialization of CCRI personnel in fields related to climate change through collection and processing of meteorological, hydrological and pedological rainfall data and identification of coffee-climatological risk zones.

Mitigation Effects on Climate Change and Its Vulnerabilities and Impact on Tea

Findings from Tocklai Experimental Station (TES) indicate that 200-mm decrease in rainfall in tea regions of Assam is due to climate change. This decrease in rainfall was also observed both in the active growing or production season (April to October) of tea and in the normal period. On the other hand, the minimum temperate on an average has risen at many places from 1 to 1.5°C in over the last 90 years (www.newkerala.com/news/fullnews.htm).

Estimates made at TES, Jorhat, also suggest that the carbon dioxide content is increasing at a rate of 1.5 ppm per year. Elevated carbon dioxide is known to influence C3 plants like tea favourably, and it is known that the photosynthesis increases proportionately with increase in light intensity and elevated carbon dioxide. However, the exact level of light intensity and temperature responsible for inducing higher photosynthetic activity is still unknown in tea. It is also worthwhile to mention that elevated carbon dioxide in the absence of shade in tea fields coupled with potential UVB radiation may impact the tea yields negatively. However, it is a researchable issue and needs thorough investigation, because a whole lot of weather parameters impact yield.

Long-term rainfall records suggest that the average annual rainfall is receding alarmingly. It appears that in the last more than 92 years, more than 200 mm of annual average rainfall has been lost. This decrease in rainfall is also observed in both the active growing/production season (April to October) of tea and in the monsoonal period. But the decrease in rainfall is little in the period from October to April. Since a tea plant stays in the field for more than 50 years, hence decreasing rainfall will certainly produce some stress on long-term basis, because it is the same plant that is experiencing water stress.

Infirmities

- Lack of suitable technologies/operations for the changes in the timing of natural processes like flowering, growing seasons, irrigation, planting, pest and disease
- Lack of facilities to carry out research on impact of elevated carbon dioxide and temperature

Recommendations

- Establishment of climate research laboratory.
- Revisiting package of practices with regard to field activities, viz. rationalization of fertilizer application, alternate control mechanism for pests and disease, pruning, plucking and manuring, to help tea industry for the overall development of the sector

Formulation of Eco-Friendly Plant Protection Measures and Management

Pesticide residues in tea cause serious concern globally. In recent years, there has been a greater dependence on the use of pesticides (7.35–16.75 kg/ha) with little importance on other safe control methods for the management of tea pests. Due to this practice, the tea pests showed a higher tolerance/resistance status. The growing concern about the pesticide residue in made tea, its toxicity hazards to consumers, the spiralling cost of pesticides and their application has necessitated a suitable planning which will ensure a safe, economic as well as effective pest management in tea (http://www.ncbi.nlm.nih.gov/pubmed/19297972). Due to continuous use of synthetic pesticide during last two decades, for example, the tea mosquito bug *Helopeltis theivora* has become the most destructive sucking pest in Northeast India and indiscriminate usage which affects the quality of tea (www.himalnews.wordpress.com). Therefore, usage of most of commonly used pesticides is restricted, and only a few pesticides are allowed for the management of pests and diseases in tea. Continuous use of synthetic chemicals for the control led to development of resistance in targeted organisms. Besides, overuse of chemical fertilizer affected the soil health and soil enzymes. Moreover, in tea only chemical weed control measures are being practised for the last two to three decades due to cost-effectiveness and requirement of less labour force.

Infirmities

- Higher pesticide residue in made tea due to overdose of pesticides, weedicides and chemical fertilizers
- Lack of adoption of GAP to minimize pesticide residue at field level

Recommendations

Development of integrated pest and disease management (IPDM) strategies with usage of:

- Biological enhancement of efficacy of biological control agents, including entomopathogens, development of kairomone and pheromone traps and microbial biocontrol agents
- Development of biological and botanical weed control techniques
- Integrated nutrient management (INM) by utilizing bio-fertilizer

Technology for Coffee Quality Improvement (Organoleptic)

The intrinsic quality of coffee is influenced by the plant material, cultural practices and processing techniques both at the estate and curing works. Delayed pulping, over-fermentation, improper washing, storing of coffee near pesticides, packaging of coffee in inferior quality gunny bags and improper drying cause off-taste in the coffee which can be evaluated during cupping.

A prescribed manner of brewing and a specific series of steps lead to a complete sensory evaluation through olfaction, gestation and mouthfeel sensation, because cupping technology is usually associated with economic purpose such as buying or blending of coffee.

Quality assurance systems (QAS) already exist and are becoming compulsory at all levels of coffee production system. It is likely to become as an essential component at the grower level over the next few years. QAS is likely to be an industry-wide requirement regardless of the level of development of the sector. It would incorporate chemical usage and be a requirement of all industries making funding applications for research and development. However, there is a need to collect, collate and modify where necessary information from other production areas and systems. Certification systems for roasters are already in place and are internationally recognized. There is a need for whole-chain management of coffee quality. Even the assistant preparing the cup of coffee can have a crucial effect on consumer satisfaction. It is therefore proposed to strengthen the quality control unit with appropriate technology for organoleptic evaluation.

Infirmities

- Restricted focus on quality aspect of development with special reference to intrinsic quality of coffee at the estate level
- Lack of adoption of GAP and GMP to ensure quality of coffee
- Limited R&D activities on quality assurance system with special reference to coffee quality profiles including safety aspects

Recommendations

- Research on *organoleptic*[1] characteristic for specialty coffee to improve flavour, taste, aroma, mouthfeel, colour, long-lasting taste and other analogous factor of cup quality
- Effects of altitude, shade, fertilization and processing factors which influence the organoleptic characteristics of cup quality
- Diffusion of information on GAP, GMP and community processing
- R&D thrust areas on quality assurance system, including the relationships between coffee composition and sensory properties and relationships between sensory properties and consumer perceptions of quality and accessibility

Research on Quality and Safety-Related Issues in Tea

Quality and safety (Qualsafe) in plantation commodity and food sector through application of HACCP/ISO 22000 and GLOBALGAP principles of sanitary and phytosanitary (SPS) agreements of WTO are essential for competitiveness, equally in case of both the producers/manufacturers and exporters, in this era of food security regime. It is particularly important to understand the application of these principles within SQF-SCM perspectives in tea sector value chain to delight customer. Principles of food hygiene are a systematic approach to the identification, assessment and control of hazards in tea sector.

The SPS aspects of HACCP/ISO22000 are an abbreviation for hazard analysis and critical control point. It is the most effective management system of maximizing product safety and quality and cost-effective system. It targets system to critical areas of processing and reducing the risk of manufacturing and selling unsafe products. Critical control points are the steps in manufacture and value addition where control is essential to guarantee that potential hazards do not become manifest as actual hazards. A critical control point (CCP) of HACCP system is a location, a practice, a procedure or a process, which, if not controlled, could result in an unacceptable safety risk in made tea.

Infirmities

- Different MRL levels for same chemicals in different countries
- Lack of documentation on data related to pesticide residue

---

[1] ISO-1992 denotes the attributes of a product that are perceptible by sense of organs. It is the science of sensory analysis, measuring flavour.

Recommendations

- To formulate new projects for fixation of MRL for national and international standards in collaboration with CFTRI, NABL, PFA intergovernmental group and the Ministry of Health, GOI
- To set up a state-of-art residue laboratory with an outlay during XII 5-year plan

R&D activities on quality assurance system including safety aspects of tea to be undertaken with special reference to the following:

1. Research for compiling need-based quality assurance system in identification of CCP, CL and corrective action across tea value chain with reference to HACCP/ ISO 22000 to meet WTO: SPS/TBT requirements
2. Industry-driven research to identify 13 critical points with special reference to tea to meet the criteria of GLOBALGAP which incorporates IPM and ICM practices within the framework of sustainable tea production for global harmonization

Need for Trans-disciplinary Development

Policy programme implementation is essentially dependent upon interagency (or) multi-R&D/extension/promotion unit collaboration and resource sharing, representing commitment to something larger than the single-focused organizational goals and objectives and a shift to enter into partnership with other commodity boards to achieve shared goals and visions and respond to mutual interest and obligations.

From a managerial perspective, commodity boards inter-organization collaboration is often encouraged on the basis that it delivers greater productivity than the alternatives. It is proposed to create linkage among four vital commodity boards as part of restructuring exercise to sustain focus on collective development through mutual help.

Infirmity

- Lack of specific occurrence of disciplinary crossovers: *trans-disciplinary*[2] realization of commodity boards activities across plantation research institutes that addresses societal problems

[2] The *trans-disciplinary approach* is a framework for allowing members of an R&D team to contribute knowledge and skills, collaborate with other members and collectively determine the services that most would benefit the commodity research and development. 'This approach integrates the developmental needs across the major research domains' and 'involves a greater degree of collaboration than other service delivery models'. A trans-disciplinary approach requires the R&D team members to share roles and systematically cross inter-institutional discipline boundaries. The primary purpose of this approach is to pool and integrate the expertise of R&D team members so that more efficient and comprehensive assessment and intervention services may be provided. The communication style in this type of team involves continuous give-and-take between all members on a regular, planned basis. Professionals from different disciplines research, teach, learn and work together to accomplish a common set of R&D intervention goals for commodity. The role differentiation between disciplines is defined by the needs of the situation rather than by discipline-specific characteristics. Assessment, intervention and evaluation are carried out jointly by designated members of the team.

Recommendations

- The proposed plantation coordination committee (PCC) serves as an autonomous organization under the Department of Commerce (DOC), Ministry of Commerce and Industry, Government of India. With four central plantation research institutes and its associated regional and substations spread across the country, PCC network (Fig. 1) shall be one of the largest national plantation research and extension systems in the world.

Retention and Turnover of Scientists

Building and maintaining the magnetism is necessary to attract and retain scientists of CCRI for dynamic and strategic R&D planning. R&D organizations face major challenges when they consider the increasing difficulty of finding and retaining talented scientists, a younger group with different attitudes about work and a growing population of senior scientists heading towards retirement. A recent study shows 85% of HR executives state the single greatest challenge they have in managing the scientists.

The retention and turnover of CCRI personnel reveal that initiative comes at a time when many strategic and futuristic programmes of CCRI are getting delayed because of manpower crunch and failure of the organization to retain scientists. 'The high attrition rate especially at the entry level is a serious problem affecting CCRI strategic progrmames, which is around 24% has become a key factor affecting its performance'.

Infirmities

- Non-availability of required scientific and technical personnel
- Delay in implementation of 6th CPC at par with ICAR/CSIR
- Delay in recruitments and implementation of appropriate career improvement policies from time to time as done in other research organizations like ICAR

Recommendations

- Recruitment of scientists/technical officers to meet basic requirement of Central Coffee Research Institute with appropriate scales at par with ICAR rank and scale.
- Appointment of new scientific personnel with and career-promising improvement, opportunities to young scientists may reduce high attrition rate and enhance performance of R&D within CCRI.

International Competitiveness

Coffee is an important commodity and a popular beverage. Over 2.25 billion cups of coffee are consumed in the world every day. Most of the world coffee production takes place in countries such as Brazil, Colombia and Vietnam. Coffee consumption

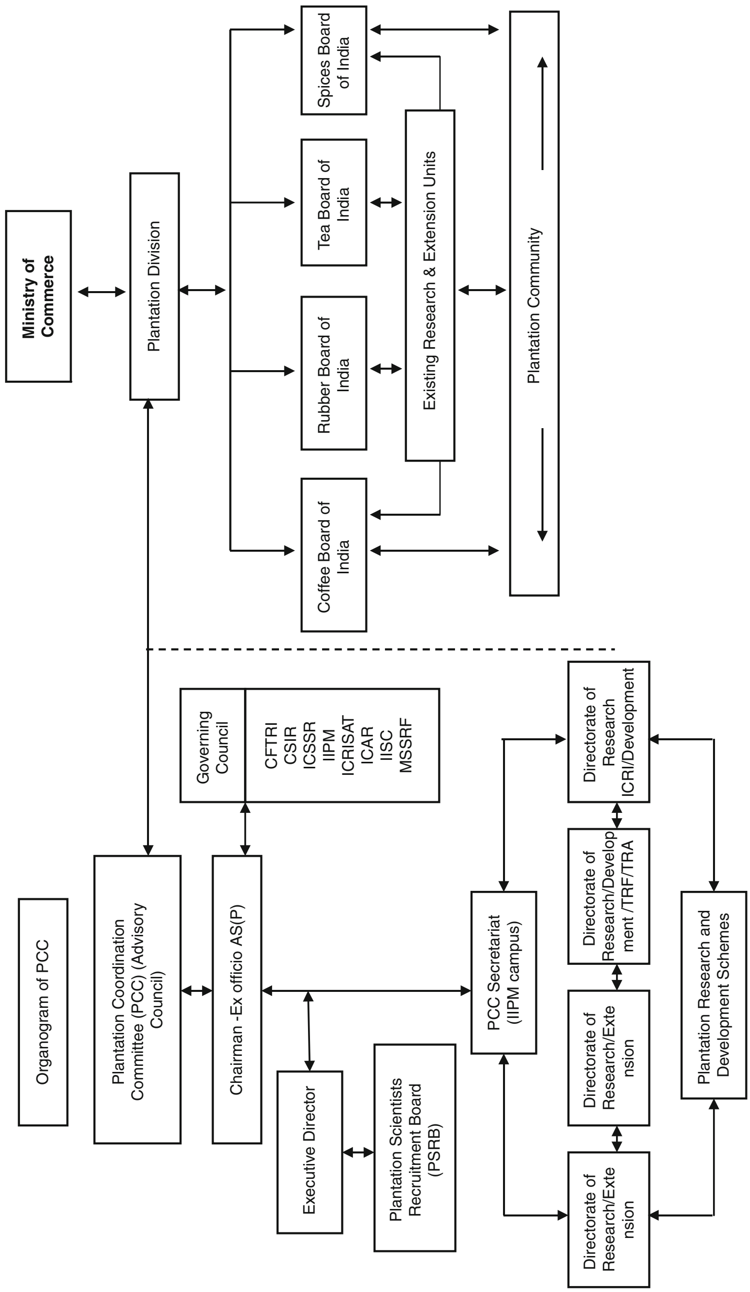

Fig. 1 Proposed organizational structure for PCC of Commodity Boards of India, Ministry of Commerce and Industry

Table 3 Comparative profile of countries

Basic indicators	Brazil	Colombia	India	Vietnam
Total production (000 bags)	39,470	8,098	4,827 (4)	18,200
Domestic consumption (000 bags)	18,390	1,400	1,573 (3)	1,583
Productivity (kg/ha)	1,259	940	766 (4)	2,011
Per capita consumption (kg)	5.7	1.84	0.08 (4)	1.08
Export of green coffee (60-kg bags)	27,366,040	7,258,326	2,092,950 (4)	17,043,720
Export of processed coffee (60-kg bags GBE)	2,973,118	635,589	1,028,890 (2)	8,014
Exports as a percentage of production (%)	53.4	82.7	67.4 (3)	91.3
Value of exports of all forms of coffee (million US$)	4269.55	1710.03	375.53 (4)	1491.64

Source: ICO and FAOSTAT (2008); Figures in parentheses denote India's position in comparison with top coffee producing countries, viz. Brazil and Colombia (Arabica) and Vietnam (Robusta)

is concentrated primarily in Western Europe and North America, though Eastern Europe and parts of Asia (especially China) exhibit an increasing trend. The report is based on secondary sources published during 2002–2011. A basic comparative profile of these countries is presented in Table 3.

Evidently, coffee is an export-intensive sector in all these countries. However, it is observed that the proportion of processed coffee exported is significantly high (rank: 2) in India compared to other competitors. India occupies a much lower rank (rank: 4) in terms of earnings from exports. Much of India's production is destined for Italy and countries in the former Soviet Bloc. Arguably, the potential for higher value realization is limited as exports to Italy take the form of just filler beans and the Indian coffee quality is not adequately rewarded. Similarly, the portion of exports to the former Soviet Bloc is converted to instant coffee, with limited export value realization compared to other countries. India's share in the premium-priced Arabica specialty market continues to be very limited at around 5%. This requires a closer attention as competing countries enhance their shares in techno-managerial quality conscious to markets and serve the growing domestic specialty sectors. A comparative assessment of relevant parameters is presented in Table 4.

Conclusion

Studies and assessments on the structural infirmities in plantation and socio-economic aspects of the planters are a prerequisite for the success of plantation sector. Design of indigenous and ergonomic dimensions of machinery by the multidisciplinary scientific team to suite the existing and proposed field design, to overcome the problem of acute labour shortage, is recommended. It is therefore suggested to establish a separate R&D group for mechanization for providing impetus on mechanization efforts.

Table 4 Comparative assessment of relevant parameters

Indicators	Brazil	Colombia	India	Vietnam
Production	Open-sun monoculture	Open-shade monoculture	Shade-grown mixed crop	Open monoculture
Practice	Intensive cultivation	Intensive cultivation	Optimum density/inputs	Intensive cultivation/high usage of inputs
Rainfall/irrigation	Well-distributed rainfall	Well-distributed rainfall	Seasonal rain/long dry spell	Basin irrigated
Soil	Fertile volcanic soil/flat to gentle slope terrain	Fertile volcanic soil	Lateritic to clay loam soil	Fertile volcanic soil
Labour issues	High labour costs	High labour costs	Comparatively lower costs/ non-availability	Comparatively lower costs
Status of mechanization	Fully mechanized farms (miniaturization)	Limited mechanization	Difficult to mechanize	Mostly manual labour (family)
R&D structure	Brazilian Coffee Research and Development Consortium	CENICAFE	Coffee Board of India CCRI	VICOFA initiatives
	Embrapa	Federacafe	Extension network	WASI

It is proposed to formulate new projects for fixation of MRL for national and international standards. Research may be undertaken for compiling need-based quality assurance system in identification of CCP, CL and corrective action across tea value chain with reference to HACCP/ISO 22000, GLOBALGAP, ISO 9000 and SQF after successful implementation of GHP, GAP and GMP to meet WTO: SPS/TBT requirements.

In order to study on mitigation of effects of climatic conditions, research should focus on development of varieties to cope with adverse climatic conditions, especially on development of suitable varieties for heavy rainfall, drought and high temperature. The weather stations should be linked to the 'Forecast Systems Laboratory' for 'global positioning system'. It is necessary to revisit production practices with regard to field activities (viz. rationalization of fertilizer application, alternate control mechanism for pests and disease, pruning, plucking, manuring).

Research on Coffee Quality Improvement (CQI), focus on organoleptic implies characteristic for specialty coffee to improve flavour, taste, aroma, mouthfeel, colour, long-lasting taste and other analogous factor of cup quality is recommended.

It is recommended that formation of plantation coordination committee (PCC) across all commodity boards with broader objectives of discussing common issues across all commodity sectors, on a common forum.

Building and maintaining the magnetism is necessary to attract and retain scientists for dynamic and strategic R&D planning. R&D organizations face major challenges when they consider the increasing difficulty of finding and retaining talented scientists, a younger group with different attitudes about work and a growing population of senior scientists heading towards retirement.

In the face of serious competition from competing countries in terms of cost competitiveness, India needs to identify new potential markets in Asia and Eastern Europe. At the same time, India has to enhance its presence in the high-quality specialty markets, which has been insignificant thus far. It requires investments in the development and orientation of differentiated quality with 'country of origin (COO)' tag to remain competitive.

Bibliography

Arya OP (2007) Report of the Committee on Legislation Plantation Sector. Department of Commerce, New Delhi

Coffee Board of India (2009) Database on coffee

Coffee Board of India (2010) Database on Coffee, July–September

Food and Agriculture Organization of the United Nations (2010) Statistic, FAO website faostat.fao.org

Crisil Research, Annual Review on Tea 2009

Indian Institute of Plantation Management (2011) Report on Structural Infirmities in Plantation Sector (SIPS): coffee. April, IIPM, Bangalore

Indian Institute of Plantation Management (2011) Report on Structural Infirmities in Plantation Sector (SIPS): tea. April, IIPM, Bangalore

International Coffee Organization (2008) Statistics, country profiles, ICO website www.ico.org

International Trade Centre (2002) Coffee: an exporter's guide. ITC, Geneva
Miebach Group (2004) Logistics and cost competitiveness of coffee exporting countries
Organization for Economic Co-operation and Development (OECD) (1992) Technology and economic growth. In: Technology and the economy: the key relationships. OECD, Paris, p 184, Chapter 8
Raghuramulu Y (2010) Mechanization in Indian coffee. A status report. Coffee Board of India Bangalore
Tea Board of India, Tea Plantation Development Scheme for the XI Plan period
Tea Board of India (official website), accessed during July 2010 – April 2011
The Plantation Labour Act (1951) Gazette of India
World Bank (2007 and 2011) Doing business databases
World Bank (2008–2011) Colombia trade logistics project

The following websites were visited and relevant information was accessed during January-April 2011

Cenicafe, Columbia
Embrapa, Brazil
Fairtrade
FNC, Columbia
Global Exchange, 'Fair-trade Farmers in Colombia'
Vietnam Coffee and Cocoa Association (VICOFA)
Western Highlands Agriculture and Forestry Science Institute (WASI), Vietnam.
Wikipedia