3.1 **INTRODUCTION**

This third Chapter of the Thesis presents a brief history of coffee in India together with a brief description of the contemporary scenario as regards coffee cultivation, harvesting and marketing.

3.2 **COFFEE’S ANCIENT AND MODERN HISTORY**

The ancient and modern history of coffee and the account of its travel to India are quite interesting and might rivet the interest of even a lay reader. But let us begin at the beginning.

In **850 BC**, in the Ethiopian highlands, was born the legend of a shepherd named Kaldi. His goats became spirited and lost sleep after eating berries from certain shrub. These ‘magical’ berries were then delivered to the abbot of a local monastery, who made a drink out of them and discovered the stimulating effects of the berries.

In **1000 AD**, Arab traders brought coffee back to their homeland and became credited with raising the first-ever coffee plantation. Coffee beans were boiled for the first time creating a drink they called ‘qahwa’, literally meaning “that which prevents sleep”.

In **1453**, Ottoman Turks introduced coffee to Constantinople (today’s Istanbul). The world’s first coffee shop “Kiva Han” was opened in 1475. Interestingly, the Turkish law permitted women to divorce their husbands if they failed to provide them with coffee.

In **1452**, coffee houses were in vogue and had become intellectuals’ forums, later dubbed as ‘Penny Universities’ - a penny being the price for a cup of coffee. It was in these coffee houses that the word ‘tips’ (To Insure Prompt Services) originated. In **1690**, the Dutch smuggled coffee plants out of Arabia and became the first to transport and cultivate coffee commercially in Ceylon and their Dutch East Indian Colony of Java.

In **1727**, the coffee industry in Brazil was born out of a bouquet of flowers presented to Lieutenant Colonel Francisco de Melo Palheta by the wife of the French Guinea’s Governor, who was enamoured by his good looks. The bouquet contained cuttings and fertile seeds of coffee.

In **1773**, coffee was brought to New Amsterdam, later called New York by the British. Though coffee houses rapidly began to appear,
tea continued to be the favoured drink in the New World until the Boston Tea Party, which made coffee drinking a patriotic duty in America.

In 1822, the prototype of the first espresso machine was created in France.

In 1901, Japanese-American chemist Satori Kato of Chicago invented the first soluble instant coffee.

In 1903, German coffee importer Ludwig Roselius turned a batch of ruined coffee beans over to researchers, who perfected the process of removing caffeine from the beans without destroying the flavour. He marketed it under the brand name ‘Sanka’.

In 1906, George Constant Washington, an English chemist living in Guatemala, experimented and created the first mass-produced instant coffee. This brand was called ‘Red E Coffee’.

In 1908, Melitta Bentz made a filter using blotting paper and invented the world’s first drip coffee maker.

In 1935, Francesco Illy invented the first automatic espresso coffee machine, which substituted compressed air for steam.

In 1938, Nescafe instant coffee was invented by the Nestle Company as it assisted the Brazilian Government in solving its coffee surplus problem.

In 1945, Achilles Gaggia perfected the espresso machine with a piston that created a high pressure extraction to produce a thick layer of creme.

3.3 Coffee’s Indian Saga

The saga of Indian coffee began with the planting of ‘seven seeds’ of ‘mocha’ during 1600 AD by the legendary holy saint Baba Budan in the courtyard of his hermitage on the Chandragiri Hills of Karnataka. For a considerable period, the plants remained a garden curiosity and spread slowly as backyard plantings. R.K.Narayan, celebrated Indian writer, has rightly observed that “The origin of Indian coffee is saintly. It was not an empire-builder or a buccaneer who brought coffee to India, but a saint, one who knew what good for humanity”.

In 1820, the British recognizing the commercial significance of the native Indian coffee plants, set up commercial coffee plantations in South India. By 1869, their number had increased to 662. At the same time, diseases like White Stem Borer and Leaf Rust were observed for the first time in Indian coffee plantations. In 1870, Stanley Jupp made efforts to introduce disease tolerant coffee plants. In 1892, a voluntary body the United Planters Association of South India, was initiated to tackle the Shivaji University, Kolhapur.
problems of the industry. In 1900, Robusta variety of coffee was introduced into India from Indo-China. In 1925, the Mysore Coffee Experimental Station at Balehonnr in Chikmgalur district was established by Dr.L.C.Coleman. In 1930, the two most disease-tolerant Arabica varieties of coffee were evolved by Jackson and Kent. In 1936, Ivor Bull set up the Coffee Cess Committee to fund the activities of coffee promotion. Finally, in 1942, realizing the importance of coffee as a commercially viable and exportable crop, the Parliament passed the Coffee Act to establish the Coffee Board. In 1946, the Coffee Board took over the Mysore Coffee Experimental Station and established the Central Coffee Research Institute (CCRI) for organized research. Till date, the CCRI continues to be the premier institution for researching all the aspects of coffee - from cultivation, marketing to exports.

In more recent times, while maintaining its stronghold in the traditional areas of Karnataka, Kerala and Tamil Nadu States, coffee cultivation has gradually spread out to such non-traditional areas as Andhra Pradesh and Orissa as well as to the Seven Sister States of Arunachal Pradesh, Assam, Nagaland, Meghalaya, Manipur, Tripura and Mizoram, where it is proving to be a commercially profitable crop.

### 3.4 Coffee Botanica

Coffee belongs to the genus *Coffea*, which is a member of the *Rubiaceae* family that includes more than 500 genera and 6,000 species of tropical trees and shrubs. Arabica (*Coffea arabica*) and Robusta (*Coffea canephora*) are the two most commercially cultivated specifics of the genus *Coffea* in the world. The following comparison brings out the significant differences in these two genuses.
### Arabica and Robusta

<table>
<thead>
<tr>
<th>Arabica</th>
<th>Robusta</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Chromosomes</strong></td>
<td>Robusta is a diploid species having 2n=22 chromosomes.</td>
</tr>
<tr>
<td>Arabica is the only tetraploid species of <em>Coffea</em> with 2n=44 chromosomes.</td>
<td></td>
</tr>
<tr>
<td><strong>Bush</strong></td>
<td></td>
</tr>
<tr>
<td>Arabica is a medium statured bush with profuse branching.</td>
<td>Robusta is a bigger bush with a spreading habit.</td>
</tr>
<tr>
<td><strong>Leaves</strong></td>
<td></td>
</tr>
<tr>
<td>Small, leathery dark green leaves with distinct wax coating.</td>
<td>Large, pale green leaves.</td>
</tr>
<tr>
<td><strong>Roots</strong></td>
<td></td>
</tr>
<tr>
<td>Arabica coffee produces deep tap root with well defined primary and secondary roots. Tolerant to drought.</td>
<td>Robusta has a shallow root system, where the feeder roots are concentrated very close to the ground. Susceptible to drought.</td>
</tr>
<tr>
<td><strong>Pollination</strong></td>
<td></td>
</tr>
<tr>
<td>Arabica is autogamous (self-pollinating), with different degrees of cross-pollination.</td>
<td>Robusta is stringly allogamous (cross-pollinating), with an in-built gametophytic system of self-incompatibility.</td>
</tr>
<tr>
<td><strong>Fruits</strong></td>
<td></td>
</tr>
<tr>
<td>Arabica fruits mature and ripen in 8-9 months after fertilization. Arranged in loose clusters, they range between 10-20 per node.</td>
<td>It takes about 10-11 months for Robusta fruits to mature. Compact clusters with 30-50 fruits per node</td>
</tr>
</tbody>
</table>

### 3.5 Coffee Cultivation Practices

#### 3.5.1 Coffee Cultivation Practice

Botanically, coffee belongs to the genus *Coffea* of the family Rubiaceae. There are more than 70 species under the genus *Coffea*, most of which are native of Africa including the two species, *viz*. *Coffea arabica* and *Coffea canephora* which are commercially cultivated in India. Another species, *C. liberica* is grown to a small extent. Apart from these, some species, *viz*. *C. travancorensis, C. bengalensis, C. khasiana* and *C. wightiana* are native of India occurring in the forests of Kerala, Tamil Nadu, Meghalaya and Assam.

#### 3.5.1.1 Arabica (*Coffea arabica*)

It is tetraploid species with 2n=44 chromosomes and is popularly known as 'arabica coffee'. Under natural conditions, arabica grows like a small tree but looks like a bush when plant growth is regulated through training. It branches profusely with dark green leaves. The flower buds are produced in clusters in the axils of leaves at each node. Under South Indian conditions, initiation and subsequent growth of flower buds

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take place from September to March. Water is essential for flowering and the blossom occurs in 9-10 days after the receipt of showers. Arabica is self-fertile. The fertilized ovary grows into a fruit (drupe) in about 8-9 months and finally ripens into dark red berries which ranges in number of 10-20 per node.

Each fruit usually contains two beans/seeds. The freshly pulped beans along with their endocarp cover (parchment) are white. Sun drying and removal of parchment cover and silver skin (seed coat) gives bluish green colour to the seed which is the final produce used in preparation of the stimulating coffee beverage.

3.5.1.2 Robusta (Coffea canephora)

It is a diploid species (2n=22) and is a bigger bush than arabica with robust growth. Hence, it is popularly known as robusta coffee. The leaves are broader, large and pale green. Flowers are white, fragrant and are borne in larger clusters than in Arabica. Under the conditions of South India, the buds initiate and reach maturity during November to February and precipitation in February-March is ideal for blossoming. The flowers open on 7th or 8th day after receipt of rain. Unlike Arabica, Robusta is self-sterile, that is, its ovule cannot be fertilized with its own pollen and hence, cross pollination is necessary. The fruits mature in 10-11 months. They are generally ready for harvest two months later than Arabica.

Morphology and growth behaviour in coffee

Coffee is a perennial plant and evergreen in nature. It has a prominent vertical stem giving rise to horizontal primary branches in pairs opposite each other. From each primary branch, several secondaries originate laterally, which in turn, produce several tertiary and quarternary branches. All these are collectively referred to as sub-laterals. In each plant, these branches spread out at right angles to the main stem and exhibit drooping as well as spreading nature. The latter also eventually drop to some extent depending upon the crop load.

A number of shoots with upright growth also arise from the main stem. These are known as ‘suckers’ and grow vertically like the main stem which can be advantageously used for vegetative propagation.

Vegetative growth and cropping

In case of coffee, the vegetative growth of a particular year determines the cropping wood of the succeeding year. Hence, it is necessary to maintain balance between cropping and vegetative growth through pruning. Usually during a high cropping year, the vegetative growth is suppressed affecting the baring wood of the succeeding year.

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Root system

Generally, coffee has shallow root system, particularly robusta which has feeder roots concentrated very close to the surface of the found. On the other hand, arabica coffee produces most of the feeder roots relatively in deeper soil. The spread of the roots depends on the type of soil and cultural practices.

Leaves

Coffee leaves are opposite decussate on suckers, but in plagiotropic branches by torsion, successive nodes with the leaves lie in one plane. The leaves are shiny, heavy and dark green in colour with conspicuous veins. The shape of the leaf is usually elliptical. The leaves of arabica are slender and more delicate than those of robusta. The leaf tip of coffee varies from pointed to blunt. The young leaves of arabica are either light green or bronze but the bronze colour slowly fades with age.

A salient feature of coffee leaves, as in the case of some other members of Rubaceae, is the occurrence of ‘domatia’, which are small openings on the lower surface of leaves in the angles at the veins intersecting the mid-rib. They do not appear to have any specific function. Stomata, the openings in the leaves meant for gaseous exchange, vary from species to species and the stomatal number is negatively correlated to ploidy level with arabica showing less number of stomata compared to robusta. The number of stomata varies from 10,000 to 17,5000 per sq.cm.

Flower

Coffee is a short day plant, i.e. floral initiation takes place during short day conditions of 8-11 hrs of day light which is prevalent between September to December in South India.

Flower buds are produced at the axils of mature green wooden short stalks which are known as peduncles. The group of flowers, technically called ‘inflorescence’ is a condensed cymose-type subtended by bracts. In robusta, bracts are leafy and expanded whereas they are small and scaly in arabica. In arabica, 4-5 inflorescence of 1-4 flowers each are produced per axil while in robusta more number of flowers per inflorescence (5 to 6) are commonly produced.

In arabica, the axillary buds are indeterminate, i.e. they may produce either vegetative shoots or flower buds depending upon the seasonal factors like temperature, moisture and photoperiod. In robusta, floral differentiation is faster than in arabica and also appears to be determinate. The flower buds grow to a length of 7-8 mm after initiation and then remain quiescent until stimulated into flowering. Rain or irrigation after a dry period induces further growth in flower buds which open into flowers within 8-10 days.

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Under adverse conditions, particularly at high temperatures, abnormal flowers called ‘star flowers’ may occurring some plants which is under genetic control also. High temperatures, radiation, prolonged dry weather and inadequate blossom showers are the reasons for the production of ‘star flowers’. The petals of these flowers are small, fleshy and often green in colour. The male and female parts are rudimentary. They may remain in this condition till the receipt of water and grow into partially successful blossom but the fruit set would be poor.

Pollination

Pollination takes place within 6 hrs after flower opening under bright light and warm windy conditions. Rain during morning hours before or after flowers opening affects pollination and thereby lowers fruit set. Wind, gravity and bees are the agents of pollination.

Arabica coffee is autogamous with different degrees of natural cross-pollination in contrast to robusta coffee which is strictly allogamous with an in-built gametophytic system of self-incompatibility. Robusta is having adaptive advantage in having longer styles compared to arabica which may also facilitate cross pollination. On the other hand, in some cases of arabica, self-pollination occurs before the opening of flower buds within the bud itself. But in interspecific hybrids between robusta and arabica, the tendency of cross pollination is observed to be high.

Fertilization and fruit and seed formation

Fertilization takes place when a pollen gain germinates to produce a pollen tube on the stigmatic surface. The pollen tube reaches the embryo sac by growing through micropyle and subsequently burns open releasing the two male nuclei, of which one unites with the egg to form zygote and other fuses with the secondary nucleus to form the primary endosperm nucleus (double fertilization).

The process of fertilization is completed within 24 to 48 hours after pollination. The zygote and endosperm nucleus formed as a result of fertilization, undergo a rest period for nearly 45 days in arabia and 60 days in robusta. Meanwhile, the integument (protective coat) of the ovule begins to increase in size to perform nutritive function for zygote. The endocarp or the parchment cover is laid down after the integument (perisperm) grows to its maximum size in 100-120 days after blossom. This determines the size of the future bean. Finally, the endosperm grows into the space that has been previously occupier by the integument and restricts it to a thin layer surrounding the endosperm. This forms the ‘silver skin’ or the seed coat of the bean. Commensurating with the growth of endosperm, the zygote grows into an embryo with a hypocotyle and two (sometimes 3-4) cotyledons. Embryo is situated at one end of the

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bean on its convex surface.

The normal duration of a flower to develop into a fruit is about 6 to 8 months in arabica and 9 to 11 months in robusta. Ripe fruits have a thick fleshy pericarp with a mucilogenous layer surrounding the parchment which is made up of stone cells or scleroides.

The fruit is a ‘drupe’ and normally contains two seeds. Abortion of one ovule due to non-fertilization leads to the formation of a single seeded fruit, called the ‘peaberry’. Occasionally, 3 or more seeds may be present due to trilocular ovaries or false polyembryony (more than one ovule per locule).

**Beans/Seeds**

Seeds are elliptical or egg shaped, plano-convex possessing longitudinal furrow on the plane surface. Seed coat is represented by the ‘silver skin’ which is also made up of scleroids. The size, thickness and number of pits in the walls of scleroids are considered as important taxonomic characters in evaluating differences between species. Bulk of the seed is formed by endosperm, which is hardly consisting of polyhedral (many sided) cells.

Seeds do not exhibit any dormancy. Viability is also short in coffee. Germination takes place in about 45 days.

**Bean defects**

‘Peaberry’ formation in a normal coffee plant (balanced constitution) is due to the abortion of one of the ovules in a fruit at or subsequent to fertilization. The fertilized ovule in the other locule grows into a round seed called ‘peaberry’.

At times, three locules having single ovule in each locule are formed in the ovary which give rise to triangular seeds.

Endosperm sometimes shows partial development with or without any embryo. These occur commonly in flats (Jollus).

Formation of more than one ovule per locule is seen occasionally arabica, but quite frequently in S.288 and S.795 varieties. Seeds from this are called ‘elephant beans’. There are two types of elephant beans:

(i) Beans inside the parchment cover inter-locked (hollow and bit),

(ii) Seeds occurring side by side (bits). When one of the ovule gets aborted, the other functional ovule usually assumes irregular shape (defective).

Black or spotted bean is a physiological abnormality where the endosperm is completely or partially blackened.

**3.5.2 Varietal Improvement**

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The arabica coffee plantations in South-East Asia, including India, had suffered to a great extent with the appearance of leaf rust disease (*Hemileia vastatrix*) on epidemic scale between 1860-1900 AD. At that time, fungicides for the control of this pathogen had not yet been invented and the knowledge available on host-pathogen interactions was also too little. In India, efforts were made by the enterprising planters to evolve disease resistant plant material through selection and also by crossing arabica with other rust hardy species like liberica, which were introduced to tide over the situation. In this context, hybrids like ‘Hamiltons’, ‘Jacksons’, ‘Netrakonda’ and selections like ‘Coorgs’, ‘Chicks’ and ‘Kents’ were some important ones that need to be mentioned. ‘Kents’ was a worthy selection which had not only served as the major source for planting during the 1920s but also featured prominently in subsequent breeding programmes taken up after initiation of organized research work from 1925 onwards.

The main objectives of varietal improvement in arabica coffee are to evolve superior types through breeding for -
- Rust resistance,
- High productivity,
- Wide adaptability,
- Improved quality.

**Germplasm**

The success of breeding programme in any crop depends on the proper evaluation and exploitation of the available gene pool. Hence, a massive gene bank was established at CCRI by collecting seeds from vigorous, disease resistant arabica and robusta plants through regular surveys to different estates. Thus, over 250 collections from indigenous sources were established between 1925 and 1940 and these formed the base for developing early Indian selections. After 1940, exotic material from all the coffee growing countries including Ethiopia, the home land of arabica were introduced into the gene bank. Presently, thee are about 360 surviving collections of arabica, 15 types of robusta and 17 different species of *Coffea* a CCRI. All these collections have thoroughly been assessed and exploited in evolving superior coffee types.

**Variability in arabica**

Arabica is polymorphic species. Variability is observed in arabica and its hybrids in relation to the various agronomic traits like plant size (dwarf, semi-dwarf, tall); branching habit (erect, spreading, drooping); flowering (precocious, no initiation, male sterile); fruit size (small, medium, bold); fruit ripening (early, late); quality traits and yield potential. Besides, a wide spectrum of resistance patterns from complete susceptibility to total resistance to rust leaf pathogen are also seen. By utilizing this variability, CCRI has successfully released 12 elite selections.
selections/hybrids by employing the standard breeding strategies like pedigree selection, inter-varietal hybridization followed by pedigree selection, interspecific hybridization followed by back-crossing, double crosses, multiple crosses and exploitation of natural hybrids by involving in hybridization.

### Improvement of robusta coffee

The second important and commercially cultivated species of coffee in India is ‘robusta’ (*C. canephora*). Hence, due importance has been given for improvement of robusta through systematic breeding programmes. Robusta coffee possesses several useful characters like high tolerance to leaf rust pathogen, white stem border, nematode invasion and potentially to give consistent yields. Because of these reasons, cost of robusta cultivation is relatively less compared to arabica. On the other hand, inability to endure long drought, late cropping as well as late stabilization of yields and inferior quality compared to arabica are some of the negative aspects of robusta coffee. The yield performance greatly depends on the use of overhead irrigation for timely blossoming. Keeping these aspects in view, improvement of robusta coffee was undertaken by CCRI and so far, three superior robusta strains for commercial cultivation were evolved.

### 3.5.3 Propagation of coffee

Coffee, both arabica and robusta, can be propagated by seed as well as by clonal means. Coffee in India is mainly propagated through seeds. This method is simple and easy to adopt by growers. By seed propagation, high degree of uniformity could be achieved in arabica coffee (on selfing) because of its self compatible nature. But in case of cross pollinated robusta, seedling progeny tends to be highly segregating, thus resulting in many undesirable plants in the estate. Even in case of recently developed disease resistant arabica hybrids, segregation is seen if propagated through seed. By adopting vegetative propagation method, uniform plants with desirable characters like high yield, resistance to pests and diseases and good quality could be established in robusta as well as hybrids of arabica.

#### Propagation through seed

Use of quality seed plays an important role in establishing a productive plantation. Hence, it is always advisable to utilize the services of the Research Department for authenticity of seed supply. However, for every grower, knowledge on seed preparation is of great use in preparation of quality seed on their own estate.

Initially, good mother plants possessing superior agronomic traits, giving consistently good yields and showing disease-free nature are to be identified. Blossom is induced in these identified plants by giving irrigation. In arabica, individual plants can be irrigated for ensuring

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selfing. But in robusta, entire plot of a particular selection has to be irrigated by eliminating ‘off type’ plants. Mature berries at correct stage of ripening but not over ripened, are collected from these identified plants and are carefully pulped on the same day of harvest by hand or using small hand pulper without damaging bans. These freshly pulped beans are stirred in a container of clean water to remove floats or lights. The bans are then mixed with finely sieved wood-ash, evenly spread out to a thickness of about 5 cm and allowed to dry slowly in shade. They are stirred thrice a day to facilitate uniform drying. Excess ash is rubbed off after five days of drying. The seed is garbled thoroughly to remove mutilated, triangular and elephant beans and spread out thickly under shade. It is preferable to treat the seed evenly with a good dresser like Batistin 50 WP (1g/kg) or Vitavax 75 WP (0.66 g/kg) of seeds before sowing. This treatment protects the seed from any fungal infection occurring during germination. Seeds do not exhibit any dormancy and under natural conditions, viability is also short. Germination takes place in about 45 days.

Seed multiplication

Plots of all selections originally established at CCRI as well as those established on substations, Cs, Ds, Fs and some private estates constitute the seed plots. These plots are inspected annually for off-types. A programme for converting off-types with high fruit abnormalities and severe leaf rust into desirable types by grafting with suitable scion is under progress. Seed is prepared under departmental supervision and distributed through zonal offices on the Extension Wing.

Vegetative propagation techniques

Coffee can be propagated successfully using conventional vegetative propagation techniques. Reproduction of plants by means of vegetative parts such as shoot, leaf and foots is called vegetative propagation. These techniques offer an advantage of preserving the unique characteristics of any individual plant its offspring. Vegetatively, coffee can be propagated by cutting as well as by grafting techniques.

Propagation by cuttings

In coffee, two types of shoots, viz. horizontal (plageotropic) and vertical (orthotropic) shoots are produced. Orthotropic shoots (suckers) are suitable for vegetative propagation. The plageotropic shoots are not suitable as they always maintain only lateral growth. Selection of mother plants having superior characteristics like high yield potential, disease/pest resistance and good quality is very important for initiating propagation through cuttings.

Three types of cuttings can be obtained from orthotropic shoots, viz. single node cuttings, terminal cuttings and mallet cuttings. The methods of preparing different types of cuttings is described below:
1. **Single node cuttings**

- Collect 3-4 month old (preferably pencil thickness) orthotropic shoots (suckers) from the identified mother plants.

- From each sucker, prepare as many single node cuttings as possible of 10 cm length from semi hardwood with a basal slant cut and top horizontal cut at internodal region. Also retain a pair of leaves (cut to half their size) at each node.

- Immerse the cuttings for about minute in a bucket containing 0.2% Bavistin solution (1 g of Bavistin in 250 ml of water) to avoid any fungal contamination.

- Dip the base of the cuttings (slant cut) for 5-10 second in IBA (indole butyric acid) solution at 5000 ppm concentration (dissolving 500 mg IBA in 50 ml of alcohol and made up to 100 ml by adding water gives a solution of 5000 ppm concentration).

These cuttings are now ready for planting.

2. **Terminal cuttings**

After preparing single node soft wood cuttings, the terminal portion of the orthotropic shoots could be made use for planting as terminal cuttings. Provide a slant cut at the base and treat it with 0.2% Bavistin solution and later with 1000 ppm IBA solution (100 mg in 50 ml alcohol made upto 100 ml by adding water) before planting.

3. **Mallet cuttings**

Mallet cutting is nothing but a young sucker of 45-60 day old, detached from main stem with a piece of woody bark. Collect the mallet cuttings from elite plants with a portion of wood by using a sharp knife. Dip the basal portion in 0.2% Bavistin and then in 1000 ppm IBA solution for 5-10 seconds before planting.

**Planting of cuttings**

All these three types of cuttings thus prepared have to be planted in punched polythene bags (23 x 15 cm) filled with soil mixture. This soil mixture has to be prepared by mixing well sieved jungle soil, sand and farm yard manure (FYM) in the ratio of 6:3:1. These bags with the planted cuttings are to be arranged in propagation trenches. The propagation trenches are of 1 m width, 0.5 m depth and 2-6 mm length covered with a transparent polythene sheet (500 gauge) over a supporting frame made of bamboos or aluminium slants. The trenches with the planted cuttings are to be provided with overhead coir mat shade. Narrow drainage channels have to be made around the trenches to drain off rain water.

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Watering is to be done once a day during morning hours in cool season. During dry season, second round of watering an be given in the afternoon hours. Cuttings will root in about three months after planting under trench condition. After rooting, the cuttings are to be hardened for 2 months under coir mat shade. The hardened cuttings would easily establish in the main field when planted in the subsequent planting season.

The season of collection of the planting material also plays an important role unsuccessful rooting of cuttings. Experimental results indicate that planting of cuttings during June-August (rainy season) gives a good percentage of success (90-100%).

For a robusta clonal plot, rooted cuttings of different mother plants and clones (example BR 9, 10, 11) should be mixed and planted, because of the high cross pollinating nature of this species.

**Grafting techniques**

Wedge-cleft method of grafting is used in coffee and the grafting can be done in two stages, i.e. seedling stage in nursery and mature plants in field. Seedling grafting is useful in overcoming the problems of nematodes, soil borne root diseases and drought conditions. The grafting in mature plants is followed for the conversion of old, unproductive, disease susceptible and off-type plants into productive ones and this technique is popularly called ‘top working’.

1. **Seedling grafting**

Seeds of selected rootstock (having tolerance to nematodes, root diseases, drought, i.e. robusta or tree coffee) and scion (high-yielding disease tolerant, i.e. usually arabica) are sown in the nursery for germination. The time of sowing of both the rootstock and scion seed material should be adjusted appropriately so as to obtain seedlings of ‘toupee stage’ at the same time. At ‘toupee stage’, seedlings of both stock and scion are uprooted carefully without injuring the root system and immersed in water to which a pinch of urea is added. Toupee end of the rootstock seedling is to be cut off with a sharp blade and a vertical slit (cleft) of 1.5-2 cm is to be made by giving a vertical cut downward. Likewise, root portion of the scion seedling is cut off and the cut end of top is to be fashioned into a ‘wedge’ or ‘V’ shape (0.5-2 cm length). The wedge of the scion is inserted into the cleft made in stock seedling and the joint is tied with a polythene strip firmly. These grafted seedlings are planted in the nursery baskets and kept under pendal shade. Remove the polythene strips after the union takes place (after 4-5 weeks). These grafted plants are to be maintained in nursery till the field planting.

**Top working**

The process of uprooting ‘off type/passenger plants’ by conventional methods and filling those gaps with young seedlings is a cumbersome and time consuming process. Moreover, these replanting

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usually start yielding only after 4 to 5 years. To avoid these difficulties, rejuvenation of off type plants through top working is practised.

In this technique, the off type plants are collar pruned at about 30-45 cm high during March-April soon after few summer showers. The stumps start sprouting and produce many vertical shoots (suckers) in about 30-45 days duration. Two to three healthy suckers arising from just below the cut end are retained and the remaining suckers are removed at the time of grafting. During monsoon season, suckers of same age and thickness are collected from elite desirable plants and single nodescious are prepared and grafted by cleft method on to the suckers arising from the collar pruned ‘off type’ plants. The preparation of wedge and cleft is same as described in case of seedling grafting. The graft portion is either sealed with grafting wax or tied with a polythene strip. The grafts are covered with polythene bags to protect them from rottin during heavy monsoon. Union takes place within 1 to 2 months after grafting depending upon weather conditions. The polythene strips are then removed to facilitate normal growth of the grafts. Around 65-70% success could be obtained using compatible scions. Hence, it is advisable to graft 2-3 suckers in each stump. The scion starts growing vigorously, by drawing nutrients from already well established root system of the stock (off type plant) and produces crop by 2 or 3 years after grating. Thus, there is a saving of about 2-3 years time towards the first crop when compared to the conventional methods. Besides, the yields from top worked plants are assured as the scion material is collected from superior mother plants. This system could also be practised to grow arabica types on robusta stocks.

**In-vitro propagation**

Recent advances in the study of developmental and molecular biology of plant cells have led to tissue culture as a major component of biotechnology. Tissue culture technique is useful for rapid clonal propagation and genetic improvement. The research being carried out at the Board’s Tissue Culture Laboratory at Mysore has established its usefulness in the following areas:

1. Rapid multiplication of elite plant materials,
2. Production of haploids through another culture,
3. Production of synthetic seeds,
4. In-vitro preservation of germplasm,
5. Introduction of alien genes such as *Bt*.,
6. Development of varieties with low caffeine content, through hybrid embryo rescue method.

Procedures have been standardized for regeneration of plant from stem and leaf cultures of arabica and robusta through calus and subsequent

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somatic embryogenesis. A batch of plants raised through tissue culture and established in the field have started giving crop. Plants have been raised from crosses between *Coffea canephora* (robusta) and *C. bengalensis, C. travancorensis* and *C. wightiana* through embryo rescue method of evaluate for low caffeine. Encapsulation technique for producing synthetic seeds by using zygotic embryos of *C. arabica* has been standardized.

3.5.4 **Planting and aftercare**

In choosing the site for plantation, due consideration should be given to altitude, aspect, rainfall, exposure to wind and transport facilities. A perennial source of water supply is an essential requirement. Soils rich in humus and with gentle slopes providing good drainage are to be preferred.

**Altitude and aspect**

Coffee comes up well at an altitude of 3300-4900 ft, but the lower and upper limits of elevation for its cultivation could be 1500 and 5400 ft respectively.

Location with northern aspects or eastern aspect is preferred. Southern and western aspects generally suffer from longer exposure to the sun, especially at elevation below 3000 ft. To protect against afternoon sun, thicker shade should given to these areas.

**Exposure to wind**

Eastern winds in December-February cause injury to plants. To prevent this, wind belts consisting of tall trees like silver oak, orange or tree coffee should be raised.

**Preparation of land**

Clean felling is not advocated when the forest land is cleared for planting coffee. Selective retention of desired species of wild shade trees, without too much over-crowding gives best results. The land should be divided into blocks of convenient size with foot paths and roads laid out in between.

**Soil conservation measures**

For satisfactory performance of coffee, it is necessary to conserve the top fertile soil. The loss of top soil is negligible on estate under proper shade. The problem of soil erosion attains serious dimensions on steep slopes without good overhead shade. Such fields should be protected with a lower canopy of *Ficus* sp. (Attis, Besris), *Albizia* sp. and other quality shade trees. In areas which are steep, terracing and contour planting may also be adopted.

**Line marking**

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Within each designated block, the points for planting of coffee seedlings are located by marketing the distance between the rows and plants. Generally square system of planting was found to be ideal in flat to gently sloping areas. In steep slopes, it is advisable to adopt contour planting. The distance between the rows and spacing of plants would depend upon the type of planting material.

Arabica
- Talls - 6’x6’; 7’x6’; 7’x7’, Dwarfs - 5’x5’

Robusta
- S.274; Old Robusta - 10’x10’, 12’x12, CxR - 8’x8’; 9’x9’.

**Pits for planting**

Pits are usually opened after the first few summer showers during March/April. The size of pits is usually determined by the texture and depth of soil. Usually pits of size 45x45x45 cm LBH are preferred. After opening, the pits are to be exposed for weathering for 15-20 days. Later, they are closed by filling in with the surrounding top soil. In poor soils, addition of compost or FYM @ 1 kg/pit is recommended at the time of closing of pits.

**Planting in the field**

Disease-free and vigorous seedlings are selected for planting in the field. Seedlings with stunted and twisted roots are to be discarded. Generally seedlings raised in secondary beds (age about 16-18 months) are planted at the commencement of monsoon (June) and polybag nursery seedlings (6-8 months) old are planted during August-September. At the time of planting, a hole is made in the centre of the pit after levelling the soil, and seedlings are planted in the hole. In case of ball plants, the polythene bag is cut at the bottom and tip of tap root is nipped if it is found bending. In case of root plants (secondary nursery seedlings), the tap root and lateral roots are to be spread out in proper position before packing with soil. Care should be taken that soil around the seedlings is packed slightly above the ground level (1”) to prevent stagnation of water around collar region. Avoid planting deep. The seedlings are provided with cross stakes to prevent wind damage and mulched with dry leaves.

**Planting shade trees**

Dalap is commonly used as a lower canopy shade. One to two meter long stakes are planted for every two plant of coffee during June when rains of south-west monsoon commence. During dry season, stems of young dalap are either painted with dilute lime solution or wrapped in agave leaves to protect them from sun scorch. Silver oaks can be planted as shade belts in east-west direction to protect coffee from southern exposure at a spacing of 200 ft apart within a row and 40 ft between the two rows. The silver oak stands should be alternated with Dalap rows. Silver oak stands are best suited for training pepper vines also. Permanent shade trees are planted at wider spacing (30-40 ft), wherever the forest tree

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cover is inadequate.

**Inter planting, replanting and under planting**

Robusta coffees are usually planted at wider spacing of 10-12 ft and the bushes take 6-7 years for maiden crop and 10-12 year for producing economic yields. Wider spacing within the row as well as between he rows could be profitably exploited by planting quick yielding varieties such as Cauvery, which comes to bearing by 3 years from planting. Because of its fast growth, Cauvery covers up the interspaces thus minimizing the weed growth too. By interplanting Cauvery both within and between robusta rows, the plant population is substantially boosted. For example, if Cauvery is planted at a spacing of 5 ft in the robusta block planted at 10 ft spacing, an additional population of 3,230 Cauvery could be accommodated per hectare. Early yields from Cauvery could be exploited with judicious nutrition and plant protection measures. Once the robusta bushes start covering up, the adjacent Cauvery plants can be systematically eliminated to pave way for spread of the main crop, i.e. robusta coffee.

In areas identified for replanting, two approaches could be made: (i) if the blocks are to be replanted with similar material, it is advisable to plant the young seedlings under the existing old blocks, in separate rows laid in between the old rows. The old bushes can be rejuvenated by collar pruning after one or two seasons of underplanting, and can be exploited on multiple stems for few more seasons, before the newly planted bushes, start covering up the allocated space; (ii) if the old blocks are to be replanted with a different variety whose spacing requirements are different from that of the old material, it is advisable to totally uproot the old stands and take up replanting in newly laid out lines. When the entire block is uprooted for replanting, manipulations in shade pattern are possible depending upon the requirement of the new variety being planted.

**Aftercare**

1. The clearing should be well fenced to prevent damaged by cattle to coffee and dalaps.

2. The plants should be protected from cockchafer attack during the first few years.

3. Weeds, especially the grasses, should be controlled by cover digging in the initial years itself.

4. Soil around the newly planted seedlings should be mulched properly.

5. In open patches, the seedlings are to be provided with artificial shade with branchlets of jungle trees (huttings) during dry months.

6. One round of manuring be taken up during March-April of the *Shivaji University, Kolhapur.*
following year at recommended doses.

7. Irrigation through sprinkler/sub-soil injection/drip method may be given wherever it is possible.

8. Plant protection measures as indicated should be carefully followed.

3.5.5 Weed Control

Weeds compete with coffee plants for water, light and mineral nutrients. If weeds are allowed to grow during late post-monsoon period, they use the soil moisture which coffee needs in the following dry weather. Free growth of weeds reduces the yield of coffee and plants assume a sickly appearance. In young clearings, weeds are a serious problem particularly during first three years. The pruned fields where ground is exposed are also prone to weed problem.

Methods of weed control

1. Manual weeding

Generally, weeds re controlled manually. New clearings re hand-weeded three to four times and established coffee fields two to three times a year. During the monsoon season, weeds are slashed back (slash weeding) with the help of a machete. Clean weeding is generally done during post-monsoon period. It is a labour-intensive and time-consuming operation in coffee estates.

2. Cultural methods

In new clearings, the field is given a thorough digging (cover digging) to a depth of about 15-18 inches, towards the end of monsoon. All weeds and vegetative debris are completely turned over and buried into the soil.

In young clearings, coffee at normal spacing covers only a small portion of soil surface and there is room for prolific weed growth. Interplanting of green manure crops, cover crops and annual crops such as grain legumes, cassava, beans, pigeon peas, yam, sweet potatoes, vegetables, pineapple, etc., help in suppressing weed growth to a large extent. Intercropping has been successful in robusta coffee in Wayanad region of Kerala. In established plantations, scuffling and mulching at the end of monsoon can be effective in controlling weeds.

3. Chemical weed control

Chemical weed control methods are employed where labour is scarce or expensive or when there is a demand for diverting labour to other important cultural operations like manuring, spraying, etc.

The chemicals used for killing the weeds are known as weedicides and these can be classified based on time of application (pre-emergent

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and post-emergent), mode of action (contact and systemic), etc.

Pre-emergent weedicides are to be applied before the emergence of weeds to moist soil. These are taken up mainly through germinating roots of weed seeds and remain in surface layers long enough to kill the surrounding weed seeds. These weedicides have long residual effect and their continuous accumulation in soil may become large enough to affect the growth of coffee and cause phytotoxicity. Pre-emergent weedicides are not usually advocated in coffee plantations, e.g. Simazine, Atrazine, etc.

Post-emergent weedicides are applied when the weed flora is actively growing. Unlike pre-emergent weedicides, the post-emergent weedicides become inactivated on coming into contact with soils and are thus unavailable to root system of plants at recommended dosage. Hence, they have no residual effect, e.g. Paraquat-di-chloride, glyphosate, etc. Most of the post-emergent weedicides have either contact or systemic action.

Contact weedicides kill only those plant parts which come into contact with them. They are quick acting and control a wide range of weeds. Care should be taken to target only the weed growth, e.g. Paraquat-di-chloride (Gramoxone).

Systemic weedicides are absorbed through roots or aerial parts and are then translocated within the plant tissue and kill the entire plant system, e.g. Glyphosate (Glycel or round up).

The efficiency of weedicides can be increased by adding surfactants, additives/ synergists, etc.

Surfactants (wetting agents) facilitate uniform spreading of spray solution leading to complete wetting and coverage of spray surface. These help in sticking of spray droplets to the plant parts and prevent bouncing off of droplets, e.g. Tween-20, Vettoplant, etc.

Note: Some weedicides contain appropriate wetting agent incorporated in the formulate itself. At the recommended rates of application, there is no need to add wetting agent to the spray fluid, e.g. Gamoxone.

Additives like urea, ammonium sulphate, etc., improve the efficacy of weedicides and thereby offer a scope to bring down the dosage of weedicides without affecting their weed killing efficiency.

Selection of sprayers and nozzles

Knapsack or Backpack sprayers (low pressure, high volume) fitted with plastic container are preferred for application of weedicides in coffee. For blanket application, WFN 062 or WFN 040 flood jet nozzles are commonly used. When systemic weedicides are to be sprayed, ULV 50 nozzle is preferred. For spot applications, WFN 024 flood jet nozzles are used. The sprayers used for weedicide application should be properly

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labelled and thoroughly washed after each application. It is advisable not to use these sprayers for spraying pesticides, etc., on the coffee bushes.

**Time of application**

Weedicides should be applied on a bright sunny day when there is sufficient moisture in soil and the weeds are actively growing before their flowering and seed setting. First round of blanket application should be taken up by the end of April or beginning of May when the weeds are about 10-15 cm high. If the weeds are taller than this, they should be slashed back and sprayed a weekly or 10 days later. Scattered patches of weed growth should be controlled by spot spraying 15-20 days after the blanket spray. A second round of blanket application may be necessary towards the end of monsoon, i.e. September/October, which has to be followed by one or two spot applications. Generally, 450 litres of spray solution is needed per hectare for each blanket spray to achieve effective control of weeds.

**Weedicides recommended in coffee fields**

1. Paraquat-di-chloride 24% EC @ 0.067% a.i. (e.g. Gramozone @ 500 ml per barrel),
2. Glyphosate 41% EC @ 0.27% a.i. (e.g. Round up or Glycel @ 1200 ml per barrel),
3. The cost of chemical weeding could be brought down by nearly 50% by addition of area @ 1% in spray solution. The dosage of Gramoxone could be brought down to 250 ml/barrel and that of Round up or Glycel to 600-800 ml/barrel when urea is added to the spray solution @ 2 kg/barrel without any reduction their weed killing efficiency.

Experimental evidences indicate that continuous application of weedicides did not affect the soil characteristics like organic matter content, pH, available ‘P’, ‘K’, etc., but slight lowered the population of soil microflora.

**3.5.6 Irrigation Management**

Coffee is predominantly cultivated as a rainfed crop worldwide. In equatorial regions such as South and Central America where there are no well defined alterations between wet and dry periods, coffee is generally not irrigated. But in the regions of single rainfall regime such as East and Central Africa and India, coffee usually encounters 4-6 months of dry spell in a year. Under such conditions, growth and productivity could be boosted substantially by irrigation.

Coffee, being an evergreen plant, requires maintenance of soil moisture during dry months. In coffee tracts of South India, the South-West moon zones predominantly receive more than 60% of rain during *Shivaji University, Kolhapur.*
June to September and he rest during North-East monsoon period upto October-December. The drought period usually consists of 4 months from December onwards. In some years, the North-Eastern monsoon tapers off by the end of October itself leading to extension of dry period by another month. The most important factor which limits the production of coffee even in well managed estates is long drought period. Besides this, if blossom rains are delayed beyond March, then the production of coffee receives a major set back. In coffee, irrigation is mainly used as an insurance against failure of good blossom and backing showers and for overcoming long drought.

**Sprinkler irrigation**

Sprinkler irrigation is the most versatile method of irrigation to supplement the natural rainfall for the growth and blossoming of coffee. In sprinkler irrigation, the water application resembles rainfall. Water is sprayed under pressure through small orifices or nozzles and is externally applied all over the plant and land surface. Systems are designed based on the factors like area to be irrigated, type of soil, location of water resources, topography of land, wind velocity, infiltration rate, etc.

For successful establishment of young plantations, coffee should be irrigated during dry months to a depth well below the root zone and the intervals between irrigations should be long enough to allow the soil to dry out without causing serious wilting. This encourages deep rooting as a protection against drought and also improves the anchorage of trees.

Robusta coffee being sensitive to drought, responds well to sprinkler irrigation compared to arabica coffee. For irrigating established coffee during dry periods, the first irrigation is to be given with 25-38 mm of water after 20-25 days of the cessation of North-Eastern rains. The next successive irrigations have to be given at an interval of 20-25 days throughout the dry period up to the first fortnight of January. In robusta coffee, blossom can be forced during the 2nd fortnight of February by applying an amount of 25-38 mm water. Subsequently, backing irrigation can be resumed 15-20 days after blossom in case of delayed showers.

**Preparing coffee for overhead irrigation**

This is essential for getting proper response to irrigation. Overcrowded and old coffee under thick shade should be avoided. Preference should be given to younger and more responsive coffee. Shade should be well regulated and coffee pruned every year after harvest. Short-hole borer affected, dead twigs and whippy wood are to be removed. Weed growth has to be checked.

**Beneficial effects of sprinkler irrigation in coffee**

By adopting sprinkler irrigation, the following benefits are observed. wod fold increase in length of laterals due to increase in number of nodes and internodal length; increase in leaf area by 45%; retention of foliage as against loss of foliage in unirrigated plants; improved nutrient

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uptake; uniform ripening of berries. Irrigating only for blossom and backing improves yields by 48-57% and continuous irrigation throughout drought period gives an yield increase of 85-95% over unirrigated plots in robusta coffee.

Drip Irrigation

The drip or trickle irrigation has assumed considerable importance in recent years in view of the greater need for economy in water. In drip method, water is distributed by a network of tubing to each plant directly, near the root system in the form of droplets daily or on alternate days based on exact water requirement of crops. Thus, the water losses during conveyance and to seepage, evaporation, etc., are totally avoided. Besides, the water is not applied to the unwanted areas like inter-spaces between the rows and the plants. Thus, drip irrigation system offers greater savings in water (upto 60%). The other advantages of drip irrigation system include, saving in labour, increased yields, better quality of produce, less weed growth, increased fertilizer efficiency, possibility of fertilizer application through irrigation water (fertigation) and reduced incidence of foliar pests. However, the initial cost of drip equipment is considered to be its limitation for large scale adoption. Cost of the unit per hectare depends mainly on the spacing of the crop. The main item of expenditure is the lateral pipeline which is run all along the rows. The wider the row spacing, less will be the cost of drip irrigation system.

Components of drip irrigation system

The basic components of a drip irrigation system include pump, fertilizer injector, filters, distribution lines, emitters/drippers and other control and monitoring equipment. Distribution lines consists of a network of graduated pipe lines starting with a main line followed by smaller sub-main and lateral lines. The main and sub-main lines are made of PVC and are buried in soil. Lateral lines are usually made of polythene plastic and are laid above ground along the rows and are connected to sub-main. Emitters/drippers which discharge water in droplet form are fixed on lateral lines near the root system of the trees.

The main control station for the drip irrigation system is organized to measure and filter the water to regulate pressure and time of water application. The control station includes the pump, back-flow preventor, primary filter, pressure regulator, pressure gauge, water meter and usually chemical injection equipment.

Beneficial effects of drip irrigation in coffee

Preliminary results obtained with drip irrigation in coffee over the last few years have revealed that this method is best suited for sustenance irrigation of coffee plants during the dry period. Establishment of young coffee is much better with drip irrigation, compared to sprinkler irrigation as there would be less weed growth under drip irrigation system. Application of 3-6 litres of water on alternate days was found to be ideal.
for establishing young coffee. In established plantations, applications of 4 litres and 8 litres of water per day per plant was found optimum for better growth of cauvery and robusta coffee, respectively. Yield increases of around 25% in case of cauvery and 45% in case of robusta coffee were observed with drip irrigation.

### 3.5.7 Mixed Cropping on Coffee

Mixed cropping also referred to as intercropping, associate cropping, multi-storeyed cropping, diversification, etc., means cultivation of two or more compatible crops for better utilization of available land and resources to the best advantage of growers.

Coffee in India is grown as a silvi-horticultural crop under a tree cover for optimal performance. This situation paves way for bringing about an association of several economic species together. The risks involved in depending on a single crop or monoculture is always greater than an investment in an assortment of crops. All these concepts are not new to coffee. From the time coffee was introduced into India, growing of suitable crops in coffee estates has been a common feature. The growers by trial and error method over a long period of time have arrived at suitable crops in each area and these crops have become popular and a source of additional income. Thus, cultivation of orange and pepper in Karnataka, pepper in Kerala and orange and banana in Pulneys (Tamil Nadu) have become standard practices among the coffee growers. However, in recent years, cultivation of orange in Karnataka and banana in Tamil Nadu have received a set back due to devastating pests and diseases.

Although cultivation of associate crops in coffee has been in vogue, systematic studies to find out the suitable crop combinations and cost : benefit ratio were initiated by the Coffee Board during the early 1970s at Diversification Farm, Chettalli, North Coorg. Two trials were laid out here. In the first trial, associate crops such as citrus, black pepper and coffee were either planted singly or in combination with a pure coffee plot as a check both in arabica and robusta coffee. In the second experiment, the multi-storeyed cropping pattern combined with strip cultivation was utilized to so that the coffee, shade trees and associate crops were all grown in organized strips to reduce interference within crops to a certain extent. It was observed that there was not much difference between planting in strips or over the entire coffee block in a mixed manner. The cost : benefit ratio for coffee based mixed crop combinations over 14 years period is given below.

<table>
<thead>
<tr>
<th>Sr.No</th>
<th>Crop combination</th>
<th>Cost : Benefit Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Arabica coffee monoculture</td>
<td>1 : 2.09</td>
</tr>
<tr>
<td>2.</td>
<td>Robusta coffee monoculture</td>
<td>1 : 1.08</td>
</tr>
<tr>
<td>3.</td>
<td>Pepper monoculture</td>
<td>1 : 2.41</td>
</tr>
</tbody>
</table>

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4. Orange monoculture & 1 : 0.05
5. Banana monoculture & 1 : 0.57
6. Arabica + Pepper & 1 : 3.10
7. Arabica + Orange & 1 : 1.86
8. Arabica + Banana & 1 : 1.09
9. Arabica + Pepper + Orange + Banana & 1 : 2.20
10. Robusta + Pepper & 1 : 2.29
11. Robusta + Orange & 1 : 1.20
12. Robusta + Banana & 1 : 1.09
13. Robusta + Pepper + Orange + Banana & 1 : 1.32
14. Arabica + Pepper in strip planting & 1 : 1.52

Arabica and robusta coffee with pepper indicated benefit of 310% and 229%, respectively. This indicates that pepper is the most compatible crop in coffee plantations. It is advisable to maintain the pepper population at 50-60 vines per acre.

**Intercropping**

Annual crops could be grown as intercrops amidst young coffee in new clearings to get some additional revenue in the initial years. Intercrops also suppress the weed growth in young clearings, but may compete with coffee for moisture and nutrients. Hence, proper care should be taken to maintain adequate soil moisture and nutrition-based on the actual requirement of intercrops as well as young coffee. Some of the intercrops like ginger and turmeric in rows are very commonly grown in Wayanad, Kerala. Other annual crops like cow pea, horse gram, beans, chillies, brinjal, pineapple, etc., could also be grown for realizing subsidiary income during early non-bearing stage of coffee. For improving the organic matter status, green manure crops like *Crotolaria*, *Tephrosia*, and cover crops like *Mimosa invia*, etc., could be grown and ploughed into soil.

**3.5.8 Pre-Coffee Harvesting and Processing**

Coffee is processed in two ways:

(a) Wet processing by which plantation or parchment coffee is prepared; and

(b) Dry processing by which cherry coffee is prepared.

Coffee fruits should be picked as and when they become ripe. Under-ripe and over-ripe fruits cause deterioration in quality, the former tending to produce ‘immature beans’ and the latter ‘foxy’ coffee. Before pulping, over- and under-ripe fruits should be scrupulously sorted out and dried separately as cherry. Bags used for harvesting fruits should be washed and dried frequently. Bags in which fertilizers, pesticides and fungicides are stored should never be used for this purpose.

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Preparation of Parchment Coffee

(i) **Pulping**: Preparation of coffee by the wet method requires pulping equipment and adequate supply of clean water. Fruits should be pulped on the same day to avoid fermentation before pulping. The pulper should be properly adjusted and checked every day for satisfactory pulping and to prevent cuts. Pulper nipped beans and other deformed beans will result in defective parchment.

Fruits may be fed to the pulper through siphon arrangements to ensure uniform feeding and to separate lights and floats from sound fruits. Uniform feeding ensures proper removal of skin and prevents cuts, choking of pulper, etc. The pulped parchment should be sieved to eliminate any unpulped fruits and fruit skin. It is desirable to separate lights from well filled, mature, heavy beans at every stage.

The skins separated by pulping should be led away from the vats into collection pits so that microbial decomposition of the skin will not affect the bean quality when it gets mixed up with the beans.

(ii) **Demucilaging and washing**: The mucilage on the parchment skin can be removed by (a) natural fermentation, (b) treatment with alkali, and (c) frictional removal in washing machines.

(a) **Natural fermentation**: Fermentation is a critical stage in processing and it has profound influence on quality. Fermentation should be controlled so that it is wholly alcoholic and not acidic. The latter type of fermentation can occur under dry, high temperature and high pH conditions as may happen usually in the top 10 cm layer of the fermenting mass of wet parchment. This should be avoided as it is likely to cause stinkers and beans producing unpleasant odours and taints. The fermentation mass should not be allowed to dry up and should be kept covered.

The mucilage breaks down in the process of fermentation. In the case of arabica, it is complete in about 24 to 36 hours. Fermentation takes longer time in cool weather than in warm weather conditions. Over-fermentation may lead to foxy beans and make the coffee in the cup sourish. If under-fermented, the sticky mucilage is left on the parchment leading to absorption of moisture by the beans and ‘mustiness’ in the final produce. When correctly fermented, the mucilage comes off easily and the parchment does not stick to the hand after washing. The beans feel rough and gritty when squeezed by hand, a feeling similar to squeezing pebbles.

Robusta coffee has a thicker and more sticky mucilage. Fermentation will not be complete even after 72 hours. Quite often, the mucilage breakdown is not complete. It is, therefore, desirable to resort to either alkali treatment or frictional removal of mucilage.

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When the mucilage breakdown is complete, clean water is let in and the parchment washed pebble clean with three to four changes of water.

(b) **Treatment with alkali**: Removal of mucilage by treatment with alkali takes about one hour for arabica and one and a half to two hours for robusta. The beans obtained after pulping are drained off excess water and spread out in the vats uniformly and furrowed with wooden ladles with a long handle. A 10% solution of caustic soda (sodium hydroxide) is evenly applied into the furrows using a water can. About one kg of sodium hydroxide dissolved in 10 litres of water is sufficient to treat 25 to 30 litres of wet parchment. The parchment is agitated thoroughly by the ladles so as to make the alkali to come into contact with the parchment and trampled by feet for about half an hour. When the parchment is no longer slimy, and makes a rattling noise, clean water is let in and the parchment washed clean with three or four changes of water.

(c) **Removal of mucilage by friction**: There are machines which pulp and demucilage the beans in one operation. These machines are especially suitable for demucilaging robusta parchment. However, a number of naked and bruised beans may result in the parchment. It is, therefore, necessary to adjust the machines carefully to obtain uniform pulping and demucilaging. Sorting the fruits into different sizes and uniform feeding using a siphon arrangement may also rectify this defect to a considerable extent. If in spite of careful manipulations, such naked and bruised beans occur in the parchment, they may be garbled out on the drying trays.

These machines are often used for demucilaging after removing the fruit skin in the traditional pulpers.

Opinion is divided on the merits and demerits of processing coffee by methods involving natural fermentation and those without prolonged fermentation. Cup-test results have indicated that there is no difference in cup quality between the coffee processed by different methods. It has, however, been observed that coffee processed without prolonged natural fermentation dries faster.

**Post-fermentation soaking**

Wherever water supply is abundant and additional vats are available, the parchment may be soaked under water for about 24 hours and then given a final wash. The method seems to improve the quality both in the appearance and in the cup of particularly such coffees that are usually substandard. Parchment coffee soaking under 1% sodium metabisulphite solution for 24 hours improved the raw appearance of the bean.

(iii) **Drying**: The next stage in processing consists of drying the parchment in the sun until the moisture content is sufficiently reduced to permit storage of beans till they are despatched to curing works. It is necessary to emphasize that proper drying contributes to the healthy colour of the bean.
and other quality factors. Both over-drying and under-drying will lead to poor quality. Under-drying leads to rapid deteriorating of beans. Under-dried parchment turns ‘mouldy’ and gets ‘bleached’ during storage and subsequent curing operations.

Draining of excess water shortens the drying time. This can be done either on specially constructed drainage platforms or on racks made of perforated galvanized sheets. Drying of surface moisture on the beans should be carried out as quickly as possible.

Surface drying is best carried out in trays with wiremesh bottom. These trays may be mounted on wooden poles at a height of 75 to 90 cm above floor level. The parchment is spread in trays to a thickness of about 4 to 7 cm. The coffee may be turned repeatedly to facilitate quick drying and to prevent cracking of parchment skin. Surface drying in trays may take about 24 to 48 hours.

After surface drying, the parchment is spread on clean tiled or concrete drying floor to be dried slowly in the lower stages by spreading to a thickness of about 7 to 10 cm. If the parchment is spread too thin, rapid drying of arabica at this stage causes skin to split which may lead to cracking of parchment, shrunken and boat-shaped beans and discolouration of the beans. Stirring and turning over coffee, at least once an hour, is necessary to facilitate uniform drying. The parchment should be heaped up and covered in the evening until next morning. For covering, polythene sheets may be used to prevent tainting of beans by contamination from coir matting. If coir mat is used, it should be kept clean. The cover may be removed and coffee spread again next morning when there is no mist and there is bright sunshine. It is desirable to keep the parchment covered during the hottest part of the day, between noon and the early part of the afternoon. Sun drying may take about 7 to 10 days under bright weather conditions at the right stage of drying the parchment becomes ‘crumbly’ and the beans split clean without a white fracture when bitten between the teeth and the dark spots at either extremity of the beans just about disappears.

The parchment is now ready for test weighing. Drying is complete when sample forlit of coffee record the same weight for two days consecutively. At this stage, coffee is shifted to the store.

When coffee is being dried, all naked beans, pulper nipped and bruised beans, blacks, greens and other defective beans are sorted out and despatched to curing works separately.

The coffee may then be bagged into clean, new gunnies. Coffees of different lots should be bagged separately. New gunnies should always be turned inside out and well aerated before use as otherwise, the coffee will absorb natural oils and off odours from the bag and give rise to an ‘acrid’ cup.

**Preparation of cherry**

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For preparation of cherry coffee, fruits should be picked as and when they ripen. Greens and under-ripe fruits should be sorted out and dried separately. The fruits should be spread evenly to a thickness of about 8 cm on clan drying ground. It is desirable that drying is carried out on tiled or concrete floors. Coffee should be stirred and ridged at least once every hour. The coffee may be heaped and covered daily in the evenings and spread against the next morning after the mist clears up. The cherry is dry when a fistful of sample forlit records the same weight on two consecutive days. The cherry should be fully dry at the end of 12 to 15 days under bright weather conditions. Each lot of cherry may be bagged separately in clean new gunnies.

**Stripping**

At the end of harvest, some amount of coffee will still remain green on the plant. These are stripped off completely, dried and sent to curing works separately. This coffee must be bagged and marked distinctly as strippings.

**Storage and despatch**

Stores should be kept well ventilated and dry without letting in moisture or rain water. The bags containing dried parchment or cherry should be stored on a raised wooden platform to ensure circulation of air underneath the bags. Parchment and cherry coffee should not be stacked together. It is desirable that they are stacked in separate compartments in the store. Other materials, especially fertilizers, pesticides, etc., should not be stored in the same room.

The bagged coffee should be despatched to the curing works at the earliest opportunity. The bags must bear labels as to their grade, lot number and other details, such as parchment, cherry, etc., with instructions to cure them separately. All gleanings, floats should be packed and sent separately for curing.

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Growing Saplings of Coffee Plants

Partial view of a Coffee Plantation (shed trees overhead, coffee plants underneath)

Replanting of Coffee Saplings

Fully-grown Arabica Coffee Plants

Robusta Coffee Plant in full Blossom

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Cherries of an Arabica Coffee Plant

Plucking of coffee cherries in progress

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3.5.9 Post Harvesting Problems and Solutions:

**Harvesting**
By definition, 'processing' does not involve harvesting. However, one cannot produce a good product from badly harvested materials. Correct harvesting techniques could be said to be the most important factor in the production of a high quality final product. Correct harvesting is essential. A good coffee cannot be made from poorly harvested coffee cherries.

**Immature harvesting**
This is the most serious problem with coffee harvesting. Under-ripe coffee cherries are very difficult to process and a low quality product is produced. One of the main causes of immature harvesting is the fear of theft. If the farmer picks it in an immature state, it prevents the thief stealing it.

**Over-ripe coffee**
With over-ripe coffee there is a possibility that the cherry will start fermenting which causes deterioration in flavour.

**Correct harvesting**
The coffee cherries should be picked when they are bright red all over. At this stage, the bean can be squeezed out from the pulp by applying light pressure between finger and thumb.

**Processing**
There are two ways coffee can be processed - dry ('natural') processing and wet ('fermented and washed') processing. In most cases, wet processing is regarded as producing a higher quality product. However, some areas prefer dry processed coffee for its 'fuller' flavour.

**Dry processing**
This is the simpler of the two methods and is popular in Brazil to process Robusta coffee and in Sri Lanka to process Arabica coffee.

**Drying**
The coffee cherries are dried immediately after harvest. This is usually sun drying on a clean dry floor or on mats. The bed depth should be less than 40mm and the cherries should be raked frequently to prevent fermentation or discoloration. However, there are problems associated with this method. The most serious problem is dust and dirt blown onto the produce. Another problem is rainstorms often appear (even in the dry season) with very little warning, this can soak the produce very quickly. Finally, labour has to be employed to prevent damage or theft. Sun drying is therefore not recommended.

**Artificial driers**
In the wet season solar drying of produce is difficult. Rain is very unpredictable and frequent. Solar driers will prevent the coffee getting wet. However, due to the low level of sunlight, solar drying can take a long time. This can lead to mould growth. An alternative drier is needed.

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Hulling
The dried cherry is then hulled to remove the pericarp. This can be done by hand using a pestle and mortar or in a mechanical huller. The mechanical hullers usually consist of a steel screw, the pitch of which increases as it approaches the outlet so removing the pericarp. Cleaning The hulled coffee is cleaned by winnowing.

Wet processing
In this method the cherry is squeezed in a pulping machine or pestle and mortar which removes the outer fleshy material (mesocarp and exocarp) leaving a bean covered in mucilage. This mucilage is fermented and dispersed. The bean is washed and dried.

Mucilage removal
The amorphous gel of mucilage around the bean consists of hemicelluloses, pectic substances and sugars and is insoluble in water. This can be removed by chemical methods, warm water or by an 'agua pulper'. However, for small-scale units the only feasible method is fermentation. Fermentation involves the beans being placed in plastic buckets or tanks and left until the mucilage has been broken down. Natural enzymes in the mucilage and feasts; bacteria in the environment work together to break down the mucilage. The coffee should be stirred occasionally and every so often a handful of beans should be tested by washing them in water. If the mucilage can be washed off and the beans feel gritty rather than slippery, the beans are ready. The beans should then be washed immediately as 'off' flavours develop quickly.

Drying
To prevent cracking the coffee beans should be dried slowly to 10% moisture content (wet basis). Drying should take place immediately after to prevent 'off' flavours developing. The same drying methods can be used for this as for the dry processed coffee.

Hulling
After drying the coffee should be rested for 8 hours in a well ventilated place. The thin parchment around the coffee is removed either by hand, in a pestle and mortar or in a small huller.

Cleaning
The hulled coffee is cleaned by winnowing.

Roasting
The final flavour of the coffee is heavily dependant on how the beans are roasted. Roasting is a time temperature dependant process. The roasting temperature needs to be about 200ºC. The degree of roast is usually assessed visually. One method is to watch the thin white line between the two sides of

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the bean, when this starts to go brown the coffee is ready. As preferences vary considerably from region to region, a lot of research will need to be done to find the locally acceptable degree of roast. Coffee beans can be roasted in a saucepan as long as they are continually stirred. A small improvement is made by roasting the coffee in sand, as this provides a more even heat. A roaster will produce a higher quality product. The simplest roaster is basically a tin can with a handle so that it can be rotated slowly over a fire. There are various other roasters suitable for larger scale units.

Grading
In some cases the crop needs to be graded, eg high quality packaged products for export. Coffee is graded by size, shape, odour, density and colour. For small-scale units this is best done by hand.

Grinding
Grinding is a means of adding value to a product. However, it is fraught with difficulties. With a whole product it is easy to assess its quality, whereas with a ground product it is very hard. The fear of adulteration and the use of low quality produce is justified. Because of this there is a great deal of market resistance to round coffee. This market resistance can only be overcome by consistently producing a good product. There are basically two types of grinders - manual grinders and motorized grinders.

Manual grinding mills
There are many manual grinders that could be used to grind coffee. An experienced operator can grind about 20kg in an eight hour day. However, this is hard and boring work. A treadle or bicycle could easily be attached to the grinder, which will make the work easier. With this system, one person could grind about 30kg in one day. Work needs to be done to find out the degree of fineness the consumer wants. The grinding mills then need to be set so that they produce the desired ground product. For small-scale production (up to 100kg/day) a series of these grinders is all that is needed. For larger scale production units, a motorized grinder would be required.

Motorized grinding mills
Horizontal plate, vertical plate or hammer mills are suitable for grinding coffee. A grinding mill has to be placed in a separate and well-ventilated room because of the dust. As above, the grinding mill needs to be adjusted so that it grinds the coffee to the desired fineness.

Instant coffee
The production of instant coffee is unsuitable for small-scale enterprises as it requires very expensive machinery e.g. an extractor and a freeze or spray drier. A report by the Natural Resource Institute (NRI) states that the smallest economically viable instant coffee factory is 1000 tons/year in India. Various people are trying to design machinery suitable for small-scale production of instant coffee which may be able to reduce the throughput.
necessary for economic viability. To produce an instant coffee, the soluble coffee solid and volatile compounds have to be extracted and then dried into a powder or granules.

**Coffee Marketing In India:**
Coffee board is the sole marketing authority in India before 1992 it is obligatory on the part of the planters to surrender all the right of the crop to the board except the right of taking the receipts. Board in turn takes care of the disposal of the entire crop. Coffee marketing system before the establishment of coffee board may not be out of place. The entire market is highly disorganized. Since coffee is the unique product which requires processing before it reaches to consumer. The processors or coffee curers playing the important role. The curers and commission agents combined the functions of financier, curer, assembling agent and wholesale buyer. The largest number of reputed curers were established in Mangalore. About 40% to 50% of the crop was assembled at and marketed through Mangalore and 75% of the exports passed through this port. Coimbatore, which comes next was biggest assembling center produced in Chennai Presidency, Travancore and Cochin. It was estimated that 10% to 15% coffee was sold on forward delivery basis. The curers and wholesale distributors used to make forward contract with planters.

**Grading:**
Coffee has a larger range to quality than any other agricultural product. The quality varies in the same type, variety and season from district to district and plantation to plantation. There was no uniform standards for grading. The curers in Mangalore, Calicut, Coimbatore and Mysore were doing a certain amount of grading on the basis of type, variety, size and bean appearance. The grades of the curers were varying from place to place and even in the same place. Besides the curers, there were large number of merchants who are doing the grading. The variation in grades and grade designation from one merchant to another merchant. Garbling and Re-garbling and mixing by dealers during the various stages of distribution were destroying any kind of uniformity in coffee.

**Prices:**
The price fluctuations were very high. The prices of coffee and the demand in the world were chief factors that influenced the prices Indian coffee. Regarding world prices, Brazil was domination the situation and practically dominating that key to coffee prices in general. The curers and commission agents assembled and distributed about ¾ of the total crop. The curers effected sales through brokers or direct to manufacturers.

There were attempts by the growers association like coffee growers association of India to bring together coffee growers to establish a central agency for the sale of coffee. But these attempts were not fruitful until the enactment of Indian coffee cess act in 1935. The wholesale

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distributors were purchasing coffee from planters, curers and commission agents were selling to the retailers or wholesalers in other distributing centers. Some wholesale distributors were keeping traveling agencies who visited consuming centers and book orders.

The London market was an important distributors center and the London trade was largely done in coffee known as home trade. Quality coffee from particular plantations had special estate marks. Coffee was sent on consignment basis was usually sold by public auction.

3.5.10 PRESENT MARKETING SITUATION OF COFFEE IN INDIA

After the W.T.O.open market came, private people were came into the market to purchase the coffee. The producers of the coffee can sale anybody of the middleman. the private middlemen can sell any of the curer in the district. The coffee curing works are also purchase the coffee directly from the producers. then they will make the curing process and sell in the domestic market or in the international market. there are any coffee curing works are in the district. they are as follows.

1. City coffee curing works
2. Sargod coffee curing works
3. Amalgamated bean coffee trading company limited
4. Chamundi curing works
5. Madhu coffee curing works
6. Mysore coffee curing works
7. Malenadu planter’s coffee curing works
8. Sarathy coffee curing works
9. Joy coffee curing works

They process the coffee and grade them on the basis of the coffee seeds. the size wise difference separate the seeds. the grading of the coffee is based on the quality of the seeds. grading is done in the following ways.

AAA= big size of the seeds.
AA= small in size
A= Very small in size
PB= Round
B= small
C= Cuts and lights
BBB= black brown bits

Coffee board which controls the coffee marketing in India is the most powerful of the commodity markets. but the open trade activities avoid the

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interference of the coffee board. The growers are selling the coffee to the middlemen or to the curers directly. Domestic consumption of the coffee estimated is 94400 metric tones in the year 2008. It was increased from 50796 metric tones in the year 1981.

The major coffee exporters of the coffee from Chikmagalure district areas follows.

1. Amalgamated bean coffee trading co.ltd
2. Sarathy coffee curing works.
3. Sargod trading company

The Indian coffee is not competing in the international market. Because of its maintenance of the quality. The growers are not having the proper knowledge of the better quality methods except the large growers. The area under the coffee is more in India but it can compete in the Brazil and Vietnam coffee.

Not only the quantity but also the quality of the crop is important, particularly in the case of the export oriented crops like coffee, tea, etc. These crops are should be improved qualitively to stand in the world competition. Here an attempt is made to study the present coffee growing system and improving the quality and quantity of the coffee by the growers. The growers are the root of the coffee industry, so the researcher is highly concentrated on the problems and prospects of the coffee growers.

3.5.11 Coffee Promotion

Promotion of coffee, under the aegis of the Indian Coffee Cess Committee, commenced on 1st July 1936. The promotional work comprised opening of Coffee Houses in Bombay and Hyderabad, running a coffee demonstration van, investigating the state of trade and the consumption of coffee in Bombay and Hyderabad, a certain amount of poster, cinema and press advertising and participation in important exhibitions. The Cess Committee also organized a Coffee Demonstration Party to work in the erstwhile State of Travancore to teach the public the correct methods of roasting, grinding and making coffee.

Although this as the general pattern of work, the Cess Committee slanted its promotional activities to suit different situations. Thus, in 1937, when prohibition was enforced in Salem district of the Madras State, the Cess Committee offered coffee as a counter attraction to toddy with appreciable success.

In the initial stages, promotion for coffee was done through an advertising agency in Bombay. However, in 1938, the services of the agent were terminated and the promotional work was taken over by the Committee. Accordingly, sub-offices of the Department were opened in different centres of the country, each in charge of an organizer of coffee.

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promotion. Each promotional unit, such as an India Coffee House or a Demon- stration Party was in charge of a leader answerable to the organizer of the area, for the efficient performance of the promotional work assigned to him.

At the time of formation of the Indian Coffee Market Expansion Board in 1940, coffee promotional work was in progress in 7 centres in North India and 9 centres in the South. Further, the staff for promotion work was strengthened by the creation of the post of an Assistant Secretary (Propaganda). In general, the Indian Coffee Market Expansion Board continued the programme of maintaining and opening more India Coffee Houses, Bars and Vans for sale of coffee in the cup at moderate rates, with a view to convincing the old and new consumers of coffee how good Indian coffee could taste when prepared well.

At one time, the Board used only Arabica Plantation Coffee for its propaganda work. Gradually, other types of coffees such as arabica cherry and robusta were also popularized in different areas. Towards the close of 1944, the Board also took up a campaign to create, in Travancore, a demand for the local robusta in proportion to its supply.

In 1945, special efforts were made with the help of promotional parties to educate growers of coffee on steps to be taken by them for improving the quality of the produce. The gradually expanding promotional activities of the Board led to the appointment in 1945 of the First Promotional Officer and creation of four promotional zones in the country, each headed by an Assistant Propaganda Officer, with headquarters in New Delhi, Calcutta, Bangalore and Coimbatore. In July 1948, there were in all, 49 promotional units in operation in India and Pakistan, comprising 43 coffee houses, 2 coffee bars, 1 coffee van and 3 coffee depots. During the years, the promotion policy of the Board centered round the act that ‘there can be no substitute for a good cup of coffee’ for promoting coffee. Hence, the emphasis on demonstration parties, coffee vans and the chain of India Coffee Houses, with an atmosphere of their own, designed to attract the connoisseurs of coffee. By holding demonstrations of the correct techniques of roasting coffee seeds, and brewing and serving liquid coffee, a taste for coffee was not only created, but the enjoyment of good coffee in homes was also enabled. Sale of domestic coffee grinders and coffee filters, at reasonable prices, through India Coffee Houses and Depots further served to spread the coffee habit. The taste for coffee resulted in demand for coffee powder which in turned help the marketing of raw coffee internally.

The promotional units of the Board made available good quality coffee powder in sealed polythene bags, not only through the Coffee Depots and Coffee Houses but also through approved agents selling coffee at fixed prices. The units of the Board served the ends of promotion and also acted as fair price depots by indirectly controlling the price of raw coffee and power in the retail market - a policy enunciated by the

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Government around 1957.

The steady increase in the number of hotels in cites and towns, specializing in the service of good coffee, in the wake of the standards set up by the India Coffee Houses, was a tribute to the promotional value of the latter. By 1956, the Board felt that the trend in growth of such coffee bars was established well enough to enable the winding up of most of the departmental coffee houses. Accordingly, in 1957, the Board drew up a fresh scheme of promotion, the central features of which were gradual closure of India Coffee Houses, opening of more sales depots in key centres and introduction of more mobile vanes as well as units for house-to-house demonstration by lady demonstrators in selected centres in North India.

Wherever an India Coffee House was closed, the Board’s policy was to allow cooperatives formed by its former employees to run it to the Board’s standards. The Board also worked out a scheme of approving well-run catering establishments and hotels which brewed and served good quality coffee. The Approved Coffee Houses were supplied with coffee powder as well as coffee display posters and publicity materials by the Board. They were also given a quota of coffee seeds and powder for direct sales to the public on which they were allowed a small commission.

Robusta drive

During 1960-61 season, receipt of robusta coffee to the tune of 28,506 tonnes created a panic among coffee growers. To meet the situation caused by the glut of robusta coffee, a special drive was organized by the Propaganda Department in 1962. This was done to create a public taste for robusta coffee and the drive comprised several measures:

- Sake of compulsory quota of robusta coffee through India Coffee Depots, granting of Agencies for sale of robusta coffee beverage at a low price from Mobile Coffee Vans. As a result, the internal consumption of robusta rose to 19,688 tonnes in 1963-64, a figure that could not have been dreamt of a few years earlier.

- Today, the Department runs 15 coffee houses in Bangalore, Calcutta, Delhi, Guruvayur, Hyderabad, Jammu, Madras, New Delhi, Tirumala, Tirupathi, besides 5 India Coffee Vans in Bangalore, Hyderabad and New Delhi. The Board also runs a chain of 42 India Coffee Depots in different parts of the country.

- The Promotion Department continues its work of expanding the demand for coffee by participation in fairs and exhibitions, publication of booklets, press and advertisement campaigns, display of posters, hoardings, slides in cinemas and production and exhibition of films, organization of coffee demonstrations and special campaigns to improve coffee brewing, to project the image of Indian coffee, as a result of which the internal consumption of coffee has been steadily going up. With continued and

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sustained promotional campaigns, there is further scope for increasing the domestic consumption in the coming years.

In 1985, the Board took up several special promotional campaigns like ‘Paint a poster’ contest on a national level, which attracted a large number of entries mainly from the younger age groups. A Special Corporate Campaign was launched in national dailies and economic publications explaining the different facets of the Indian coffee industry and the working of the Coffee Board. Creation and broadcast of Coffee jingles from All India Radio stations produced a good impact. Coffee brewing excellence award scheme launched by the Board to promote the brewing of pure coffee of the highest excellence in hotels/restaurants and canteens in Bangalore generated good response. And also coffee brewing demonstrations were held regularly at different places to promote the brewing of pure coffee.

**Overseas promotion**

*History:* For overseas promotion, an Indian Coffee Market Expansion Board was organized in London. The Board commenced work on 28th July 1936, under the stewardship of a Director of Indian Coffee Propaganda in London. The external promotion work was done in the U.K. in close cooperation with wholesalers, distributors, institutions and government departments, by creating an interest in ‘Indian Coffee’ among them and removing prejudices against it. Indian coffee was also brought to the notice of the consuming public and retailers through exhibitions and special displays.

The London Board maintained close contacts with wholesale and retail coffee traders and continued to give weekly demonstrations in the art of brewing and serving coffee in important stores and canteens. Between 1942 and 1945, as coffee was in short supply in the U.K., the London Board changed its programme of work from demonstrating Indian Coffee as a ‘straight’ drink to giving educational lectures on ‘the history and romance of the Indian Coffee Industry’ as well as coffee facts for homemakers and canteen workers.

The London Board survived the period of six years of war. In August, 1947, it altered its title to Indian Coffee Board, London, and worked on a contract basis to maintain the interests of the Indian coffee in the U.K.

The Department is expanding its activities further to impress the image of the Indian Coffee in the new markets abroad.

**‘Indian Coffee’ Magazine**

The monthly magazine ‘Indian Coffee’, which is the official organ of the Board is brought out in four languages, viz. English, Kannada, Tamil and Malayalam, and is dedicated to the promotion of the Indian Coffee Industry. The magazine has a wide circulation both in India and

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abroad and serves as an effective communication tool between the different interests connected with the industry.

Recently, the Board has produced a short film titled ‘Royal Indian Coffee’ on the rich tradition of Indian coffee, demonstrating the art of brewing and serving coffee, besides various stages of coffee from the seed to cup. This film was shown in international fairs and exhibitions as a part of promotion. A short clip of this film is also shown in Air India flights.

3.6 HEALTH FACTS OF INDIAN COFFEE

Although coffee has a long history of human food use, until recently, most of the studies on its health effects have focused on potential adverse effects. However, in recent years, there is a significant authoritative scientific information available to support the fact that drinking coffee in moderation has many positive effects on our health and well being.

3.6.1 Coffee and antioxidants

Antioxidants may be of great benefit in improving the quality of life by preventing or postponing the onset of cardiovascular disease, cancer, cataracts, the age-related decline in the immune system and degenerative diseases of the nervous system. Diets that include soya beans, green and black tea, coffee, red wine, sage and other spices, citrus and other fruit, onions and olives help contain these diseases.

Many studies have implied that coffee contains high levels of antioxidants compared to other commonly consumed beverages and latest research findings clearly demonstrate that while both coffee and tea display powerful antioxidant properties, coffee proved to be four times stronger than tea.

Chlorogenic acid, which is a combination of caffeic acid and quinic acid is the most abundant polyphenol in coffee and is likely to represent a substantial part of coffee antioxidants.

3.6.2 Coffee and Mental Performance

The latest scientific evidence indicates that about 200 mg of caffeine, which is the amount of coffee used to prepare two cups of coffee, increases your level of alertness as well as helps your short-term memory. Since coffee helps boost short term memory, it helps us remember all the tiny details that we try to cram in at the last minute. Coffee is most often used as a mood optimizer or the ‘feel good factor’ that helps us to make the best of a special occasion. Coffee also helps to improve alertness, attention and wakefulness and helps to counter the mental fatigue during the course of long exams when you get tired.

3.6.3 Coffee and Liver Function

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Coffee is reported to reduce cirrhosis of the liver, which is basically a disease causing progressive damage and scarring of the liver tissue and function. A study involving over 128,000 adults showed that persons drinking four cups per day were at one-fifth the risk of those who did not drink any coffee.

Caffeine in coffee has been demonstrated to have the ability to increase bile flow and inhibit biliary cholesterol crystallization, both key factors in limiting the risk of developing stones in the gallbladder.

3.6.4 Coffee and Exercise Performance

One cup of coffee has enough caffeine to reduce the sensation of fatigue in humans. Contrary to popular belief, caffeine does not cause dehydration nor affect the balance of fluid and electrolytes in the body. The small amount of caffeine found in a regular cup of coffee, about 100 mg, is sufficient to have performance enhancing effect.

3.6.5 Coffee and Cardiovascular Diseases

Till date, research has shown that drinking coffee in moderation is not associated with the development of cardiovascular problems, including atherosclerotic disease, myocardial infarction, ventricular arrhythmias and hypertension.

3.6.6 Miscellany

(a) Is coffee stimulating? Yes, it depends on your actual level of mental and physio- logical activation. When an activity is boring or not motivating, the caffeine in your coffee acts as a stimulant, and gives you the energy to complete the activity and make the best of it.

(b) How much coffee is ‘safe’? Coffee is one of the most extensively researched commodities in the world. Literally thousands of studies have shown that coffee drinking in moderation is perfectly safe and can even be beneficial to health. Moderation is generally accepted as being 4-5 cups of coffee a day.

(c) Can coffee help when you have a jet lag? The caffeine content in coffee has been proven to increase attention span and vigilance, improve your ability to communicate and to boost your short term memory. In effect, caffeine can help reset your body clock to a new schedule.

(d) Does coffee lead to better physical performance while exercising? Research shows that caffeine does improve physical performance and its effects are widespread across a diverse variety of sports and exercises. These studies have included well-trained athletes as well as relatively sedentary individuals.
(e) **Is coffee addictive?**  
Coffee drinkers do not require increasing amounts of caffeine over prolonged periods of time and they can moderate or change their consumption with no difficulty. Also, coffee does not cause any psychological social effects.

(f) **Does coffee really have a role in healthy diet and lifestyle?**  
Caffeine, in the form of coffee, has the ability to reduce the discomfort and fatigue most people feel when exercising, and its widespread and long-standing use in most diets can make a significant contribution to helping us become fitter and healthier.

*Compiled from:*

*Various publications of Coffee Board and Central Coffee Research Institute (mostly undated).*