CHAPTER - IV

TECHNICAL ASPECTS OF TEA PRODUCTION

4.1 Technical Aspects Of Tea Production

Before going to the analyses of different facets of tea production economics , it is imperative to understand various technical aspects related to tea production system itself. Unlike other agricultural commodities tea comprises of both ' farm ' and ' factory ' in its domain of production. Farm produces green leaves which the 'factory' transform into 'processed tea' i.e., 'made tea'. The functioning of these sub- systems are interdependent to each other though the operations involved in farm are entirely different from those of processing tea in the factory. Tea is the only crop in the world where the perennial plant is harvested at a regular interval of time for its leaf throughout the season. Therefore, to sustain its longevity and economic viability various agro-techniques and practices are followed in the tea plantations system, which have direct bearing on the production and productivity of tea whether it be 'green leaf' or 'made tea' . The operations involved in cultivating tea can be grouped as ''Agricultural Operations'' while those involved in the factory as ''Industrial Operations''.

4.1.1 Agricultural Operations

The agricultural operations can broadly be divided into three types of operations namely,

A. Planting ;
B. Maintenance which includes pruning , manuring ,watering and shading of tea plant; and
C. Plucking .

A. Planting Operation

(i) **Soil** : Soil is the medium through which tea grows. It is perhaps the most important factor governing and limiting the life of the tea plants. The economic viability of the plants directly depends upon the condition, status and physical features along with the chemical constitutents of the soil on which plant is laid and developed. The concept of soil required for tea plantation is complicated and it is also beyond the scope of this study. The basic requirement of soil ideal for

good plantation is that it should have all the 16 vital nutrient elements[1] like carbon, hydrogen, nitrogen, phosphorous, magnesium, etc; it should be acidic in nature; pH of the soil should lie between 4.5 to 5.5[2]; it should be free from lime and calcium carbonate[3] ; it should be porous so that the delicate roots penetrate through it easily. Mulching of soil is the pre-requisite for the preparation of the soil for tea plantation .

(ii) **Propagation :** Once land is prepared planting operation starts . Previously bushes were propagated from the seeds . But since fifties with continuous release of vegetative clones by Tocklai Experimental Station clonal propagation has been gradually introduced. Of late, use of bi-clonal seeds has also been started . Each type of materials has its own advantages as well as disadvantages. Seed populations are suited for wide range of environmental conditions. They are drought tolerant , their life span is long. On the other hand, clonal plants are environment specific in adaptability, less drought tolerant and their longevity is less. [4] But it has one merit that it is more productive than the seed plants. This is the main motive behind the introduction of clonal materials.

B. Maintenance Operations

Pruning , skiffing, watering and shading of the tea bushes are the major operations required to keep the tea bushes in healthy condition so that the bushes remain productive for a longer period. Technical details of these operations are given in the following.

(i) **Pruning and Skiffing** : These are very important operations in tea gardens. The main objective of pruning is to modify the growing pattern of the tea plants to the shape of a bush enabling the labour to pluck the shoots from a flat plucking surface conveniently. It is also carried out to remove the top congestion of the bushes by removal of the dead, diseased and unproductive branches. A young tea plant, if permitted to grow freely, will develop into a tree of 15 to 25 feet or even more which will produce very few shoots for manufacturing. Hence the young trees are prunned to develop a sturdy frame which can sustain a vegetative growth in future and maximum crop even in the early years . Mature bushes are prunned to

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1. Barua , D.N. , *Science and Practice in Tea Culture*, Tea Research Association, Toklai , Jorhat, 1989, p. 129.
2. Sinha , M.P., "Fertiliser Management in Tea, " *Field Management in Tea* (ed.) , Tea Research Association , Jorhat , 1988, p.33.
3. Barua , D.N. , *Science and Practice in Tea Culture* , Tea Research Association , Toklai , Jorhat , 1989, p. 129.
4. Bezbaruah , H.P., Singh ,I.D. , "Advancement in the Use of Planting Materials"*Field Management in Tea (ed.)*,Tea Research Association , Jorhat , 1988 pp.11-12.

renovate the branch system and to keep the bush in vegetative phase. Pruning thus increases production.Skiffing is one kind of pruning. When the bushes are cut lightly it is called skiffing. Depending upon the extent of cutting pruning and skiffing are classified into several categories descriptions of which are given below.

(1) Light Pruning (LP) : It is a cut made by a sharp pruning knife into the wood which are one or more year old at a level usually 1.5 cm. above the previous pruning cut. The pruning Table should be absolutely flat.

(2) Deep Skiff (DS) : It is a cut made by sharp skiffing knife at a point half way between the previous year's tipping and pruning height . For instance, tea tipped at 20cm. is deep skiffed at 10cm. above the previous level .

(3) Medium Skiff (MS) : It is a cut made by sharp knife about 5cm. below the previous tipping level.

(4) Light Skiff (LS) : It is a cut operation carried by a sharp skiffing knife usually made 1cm. above the previous tipping height.

(5) Level of Skiff (LOS) : This is a practice carried out to level off the plucking surface at the end of the plucking season by removing plucking stubs.

(6) Medium Pruning (MP) : This operation is done to shorten the height of the bushes and thereby to remove the knots and unproductive woods from the bushes. The height of the bush in this operation is usually kept at 50-70 cm. from the ground. Sometimes tea bushes are kept without pruning or skiffing. This is called unprunned.

Previously annual pruning was followed in the tea gardens. But after 1960 with the innovation of skiffing, longer pruning cycles were adopted. A pruning followed by skiffing or unprunned for two, three or four years till it reaches again for pruning treatment is called the pruning cycle. In order to increase the crop, and growing period a longer pruning cycle with various combinations of skiffing and unpruning is followed. S.K.Datta (1969) [5] in his study worked out the estimates of gain under given condition from different forms of skiffing.

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5. Dutta, S.K. , " Pruning Times and Types and Crop Distribution ", Proceedings of 24th Conference , Toklai Experimental Station , 1969, pp.39-46.

The results of his study are given below.

Unprune/Skiff	Percentage gained
DS	10-15
MS	15-20
LS	20-25
LOS / Unprune	30-35

Since the conditions and objectives differ from garden to garden and even from section to section of the same garden, there is no hard and fast rule regarding the following of pruning cycle. It depends on the wisdom of the management.

Pruning operations in Dooars is generally carried on during the month of December and January. This enables the plucking of leaves from bushes with the start of pre-monsoon rain in March.

(ii) Manuring : Manuring of tea plants is the operation essential for perpetuating its life span and to keep it more productive. When the soil fails to supply the proper food nutrients essential for living of the plants, the necessity of manuring arises which in turn ensures better crops during the growing season. Deficiency of any of the nutrients essential for the plants is reflected by different symptoms on the bushes and when this is observed manure from outside is applied after judicious consideration in order to keep the bushes vegetative at the economic level.

It is impractical to apply manure in very wet weather or in very dry weather. On dry soil the nutrients will not go to the reach of the roots of the plants. Again during heavy rain when the soil is very wet the fertiliser will be leaching out. It is ideal to apply manure on moist soil . Therefore, under the rainfed condition manure usually is applied when spring rain moisten the soil. In Dooars the month of March is reported as the optimum time for manuring.

Out of the 16 macronutrients, Nitrogen (N) is most widely used in the tea gardens. But nitrogen alone cannot augment the growth of the tea plants. In the absence of other nutrients needed by the plants, the growth of the plants suffer. To get the desirable result i.e., to get higher yield nitrogen must be applied in combination with other elements mainly potassium(K) and phosphorous (P). At present use of potassium is increasing day by day throughout the tea growing world . Phosphorous requirement is also being realised. A supporting dose of

phosphatic fertiliser to the NK combination is found to enhance yield of tea.[6] Nitrogen being the major nutrient for tea, potash and phosphate are tagged on to it for increasing its efficiency. The three major nutrients N,P and K are usually applied in a fixed proportion although this proportion vary from place to place.

(iii) Water Management : Water management is also an important part of the maintenance of tea bushes. It means the control of water use in tea husbandry in a way that it would create an environment congenial to the healthy root growth system resulting maximum crop from the tea bushes. To quote Barua[7] , " Plants take up nutrients from the soil aqueous solution. In a dry soil nutrients applied as fertilisers as well as that present in the soil remain unavailable to the plants. Water itself is essential for plant growth but its excess in soil interfere with the absorption of nutrients by plant roots. Manuring become ineffective if plants do not get the right amount of water. In practice water management in tea involved dealing with situation arising out of too little , too much and uneven distribution of rain ".

A well designed drain promotes conditions for root growth , thus enabling the bushes to more drought tolerant , keep the p^H level within desirable level , resist soil erosion, solve the problem of water logging ,etc. In this way a good drain would keep proliferation of the branches of tea bushes.

As good drainage is important to pass off the excess water from the garden during the rainy season, irrigation is also equally important to cater need of water to the plants during the dry season when the bushes suffer from water deficiency which inhibits the supply of nutrient to the bushes resulting poor growth and even death of the bushes. Before this stage is reached it is essential to irrigate which basically makes water more available to the roots thus facilitating early crop and more crop from the bushes . Now-a-days the sprinkler system is introduced in most of the gardens to irrigate bushes during the dry season . The irrigation to mature tea bushes seems to be necessary from October to March-April whereas for young tea it should be from October to January under Dooar's agro-climatic condition.

C. Plucking

The operation of harvesting the crop is termed as plucking . This means the removal of the tender shoots from the bushes and with these shoots ' tea' is manufactured . The plucking practices determine the quantity and quality of made tea. Growth of shoots is one of the main

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6. Barua, D.N., *Science and Practice in Tea Culture* , Tea Research Association , Jorhat , 1989, p. 465.
7. ibid, pp. 482-483.

factors which determine the yield. Hereditary character (i.e., seed or clone etc.) of the bushes , rainfall, humidity , temperature , fertility of the soil are the most influencing factors in determining the growth of the shoots[8]. Standard of plucking (i.e., the number of leaves to be included in the plucked shoots) has a direct bearing on the quality of manufactured tea (i.e., made tea) . Chemical analyses confirm that best tea is made from flush that consist of ' two leaves and a bud' . Plucking which consists of ' two leaves and a bud ' is called the ' fine plucking '. Tea made from the course leaves is poor in quality and freaky in appearance . Interval in-between two successive plucking is the major determinant of types leaves to be plucked . This interval in days between two successive plucking operations is termed as 'plucking rounds'. Longer the plucking rounds coarser be the shoots plucked and poorer will be the quality of tea manufactured . The reverse is true in the case of shorter plucking round . However, there is no optimum plucking round and it differ from variety to variety and from place to place . Climatic conditions also influence the length of plucking remarkably.

D. Shade

Shade means a thin and unbroken cover of foliage over tea bushes. The available studies on shade in different regions and countries reveal the contradictory conclusion on the efficacy of shade trees in tea gardens. But in North-East Indian condition the beneficial effect of shade on growth and productivity of tea has been well established [9]. Investigation on shade trees reveal the following beneficial effects on tea.

(a) it helps in keeping soil temperature cooler and soil moisture even during the driest days in summer ;

(b) it helps in adding nutrients to the soil in the form of leaf , twig and pod droppings ;

(c) it helps in activating photosynthesis by reducing the leaf temperature in hot days when temperature exceeds 35^0 C , the upper critical limit for photosynthesis [10]. However, in cool climate where leaf temperature remains below 30^0 C , shade will depress photosynthesis by preventing temperature of leaves to rise towards the optimum ;

(d) it helps in increasing yield by partitioning of growth between different plant organs [11];

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8. Sarkar , S.K., "A Few Aspects of Plucking " , *Field Management in Tea* (ed) , Tea Research Association , Tocklai Experimental Station , Jorhat, Assam, 1988 , p. 50.

9 Barua D.N., Sharma , P.C, " Effect of Leaf Pose and Shade in Yield of Cultivated Tea " , *Indian Journal of Agricultural Science* Vol. 52, 1982 , pp. 653-656.

10 Phukan , B.C. , " Management of Shade Trees", *Field Management in Tea* , Tocklai Experimental Station , Jorhat , Assam ,1961 , p. 63.

11. Ibid , pp. 64.

(e) it absorbs both infra red rays and visible radiation of sunlight reducing thereby the incidence of not only heat but also light energy on the tea bushes underneath .

In spite of all these beneficial effects of shade trees there are also some disadvantages associated with it . Not every type of shade species produce the above mentioned beneficial effects to tea bushes. The beneficial effects of shade trees varies from species to species and from place to place . Competition of shade trees with the tea bushes for water and nutrients and depreseing effect of dense shade on yield are considered to be the major disadvantages of shade trees. Most of the shade trees used in North-East India do not posses thin , spreading canopies and even at normal spacing , they provide patchy shade .Only *Albizzia Chinesis* posessed the quality of thin coverage . But due to its susceptibility to ' canker ' it has killed thousand of bushes and hence it has been abandoned .The widely used species *Albizzia Odoratissima* , if planted closely to provide continuous cover , shade becomes too heavy . These heavy shades obstruct the penetration of sunlight to the tea bushes particularly to the lower leaves which do not get enough light . Consequently a photosynthesis is reduced causing yield depression of a large fraction of tea foliages[12] . Not only this , in the presence of reduced photosynthesis , fertilisers becomes less effective [13]. In the course of time a stage is reached when further increase in the dose of the fertiliser cannot induce any more growth to the bushes[14]. Shade trees are prone to attacks by various pests and diseases , some of which are very common enemies of tea . Very often these pests and diseases are migrated to the tea bushes from the shade trees. This again may depress the yield of the bushes unless proper measures are taken to control them .

3.2.1 Industrial Operations

With plucking , the agricultural operation is over and the produce becomes ready for the factory operation . Tea leaf has to undergo several physical as well as chemical changes before it is ready for consumption . It requires the development of suitable factories equipped with the method of bio-chemical engineering in various stages of production process.

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12. Barua , D.N., *Science and Practice in Tea Culture* , Tea Research Association , Jorhat ,1989. p. 418.
13. ibid , p. 417.
14. ibid , p 418.

Tea making is an art as well as a science which constitute five different processes as discussed hereunder :

(1) Withering
(2) Rolling
(3) Fermenting
(4) Drying
(5) Sorting and Grading

(1) Withering : Withering means the partial dehydration of the shoots i.e., evaporation of water from the shoots by which the leaf becomes flaccid and is reduced from its turgid condition to a pliable form by uniform and gradual loss of moisture . It is a vital link in the chain of manufacture.

Leaves are withered in withering lofts, drums , tunnels , troughs and continuous withering machines . But use of withering trough is the common practice in most of the tea gardens in Dooars. This is also true for the gardens selected for the study. Trough is usually of 6ft. wide and 12 inches in depth, length varies from 45ft. to 120ft. When leaves are brought to the factory from the garden they are evenly spread over the trough. This reduces the moisture of the leaves . There is no hard and fast rule regarding the extent of moisture dissipation . Nevertheless , an extent of 55 to 60 per cent evaporation is generally regarded as desirable . The process of withering increases the content of caffeine , soluble sugars and amino acids . It also changes the proportion of organic acid and activity of leaf enzymes [15]. There are two types of withering --- natural and artificial . But the most convenient form is natural withering where leaf is spread over the surface of the trough and the atmosphere absorbs all moisture from the leaf . In the artificial withering atmosphere has no role and withering is conducted by mechanical and scientific aids to control the rate of moisture evaporation .

The factors inflencing the rate of withering are as follows :

a. Temperature and humidity of the atmosphere
b. Air flow rate
c. Thickness of spreading leaf

(2) Rolling : When the leaf has been correctly withered and becomes flaccid it is ready for the

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15. Mitra . K.K . "Monitoring and Control of Processing Variable in Tea Manufacture ", *The Assam Review and Tea News*, Vol .78 ,No. 6, 1989, p. 7.

next important operation of rolling. The object of rolling is to extract the sap and juices from the leaf by rupturing its cells. As soon as the cells are ruptured the enzymes in the leaf come in contact with oxygen of the air and oxidisation takes place. This oxidisation is necessary to develop flavour, colour etc. of made tea.. The most popular method of rolling followed in Dooars is the use of "Crushing , Tearing and Curling " (in short C.T.C) machine where 3 or 4 sets of rollers each consisting of 2 engraved rollers move frequently and rupture the leaf . The rollers are generally 36 inches long. For better result the cutting teeth on the surface of roller are kept sharpened from time to time. The CTC machines with its differential roller movement would tear and curl the leaf and repeat the treatments with ever increasing pressure. This results in the development of a particle which can be said to be the very core of tea leaf cell-structure. There is also use of " orthodox " roller to manufacture orthodox tea. Such roller consists of circular table with baten fixed in the top, a cylindrical box with a bottom and a pressure cap.

(3) Fermentation : The moment tea leaf is crushed the operation of fermentation starts . It means the decomposition of carbohydrates by yeasts. In fermentation cell constituents of the leaf come in contact with air under controlled temperature (about 30^0 C) and humidity . It begins to change colour immediately and develop quickly the reddish hue. It is during fermentation that the flavour associated with tea develops. During the process of fermentation tea tannin which is colourless in its raw state, on becoming oxidised develop into red products which are responsible for the characteristic red colour of tea infusion and account for the strength of liquor.

For better fermentation , cool , humid , and well ventilated place is chosen . It is advised that rolling room and fermenting room should be placed together to obtain satisfactory result . The fermenting leaf should not be exposed to sun light.

Several methods are followed in the fermenting process. These are fermenting floor, fermenting tray , fermenting trough , mono-rail fermentation , continuous fermenting machine etc. But the 'use of fermenting floor' in fermenting the leaf is found most common in our selected gardens . The use of mono-rail and continuous fermenting machine is being adopted of late. In the floor system of fermentation , floor of the fermenting room is painted with a very costly paint . On this floor the crushed leaves are thinly spread . In the mono-rail system several plates containing thinly spread rolled leaf are hung from a chain fitted with wheel like the rail . These chains along with plates slowly move in the fermenting room till the leaf is fermented . Continuous fermenting machine is a type of machine on which the leaf is spread and the machines by virtue of its characteristic render the leaf fermented.

But whatever be the method used , leaf which has been put to fermentation begins to change its colour , gradually acquire a coppery hue and develop the aroma . The time of fermentation is very important in determining the quality of liquor and flavour . Correctly fermented leaf gives liquors which are brisk and pungent.

(4) Drying : Fermentation being over , the processed leaf is put into drying machines where it is passed through a chamber heated by firing to a temperature of about 250^0 F . The object of firing is to arrest fermentation and to remove moisture . Where the physical aspects of firing concerns the removal of excess water to bring down moisture content , the chemical aspects concerns to giving desired mellowness which is autometically brought about by temperature , time and air speed to remove excess water.

There are different types of drying machines which differ from one another by technical aspects. But the basic principle lying behind the functioning is the proper timing of firing as well as the temperature of the drier to which tea is subjected to is very important determinant for successful tea making. The lowest temperature at which fermentation is stopped noted to be 140^0 F The tea drier blows hot air to allow such a range to temperature to arrive at the spot where the fermented leaf is charged into a tea drier. Tea in the machine met with two types of temperature--the inlet temperature and the exhaust temperature. Though there is no specific level of the inlet temperature i.e., the temperature of the air entering the drying chamber, the usual range lies between 180^0 F and 250^0 F. Regarding the exhaust temperature, (the temperatures , a few inches above the leaf entering the drier) the range should be between 120^0F and 140^0 F and must not fall below 120^0 F.

The drying is a continuous process where the fermented leaf is fed into the top of the machine , which gradually comes down on a series of trays which travel toward and forward through the hot air of about 250^0F temperature blowing from the bottom of the machine . In this way the trays reach to the discharged opening at the bottom . The leaf just discharged is collected in baskets or mats which are kept to receive it.

This is the first firing that leaves the tea with 2 per cent to 4 per cent of moisture . But if the moisture content happens to be more than this , the question of second firing arises . This finishes off the drying process at a lower inlet temperature and shorter period of time to arrive at the established 3 per cent moisture content.

Previously wood was used as a fuel in drying machine . But now the firing conditions have been improved considerably . Now-a-days coal and furnace oil is used as fuel in most of the gardens.

(5) Shifting and Grading : After drying , teas are put through shifting and sorting machines that convert the bulk tea into different grades. The shifting room is usually a larger one which is provided with a dust fan and several fibre extracting machines. These machines discharge the dust and fluff from shifters out side the building . The shifting machines are of two types--- revolving and oscillating . These machines are equipped with several compartments with nets of various meshes. When the tea is made to pass over these meshes these are agitated and the tea passes from one division to other division and falls through the nets into the trays . It is then classified into different grades such as Broken Orange Pekoe (B.O.P.), Broken Pekoe (B.P.) , B.O.P. (small) . Dust , Fannings etc. Grading percentages are in fact nothing more than the result of more mechanical sizing to meet the established demand of the tea market

After this , it only remains to pack the tea into chests or packets . This is done by the packing machines.
