COFFEE

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INTRODUCTION

LIFE BEGINS AFTER COFFEE

148 million: Estimated number of 60 kg bags of coffee produced in 2015/16 (October-September).
+ 0.9%: Estimated increase in global coffee production in 2015/16 compared to 2014/15.
151.3 million: Estimated number of 60 kg bags of coffee consumed in coffee year 2015/16.
1.3%: Average annual growth rate in global coffee consumption since coffee year 2012/13.
(Source: International Coffee Organization)

The coffee plant is a woody perennial whose fruit yield depends on the balance between vegetative and reproductive growth. The coffee plant is believed to have originated in the Ethiopian highlands in a county called Kaffa, hence the name.
But the English word 'coffee' is derived from the Italian 'caffe'.
Brazil is the highest coffee producer, providing 35% of global production.
Coffee is grown within 1,700 km of the equator in both tropical and sub-tropical climates.

Though the genus coffee has numerous species (Rubiaceae), only two - Arabica and Robusta - are commercially significant. Arabica coffee grows best in altitudes of above 900m. (In Brazil, it is cultivated in places above 700m, but it is highly susceptible to pest and diseases.) Robusta grows in relatively low altitudes. It is relatively drought-resistant and is more resistant to pests. Robusta has high caffeine content, while Arabica has half the caffeine content of Robusta. Because of this trait, Robusta is used in most commercial coffee blends and in the production of instant coffee. The productivity of Arabica coffee is about 600 kg/ha, while that of Robusta is 1070 kg/ha (Source: Coffee Board). In Brazil, the average yield is 1,300 kg/ha of Arabica processed coffee (Source: MAPA Brazil) and 1,800 kg/ha of Robusta processed coffee *(Source: ABIC - Brazil)*.

CLIMATIC EFFECT

Coffee growth is affected by climatic factors, such as light, temperature, rainfall and humidity, as well as by soil abiotic factors, such as concentration of nutrients, pH, moisture, drainage and soil temperature.

SHADE GROWN COFFEE

Coffee is cultivated in two ways: in direct sunlight and in shade. Growing under shade is done differently in different parts of the world. In the Philippines, for example, many growers use banana as an inter-crop during the first two years after planting. In India, it is common to grow coffee in a forest with a 3-tier shade system, in which every tier consists of different types of trees with specific characteristics for each tier. In Brazil, the majority of the coffee is grown in direct sunlight, which is a more intensive crop system requiring fertigation and harvesting machinery.

Studies have shown that there are two main phases of growth: phase I from March to July; and phase II from August to October. (This is true for crops located in the northern hemisphere, while in the southern hemisphere there is a lag of 6 months.) The second phase of growth is more pronounced. In a high production system, the input management (water and fertilizer) has to take into account these growth phases.

SOIL AND CLIMATE

Coffee requires aggregated, well-drained and slightly acidic soils.

Conditions suitable for growing both Arabica and Robusta coffee.

Factors	Arabica	Robusta
Soils	Deep, friable, rich in organic matter, well-drained and acidic (pH 6.0-6.5)	Deep, friable, rich in organic matter, well-drained and acidic (pH 6.0-6.5)
Slope	Gentle to moderate	Mild slopes to leveled fields
Elevation	700-1,500 m	500-1,000 m
Facing	North, east and north-east	North, east and north-east
Temperature	15-25°C, cool climat	20-30°C hot, humid climat
Relative humidity	70-80 %	80-90 %
Rainfall	1600-2500 mm	1000- 2000 mm
Precipitation	1,600-2,500 mm Well-distributed	1,000-2,000 mm Well-distributed

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LIMING OF SOILS AND MAINTENANCE OF pH.

In order To grow healthy coffee plants and to ensure better crop yield, it is important to maintain a soil pH of about 6.0. Some plant nutrients, such as phosphorus and micro-nutrients, are soluble when the soil pH is about 6.0. This pH ensures that the nutrients are available to the coffee plant and also determines the nutrient assimilation/mineralization in the soil. Due to the continuous application of acid-forming fertilizers, like ammonium sulphate, ammonium chloride and DAP, the soils tend to become more acidic. Therefore, in order to monitor the soil pH, soils should be tested once every 1-2 years. When the soil pH increases significantly above 6.0, or decreases significantly below 6.0, the soil pH needs to be corrected. Whenever the soil pH falls below 6.0, it should be corrected by applying alkali-forming soil amendments, like agricultural lime (calcium carbonate), or dolomite (calcium and magnesium carbonates). Liming of the soils can be done at any time of the year, except during the wet season.

For the best use of applied lime, take care that adequate moisture is present in the soil. If the recommended dose of liming material is more than 3.5 metric tons per hectare, the dose should be split into two equal parts and applied for 2 consecutive years.

WATER CONSERVATION IN COFFEE PLANTATIONS

Traditional coffee plantations are located in high rainfall zones all over the world.

However, the erratic rains during the wet season make it imperative for planters to introduce irrigation technology for coffee plantations. Planters generally implement various run-off control measures, which also restrict soil erosion. In addition, the top soil and the rich organic matter maintain a sponge-like texture on the soil surface that helps to store moisture in the rhizosphere and other lower strata. Plant litter (fallen tree leaves) act like a mulch, preventing the escape of moisture.

However, in recent years, climate change has caused irregular precipitation and a decline in the volume of rainfall. Rates of water infiltration into the soil have decreased, and factors like deforestation and soil compaction have caused a decline in the soil's ability to store water.

Water is becoming increasingly limited for coffee cultivation, so planters are finding it difficult to maintain the growth of coffee plants without the help of irrigation.

Mulching: Mulching young coffee plantations helps to maintain soil temperature, conserve moisture, and prevent soil erosion.

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COFFEE IRRIGATION

Because of drastic changes in the rain cycle over the years, irrigation is now essential for coffee production. Robusta plantation areas have been increasing since Arabica coffee began to decline as a result of increasing damage from pests. Robusta requires well-timed and systematic irrigation during the annual production cycle. In countries like India, Kenya, Ethiopia and Vietnam, coffee production thus depends on irrigation for at least 4-6 months of the year.
In the dry season it is necessary to irrigate coffee to prevent water stress. The acceptable amounts are ~2 mm per day for Arabica coffee and ~4 mm per day for Robusta coffee. These amounts may differ according to plantation age, climate and other factors.
However, it is sometimes crucial to allow water stress during the period before flowering. The purpose of this water stress is to delay the flowering until the last moment, when the climatic conditions, mainly the first rains of the spring, are optimal. By this time, most of the flower buds will be ready.

In this way, this first flowering will be the main one, with the majority of the flowers generating fruits at the same time. Consequently, the main harvest will bear a great quantity of fruits.
In general, irrigated coffee trees have fewer harvests, generating not only increased productivity, but also savings in labor and costs.

Growth stages of coffee when irrigation is most critical:

- Flowering
- Berry expansion
- Bean filling

Irrigation for the next flowering:

In addition to the importance of irrigation in these 3 stages of grain formation, irrigation is also very important for the development of all the branches for the next production. This reduces the biannuality of production (one year produces much, another year produces little).

THE BENEFITS OF IRRIGATION

- Enhances Facilitates fertigation all year round, regardless of rain or drought
- Increases the number of flower bunches
- Enhances vegetative growth, thus ensuring yields the following year (reducing intermittence)
- Increases bean yield
- Improves the soil ecology by enhancing microbial population
- Improves the rate of decomposition of soil organic material, thus maintaining soil CN ratio
- Ensures ideal micro-climate of the soil for coffee growth
- Improves nutrient uptake by plants
- Prevents situations of water stress
- Provides continuous and adequate soil moisture during the vegetative and fruit growth stages

SUITABLE IRRIGATION SYSTEMS FOR COFFEE

Heavy-duty sprinklers, rain guns and furrow irrigation have been adopted by large coffee plantations during the last two decades or so. The water use efficiency of these methods has been found to be inadequate, wasteful of water and inaccurate. Due to lack of water availability, a better understanding of plant requirements and improvements in technology, the use of micro-irrigation—micro-sprinklers or drippers—is now more common for coffee plantations.

The drip system, with its lower energy requirement, higher water use efficiency, and above all, its facilitiation of fertigation (a more efficient use of fertilizer), is the best irrigation method available.

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WHY MICRO-IRRIGATION ?

Excess water creates anaerobic conditions in the soil, which deprives the roots of vital oxygen. This is known as water logging. The use of micro-irrigation maintains a desirable water-to-air ratio in the root zone, which is achieved by low flow rate application of the irrigation water. Of all irrigation methods, micro-irrigation provides the most efficient and most suitable way of fertigating. The use of drip irrigation makes it possible to irrigate efficiently, regardless of topographical conditions.

FERTIGATION

As mentioned above, one of the main advantages of an irrigation system is the ability to fertigate. As opposed to traditional ways of fertilizing, fertigation allows planters to determine the time, place, quantity, frequency and ratio of the nutrient elements.

THE BENEFITS OF FERTIGATION

- Reduces labor costs
- Precise distribution of the fertilizer in the soil –"spoon-feeding" the plant (fertilizer is localized in the root zone)
- Prevents fertilizer leaching below the root zone
- Reduces the need to enter the orchard
- Full control of the fertilizer composition at any given time
- Controls the distribution of fertilizer in the water (quantitative/proportional)

The most advanced automated system of fertigation is the Gavish system, which provides accurate control and application with multiple functionality.

COFFEE FERTIGATION

Coffee is a perennial plant with an annual cycle of flowering and fruiting. Coffee soils are often highly organic due to the continuous decomposition of available leaf matter. The processing of coffee beans also produces large quantities of fruit skins and pulp . For example, it is estimated that the processing of 6,000 kg fruits to get one ton of coffee beans also brings back 15 kg N, 3.7 kg P, and 37 kg of K to the soil (if it is properly composted and recycled). However, the use of organic manure, dung, slurry or compost alone cannot provide for high productivity of coffee. According to the 2000 Coffee Guide, published by the Coffee Board, one ton of clean coffee of the Arabica variety (6,000 kg mature fruit) removes 40 kg N, 7 kg P and 45 kg K, while one ton of the Robusta variety (5,000 kg mature fruit) removes 45 kg N, 9 kg P and 58 kg K.

An essential part of coffee plantation management is frequent soil and leaf analysis for nutrient status. The target leaf nutrient contents are given below.

Target leaf nutrient content in Coffee for high production

LEAF NUTRIENT TARGETS FOR COFFEE

N	2.6 -3.0 %	B	31-50 ppm
P	0.14 - 0.17 %	Zn	> 15 ppm
K	1.9 -2.5 %	Mn	< 200 ppm
Ca	1.2 -1.5 %	Aluminium	< 120 ppm
Fe	43- 60 ppm		

Coffe Fertilizer Requirement (Young bush)

COFFEE FERTILIZER REQUIREMENT (YOUNG BUSH)

Variety & age	NPK Dose (kg/ha)	Fertilizers (g/plant/yr)		
		Urea	DAP	MOP
Arabica 1yr	50:25:50	35	22	33
2 yr	50:25:50	35	22	33
3 yr	60:40:60	41	33	42
4 yr	60:40:60	41	33	42
Robusta 1 yr	95:70:95	59	61	63
2 yr	95:70:95	59	61	63
3 yr	95:70:95	59	61	63
4 yr	100:75:100	61	65	67

COFFEE – ARABICA (5YR PLUS)

Bearing bush Yield level (kg/ha)	Recommended NPK (kg/ha)	Fertilizers (g/plant/yr)		
		Urea	DAP	MOP
2,500	300:225:300	180	196	200
1,250	175:125:175	104	119	116

COFFEE – ROBUSTA (5YR PLUS)

Bearing bush Yield level (kg/ha)	Recommended NPK (kg/ha)	Fertilizers (g/plant/yr)		
		Urea	DAP	MOP
2,500	300:225:325	180	196	200
1,250	175:125:200	104	119	335

BUSH MANAGEMENT

Training

When the coffee plant reaches a height of 75 cm (Arabica) or 110 cm (Robusta), it is topped. This allows for the lateral spreading of the branches and increases the fruit bearing area. In cases of vigorous vegetative growth, a second topping is sometimes recommended.

Pruning

Coffee plants are pruned immediately after harvest. Pruning involves:

Centring :removal of the vegetative growth up to 15 cm radius from the center and up to the first node of all primary branches.

Desuckering : removal of orthotropic branches arising from the main stem.

Handling : removal of young shoots growing towards the inner side of the canopy and causing shade. They become unproductive wood.

Nipping : nipping of the tips of primary branches to allow secondary and tertiary branches.

Pruning is an important technique requiring careful attention from the coffee grower, always bearing in mind the production of the coffee tree during the year. Pruning reduces the size of the plant and allows the formation of new branches.

PLANT PROTECTION

There are different diseases and pests in different countries:

Insect pests

White stem borer: Infected plants wilt and leaves become yellow.
Shoot hole borer: Infected plants dry up.
Mealybug: This is one of the significant pests. Infection starts in a few isolated bushes but spreads quickly to others.

Diseases

Leaf rust: Pale yellow spots on the lower surface of leaves turn into an orange-yellow powdery mass, and the infected plants defoliate.
Black rot: Affected leaves, twigs and berries blacken and rot.
Root diseases: Affected plants show gradual yellowing of leaves, followed by defoliation and death of parts of the plant above the ground.

Some diseases and pests are treated with different kinds of chemicals. In the case of systematic pesticides, the chemicals can be delivered via the irrigation system. They are taken up by the root and reach every part of the plant. This makes irrigation a valuable tool in pest management.

HARVEST

Coffee berries should be picked as they ripen in order to obtain quality coffee. Arabica comes to harvest early, with the fruits taking 8-9 months from flowering till full development. Robusta takes 10-11 months.
The coffee is is either harvested mechanically or hand-picked. When hand-picked in India and Africa, for example, the first picking (called fly picking) entails the selective picking of ripe berries. This is followed by an additional 4-5 main pickings at 10-15 day intervals, followed by the final harvest.

SHADE VS SUN (OPEN LAND) COFFEE

The Arabica coffee plant generally inhabits the middle tier of the forest, halfway between the bushy ground cover and the taller trees. The coffee tree requires some - but not too much - direct sunlight. Two hours of sunlight a day is ideal. The leaves of the upper levels of the rainforest originally shaded the coffee tree. In many parts of the world, including Central America, Mexico, Colombia and Ethiopia, Arabica coffee is traditionally grown in shade. However, in other parts of the world, such as Hawaii, Sumatra, and Jamaica, coffee is not grown under shade because the weather is too rainy and wet and the coffee bushes need all the sun they can get. In Yemen and Brazil, coffee is traditionally grown in the sun (not under shade trees). Shade planting generally increases relative humidity, generating ideal conditions for the development of rust fungus.

Recently there has been a tendency in shade growing regions to replace shade-grown coffee groves with new hybrid trees that grow well in the sun and bear quickly and heavily. This trend is slowly moving to South India too. The culivation of the sun-grown coffee and which varieties perform well in these conditions need to be researched and standardized. One thing is clear: with shade trees disappearing from coffee plantations, more mechanization is possible, including the introduction of mechanical harvesters.

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DRIP IRRIGATION

Tal Drip

Thin & medium walled non-PC flat dripline
Innovative thin/medium-walled dripline with the most advanced labyrinth dripper on the market for maximum durability, accuracy and clog resistance.

- Light dripline with molded and integrated Cascade drippers.
- Effective, uniform crop irrigation with low CV and high EU% standard.
- Clog resistance: self-cleaning design with a double-flow regime that continuously flushes out small dirt particles
- Available at 12-22 mm diameter, 6-35 mil wall thickness
- Dripper flow rate: 0.6, 1.0, 1.7, 4.0 l/h
- Dripper spacing: from 15 cm

Top Drip HD PC & PC AS

Innovative, cost effective, heavy duty pressure-compensating (PC) and anti-syphon (PC AS) thick-walled dripline models based on the cascade labyrinth.

- Cost-effective PC dripper
- Accurate performances at variable topography and pressure fluctuations.
- High clog resistance due to Cascade labyrinth.
- Available with anti-syphon (AS).
- Diameter: 16, 17, 20 mm
- Flow rate: 1.0, 1.6, 2.0, 2.2 l/h

Amnon Drip PC & PC AS

Pressure-compensating (PC) and anti-syphon (PC AS) dripline models based on the Cascade labyrinth.
Ideal solution for irrigation in topographically challenging terrain, and where long laterals are required

- Hydrodynamic dripper design ensures continuous flushing of sediments and small dirt particles
- Low CV for maximal uniformity
- Weir structure improves resistance to root intrusion and sand suction
- Available with anti-syphon (AS).
- Diameter: 16, 17, 20 mm
- Flow rate: 1.1, 1.6, 2.0, 2.2, 3.8 l/h

Naan PC 16mm

State-of-the-art cylindrical PC (Pressure-Compensating) dripper ensures highest durability and excellent performancey

- 16 mm and 20 mm polyethylene dripline with integrated pressure-compensating drippers
- Double water inlets and outlets per dripper
- New formulated silicone diaphragm ensures reliable and accurate performance with diverse water qualities, chemicals and fertilizers
- Individual double filter and flushing mechanism for maximal clog resistance and self-cleaning

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MICRO-SPRINKLERS AND JETS

Emitters vary in flow rate, wetted area shape and diameter, as well as special features, such as self-compensating and insect-resistant mechanisms. Micro-sprinklers can be very efficient in rocky conditions. In organic plantations they ensure efficient use of compost and manure

Smart Jet

Complete family of micro-jets includes four models: Smart Jet, Smart Jet IP (Insect-Proof), Smart Jet PC (regulated) and Smart Jet PC IP.

- Innovative design using the same frame for all four models with various jet patterns.
- No wear and tear.
- Exclusive approach to insect-proofing based on extended nozzles. Insect-proof model reduces clogging and cuts down on the amount of labor required to check for clogging.
- Wide variety of nozzles and jet patterns can match any tree spacing.
- PC model maintains flow and facilitates the use of longer laterals.
- Smart cap limits wetted area for the irrigation of young trees.

WATER REQUIREMENT OF MATURE YIELDING COFFEE

ET = E x 0.7 x 0.95 x 1 (mm)
• where E= Class Pan Evaporation
• 0.7 = Pan coefficient
• 0.95 = Crop factor for full leaf cover
• 1.0 = Canopy factor at full leaf cover
At peak
WR for Robusta at 3 x 3 m = 36 l/bush**
WR for Arabica at 1.8 x 1.5 m = 10.8 l/bush
** The WR changes with Pan Evaporation of the location.
Blossom Irrigation at 1 inch (as recommended)
Robusta = 222 l/bush***
Arabica = 67 l/bush

***in drip irrigated gardens, continue dripping for 4-6 hours to completely soak the root system without allowing for run off.

In general, as seen in Brazil, the first rain of spring acts as an induction of the main blossom. From that point, irrigation is used whenever there is a water deficit until the water stress, which precedes the next blossom, namely around 60 days before flowering.

Every morning millions of people around the world begin their day with a cup of coffee. This universal experience can be affected and manipulated by the same cultivation practices discussed in this booklet. Knowing the coffee crop inside and out can determine how the world population starts the day.




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NaanDanJain is committed to finding the ideal solution for your Coffee crop, tailored to your local climatic conditions, soil, water properties, and budget. Contact our office or your local dealer for further information.

All information should be used only as a guideline. For specific recommendations contact your local agronomist.

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