Coffee (*Coffea arabica*): A New Crop for Southern California

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Presentation Overview

- Facts and Figures about Global Coffee Industry
- Coffee Taxonomy and Cultivated varieties
- Coffea Arabica – Typica vs. Bourbon
- Coffee production in Southern California – growing tips
- Coffee harvesting, processing, and storage
- Our coffee research efforts
- Summary and conclusions!

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Facts About Global Coffee Industry

- Second only to oil as the world's most traded commodity with a value of more than $100 billion annually
- 500 billion cups of coffee are drank daily (14 billion Italian espressos)
- Coffee farms support 25 million people worldwide (grown in 50 countries in Asia, Africa, South America, Central America & the Caribbean) with 67 % grown in the Americas.
- There are only two types of coffee…Arabica and Robusta! Despite the different flavors and varieties

Source: Business Insider's 11 Incredible Facts about the Global Coffee Industry http://www.businessinsider.com/

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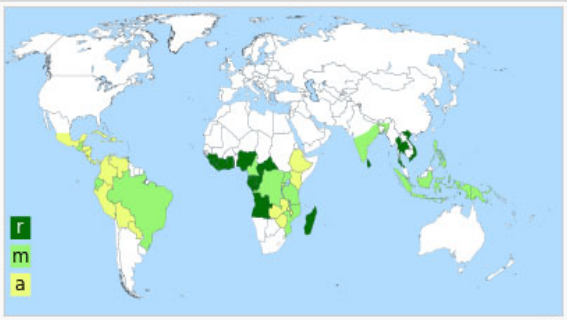
Coffee Producing Regions & Top Producing Countries



Map showing areas of coffee cultivation:
r:*Coffea canephora*
m:*Coffea canephora* and *Coffea arabica*
a:*Coffea arabica*

Top Ten Green Coffee Producers – 2011 (millions of metric tons)	
Brazil	2.70
Vietnam	1.28
Indonesia	0.63
Colombia	0.47
Ethiopia	0.37
Peru	0.33
India	0.30
Honduras	0.28
Mexico	0.25
Guatemala	0.24
World Total	**8.46**

Source:
UN Food & Agriculture Organisation (FAO)[1]

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Facts About Global Coffee Industry

- Coffee shops are fastest growing niche in restaurant business with a 7 % annual growth rate (Starbucks is 3rd largest chain in the US)
- 90 % of world coffee production occurs in developing countries, but it is consumed in industrialized nations.
- Finland drinks most coffee per capita in the world…the US ranks 25th per capita but is largest consumer overall
- Fair trade coffee, though a small portion of the market, is most popular fair trade commodity ($1.26/pound vs. $0.70 to 0.90/pound)
- 37 coffee producer countries listed in the WWF's 50 countries with the highest deforestation rates

Source: Business Insider's 11 Incredible Facts about the Global Coffee Industry http://www.businessinsider.com/

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Facts About Global Coffee Industry

- Top five importing countries (France, Germany, Italy, Japan & the US) consumed about 51.5 million bags in 2013 (49.7 million in 2012)
- Retail value of the US coffee market is $48 billion (55 % specialty)
- 48 % of US coffee cups perceived by consumer to be specialty coffees
- Daily consumption among 18-24 year olds steady at 35 %, but declining among 25 to 39 year olds from 42 % in 2014 to 36 % in 2015
- US is world's largest single buyer with 27.5 million bags imported in 2014, or about ¼ of global coffee imports
- Over half of Americans over 18 drink coffee daily & coffee drinkers average 3.5 cups a day
- Coffee provides 75 % of America's caffeine

Source: Specialty Coffee Association of America Website http://www.scaa.org/

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Facts About Global Coffee Industry

- Brazil (25%), Vietnam (18 %) and Colombia (13 %) account for most coffee imported to the US
- Coffee consumption in producing countries increasing rapidly
- Brazil consumed 21 million bags in 2014, about to replace the US as the single largest coffee consuming market at 23.4 million bags

Source: Specialty Coffee Association of America Website http://www.scaa.org/

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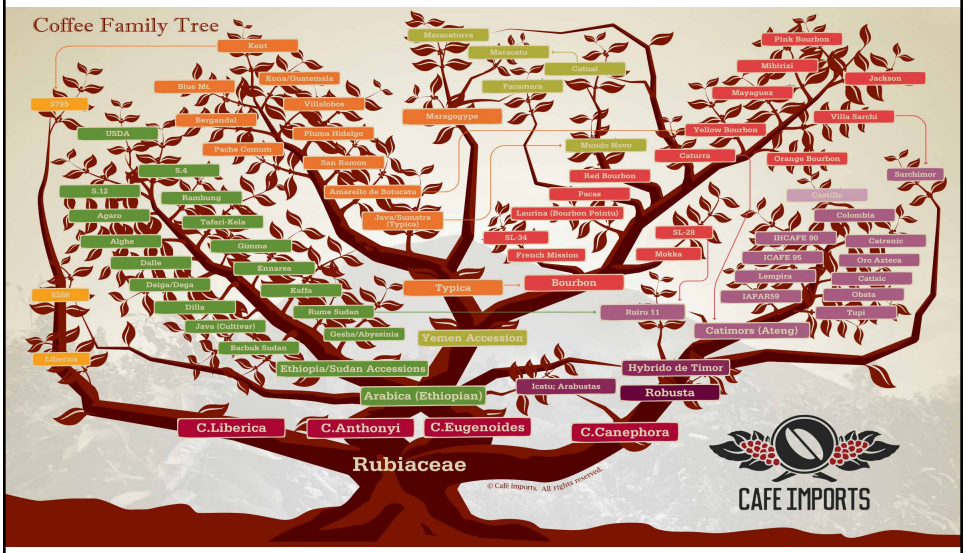
TAXONOMY and VARIETIES



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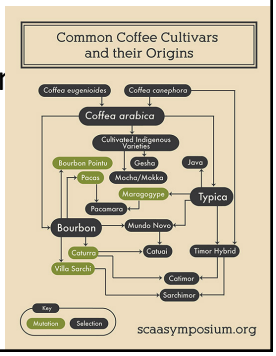
Taxonomy of Coffee

- Family: Rubiaceae, the coffee or madder family
  - 450 genera and 6500 species worldwide
  - Plants have simple, undivided leaves, opposite each other, usually near a lateral bud or shoot
  - Flowers have both male and female organs
- Genus: Coffea, which has about 100 – 120 species identified
- Species: Only three commercially relevar
  - C. Arabica – about 70 - 80 % of coffee produced
  - C. canephora (Var. Robusta)
  - C. eugenioides
  - C. liberica



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Taxonomy of Coffee, Continued:

- ***Coffea arabica*** – genus and species for Arabica coffee, originated in the forests of Ethiopia and South Sudan
- ***Coffea eugenioides*** – genus and species for eugenioindes coffee, native to highlands of East Africa including D.R. Congo, Rwanda, Uganda, Kenya and Western Tanzania.
  - ✓ One of two diploid parent of C. arabica, with lower caffeine content
- ***Coffea canephora*** – genus and species for Robusta coffee, native to Western and Central sub-Saharan Africa.
  - ✓ One of two diploid parent of C. arabica, very productive cultivar different from C. arabica with much higher caffeine content
- ***Coffea liberica*** – genus and species for Liberica coffee, little value

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Differences Between Arabica and Robusta

- **Taste** – Arabica has the better flavor with Robusta often described as burnt tires or rubbery
- **Caffeine Content** – Robusta has more caffeine (2.7%) than Arabica (1.5 %)
- **Lipid & Sugar Content** – Arabica has about 60% more lipids and almost twice as much sugar than Robusta
- **Price** – Arabica is about twice the price of Robusta
- **Care and Maintenance** – Robusta is much easier to care for and has resistance to leaf rust and some nematodes
- **Plant height and Bean Shape** – Robusta are much taller trees, 4.5 to 6 m, versus 2.5 to 4.5 m for Arabica, Robusta bean are rounder, Arabica are more oval.
- **Chlorogenic Acid (CGA) Content** – This antioxidant and insect deterrent is much higher in Robusta (7-10 %) than Arabica (5.5 – 8 %)
- **Cultivation** – Arabica accounts for 75 % of world's coffee production versus 25 % for Robusta (Brazil and Vietnam are largest producers).

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Varieties, Cultivars or Hybrids?

- **Variety** – Taxonomic rank below that of species and subspecies but above that of form. Plants within a variety are very uniform and share many characteristics.
- **Cultivars** - A plant or grouping of plants selected for desirable characteristics that can be maintained by propagation. Most cultivars have arisen in cultivation but a few are special selections from the wild.
- **Hybrids**: Any offspring resulting from the breeding of two genetically distinct individuals, which usually will result in a high degree of heterozygosity.

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Coffea arabica: Typica vs. Bourbon

- Indigenous to Ethiopia and taken to Yemen in YEAR and then spread around the world
- Typica coffees known today originated from plants taken from Yemen to Java and neighboring islands
- Bourbon coffees orinated from plants taked to the island of Bourbon by the French (now Reunion Island)
- These two cultivars are the basis for most of the coffee varieties cultivated in Latin America and Hawaii

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Typica Cultivars:

- Java
- Maragogype
- Kent
- Geisha
- Kona
- Blue Mountain
- Sumatra
- Criollo
- Arabigo
- Pluma Hidalgo
- Bergundal, AKA Garundang
- San Bernardo, AKA Pache
- San Ramon
- Chickumalgur
- Blawan Paumah
- Sidikalang
- K7
- K20
- BMJ
- Guatemala
- Pache Comun
- Pache Colis
- Villalobos
- Amarello de Botucatu

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Bourbon Cultivars

- Bourbon Pointu/Laurina
- SL28
- SL34
- Tekisic
- Villa Sarchi
- Pacas
- Pacamara
- Caturra
- Mocha/Mokka
- Batian
- French Mission
- Yellow Bourbon
- Red Bourbon
- Orange Bourbon
- Pink Bourbon
- Mibirizi
- Mayagues
- Bourbon Chocola
- Sempenflorens
- Arusha
- Ibairi
- Cera
- Jackson
- Jackson 2/1257

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Typica - BourbonCrosses

- Acaia
- Mundo Novo
- Catuai
- Maracaturra
- Rubi
- Ouro Verde
- Ouro Bronze

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The Timor Hybrid

- Naturally occurring cross between C. canephora and C. arabica, var. Typica on the Island of Timor in Southeast Asia
- Known as Arabusta hybrids, they were naturally resistant to leaf rust and became popular in the 1950s
- Different lines of this hybrid have been used in breeding programs to create rust resistance varieties
- Three main variety groups resulted from this effort and are cultivated in Latin America today:
  - ✓ Catimors – Caturra X Timor Hybrid
  - ✓ Sarchimors – Villa Sarchi X Timor Hybrid
  - ✓ Colombia – Yellow Caturra X Timor Hybrid

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Cultivars with Timor Hybrid Origins

- Catimor
- Colombia
- Icatu
- Ihcafe90
- Ruiru 11
- Anacafe 14
- Sarchimor
- Castillo
- Oro Azteca
- Acaia
- ICAFE 95
- ICAFE 90
- IAPAR 59
- IAPAR 103
- IPAR 103
- Tabi
- Costa Rica 95/CR 95
- Devamachy
- Marsellesa
- Catigua
- Bogor Prada
- Tupi
- Obata
- Catrenic
- Paraiso
- Rasuna
- Catucai
- Lempira
- Maracatu
- Catiga MG2
- Selection 9
- Ateng
- Parainema
- Arla

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Ethyopian and Sudanese Coffees

- Geisha
- Harrar
- Sjimma
- Djimma
- Lekempti
- Sidamo
- Agaro
- Mugi
- Wellega
- Melka
- Haru
- Gera
- Mettu
- Awada
- Wenago
- Mechara
- Alghe
- Cioccie S6
- Dalle
- Abyssinia
- Longberry Harrar
- Gawe
- Melko-CH2
- Ababuna
- Tegu
- Rambung
- Tafarikela
- Dega
- Ennarea
- Dilla
- Ghimbi
- USDA 762
- Barbuk Sudan
- Rume Sudan

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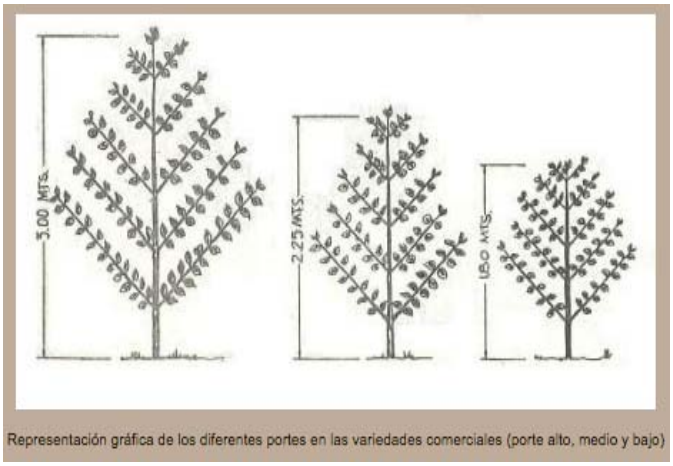
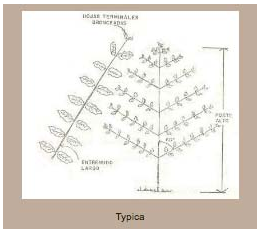
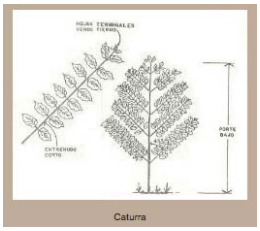
Coffee Plant Structure



Representación gráfica de los diferentes portes en las variedades comerciales (porte alto, medio y bajo)



Typica



Caturra

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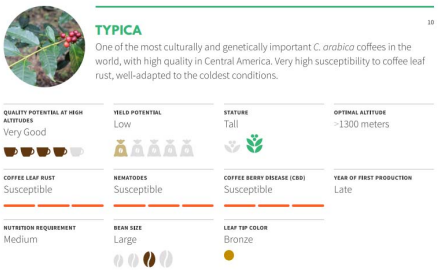
Typica o Arabigo (Etiopia)

- Tall plant (3.0 mts.)
- Lateral branches for 60 degree angle from main axis
- Long internodes
- Terminal leaves/shoots bronze color
- Narrow and dull colored leaves
- Low productivity
- Low tolerance to wind
- Not usually recommended for planting, but always included as a reference



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Bourbon (Red & Yellow)

- Tall plant (3.0 mts.)
- Lateral branches form 45 degree angle from main axis
- Internodes shorter than Typica.
- Terminal leaves/shoots lime green
- Leaves rounder and shinier/glossier tan Typica.
- High producer.
- Low wind resistance

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Robusta (Coffea canephora, Etiopia)

- Flagship variety within the specie
- Cultivated primarily in Asia & Africa
- Tall and vigorous plant (>4 mts)
- Plants have 3-5 vertical axes with moderate inclination
- Lateral branches are long with little secondary branching
- Long internodes with large leaves
- Fruit is small and round, in clusters of 15-25 fruits

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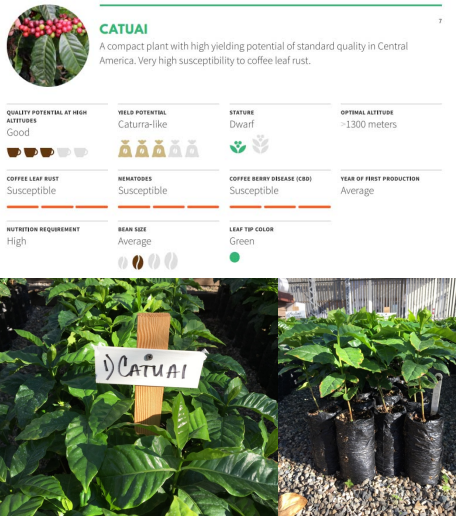
Catuai (Brasil)

- Cross between Mundo Novo and Caturra
- Semi dwarf(2.25 mts.)
- Lateral branches form 45 degree angle from main vertical axis
- Short internodes
- Terminal leaves or shoots are lime Green
- Wind resistant



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Pacamara (El Salvador)

- Cross between Pacas & Maragogype
- Dwarf plant with short internodes
- High productivity
- Terminal leaves/shoots green or bronze
- Leaves and fruit are large
- Variety not homogeneous

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Caturra (Brasil)

- Natural Bourbón mutation
- Dwarf, compact plant (1.80 mts.) with short internodes
- Lateral branches form 45 degree angle from main axis
- Terminal leaves or shoots lime green color
- Leaves round and shiny, glossy
- Excellent producer
- Wind resistant

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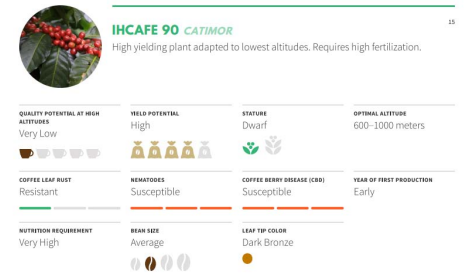
Ihcafe-90 (Honduras)

- Catimor selection
- Dwarf, compact plant with short internodes
- Terminal leaves/shoots are dark bronze color
- High production potential with low cup quality



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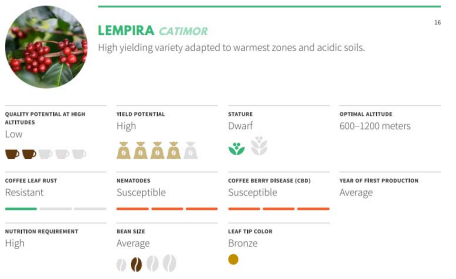
Lempira (Honduras)

- Catimor selection
- Dwarf plants with short internodes
- Terminal leaves/shoots are bronze color
- High production potential
- Well adapted to warmer zones and acidic soils



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Icatu (Brazil)

- Hybrid between C. canephora and red Bourbon
- Tall plant
- Highly productive
- Good resistanc to leaf rust
- Better than average cupping quality/flavor profile

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Coffee Production in the US

- Commercial production very limited, few "commercial" growers in California (Santa Barbara and San Diego Counties) since mid 90s
- Coffee has great potential as a house plant and can be grown indoor or outdoor with some protection in frost free zones
- Can be a rewarding experience

Source : http://houseplants.about.com/od/Tropicals/p/Coffee-Growing-Coffee-Plants.htm

Source: http://www.gardeningknowhow.com/houseplants/coffee/growing-coffee-plants-indoors.htm

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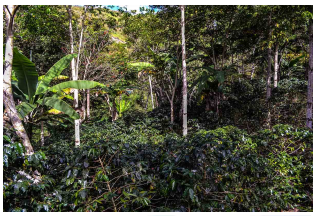
Climatic Requirements

- Coffee is usually grown under partial shade as an understory crop, but adapts well to full sun
- Optimum temperatures range from 59 to 75 F (15-24 C)
- Coffee plants like high humidity with well defined rainy and dry seasons
- They like protection from winds
- Coffee plants may be damaged or killed by freezing temperatures
- Arabica Coffee grows better at altitudes between 1800-3600 feet; whereas Robusta grows from sea level to 3000 feet.
- Coffee trees must be planted in shady areas to minimize exposure to direct sunlight or near a window if grown indoors



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Propagation

- Commonly done from seed, but tissue culture is gaining popularity
- Seed should be selected from the biggest, ripest cherries, and used as soon as possible
- Select the best seeds…avoid triangles, peaberries or any damaged seed
- Germinate seeds in seed beds or in deep trays to foster root growth
- Seeds should be placed face down, covered with 1-2 cms of soil/mix, and shaded
- Mix of peatmoss, perlite and vermiculite works well for seed germination

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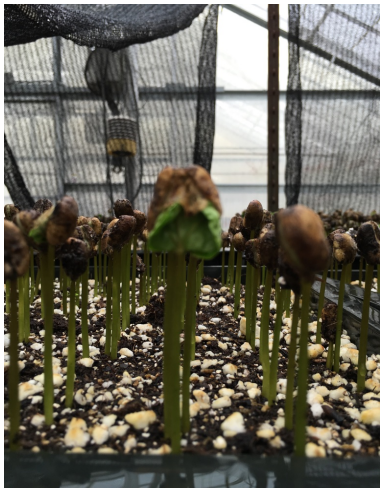
Propagation, Cont'd



- Seed beds or trays must be kept moist at all times avoid drying
- Seeds take about 40 days to germinate and start emerging, and seedlings should be ready for transplant after 90 days

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Anatomy of the Coffee Cherry and Beans

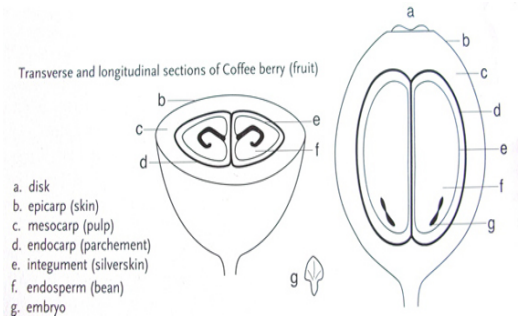
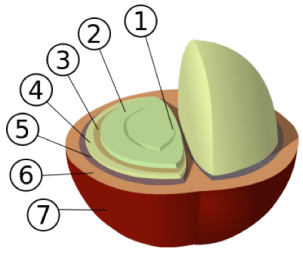


Figure 1.1 Coffee cherry (fruit). From Wintgens, J. N.: Coffee: Growing, Processing, Sustainable Production. Page 4. 2009. Copyright Wiley-VCH Verlag GmbH & Co. KGaA. Reproduced with permission.



Structure of coffee berry and beans:
1: Center cut.
2: Bean (endosperm).
3: Silver skin (testa, epidermis).
4: Parchment coat (hull, endocarp).
5: Pectin layer.
6: Pulp (mesocarp).
7: Outer skin (pericarp, exocarp).

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Soil Requirements

- Coffee plant prefer well drained, slightly acidic soils with high organic matter content
- If pH is a problem or drainage are an issue, they must be corrected before planting to encourage proper nutrition and healthy plant growth
- If grown in containers you may want to use a slightly acidic mix and amend as needed with mulch or other source of organic matter
- If grown in containers you must repot your plant to accommodate the root system and promote growth…the larger the pot, the larger and fuller the plant will be
- Azalea mix or any acid loving plant mix could be used but should be amended with organic matter and/or perlite to improve drainage and air porosity

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Transplanting Seedling to Nursery Liners

- Select only healthy, strong seedlings with straight root systems…avoid any root deformities!!
- Seedlings can be transplanted to their final location at this stage but it is better to grow them in nursery liners for 3 to 6 months before transplanting them

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Growing your Nursery Plants

- This is a good time to start acclimating your plants if you will grow them outdoors
- Select only healthy, strong plants, with a straight stem for growing
- You must repot your plants every 2-3 years to accommodate the root systems and promote healthy growth

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Watering & Water Requirements

- Coffee plants like water and do great under high humidity
- Water enough to keep the soil moist, but avoid saturating the soil
- Coffee roots are fibrous and somewhat shallow so higher frequency and shorter irrigations are better
- Overhead irrigation (sprinkler or hose) could be used to keep plant clean, increase humidity and stimulate bud development
- Watering should be reduced to a minimum in the winter and resumed to normal in the spring to induce flowering
- Coffee plants will tell you when they need water (they will wilt)…but this should be avoided to maintain a healthy plant

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Feeding Your Coffee Plants

- Fertilize your plant with a complete formula (NPK) when transplanting from the nursery container to the soil or a larger container
- Young nursery plants should receive a small amount of fertilizer to start and increase amount gradually as the plant grows
- Apply ½ to 1 oz of a complete formula quarterly for the first 2 years, and increase up to 6 oz/year total from year 3 and older
- Coffee plants respond well and benefit from foliar fertilization with both macro and micro nutrients

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Flowers and Flowering

- Flowers are small, fragrant and clustered around the axil of the leaves
- Flowers have 5 white petals and a single ovary
- They open in the morning and last for 2 days
- C. Arabica flowers are self fertile, and mostly self pollinating (about 90% of the flowers are pollinated by the time they open)
- Robusta coffee flowers are self-infertile and need cross pollination
- It takes about 9 and 11 months from bloom to harvest for C. arabica and C. canephora respectively

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Coffee Harvesting

- Coffee is usually harvested by hand, selecting the berries that are fully ripe, full color
- Avoid picking green or overripe berries, they will affect the quality of the coffee
- Sort green or overripe berries and any foreign materials before processing

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Coffee Processing & Storage

- The processing method is one of the most important contributors to the flavor profile of coffee
- Various methods are used in different regions of the world, including:
  - ✓ **Dry or Natural Process** – the cherries are dried whole, resulting in a coffee that is fruity, heavy in body, sweet, smooth and complex.
  - ✓ **Wet Process** - Usually involves removing the outer skin and the pulp, fermenting and washing the coffee to remove the mucilage or pectin layer. The result is a cleaner, brighter and fruitier coffee.
  - ✓ **Pulped Natural** – involves pulping the coffee but omitting the fermentation and the washing to remove the mucilage. This results in a coffee with characteristics of both the dry and wet process.

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Dry & Wet Processing

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Coffee Pests and Diseases

- Insect pests or diseases do not seem to be a problem in the US, but they are a major problems elsewhere:
  - ✓ Coffee Leaf Rust (*Hemileia vastatrix*) -
  - ✓ Coffee Berry Disease (*Colletotrichum kahawae*) – considered a major factor limiting Arabica coffee production in Africa
  - ✓ Bacterial Blight - (*Pseudomanas syringae pv. garcae*) is a disease that occurs where wet and cold conditions prevail
  - ✓ Nematodes - *Meloidogyne exigua, M. incognita, M. coffeicola, Pratylenchus brachyurus, and P. coffeae* are the most common species of root-knot coffee nematodes.
  - ✓ Coffee Borer (*Hypothenemus hampei)* – the most damaging pest affecting coffee throughout its history
  - ✓ Other insects – stem borers. Leaf miners, mealy bugs, scales and mites may potentially attack coffee but not an issue yet.

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Coffee Research Project Goals

- Horticultural Component:
  - ✓ Evaluate 12 varieties of coffee at various locations in So. California
  - ✓ Explore the potential for C. canephora as a drought tolerant root stock for specialty coffee production in Southern California
  - ✓ Establsih a coffee variety garden at South Coast and Hansen RECs for use as demonstration and to produce coffee seed of various cultivars
- Educational Component:
  - ✓ Develop an enterprise budget to assess the economic feasibility as a viable crop alternative for the region
  - ✓ Engage limited resource, small-scale growers in the research and development process by facilitating access to plant material
  - ✓ Organize an annual workshop and field day to disseminate results and distribute plant material to interested parties

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Want to get involved in research?

- Potential MG Collaborators may play a key role in assessing the performance of coffee varieties in various micro-climates across San Diego County
- Collaborators will receive a set of plants from different varieties to be grown at their location using technical guidelines and cultural practices recommended
- Collaborators will collect and provide data collected to project PIs to be shared, aggregated and analyzed
- Final result will be more information about growing coffee in Southern California, published in the form of a production guide, trade magazine articles or peer-reviewed publication.

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Comments/Questions or to get involved with the project?

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