



Sabyasachi Ray, born and brought up in Cuttack, Odisha, is a Mechanical Engineering graduate with a strong inclination toward environmental sustainability, natural resource management, and rural development. His passion for working at the intersection of technology and ecology inspired him to pursue a career in the Indian Forest Service, where he aims to contribute to sustainable forestry and community-based conservation.

He is currently undergoing professional training at the Central Academy for State Forest Service (CASFOS), Coimbatore, as part of the State Forest Service (SFS) 2023–25 Batch. During his training, he has actively engaged in field studies, case analyses, and research projects focusing on sustainable land use, ecological restoration, and livelihood enhancement in forest-dependent regions.

His book on *“Coffee Plantation in Koraput, Odisha”* reflects his commitment to promoting sustainable plantation practices, integrating scientific knowledge with grassroots realities, and highlighting the potential of non-traditional crops in tribal and hilly regions of India.

With a blend of technical acumen and ecological sensitivity, Sabyasachi Ray aspires to work towards developing climate-resilient, community-centric forestry models that balance conservation priorities with socio-economic development.

Coffee Plantation in Koraput

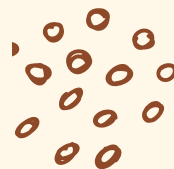


Sabyasachi Ray



**CENTRAL ACADEMY FOR STATE FOREST SERVICE
COIMBATORE**

2025



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FOREWORD

Coffee cultivation in India's non-traditional regions represents a remarkable intersection of ecological restoration, livelihood generation, and sustainable land use. The district of Koraput, Odisha, with its undulating hills, rich biodiversity, and vibrant tribal communities, stands as a promising model for such integrated development. This book, *"Coffee Plantation in Koraput, Odisha"*, by Sabyasachi Ray, is an insightful and comprehensive documentation of this evolving landscape.

Through meticulous research and first-hand observation, the author has explored the history, agronomic practices, and socio-economic significance of coffee cultivation in Koraput. The study highlights how the introduction and expansion of coffee plantations have contributed not only to soil and water conservation but also to the empowerment of local communities, particularly the tribal population dependent on forest and land-based livelihoods.

I commend the author for this well-structured and informative effort that captures the spirit of sustainable coffee cultivation in Koraput and its potential as a model for non-traditional coffee-growing regions across the country.

V. Thirunavukarasu, IFS
APCCF & Principal,
CASFOS, Coimbatore



PREFACE

The book, '*Case Study on Coffee Plantation in Koraput*', is a modest attempt to document the history, practices, challenges, and opportunities associated with coffee cultivation in the hilly terrains of Koraput, Odisha. Coffee, often considered a global beverage, has a unique socio-economic and ecological footprint in India's non-traditional coffee growing regions. Among these, Koraput occupies a special place due to its favourable agro-climatic conditions, its integration with tribal livelihoods, and its potential for sustainable development.

This case study has been undertaken as part of the academic requirements of the **SFS Induction Course (2023–25 Batch)** at the Central Academy for State Forest Service (CASFOS), Coimbatore. In preparing this study, I have sought to blend historical accounts with present-day field observations, technical details with socio-economic insights, and scientific approaches with on-ground realities.

The purpose of this document is not only to highlight Koraput's journey with coffee cultivation but also to underscore its relevance as a model for agroforestry-based rural development. I hope this study will serve as a useful reference for forestry professionals, researchers, students, policymakers, and anyone interested in sustainable plantation practices in non-traditional areas.



I express my deep gratitude to the faculty of CASFOS, Coimbatore, for their guidance; to the officials of the Coffee Board of India, Koraput, for their valuable inputs; and to the coffee growers and entrepreneurs of Koraput, who generously shared their experiences. Their cooperation and encouragement have made this book possible.

-Sabyasachi Ray



ACKNOWLEDGMENT

The successful completion of this book, *“Coffee Plantation in Koraput, Odisha”*, has been possible through the guidance, encouragement, and cooperation of many individuals and institutions to whom I owe my sincere gratitude.

I extend my heartfelt gratitude to the Odisha Forest Development Corporation Ltd., and the local communities who generously shared their knowledge and experiences.

I would like to express my sincere gratitude to Principal, CASFOS, Coimbatore Shri. V Thirunavukarasu, IFS, and Course Director, Dr. C. Vidhyasagar, IFS, for encouraging and motivating me to come up with something substantial related to my area of interest.

I would like to thank all the faculties of CASFOS Coimbatore for shaping me in such a way so that I could develop an inclination for a specific field. I also extend my gratitude to Editorial committee of CASFOS Coimbatore, Dr. Ramkrishnan R., Scientist C and Dr. B. Muhamad Rafi Hussain for their technical guidance and editing this book.

I am deeply indebted to my mentors and colleagues at the Central Academy for State Forest Service (CASFOS), Coimbatore, for their constant guidance and encouragement.

Sabyasachi Ray
SFS Trainee (2023–25 Batch)
CASFOS, Coimbatore



CONTENTS

CHAPTERS	PAGE NO.
1. Introduction	1
2. History of Coffee Cultivation in Koraput	11
3. Seed Propagation Techniques	17
4. Shade Management in Plantations for Sustainable Coffee Cultivation	27
5. Training and Pruning	32
6. Soil Acidity and Management	36
7. Pests, Diseases and its Management	38
8. Harvest and Post-Harvest Practices	50
9. Conclusion	59

Introduction - Coffee in India

Coffee and humans go back a long way-back to 800 A.D. Legend has it that an Ethiopian goat herd noticed that his goats were frisky after eating a certain berry. The goat herd, Kaldi tried the berries and found it banished sleep. Local monks heard of this wondrous berry and tried it out, making a drink of the berries.



Fig.1 Coffee drink

This discovery spread to Arabia, where sometime around 1000 A.D. coffee beans were roasted and brewed. Coffee as we know it had arrived, by thirteenth century, it was a popular drink with the populace. The Arabians, being inveterate travellers, spread the coffee habit wherever they went - North Africa, India etc.

However, realising the advantage of controlling the growing trade in coffee, they kept the fertile beans and their cultivation a secret. Thus, only infertile beans (made infertile by boiling or parching) were traded and so no coffee was grown outside Arabia (and Africa of course) till the 17th century. It is said that in 1600s, an Indian traveller, Baba Budan smuggled fertile beans from Mecca, thereby leading to Indian Coffee cultivation boom world wide.



Fig. 2 Journey of Coffee to India

Baba Budan, who smuggled coffee beans from Arabia, is said to have planted coffee near his hermitage in Dattareya Peeta in what is present day Karnataka's Chikkamagaluru area. However, it was not until the late 1820s that commercial plantations were developed in South India with British enterprise and investment. The cultivation of coffee rapidly progressed during the next forty years.

In 1856, there were only seven British planters in Mysore. By 1869, their number had increased to 662 owning 8,094 ha of the total cultivated area of 58,670 ha. Indian coffee soon established itself as outstanding in quality and became a commodity second to none in the world market.

1.1 Morphology and growth behaviour of Coffee

Coffee plants need a period of three years to grow and develop from seed germination to first flowering and fruiting. It is a perennial plant (lives for many years), a well-maintained coffee plant lives more than 80 years. It is evergreen (plants that do not shed their leaves during a specific season) in nature. It has a prominent vertical stem giving rise to horizontal primary branches in opposite decussate manner (where two leaves/branches at each node are arranged opposite to each other and each pair of leaves/branches are at right angles to each other).

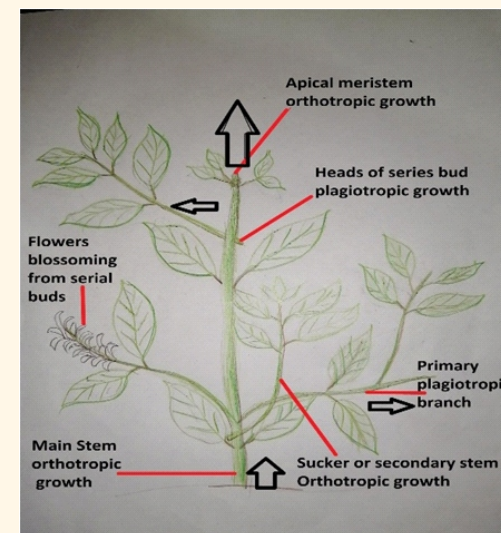


Fig. 3. Morphology of Coffee plant

The primary branches develop several secondaries laterally which in turn give rise to several tertiary and quaternary branches. These are collectively referred to as sub-laterals. In each plant, the lateral branches spread out at right angles to the main stem and exhibit either erect, semi-erect or

drooping growth habit. Apart from the lateral branches, a number of vertical shoots with upright growth also arise from the main stem. These are known as 'suckers' and because of their vertical growth habit like the main stem, the suckers are used in vegetative propagation.



Fig. 4 Parts of Coffee plant

Coffee growing regions in India can be grouped under three distinct categories:

1. **Traditional** areas representing the southern states of Karnataka, Kerala and Tamil Nadu.
2. **Non-traditional** areas comprising Andhra Pradesh and Orissa in the Eastern Ghats of the country.
3. **North Eastern** regions.

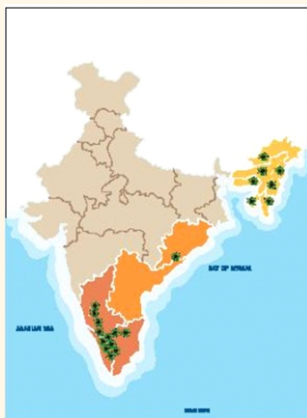


Fig.5. Coffee producing States in India

1.2. Varieties of Coffee in India

1. Arabica (*Coffea arabica* L.)

Popularly known as 'arabica coffee', it is a tetraploid species. Under natural conditions arabica grows like a small tree, but under regulated conditions looks like a bush. The plants produce profuse branches and the matured leaves are dark green in colour while the young leaves (leaf tip) are either green or bronze. The flower buds are produced in clusters in the axils of leaves at each node.



Fig.6. Arabica (*Coffea arabica* L.) bean

Under South Indian conditions, initiation and subsequent growth of flower buds takes place from September to March. Water is essential for flowering and so the blossoms occur 8 to 10 days after showers. Arabica is self-fertile.

The fertilized ovary grows into a fruit (drupe) in about 8 to 9 months and finally ripens into dark red berries which ranges in number from 10 to 20 per node. Arabica coffee is susceptible to major pest and disease of coffee viz., coffee leaf

rust and white stem borer. Arabica is considered as superior in quality to robusta with rich flavour and aroma.

2. Robusta (*Coffea canephora*)

Robusta, as the name implies, grows vigorously (compared to arabica). It is a diploid species ($2n=22$) and has broad, large leaves that are pale green in colour. Flowers are fragrant and borne in compact clusters at each node.



Fig. 7. Robusta (*Coffea canephora*) bean

The number of flowers per node are higher than in Arabica. Under the climatic conditions of South India, the buds initiate during November and are ready for blossom in February and March, on receipt of summer showers or by irrigation, the flowers open on 7 or 8 days after rains.

Unlike Arabica, Robusta is self-incompatible, i.e., the ovule of same flower cannot be fertilized with its own pollen. Hence, cross pollination is essential in Robusta. The fruits mature in 10 to 11 months and generally ready for harvest two months later than arabica. *C. canephora* is shallow rooted and susceptible to drought. It is tolerant to major diseases and pests of coffee like coffee leaf rust and white stem borer.

The quality of Robusta coffee is inferior to that of Arabica in bean size as well as in organoleptic characteristics like aroma, flavour and taste.

Varieties	Elevation (mtr)	Rainfall (mm)	Distribution
Robusta	500-1000	1000-2000	Blossom Shower- Febraury -March
Arabica	1000-1500	1600- 2500	Blossom Shower- March- April
Backing shower during April- May is required for both the varieties			

3. Tree coffee (*Coffea liberica*)

Liberica is known as tree coffee because of its growth habit and is cultivated along the fence and boundary line of estates. It is also a diploid species with $2n$ chromosomes. The leaves are dark green, leathery and are 2 to 3 times larger than arabica. The flowers are large and fleshy. Flower to fruit maturity is slow; taking about a year. The fruits are larger in size than arabica and are yellow to reddish-brown in colour. Cup quality is generally considered inferior to robusta.



Fig. 8. Tree coffee (*Coffea liberica*) bean

1.3 Genetic Varieties in Coffee

Varieties	Parentage	Special Characters
Selection 1 (S288)	Tetraploid hybrid from S26 (C. liberica x C. arabica)	Resistance to leaf rust race 1 & 2, high yielding, wider adaptability
Selection 3 (S795)	Cross between S.288 x Kent	Resistance to leaf rust race 1 and 2, 700-1200 kg/ha, bold fruits 75% A grade
Selection 5	Devamachy x S-881	Small, oblong fruits, 900-1100 kg/ha
Selection 6z	S-274 (Robusta) x Kents	High A grade beans, 900-1000 kg/ha
Selection 7	San Ramon – a short internode arabica	Dwarf in stature, segregates to tall by 30%
Selection 8 (italic)	Pure line selection of Hibrido de Timor	Highest resistance to leaf rust, drooping branches
Selection 9	Sln 8x Tafari-kela	Drought hardy, suitable to different coffee zones
Selection 10	Double cross hybrid, Cattura x (S795 XHDT)	Resistant to leaf rust
Selection 11	Progeny of C.liberica X c.eugenoides	Field resistance to rust and drought hardiness
Cauvery	Catimor x Hibrido de Timor	Plants are dwarf, suitable for high density planting, yield ~3000kg/ha, superior cup quality
Selection 12	Cross Caturra x HDT, followed by selfing	Precocious, suitable for close planting, resistant to leaf rust

Fig. 9. Comparison of Arabica and Robusta



Fig.10. Comparative image of Arabica and Robusta Coffee Beans

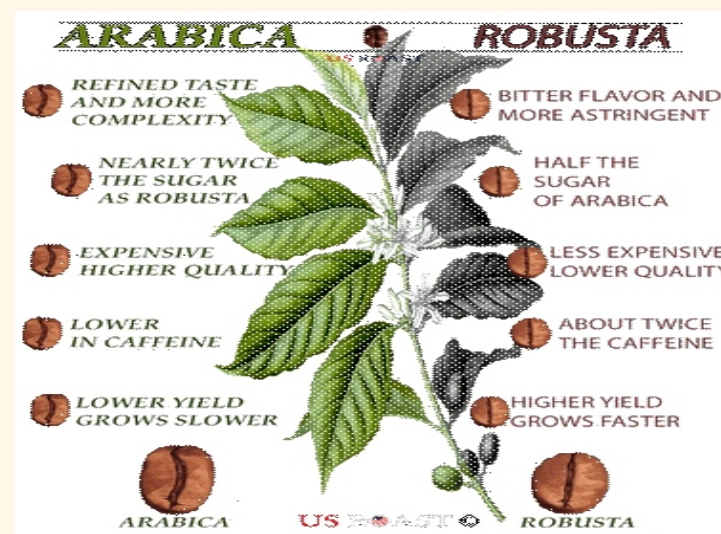


Fig.11. Comparison of Arabica Vs Robusta

History of Coffee Cultivation in Koraput, Odisha

Koraput, located in southern Odisha, is a district known for its hilly terrain, diverse mineral deposits, and rich tribal culture. It's a nature lover's paradise, featuring lush valleys, dense forests, and cascading waterfalls.

History of coffee in Koraput district can be traced back to the times of Maharaja Ram Chandra Deo of Jeypore in 1940's who had set up silviculture stations to take up cultivation of coffee plants on an experimental basis near present day Mohulbhata village and Peta ghat. The experiment was successful to some extent as well.



Fig. 12. Field visit to Technology Evaluation Centre, Koraput



Fig. 13. Coffee Plantation site visit, Koraput



Fig. 14. Mohulbhata village and Peta ghat.

The erstwhile ruler had foreseen the suitability of Koraput climate for rearing of coffee plants. Though the real head way was made post-independence when soil conservation department of government of Odisha, to mitigate soil erosion, decided to take up large scale plantation of coffee in the catchment area of Machkund reservoir. Further some private entrepreneurs from within and outside state acquired land and started cultivation of coffee with pepper in Kasipur, Dasmantpur, Kakrigumma, Podagada, Pottangi area as a cash crop. These areas being located on the 900 Mtr. plateau of Eastern Ghat mountain range offer suitable climate for coffee rearing.

In 1970s and 1980s nearly 200 aspiring planters raised coffee plantations in different areas of Koraput district to reap the benefits of the conducive climate.

2.1. Coffee Board of India, Koraput



Fig. 15. Coffee Plant Cultivation

Coffee is cultivated in an extent of 3,935 ha. in Odisha and is owned by 2,545 growers. The Coffee Board of India, Koraput setup to support to the Coffee growing sectors in

enhancement of Coffee production, research & development and technology transfer to production of quality beans and promotion of coffee in export and domestic markets. The Technology Evaluation Centre located at Koraput was set up in the year 1978. It serves as a demonstration farm of location specific technologies for the region.



Fig. 16. Coffee Board, Koraput, Odisha

The extension activities include transfer of technology through contact and follow up visits to coffee holdings, conducting field demonstrations, group discussions, quality



Fig.17. Quality checking of Coffee beans

awareness campaigns include conducting study tours to the tribal growers and the traditional coffee growing areas, for improvement in production, productivity and quality of coffee in the tribal sector.

2.2. Dreamhills Coffee, Koraput

Dream Hill is more than just coffee. The pioneer behind this enterprise is Sri Susanto Panda who established this farm in the year 1997. Their vision has always been to create a brand that combines exceptional coffee with ethical sourcing and sustainability. They aspire to not only represent Koraput's unique coffee on a global stage but also to continue supporting local community.

Sri Panda always inspires the visitors of his farm by sharing his years of experience on coffee plantation techniques, his tour visits to the traditional coffee areas and the challenges faced.

Dream Hill's future is about growing a family of coffee enthusiasts and making a positive impact on the world.



Fig.18 Susanto Panda explain the visitors about his farm

2.3. Need for Coffee Plantation - Objectives

- ❖ Coffee is a plantation crop.
- ❖ It has two major species under Cultivation Arabica & Robusta
- ❖ In Non Traditional Areas such as Odisha and Andhra Pradesh coffee plantation is seen as potential hill area development activity which provides livelihood sustainability and checks podu / shifting/ jhum/ slash & burn cultivation.
- ❖ Secondly it can solve migration crisis and enhance rural economy.
- ❖ Thirdly it can be a good agroforestry model for sustainable forest management.



Fig.19. Tribal workers in Coffee Plantation Area

2.4 Climatic requirements for Coffee Cultivation

Factors	Suitable for Arabica	Koraput
Soils	Deep, fertile, rich in organic matter, well drained and slightly acidic (pH 6.0-6.5)	Fertile/rich Organic/pH6.0 to 6.5

Seed Propagation Techniques

Coffee being a perennial crop, use of high-quality seeds is critical in establishing a productive coffee plantation. To raise good quality seedlings, use of authentic seed material from authorized sources like the Coffee Board, Research Department is recommended.



Fig.20. Coffee Plantation

The production of quality seeds involves careful monitoring at every stage of seed preparation. It starts from establishing genetically pure seed blocks, removal of off types, forcing the blossom well in advance i.e., prior to the receipt of blossom showers to arrest the pollen contamination and adopting strict seed preparation protocol. The seed preparation protocol includes the selective harvest of fruits at

Factors	Suitable for Arabica	Koraput
Shade	Needs medium to light shade (Two tire Filter shade of 50-60%),	Mono/Natural shade
Slopes	Gentle to moderate slopes	Moderate
Elevation	2500-4000ft	1800 ft to 4200 ft
Aspect		North, East and North-East aspects
Temperature	15°C-25°C ; cool, equable	Min: 6°C-10°C; Max: 20°C - 40°C
Relative humidity	70 - 80%	30% - 90%
Annual rainfall	1600-2500 mm	1200 - 1800 mm
Blossom showers	March-April (25-40 mm)	Assured*
Backing showers	April-May (50-75 mm) well distributed	Assured

correct stage of ripening, pulping by using hand pulpers and shade drying to maintain the required moisture levels.

3.1 Seed sources and preparation protocol

The seeds blocks established at the Central Coffee Research Institute (CCRI) and its Regional Coffee Research Stations, and certain Technology Evaluation Centres (TECs) of the Coffee Board using the nucleus seed material of a given variety are used as source plots for seed preparation. All the seed plots are regularly maintained by removing off-type plants, if any. For ensuring controlled pollination, the seed plots are irrigated in advance, before the receipt of blossom showers.



Fig.21. Coffee Seeds

At the time of harvest, mature berries at correct stage of ripening are collected by avoiding over ripened as well as under ripened ones and carefully pulped on the same day of harvest using hand pulper without damaging the beans. The freshly pulped beans are stirred in a container of clean water to remove any floats or light beans. The beans are then mixed with finely sieved wood ash, spread evenly about 5 cm thick,

and dried in shade. While drying, the beans are stirred at least thrice a day to ensure uniform drying and to remove excess ash.

After drying, the seeds are garbled thoroughly to remove the excess ash as well as any mutilated, triangular, or "elephant" beans. The seed coffee is then packed and distributed to the indented growers through the Board's extension network.

Before packing, the seeds are treated with a fungicide (Bavistin 50 WP) at a ratio of 1g/kg. This step is crucial to protect the seed from potential fungal infections during transit or germination. In berry borer infested areas, the seed should be subjected to fumigation with Aluminium phosphide (Celphos) to kill any live stages of berry borer. It is important to note that coffee seeds do not exhibit dormancy under natural conditions, but the viability of seed is relatively short. So, it is always advised to sow the seeds on primary beds in the nursery soon after procuring the seed.



Fig.22. Coffee seeds drying process

After the procurement of authentic seed material from authorized sources, the seedlings have to be nurtured and taken care during initial period of the growth in the nursery conditions carefully. Nursery plays a major role in raising desirable planting material wherein the seedlings are given utmost attention to make them vigorous and free from pest and diseases.

3.2. Guidelines on establishing a Nursery

1. Identifying location for a good nursery

When choosing a site for a nursery, look for a gently sloping land without large shade trees, nearby and close to a water source. Make sure that the water doesn't accumulate or stagnate in the nursery area. The soil should be of a light to medium loamy texture and free from harmful soil-borne pests like nematodes.

To protect the seedlings, fence off the nursery from cattle and other grazing animals. Additionally, provide



Fig. 23. Coffee seedlings Nursery

overhead shading using a pandal to keep the seedlings safe and healthy.

2. Germination bed preparation for seed sowing

To sow the seeds, prepare germination beds that are one meter wide and six meters long, raised to a height of 15 cm from the ground. For each bed, mix four baskets (10 kg) of well-rotted cattle manure or compost, 2 kg of finely sieved agricultural lime, and 400 g of rock phosphate. Space the beds 30 to 45 cm apart and ensure a gentle slope between two beds to prevent water from stagnating.



Fig.24. Preparation of germination beds

If the nursery soil is heavy and loamy, consider adding coarse sand to improve drainage and aeration. For clayish soil, mix it properly with coarse sand to enhance air circulation. Insufficient air circulation can cause stunted seedling growth or even lead to plant death.

3. Sowing of seeds

To ensure quality of seedlings, use only the certified seeds from authentic sources. During December-January, sow

selected seeds with their flat side facing the soil, at a distance of 2.5-3.0 cm in regular rows. Cover them with a thin layer of finely sieved soil. After sowing, mulch the beds with paddy straw to maintain ideal temperatures for seed germination and protect the seeds from drying out.

Water the beds daily in the morning using a rose cane. Under the right conditions, the seeds will germinate in about 45 days and reach the button or topee stage. Once they reach this stage, remove the paddy straw cover. Now, the seedlings can be transplanted either into polybag nurseries (baskets) or secondary nursery beds.

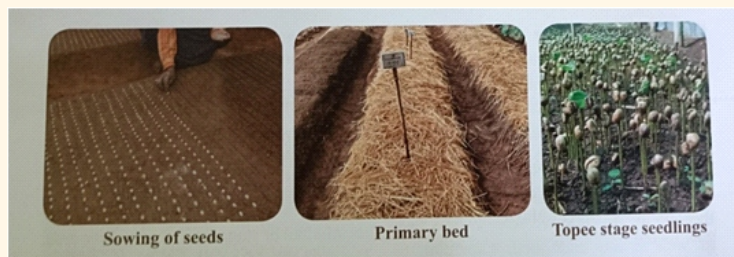


Fig.25. Sowing seeds and germination of seedlings

4. Polybag (Basket) Nursery

Preparations for the polybag (basket) nursery should commence well before transplanting. Begin by collecting fertile top soil, preferably from virgin forest lands, and allow it to dry thoroughly. Once the soil is dry, sieve it to get a fine texture. For the nursery mixture, combine six parts of sieved jungle soil, two parts of well-rotted and sieved cattle manure or compost, and one part of fine river sand. Use polybags of 22.5 x 15 cm size and 150-gauge thickness for the nursery, ensuring they have adequate 3 mm holes (10-12 bag⁻¹) at the bottom half. Moisten the nursery mixture with water and firmly fill it into the polybags. Arrange the filled bags in rows

within rectangular frames made of bamboo reapers. Keep the frames in position using bamboo or wooden props firmly driven into the ground at suitable distances. This well-prepared polybag nursery will provide an ideal environment for your seedlings to thrive.



Fig.26. Polybag (basket) nursery

5. Transplanting

While transplanting coffee seedlings, take care to do it properly for the best results. The seedlings should be transplanted at the 'button' stage when they are in germination beds. To minimize root damage, use a bamboo stick to gently lift them from the germinating beds.

Before transplanting, make sure to water the nursery baskets and create a vertical hole about 5 cm deep at the centre of each basket. When planting the seedlings, nip off the tip of the tap root and position them in the hole, making sure the shoot system is at the same height above the soil as it was in the germination beds. It's best to do the transplanting during the cooler hours of early morning or late afternoon. Try not to store uprooted seedlings for too long, transplant them right away.



Fig.27. Transplanted coffee seedlings

To prevent desiccation, you can dip the roots of the seedlings in cow dung slurry or water. Typically, basket grown seedlings are planted in the main field during the late monsoon season, around August to September. These seedlings can withstand long distance transport, making it easier to move them to their final location in the main field. Proper transplanting ensures healthy and thriving coffee plants as they continue to grow in the field.

6. Aftercare of seedlings

For the aftercare of coffee seedlings, make sure to water them daily, preferably in the early morning, based on the weather conditions. Provide overhead pandal shade until the regular monsoon begins. To keep the seedlings nourished, apply manure once every two months. Supernatant solution of fermented cow dung slurry or urea dissolved in water can be used for the same.

For every square meter area, 20 g of urea dissolved in 4.5 litres of water will suffice to support their growth and health. By following these aftercare practices, you can ensure that

your coffee seedlings thrive and develop into strong, healthy plants.



Fig.28. Aftercare practices for coffee seedlings

7. Boosting the growth of coffee seedlings

To enhance the growth of coffee seedlings, especially when sowing and transplanting are delayed, you can boost their development by using growth regulators in combination with urea. Apply one of the following growth regulator options at least one month before field planting or when the seedlings have 4-5 pairs of leaves.



Fig.29. Nursery Practices for Coffee



Fig.30. Activities for Boosting the seedling growth

The options include Planofix 50ml + Urea 1 kg, Agronaa 50ml+ Urea 1 kg, or Cytozyme crop plus 60 ml + Urea 1 kg in 200 litres of water. This treatment will help promote the desired growth of the seedlings ensuring they catch up and are ready for successful field planting.

Shade Management in Plantations for Sustainable Coffee Cultivation

The main advantage of shade trees is their ability to reduce the intensity of sunlight and temperature. Growing coffee under shade prevent excessive evaporation of moisture from the soil and thus combating the effects of drought. Additionally, shade trees protect coffee plants from hailstone damages, high wind velocities and overbearing which can negatively impact coffee production.



Fig.31. Growing coffee under shade

Shade trees also contribute to the improvement of soil fertility. The fallen leaves from the trees add organic matter to the soil, increasing its nutrient content and supporting the growth of beneficial microorganisms.

This organic matter enhances soil health and nutrient availability for the coffee plants. The well-maintained shade can also minimize the pests and diseases incidence by creating a microclimate which is not favourable for the development of certain pests and diseases.

In addition to the agronomic benefits, coffee grown under shade is found to have superior quality and taste. The shaded environment allows the coffee cherries to ripen more slowly and evenly, resulting in a more refined flavour profile in the final cup of coffee. Under South Indian agro-climatic conditions, high light intensities and low soil moisture, limit the growth and productivity of arabica plants and causing yellowing of leaves and defoliation. In addition to this, the exposure to sunlight also causes die-back during drought period in Arabica plant.



Fig. 32. **Dadap** (*Erythrina lithosperma*) grown as shade tree

The high temperature during summer months also causes the reduction in photosynthesis in Arabica plants. To produce economical yield consistently in arabica plants, it is very much essential to maintain adequate shade. For this purpose, development of two-tier canopy shade is advocated for Arabica plants by in the lower canopy and permanent shade trees in the upper canopy.



Fig. 33. **Silver oak** (*Grevillea robusta*) grown as shade tree

Dadap (*Erythrina lithosperma*) is commonly used as lower canopy shade tree in the coffee plantations of India. It is typically planted alongside of coffee in newly cleared areas. When Dadap stakes are planted in June, they tend to grow rapidly due to the presence of sufficient moisture in the soil and good relative humidity (RH).

Silver oak (*Grevillea robusta*) is also commonly planted as a temporary shade tree at the spacing of 6 X 6 meters on need base to establish the required shade quickly especially in new

clearing/replanted area. The Silver oak trees could be thinned out gradually on need base after achieving the desired canopy development in young coffee plants.

However, maintaining oak is strongly discouraged in coffee plantations. These monoculture shade plantations tend to have higher atmospheric and soil temperatures compared to other fields, which can have negative impacts. Incidences of pests and diseases such as white stem borer, leaf rust, and black rot are also found to be more common in plantations where silver oak used as mono shade.

Further, the fallen leaves of Silver oak will take longer period for decomposition in addition to increasing the aluminium content of the soil, which will enhance the acidity of soil. It is better to avoid planting of Silver oak trees inside the block of Arabica coffee to minimize the black rot incidences especially in the areas with high rainfall and hanging mist. Hence mixed shade canopy of Dadap, Silver oak and permanent shade trees is always found to be very advantageous in maintaining the higher productivity with low dosage of fertilizers due to recycling of nutrient.

For permanent shade, the most popular choices are trees from the Indian fig family, such as Atthi (*Ficus glomerata*), Mitli (*Ficus microcarpa* L.f.), Mallegaragathi (*Ficus nervosa* Heyne e Roth), and Bilibasari (*Ficus amplissima* J.E.Smith), as well as trees from the legume family like *Albizzia stipulate*, *Albizzia lebbek*, *Albizzia moluccana*, and *Albizzia sumatrana*. Additionally, Rosewood, Jack, and Gandhagarige are also commonly used as shade trees. Permanent shade trees are generally planted at a distance of 12 to 14 meters apart.

Similar to Arabica coffee, the Robusta coffee requires shade especially for the un-irrigated fields on account of its susceptibility to drought, although it has tolerance to high light intensity and temperature to some extent.

To overcome the effects of drought and also to maximize the crop production in Robusta coffee, irrigation is being given for blossom and backing. These fields could be maintained with thin and minimum shade.

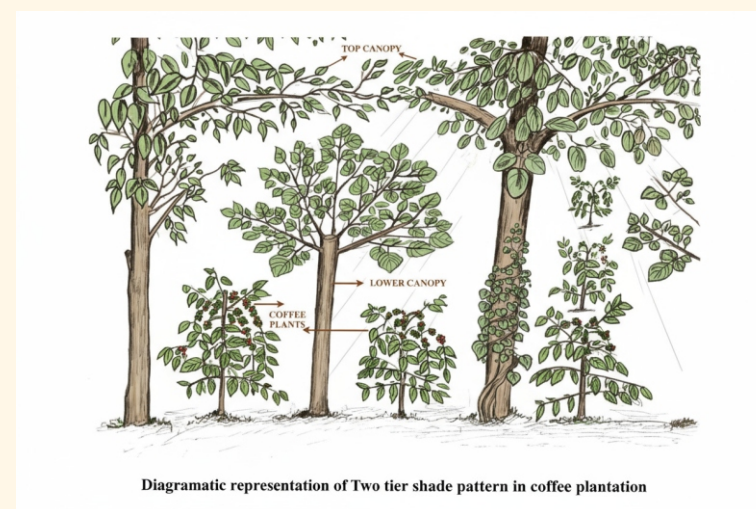


Fig. 34. Two tier shade patterns in coffee plantation

Shade requirements: Arabica coffee requires 50 to 60% filtered shade, while Robusta coffee requires 40% to 50% shade for un-irrigated blocks and 30% to 40% shade for irrigated blocks to maintain consistent crop production.

Training and Pruning

Training is essential to create a strong framework for coffee bushes, while pruning removes unproductive parts like old, dead, and intersected branches to help the new growth with better spacing and light penetration to boost the future yields.

5.1 Importance and methods of training coffee bushes

Training coffee bushes is essential for shaping them appropriately and controlling their growth to a desirable height for efficient cultural practices. This process establishes



Fig. 35. Shaping the coffee bushes

a sturdy framework and encourages the development of productive wood. Two common training systems are widely practiced worldwide: the single stem system and the multiple stem system.

5.2. Single stem method: training coffee bushes for optimal growth and management

The single stem system of training is particularly suitable for coffee cultivation in India, where shade is provided to the plants. In this method, the height of the coffee bush is controlled by a process known as topping or capping.

Topping diverts nutrients towards thickening the main stem and primary branches, promoting lateral spreading of the plants. Additionally, coffee plants trained on a single stem form a dense ground cover that protects the soil from erosion and minimizes fertility loss.

Single stem trained plants exhibit a well-shaped bush framework, making them easily manageable during farm



Fig. 36. Single stem coffee plantation

activities such as pruning, spraying with protective chemicals or nutrient solutions, and harvesting. Their uniform height allows for convenient handling and maintenance. Moreover, the balanced structure of single stem trained plants reduces the risk of breakage, distinguishing them from plants trained using the multiple stem system.

5.3 Topping: A technique for optimal growth and maintenance of structure of the plant

The process of topping involves cutting the vertically growing main stem approximately two inches above the node at the prescribed height. arabica coffee plants usually reach the topping height within 9-12 months, while robusta varieties take 18-24 months.

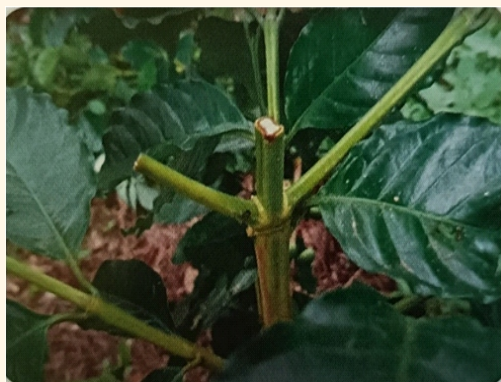


Fig. 37. Topping the main stem

1. Pruning in single stem system

In evergreen plants like coffee that bear crops on current season/one-year wood, regular pruning is crucial. Pruning serves the purpose of maintaining a proper balance between vegetative and cropping wood, as well as directing the plant's vigour towards productive

wood. It plays a vital role in reducing the biennial bearing habit of coffee by preventing overbearing and exhaustion in any given year.

Pruning also facilitates the entry of sunlight and improves aeration to the lower parts of the coffee bushes, thereby enhancing flower bud induction and promoting uniform ripening. Additionally, it helps minimize the buildup of pests and diseases.

By keeping the bushes in a manageable shape, pruning improves the efficiency of field operations such as spraying, swabbing, and harvesting. In summary, pruning is an essential practice in the single stem system of coffee cultivation. It ensures a balance between vegetative growth and crop production, enhances plant health, and optimizes the efficiency of various field operations.



Fig. 38. Pruning in single stem coffee plant

Soil Acidity and Management

Soil acidity is determined using the pH scale which ranges from 0 to 14. A pH value less than 6.5 indicates an acidic reaction while a pH between 6.5-7.5 is neutral and above 7.5 is alkaline. For optimal coffee plant growth, the soil pH should be about 6.2.

Soil acidity has several adverse effects:

1. Reduced availability of essential nutrients like nitrogen, phosphorus, potassium, calcium, magnesium, zinc and boron.
2. Toxicity of aluminium, iron and manganese.
3. Decreased activity of beneficial microorganisms in soil



Fig. 39. Soil testing

4. Enhanced activity of harmful micro organisms specifically fungi which cause root and other diseases.

6.1 Amelioration of soil acidity

Soil acidity can be corrected by applying liming material such as Agricultural lime (calcium carbonate), Dolomite (calcium & magnesium carbonate), Slaked lime or Hydrated Lime (calcium hydroxide) and Burnt Lime (calcium oxide).

Correcting soil acidity using liming material is an essential soil management practice regularly undertaken in coffee plantation to maintain soil fertility and productivity.



Fig. 40. Correcting soil acidity using lime

Pests, Diseases and its Management

7.1. Pests and its Management

1. Green coffee scale

Green coffee scale (*Coccus viridis*) is a common and serious problem. Scales suck the plant sap resulting in reduced growth and crop yield. Sooty mould (a black, loose, sooty-like cover) often develops on leaves. It grows on the sweet exudate from the scales (honeydew) that also attracts ants.

Symptoms: Green oval shaped scales about 2 to 3 mm long. Often found concentrated on leaf veins and tips of new shoots.



Fig. 41. Green Coffee scale infestation in Leaves & Fruits

Infestations then produce spots of honeydew, which become covered with a black sooty mould. Defoliation of badly affected trees can occur.

Control: There are a number of natural predators of coffee scale such as wasps, ladybugs and *Verticillium* fungus. In many instances, these will reduce the level of scale infestation.

Chemical: Mineral spraying oils at 200 ml/ 20 L water applied as a spray to affected plants. Only spray if 10 or more leaves are infested with one or more scales. The spray must completely wet and cover the scales. Carbaryl 85 % wettable powder at 20 g/10 L water applied as a spray. Apply weekly until scales disappear.

Traditional: 1 kg strong tobacco per 2 L water. Soak for 2 nights. Then remove tobacco. Add 500 g of washing powder and make up to 20 L. Spray weekly until scales disappear.

2. Aphids

Aphids (*Toxoptera aurantii*) can occur in large numbers on new shoots in the rainy season. Aphids suck sap from



Fig. 42. Stem infested by Aphids (*Toxoptera aurantia*)

young shoots and cause damage to these developing shoots.

Symptoms: Large numbers of small black aphids (2 to 3 mm long) concentrated on new growth. Often associated with black sooty mould.

Chemical control: Neem oil 10 to 20 ml/L, plus soft, finely grated laundry soap at about 7 g/L water.

3. White Stemborers (*Xylotrechus quadripes*)

The adult is a black and white banded beetle (about 1 to 2 cm long); the head of the male beetle has distinctive raised black ridges. Adults are active during daylight. Damage is caused by the white larvae, which hatch from eggs deposited in cracks and crevices and under loose scaly bark of the main stem and thick primary branches, especially on plants exposed to sunlight. Young larvae feed on the corky tissue just under the bark, which splits making the stem appear ridged. Later, larvae enter the heartwood and tunnel in all directions, even into the roots.

Symptoms: Wilting of leaves and dead trees or branches. Affected branches are easily broken off. When trees are first



Fig. 43. White Stemborer

infested there may be evidence of frass (sawdust-like residues) on the ground. The trunk may be ring barked.

The lifecycle of both pests is completed during the rainy season, but often damage is more evident during the dry season. Larvae remain inside the tree and are normally not seen. Usually damage is not economically important, although individual trees can be lost.

Preventative

- ❖ Less damage occurs under conditions of good shade.
- ❖ Higher altitude (above 800 MSL) seems to reduce the incidence of infestation.
- ❖ Burn affected trees or branches with borers inside.
- ❖ Do not plant trees with twisted taproots. These deformed roots result in weak trees that have been shown to have a high incidence of stem borer infestation.

4. Coffee Berry Borer

Coffee berry borer (*Hypothenemus hampei*) is a relatively new, but very serious problem in Lao. It is causing significant damage, with perhaps as high as 50% yield loss. The adult is a small black beetle (about 2.5 mm long) and covered in thick hairs. The female beetle bores into berries through the navel region. Cherries are attacked in various stages but tunnelling and laying of about 15 eggs occurs only in hard beans. The eggs hatch in about 10 days and the larvae feed on the beans making small tunnels. Beetles in the cherries either on the plant or on the ground, can survive for more than five months.

Symptoms: Fruit drop of young, green cherries. A small hole is evident on the cherry. Cherries that do not drop often have defective, damaged beans.



Fig. 44. Coffee berry infested by Coffee berry borer

Control

Orchard hygiene (keeping the area clean, removing dropped cherries, removing carry-over fruit from coffee bushes are suggested), but it is reported to have limited impact and can be expensive. Cherries on the ground and old berries remaining on the trees are sources of new infection.

There are few natural enemies of the borer. One wasp (*Phymastichus coffea*) has shown promise in Columbia, but its



Fig. 45. Coffee berry borer

effectiveness and that of other wasps is not yet fully known. The wasp may make a contribution in an IPM system. Lao should procure this and other effective parasitoids from Cenicafe in Colombia and technical biocontrol support.

Chemical control is difficult as the borer spends most of its life cycle deep inside the coffee berry. Cypermethrin and Deltamethrin, pyrethroids (0.01%) at 26 ml/15L of water are an alternative, or Chlorpyrifos used at recommended rate on label.



Fig. 46. Coffee bean infested by Coffee berry borer

Quarantine. The pest cannot migrate any distance on its own. Do not allow cherries or coffee bags from other farms onto the farm property. Crop bags should be fumigated before being transported to other coffee growing areas.

Ethyl alcohol and methyl alcohol at a rate of 1:1 is effective in trapping CBB and can be used most effectively at processing/ washing places to prevent re-infestation. Place traps in the first five rows of coffee growing near the processing area.

Coating pieces of plastic with axle grease and engine oil and attaching these to pulpers and machines in the coffee processing area can also be used to capture CBB.

Careful drying of coffee cherry or parchment reduces reproduction of the pest as they cannot survive in coffee beans that are properly dried to 12% moisture.

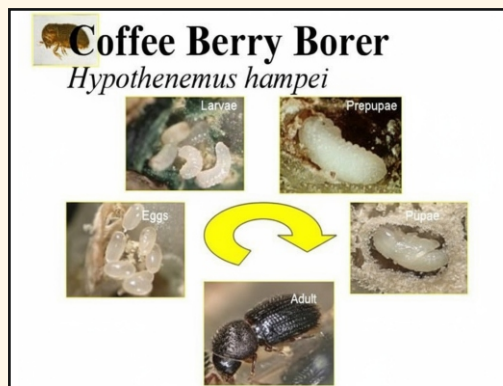


Fig. 47. Lifecycle of Coffee berry borer

7.2 Major Coffee Diseases and Management

NURSERY DISEASES:

1. **Damping-off:** This disease occurs on young coffee seedlings in the germination bed, after germination and before transplanting. It is caused by a *Pythium* spp. fungus.

Symptoms: Patches of coffee die quickly. Coffee stem is soft and rotten.

Causes

- ❖ Soil borne fungi.
- ❖ Soil too wet.

- ❖ Too much shade (insufficient drying of soil).
- ❖ High planting density (too many plants in a small area).



Fig. 48. Damping-off in Coffee seedling

Preventative

- ❖ Don't use old soil from nursery beds or bags as disease is soil borne and can be carried over. Use new soil for nursery beds and potting-up.
- ❖ Avoid over-watering.
- ❖ Do not plant seed too close; seeds should be 25 mm apart in rows 100 mm apart.

Chemical control: Soil drenches of either Benlate (Benomyl) or Captan (Follow label directions as formulations differ).

2. **Cercospora leaf spot (brown eye spot):** Cercospora leaf spot is a fungus that occurs on leaves when plants are under stress. The fungus can develop both in seedbeds and after plants have been transplanted into bags. It is the most common nursery disease and a sign of poor management

Symptoms

- ❖ Brown spots on leaves gradually expanding with reddish brown margin.
- ❖ Spots on both sides of the leaf.
- ❖ When there are many spots, leaves appear to have been burnt.

Causes

- ❖ Soil too wet.
- ❖ Too much shade or too much sun.
- ❖ Lack of air movement
- ❖ Lack of nitrogen and potassium



Fig. 49. Cercospora leaf spot disease

Preventive

- ❖ Avoid over-watering.
- ❖ Maintain 50% shade cover.
- ❖ Space plant bags to allow air movement.
- ❖ Proper fertiliser application (refer section on nursery management).

Chemical: Copper sprays such as the following will give control

Copper Cupravit (85% WP)	80 g/20 L water
Copper oxychloride	80 g/20 L water
Copper hydroxide	40 g/20 L water.



Fig. 50. Cercospora leaf spot disease

FIELD DISEASES

Coffee leaf rust

Coffee leaf rust (*Hemileia vastatrix*) occurs on leaves and can cause leaf drop if severe.

Symptoms

The first symptom is the formation of pale-yellow spots up to 3 mm in diameter on the underside of the leaves. As the spots expand, they become powdery and yellow to orange in colour and may reach 20 mm in diameter. Occasionally the whole leaf becomes covered with rust spots.

Older rust spores become brown at the centre surrounded by powdery orange spots. Leaf drop occurs, which if severe, can lead to dieback and berry loss and a loss of both yield and quality. Berries tend to be very small, not fully ripe and turn black.

Causes

Variety: Catimor is rust resistant. Java, Typica and many other Arabicas are susceptible under poorly shaded conditions and at altitudes of less than 1000 MSL.

Control

Plant pure Arabica at high elevation only and always use good shade.

Chemical

Monthly copper sprays (May to October).



Fig. 51. Coffee leaf rust (*Hemileia vatatrix*) disease

Harvest and Post-Harvest Practices

Coffee harvesting and processing is both an art and a science. It should be a matter of considerable pride and joy to a planter to make his contribution to the production of good quality coffee which has always been our greatest asset in the international market.

All the coffee producing countries in the world, process the coffee in two distinct ways viz.,

- i) Wet processing by which plantation or parchment coffee (also called as "Plantation Coffee" in India) is prepared and
- ii) Dry method by which cherry coffee is prepared.



Fig. 52. Coffee bean harvesting

In case of wet method of processing, the fruit skin and mucilage are removed and the coffee beans along with the parchment cover are dried up to a desired moisture level before storage at estate level. The dried parchment coffee is subjected to peeling and polishing at the secondary processing facilities (also known as 'curing works') to remove parchment cover and silver skin and to obtain clean coffee. Clean coffee obtained by this process is known as "washed coffee" or "plantation coffee".



Fig. 53. Coffee bean harvesting by tribal women

In dry method of processing, the fruits are dried as such at the estate level till they attain desired moisture level. The dry cherries are subjected to hulling and polishing at 'curing works' to remove the dried fruit skin (hulls) and to obtain clean coffee. Clean coffee obtained by this method is known as "cherry coffee/natural coffee".

Parchment coffee prepared by the wet method is generally favoured by the market. Cherry coffee, because of its

very nature of preparation and due to its longer contact with the mucilage and fruit skin, is usually associated with a characteristic "fruity" flavor which is not favoured by many consumers. Nevertheless, because of the differences in consumer's taste preferences and availability of advances in coffee roasting as well as blending techniques, even well processed cherry coffee has a demand in the global coffee market.

Generally, Arabica coffee is mainly processed by wet method while Robusta coffee is processed by dry method as the mucilage present in Robusta fruits is difficult to remove due to thick consistency. Even in India, almost all of Arabica coffee is processed by wet method while Robusta coffee is predominately processed by dry method. India has pioneered in the preparation of parchment coffee even from Robusta coffee which ensures elimination of fruity flavor and reduction of bitterness when compared to Robusta cherry coffee. Indian washed Robustas are well recognized and fetches very attractive premiums in the international market.

8.1. Wet Method of Processing (Parchment Coffee Preparation)

Infrastructure Requirement for Wet Method of Processing

For processing of coffee by wet method, pulping machines, de-mucilization facilities (fermentation vats or tanks for natural fermentation) or washers (de-mucilization machines), tiled/cemented drying yards and adequate supply of clean water are essential.

Harvesting for Wet Method of Processing

Under Indian conditions, there is only one season for coffee because of distinct wet and dry spells. The period between November and January is the main harvest season for Arabica while Robusta harvesting takes place from December to January months. Harvesting is the most labor-intensive operation in coffee estates, as the harvesting is done mainly by manual labour.



Fig. 54. Pulping machine for Wet Processing

For the preparation of parchment coffee, picking of the right type of fruits is very much essential. Coffee fruits should be picked as and when they are just ripe. Coffee fruits is considered as "just ripe" when on gentle squeezing, the bean inside the fruit "pops" out easily. Presence of unripe (greens) and overripe fruits would affect the final quality of coffee in the cup. The unripe or green fruits result in the production of "immature bean" while the over-ripe fruits result in "foxy" bean which are considered as undesirable in coffee quality circles.



Fig. 55. preparation of parchment coffee

After harvesting, the fruits should be pulped as soon as possible preferably on the same day. Fruits should not be stored beyond six hours after harvesting, as it would lead to setting of pre fermentation within the fruits that would result in fruity/winey taste in the final product. In case of unavoidable delay in pulping, the fruits should be immersed in water to avoid pre-fermentation.

Sorting

As stated earlier, only ripe fruits should be used for pulping. Since the harvested fruit lot contains many green fruits and overripe fruits, they should be scrupulously sorted out before pulping. The overripe fruits and green fruits should be dried separately and processed as cherry coffee.

Pulping

Pulping is usually referred to the removal of outer fruit skin to separate the beans. Different types of pulping



Fig. 56. Sorting of coffee fruits



Fig. 57. Pulping the coffee fruits

machines viz., drum pulper, disc pulper and vertical pulper are available in the market.

De-mucilization

The process of removing the sticky mucilage present on parchment cover is known as de-mucilization. The removal of mucilage can be done by four different methods namely i) natural fermentation, ii) use of commercially available pectin degrading enzymes, iii) use of machines (aqua-washers) and iv) treatment with alkali. Of these four methods, aqua washers



Fig. 58. De-mucilization coffee fruits

are largely used for removing the sticky mucilage while the natural fermentation is essentially followed by specialty coffee producers.

Drying

The next stage in wet processing is drying the parchment in the sun until the desired moisture level is reached. Proper drying contributes to healthy colour of the beans.

8.2. Dry method of processing (cherry coffee preparation) Infrastructure requirement for dry method

This method requires availability of adequate drying yards. It is desirable that the drying yards are covered with tiles or concrete surfaces.

Harvesting of coffee for dry method

For preparation of cherry coffee, fruits should be picked as and when they are ripe. However, for the sake of economy,



Fig. 59. Drying coffee beans

the fruits are harvested when about 90% fruits are ripe. Before subjecting the fruits for drying, all the un-ripe (commonly known as greens), tree dried fruits as well as damaged fruits should be sorted out and dried separately, as they are potential source for mould contamination.

One of the easy ways to remove tree dried fruits and damaged fruits is to immerse the harvested fruits in water and removing all the floating fruits (tree dried fruits and damaged fruits are lighter in weight and thus floats in water).

Drying

After sorting, the remaining sound/matured fruits should be spread evenly to a thickness of 4 cm for the first two to three days and then increase to 8 cm on a clean drying yard. The drying yard area requirement for drying of cherry equivalent to 1,000 kg clean coffee is 11 x 11 meter. The coffee fruits put up for drying should be stirred at least once an hour. As in the case of parchment preparation, the cherry coffee should be heaped and covered from third day onwards in the evening and spread again in the next morning after the mist clears up.



Fig. 60. Drying process of coffee beans

The cherry coffee would be fully dried at the end of 12 to 15 days under bright sunny weather conditions. At this stage, the dry cherry is winnowed (manually or mechanical winnower) to remove dried leaves, twigs, dirt etc. before packing and storing.

Chapter – 9

Conclusion

The case study of coffee plantation in Koraput district highlights the region's immense potential for sustainable coffee cultivation, especially in tribal-dominated and hilly areas. The favourable agro-climatic conditions, combined with traditional knowledge and government interventions, have helped transform coffee from a minor crop to a significant livelihood option.

The involvement of tribal communities, promotion of organic farming, and support from organizations like the Coffee Board of India have contributed to enhanced income, employment, and ecological stability in the region. However, challenges such as market access, expansion and price fluctuations remain. Strengthening value chains, providing capacity building and ensuring fair trade opportunities can further consolidate the gains and make Koraput a model for inclusive and sustainable agroforestry development.