Organic Farming in the Tropics and Subtropics

Exemplary Description of 20 Crops

Coffee

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Franz Augstburger, Jörn Berger, Udo Censkowsky,
Petra Heid, Joachim Milz, Christine Streit.

The cultivation guidelines are available in English, Spanish and German for the following crops:

banana, brazil nut, cashew nut, cocoa, coconut, coffee,
cotton, hibiscus, macadamia, mango, papaya, peanut,
pepper, pineapple, sugar cane, sesame, tea, vanilla.

The cultivation guidelines for Bananas, Mangoes, Pineapples and Pepper were revised in 2001 for the United Nations Conference on Trade and Development (UNCTAD) by Udo Censkowsky and Friederike Höngen.

In 2002 two more guidelines, for rice and date palms, were published in English.

All the authors emphasize, that the cultivation recommendations at hand can just provide general information. They do not substitute technical assistance to the farmers with regard to the location.
All indications, data and results of this cultivation guidelines have been compiled and cross-checked most carefully by the authors. Yet mistakes with regard to the contents cannot be precluded. The indicated legal regulations are based on the state of the year 1999 and are subject to alterations in future. Consequently all information has to be given in exclusion of any obligation or guarantee by Naturland e.V. or the authors. Both Naturland e.V. and authors therefore do not accept any responsibility or liability.

Furthermore the authors kindly call upon for critical remarks, additions and other important information to be forwarded to the address below. The cultivation guidelines will be updated regularly by Naturland e.V.

Naturland e.V.
Kleinhaderner Weg 1
82166 Gräfelfing
Germany
phone: +49 - (0)89 - 898082-0
fax: +49 - (0)89 - 898082-90
e-mail: naturland@naturland.de
website: www.naturland.de

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Index

Organic Coffee Cultivation

1. Introduction

Coffee is the most important raw material traded throughout the world behind crude oil, and has become the most important export article for the nations that grow it.

1.1. Botany

The coffee plant belongs to the family of rubiaceae. *Coffea arabica* as a bush, *Coffea canephora* as a bush-like tree. The white, aromatic coffee blossom does not depend on cross fertilisation. The ovaries develop into an oval fruit containing two seeds, and needs 6-8 months to ripen. Ripe coffee cherries have a red or yellow, sweet type of flesh; the actual coffee beans are contained within them, in a membranous pellicle and thin, hard endocarp.

1.2. Varieties and countries of origin

Economically, the most important coffee varieties are *Coffea arabica* called “Arabica” and *Coffea canephora* called “Robusta” (comp. following table). In comparison with Arabica, 30 % higher yields are gained from Robusta, although the price is around 30% lower. There are also other coffee varieties, and although these play hardly any role in today’s coffee trade, they can be important locally (e.g.. *Coffea maragohipe*, which has similar site requirements as “Robusta”, and is characterised by its extremely large coffee beans).
Organic coffee cultivation is of economic importance mainly in Mexico, Peru, Guatemala, Bolivian and in the Dominican Republic. Until now, organic cultivation has been of less importance in such regions as Costa Rica, Brazil, Columbia, Venezuela, Indonesia, India, Ethiopia, Kenya and Mozambique. It is mostly organic “Arabica” that is being cultivated. “Robusta” is currently barely available in certified organic quality.

Variety characteristics	*Coffea arabica* (Arabica)	*Coffea canephora* (Robusta)
Share of world production	ca. 70%	ca. 30%
Site requirements	High sites; fluctuations in annual rainfall and temperature	Low sites; steady high temperatures and rainfall
Main growing areas	Latin America, East Africa	Asia, Africa
Caffeine content	0.6-1.5%	2.0-2.7%
Diseases/ pests	Susceptible to the berry borer and coffee rust	Resistant against the berry borer and coffee rust

Successful attempts have been undertaken to scion graft Arabica varieties onto Robusta rootstocks during the past few years. This method seems to be useful to organic coffee cultivation, because Robusta has a more highly developed root system, and is thereby very proficient at acquiring nutrients, and, apparently, also has a higher resistance against pests.
The “modern” varieties currently in use, have all been bred for conventional coffee cultivation (single-form resistances, good nutrient extraction and high yields).
These are of little import to organic coffee cultivation; in general, older local varieties that are adapted to site conditions are used:

Local varieties

Arábica, Típica Criolla,
Very old, original variety with many local types. Well suited to high altitude sites with dense, diversified shade. Grows tall, yet its branches are elastic, and can be bent down to harvest. Easy to trim and cultivate. Is undemanding, does not alternate and is resistant to drought. The variety produces large beans of a good quality. Relatively susceptible to coffee rust *(Hemileia vastatrix)* and brown spot (*Cercospora coffeicola)*. Very well-suited to extensive organic cultivation.

Bourbon
Old variety, from the Caribbean island Bourbon. Widely spread, suited to deep lying sites with intensive shade. Grows tall, easy to trim, undemanding and alternates little. Ripens earlier than Típica, has small beans of an acceptable quality. Susceptible to coffee rust and berry borers (*Hypothenemus hampei*). Well-suited to organic cultivation in lower regions.

Mundo Novo
Similar variety to Bourbon, bred in Brazil for monocultures. Can withstand high crop densities, only suited to organic cultivation in lower regions under certain conditions.
In practically all of the traditional coffee cultivation areas, local varieties or sorts have been selected that were very well adapted, until new strains of coffee diseases

and pests appeared, and which still are to some extent. The following represents a few examples:

Examples of local selections:

Pache (Central America)
Local selection of Típica. Well-adapted to high sites and dense shade. Late ripening, with large beans and excellent quality. Low yield.

Pluma Hidalgo (Mexico, Guatemala)
Excellently adapted to high sites above 1,200 m (cultivation also up to 1850 m). Not alternating and very resistant. Low yield, yet very large beans of excellent quality.

New varieties

Caturra (South America)
Small plant with short internodes and thick, dark green leaves that has been developed for monocultures. Well-suited to intensively cultivated organic plantations. Needs more sun and more intensive trimming than the local varieties, and produces a much higher yield. Coffee plantations only have a short life-span, and must be renewed after 20 years. Beans are of a reasonable size and quality.

Catuai (South America)
Developed in Brazil für monocultures as a cross-selection between Caturra and Mundo Novo. Plant is stronger in growth than Caturra, some lines produce red and yellow cherries. Needs more sun and more intensive trimming than the local varieties, yet produces a much higher yield. Suited under certain conditions to intensively cultivated organic plantations. Beans are of a reasonable size and quality.

Colombia (Columbia)
Developed for monoculture in Columbia, resistant against rost, consists of 12 lines, and therefore not self-proliferating. Poorly developed root system, is demanding and very productive. Unsuitable for shady organic cultivation systems. Large beans of good quality. (In Costa Rica, a similar variety is called Costa Rica 95.)

Yapar 59 (Brazil)
Variety developed for monocultures which lack shade, resistant against rost. High demand of nutrients, little shade tolerance, therefore not well-suited to organic cultivation (in Mexico, variety is called Oro Azteca).

Catimor
Is a cross-selection between Caturra with a hybrid from Timor. Useful due to good resistance against rost, even under dense shade. High demand of nutrients. Certain Catimor lines have problems with organo-leptic quality.

Carnica (Mexico)
In Mexico, well-adapted to sites between 1000 m and 1400 m.. Good yields, even at low temperatures, good resistance against rost, yet susceptible to Cercospora; medium yields. Not alternating. Low quality.

1.3. Uses and contents

Coffee is used almost exclusively in the drinks industry, and is offered to consumers as roasted beans, ground, and also as instant coffee. This also counts for coffee in organic quality. In the most important consumer countries, roasted coffee is almost always sold as a blend of different origins and qualities. Only gourmet coffees are not blended, but are generally one single product. Espresso blends, for example, contain much caffeine-rich Robusta coffee and strongly roasted, unwashed Arabica coffee.
An important constituent of the coffee bean is caffeine. The free caffeine content in a bean is dependant on the coffee type, variety, the site conditions and other factors, and can be more than 2.5%.

2. Aspects of plant cultivation

Coffee originates from the subtropical forest eco-system of the Ethiopian high lands, where it grows under the shade of a variety of trees in a summer rain region. Traditional coffee cultivation, which today is practised predominantly by small and medium sized farms, re-creates coffee's original growing conditions on diversified agroforestry systems. These are also the foundations of organic coffee cultivation, which nevertheless differs slightly through its more intensive cultivation.
Coffee can, of course, also be produced in monocultures, with a high input of additional substances. This mostly the case on plantations in Africa, Brazil, Columbia and Costa Rica. They produce most of the conventional coffee.
In practice, though, organic coffee cultivation has proven that cultivation in monocultures is hardy possible in economical and technical terms, and, in ecological terms, is highly undesirable.

World-wide organic coffee cultivation is quite disparate, and been adapted to suit the site conditions. Nevertheless, two types of systems can be differentiated:

- Extensive systems, with essentially closed nutrient cycles – that are predominantly cultivated by indigenous farmers and smallholdings. (no import of organic fertiliser.)
- Intensive systems, with nutrient imports, that are predominantly cultivated by medium to large holdings. (import of organic fertiliser.)

2.1. Site requirements

Coffee plants prefer well-drained and airy soils. They can grow in shallow ground, due to their network of surface roots. Humus-rich, lightly acidic soils are beneficial; the best conditions are those to be found on virgin soils of volcanic origin.
The ideal temperature range for Arabica coffee plants lies between 18°C and 24º C. At higher temperatures, bud formation and growth are stimulated, but the greater proliferation of pests increases the risk of infection, and quality sinks. Coffee plants are susceptible to frost, temperatures below 10º C inhibit growth. Robusta plants can withstand higher temperatures, and are more resistant against infection.
The ideal amount of rainfall lies between 1500 mm and 1900 mm. Coffee plants react positively to a drought period, that should nevertheless not be longer than 3 months. The rainfall should be evenly spread throughout the rest of the year. Irregular rainfall causes uneven blossoms and fruit maturity
Coffee is a half-shade plant, that can only utilise around 1% of the sunlight (ideal is around 1500 hours per year) photosynthetically. At leaf temperatures over 34º C, assimilation is practically zero, meaning that the rate of photosynthesis of a shaded plant is actually higher than that of a plant fully exposed to the sun.

As a rule: In lower regions Robusta and in higher regions Arábica. The limit is variable, and lies around 600-900 m.

The berry borer and coffee rost pests are important indicators as to whether the coffee variety is suited to the site conditions. An Arabica plantation at 600 m, which is heavily infested by coffee rost and berry borer, despite sufficient shade, is an indication that the variety is ill-suited to the site, and should, in time, be replaced with Robusta.

2.2. Diversification strategies

2.2.1. Crops of the upperstorey (shade)

The most important functions of shading trees on coffee plantations are:

- Creation of large amounts of organic material and humus. Pumping up of nutrients from the lower soil regions. Leguminous trees fix nitrogen, and palm trees break down phosphorous compounds, making them available to plants.
- Protection of the coffee plants against too much sun, which then regulates the intensity and rhythm of the plants' photosynthesis. The alternation in yield is thereby reduced, and the life-time of the plantation increased.
- Shade also has an immense influence on the quality of the coffee, simultaneously, though, it also reduces the yield (fewer coffee plants per surface unit).
- Reduction of weeds: When an optimum density of coffee and shading trees is reached, tilling weeds is hardly necessary anymore.

- Protection against soil erosion.
- A diversity of micro-climatic effects. By choosing the correct varieties and cultivation method for the shading flora, the micro-climate can be influenced at any point in time, which is of central importance to the regulation of pests.
- Fruit trees offer a diversification for the farmer's diet and economic base.
- Precious woods can provide long-term increase in value of the site: along with other varieties, they can provide wood for construction and fuel.
- More pleasant working temperatures on the plantation.

No figures can be offered for the optimum shadow density, as this depends on the local site conditions and the state of the plantation. A rule of thumb says that the shade should be around 50%.
The higher in altitude the coffee plot lies, the less the distances should be between the coffee bushes and start of the shading roof (the distance is in an inversely proportional ratio to sea level). At the upper growth limits for coffee plants, the shading plants are therefore at around the same height as them.
Care should be taken to trim the shading plants synchronously to the coffee blossoming (6-8 weeks before the blossom). Blossom formation can thereby be assisted and synchronised.
The following examples of "successful" shading trees should only be used as a guideline. Most important is taking varieties found at the site into consideration.

Variety	**Suitability**	**Remarks**
Inga spp. *(I.edulis,I.deniflora,I. spectabilis* and others*)*	Very well suited to good sites Requires regular trimming Foliage forms more slowly than e.g. Erythrina Edible fruits and good fuel Excellent N-Fixer	Widely available; many local varieties. Must be combined with other crops, because *Inga spp*. is susceptible to pests when grown alone.
Erythrina spp. *(E.poeppigiana, E.edulis)*	Produces a lot of easily degradable foliage Excellent N-Fixer	Needs extensive trimming; wood is unusable, can be used as fertiliser and fungi nutrient.
Albizzia spp.	Tall trees with sparse shade Very good for lower sites	Difficult to trim.
Alnus spp.	At very high, humid and cool sites Large leaves good for fuel	Not a legume, yet still an N-Fixer.

Leucanena leucocephala	Unsuitable, because aggressive Must be trimmed often	
Cedrela odorata	Tall tree with dense crown Suited to low, not so humid sites Valuable precious wood	Can be trimmed.
Cordia alliodora	Tall tree suited to warm sites Produces little foliage valuable wood	Cannot be trimmed.

2.2.2. Crops of the middle storey

As with the plants of the upper crops, the combination of varieties used for the middle crop should be adapted to the local site conditions, and the need for fruits and additional products for each individual plantation. Bananas should, if possible, always be integrated as an additional crop. They are well suited to providing temporary shade, and for 'drying out' of the wetter parts of a plantation. Their ability to mobilise potassium reserves in the soil, and to make them available for the coffee plants is very important.
A whole diversity of combinations with other fruit trees can be integrated into the system: Citrus- varieties, planted together with avocado, are especially good for sites which enjoy intensive sunlight. In warmer climates, especially on Robusta plantations, combinations are possible with, for example, mangosteen trees, rambutan and Jackfruit.

2.2.3. Crops of the understorey

On sub-optimum sites (e.g. too dry or poor in nutrients), it makes sense to replace the natural vegetation in the understorey with green manuring plants (legumes). Yet the bottom crops should not be allowed to dominate and completely supplant the natural vegetation.
Many varieties are suitable as bottom crops. They should be selected according to the amount of shade they provide, soil conditions and rainfall. In principle, bottom crops should be sown on new plantations, or when the shading trees and coffee bushes are being trimmed, otherwise there will not be enough light on an organic coffee plantation for the bottom crops. It is very important to sow perennial, non-climbing and not very aggressively growing legumes. Otherwise there is a danger of the coffee plantation becoming overgrown (e.g.. with *Pueraria phaseoloides* or *Mucuna spp.)*.

The following lists a few successful varieties:

Variety	Suitability	Remarks
Arachis pintoi	Needs much rain and light (but cannot tolerate direct sunlight) Deep roots, only grows to 30 cm Covers a large surface area, highly competitive, and prolific foliage production High N-fixing and good for fodder for small animals and chickens	Seeds very expensive, can be easily self-cultivated; good vegetative growth; once established *Arachis pintoi* is difficult to remove; slow initial growth.
Desmodium ovalifolium	Fodder plant, needs little rain, yet relatively large amount of light competitive and prolific foliage production with rapid turnover	Can grow to 80 cm tall and certain lines might begin to climb; slow initial growth
Glycine wighti	Fodder plant, needs little rain, yet relatively large amount of light prolific foliage production with rapid turnover Climber, yet not too aggressive	Slow initial growth up to 80 cm tall
Centrosema macrocarpum	Grows well with little light Withstands drought periods Competitive, stubby growth	Seeds relatively expensive, difficult to cultivate; slow initial growth
Indigofera suffructicosa	Can tolerate shade Also grows at wet sites Little foliage production (with rapid turnover)	Seeds difficult to obtain; slow initial growth; often grows naturally, and can be encouraged through selective weed tilling
Canavalia ensiformis	Suitable for new plantations	

2.3. Supplying nutrients and organic fertilisation management

The many reports on requirements of individual nutrients all offer different figures. The following represents average values that have been confirmed in practice:

Average nutrient requirements of 800 kg green raw coffee per Hectare
(Represents a good harvest of in organic farming systems)

	Nutrients kg / ha		
	N	P_2O_5	K_2O
Coffee beans	34,0	6,0	8,0
Pellicle membrane	2,5	0,6	2,0
Endocarp	15,0	4,0	27,5
Total	51,5	10,6	37,5

These figures make it obvious that both the endocarp, and also the pellicle membrane, if possible, should be returned and utilised on the plantation. This is best achieved through composting, whereby it may make sense to enrich the compost with wood ash and rock phosphate.
A high-performance coffee eco-system with good site conditions and optimum yield should be capable of fixing the net amounts displaced itself (34 kg N), or to be able to mobilise them from the soil or subsoil (6 kg P_2O_5 and 8 kg K_2O per year).
It is recommended to actively supply fertiliser to help the long-term balance of nutrients when:

- New plantations: Every plant hole should receive a generous amount of fully decomposed compost. In cases of very low phosphorous reserves in the soil, rock phosphate can also be added (no feeding bone meal, as this will draw mice and other animals that may damage the young plants).
- After the coffee bushes have been trimmed, so that the new growth can develop healthily and strong (add compost).
- In times of high coffee prices, when the substantial work of using additional organic fertilisers can be justified. These measures need to be well co-ordinated, so that the coffee eco-system does not suffer in the long-term.

In order to avoid damaging the surface coffee roots, compost and other organic fertilisers are not worked in, but are instead covered over with a thick layer of mulching material.

2.4. Biological methods of plant protection

Conventional coffee plantations are generally confronted with a multiplicity of pests and diseases. In practice, on ecological coffee plantations, the following may be of relevance. An infestation of either pests or diseases is always an indication that the coffee eco-system is not balanced, and that the causes must be investigated. Possible causes are:

◊ Unsuitable site (too low altitude, too warm, too humid, stagnant water, too dry).
◊ Degenerated and poor soils, lack of organic material.
◊ Too little diversity and too few shading trees.
◊ Non-adherence of the correct succession of the forest system, trees too old or wrong variety.
◊ Varieties too close together, which have an identical status in the system.
◊ Failure to trim the shading trees (too much shade).

Fungi infections which occur can generally be dealt with by radically tilling weeds, or a bottom crop trim, or by trimming the shading trees (which would regulate the air circulation and humidity).

Should problems with diseases re-occur, possibilities exist to improve the whole system, providing the site is suitable for the coffee variety used. Usually, both the coffee bushes and the shading trees will need to be radically trimmed, or, unwanted shading trees removed and replaced with varieties that are lacking.

Disease/vector	**Cause in an ecological system**	**Possible measures**
Coffee rust *Hemileia vasatrix*	Susceptible variety	Plant resistant variety, or graft with Robusta rootstocks
	Coffee bushes planted too close together	Change density
	Too much or too little shade	Regulate shade
	Unbalanced nutrient supply	Trim plants; supply organic fertiliser to young plants; Treatment with Cu preparations[1] makes little sense ecologically and economically; little is known about treatments with *Verticillium spp*. preparations.

[1] According to the European Regulation for Organic Agriculture (EEC) 2092/91 the use of copper preparations for plant protection (e.g. Bordeaux Mixture) is allowed for a transitional period which will end at the 31st of March 2002. However, any use of copper preparations until 2002 has to be approved by the certification body. In case copper preparations have to be applied it is recommended to use preparations which contain less copper and therefore to reduce the accumulation of copper in soils (e.g. tribasic copper sulphate, copper hydroxide).

Brown Spot *Cercospora coffeicola*	To dense cultivation in tree nursery; wrong irrigation and shade Site too wet/trees to close together Too much shade	Change density Trim, produce more air circulation Change shade
South American Leaf Spot *Mycena citricolor*	Site too cool and wet Too much shade or weeds Distance between coffee bush and tree crown too small	Regulate shade and weeds Plant taller shading trees
Pellicularia koleroga	Warm humid sites with plenty of shade	Regulate shade and 'dry out' site, e.g. with bananas, plant trees with large leaves to provide shade
Coffee Berry Borer *Hypothenemus hampei*	Plantation at too low altitude; Abandoned or infected plantations nearby; Several blossoms, coffee cherries which ripen over long period	Complete harvest and collection of all coffee cherries (harvesting hygiene) Infect the plantation with the entomophageous fungi *Bauveria bassiana*. Generally, 2-3 settings suffice, then the infection will have taken; Release of chalcid wasps *Cephalonomia stephanoderis,* is very involved, and only makes sense on dry sites where *Bauveria bassiana* does not work well enough.
Coffee Leaf Miner *Leucoptera coffea*	Too much sunlight, and too dry micro-climate	Improve shade

2.5. Crop cultivation and maintenance

2.5.1. Establishment of new plantations

When starting a new plantation, maize can be sown as a pioneer crop. Depending on the initial conditions (soil fertility, consumer habits, market access), these can then be sown in a mixed crop with, e.g. beans (*Phaseolus sp.*), manioc (*Manihot esculentum*), bush peas (*Cajanus cajan*) or, as a temporary covering for the soil, together with jack beans (*Canavalia ensiformis)*. Before planting the pioneer crop, bananas should have been planted already, whereby the relevant distance between

the plants is dictated by the coffee variety, density and type of cultivation. Along with normal coffee varieties, tall-growing and local varieties which can tolerate shade should be integrated within the plantation.
The density and type of cultivation of the coffee bushes should be determined according to local experience and knowledge, according to variety and the amount of cultivation carried out. The density of the coffee bushes should not exceed 1,000-2,500 plants per hectare, in order to leave enough standing room for the shading trees. It is important to cover up the ground as soon as possible.

2.5.2. Nurturing young plants

The seeds should originate from healthy organic plantations, and if possible from the same altitude and region. When selecting and preparing the seeds, general criteria such as choosing only large, ripe fruits from middle-aged plants, only from the middle part of the shoots; shelling and washing them without fermentation occurring, etc.
Seedling nurseries can be established according to well-known methods in shaded nursery beds of pricked polyethylene sacks.
The best method has proven to be the direct sowing of two or more seeds per polyethylene sack, which are then later thinned out to one healthy plant (saves time, no pause in growth through transplanting, many seeds used).
The substrate should compose of at least 30% good quality compost (coffee pulp), with additional fresh forest soil. If necessary, it may be heated up by the sun by covering it with black plastic foil.
Shortly before the plants are transplanted, the amount of shade covering the seedling nursery should be similar to that of the final plot.
Green manure and liquid manures, as well as other intensive cultivation measures, should be identical to those carried out on the future plantation. It makes no sense to provide intense measures to the young coffee plants in the seedling nursery, if the plantation itself will later be extensively cultivated. When transplanting, an application of compost is recommended.

2.5.3. Cultivation measures

The coffee eco-system should always be cultivated at a constant intensity. Yet one of the most important advantages of a diversified system is that during periods when the coffee price is high, the system can be cultivated more intensively to produce higher yields, yet when the price is low, the proceedings can be slowed – without the plantation being harmed. The coffee yield will drop off slightly, yet at the same time, the other crops in the system will gain in importance.

The coffee plants should regularly be trimmed after a harvest, although this varies from site to site, and with local tradition, and is also dependant on the variety. The Típico varieties (Arabica) allow themselves to be bent down quite a way during the

harvest, and therefore do not need to be cut back so much. Every 8-16 years, a cure of radical trimming is recommended (down to ca. 40 cm above the soil), yet the precise time depends on the site and condition of the plantation. Care should be taken to always trim whole portions of the plantation (10 % of the plot), so that the positive results of the renewing stage can take effect in the coffee eco-system.
The shading trees must also be regularly trimmed. Old trees should be felled at the same time as the coffee plants are radically trimmed, so that damage caused by falling branches can be minimised, and the new influx of light can effect a new growth dynamic on the plantation. Under no circumstances are trees to be „ringed“ (remove of the bark), in other words killed off gradually by removing their protective layer of bark, because the slowly dying tree will have a negative influence on the entire dynamism of the system.

2.5.4. Weed management

The layer of foliage under the coffee bushes is more or less dense, according to the density of the coffee bushes, and the amount of light that the shading trees let through. In a coffee eco-system with optimum plant and shade density, tilling weeds is barely necessary. A certain number of weeds are always present – especially on young plantations – where they can also offer protection against erosion on steep slopes.
Working the soil to regulate weeds should be avoided to prevent doing damage to the shallow roots of the coffee bushes. Hoes should on no account be used. Grasses and other flora should be ripped out when the soil moisture content allows. Weeds should be cut down to a height of 5 cm with a knife, motor scythe or mulching machine. No deeper, so that the root system helps to hold the soil together.
Selective trimming of the accompanying foliage is very important. The desired part of the accompanying flora should be cut back less, and thus encouraged, the unwanted weeds can be radically cut back or pulled out. In addition, some of this accompanying flora should be kept as a food source for insects.
All plant material should remain on the plot as mulching material. The trimming of the accompanying foliage should be timed to coincide with the nutrient requirements of the coffee plants. The frequency of trimming depends largely on local site conditions, especially rainfall (nevertheless, at least twice a year). Only the weeds at the blossoming stage should be cut down.

2.5.5. Soil protection

An agroforestry system which is permanently covered with mulching material provides an ideal protection against erosion. Sites built on steep slopes could need additional measures to protect them. This is especially true on new plantations. Here, stone walls should be erected along the contour lines, in combination with a deliberate cultivation of erosion preventing plants. The shade-tolerant pineapple

varieties *Annanas comunis* and rather light intensive grasses *Vertiveria zizanoides* or *Cymbopogon citratus* (lemon grass).
The erection of terraces on existing coffee plantations is not recommended. Coffee roots run close to the surface, and ground work should be avoided if possible to prevent damage occurring to them. Yet if these measures cannot be avoided, then the construction should take place simultaneously with a radical trimming of the coffee bushes, and a renewing cut back of the shading trees. Cover up any exposed coffee bush roots with mulching material.

2.6. Harvesting and post harvest treatment

High quality requirements are placed on organic coffee. The main influences next to the site conditions and type of cultivation are time of harvesting and the post harvest handling.

2.6.1. Harvesting

Only ripe fruits should be harvested, meaning that, depending on the frequency of blossoming, that up to five stages may be necessary. The wet stage of processing must also commence on the same day (Arabica).

2.6.2. Post harvest treatment

Especially when a wet stage of processing (Arabica) is necessary, care should be taken to provide adequate drying places for the coffee beans (concrete drying surfaces; roofed structures to offer protection against rain). Coffee beans stored in a wet state (after insufficient drying), or storage areas that are not well enough protected against the rain, will encourage the growth of fungi. The quality of the coffee can be very strongly affected by this, or even, in extreme cases, become unsellable (creation of the fungus toxin Ochratoxin A).

3. Product specifications and quality requirements

3.1. Raw coffee

3.1.1. Processing

Raw coffee is made by processing the ripe, red coffee cherries of the bush-like coffee tree, species coffea, and traded on the world's markets. Blending and roasting the raw coffee is mostly carried out in the importing countries.
Two different procedures are used to process coffee cherries, the 'dry and the wet methods'. The requisite stages are listed below:

- **Dry processing**

During the dry processing procedure, small stones, twigs and leaves etc are removed from the harvest in a type of floating chamber. The remaining coffee cherries are then spread out on a large rack and laid out in the sun to dry out, being turned over occasionally with a rake, in order to prevent mould developing. Depending on the weather, the drying process can take up to eight days. It has been completed when the beans rattle around in their shells when shaken. Under unsuitable weather conditions, the beans may begin to rot, which can result in a drop in quality.

- **Wet processing**

During the dry processing procedure, the freshly picked coffee cherries are filled into large water containers. The healthy, ripe cherries sink immediately to the bottom of these tanks, which are usually built of raised concrete, whilst twigs, leaves and damaged or mouldy coffee cherries float on the surface and can easily be collected. This also means that the harvest is simultaneously washed. The coffee cherries are then fed into a swelling tank via a water channel, where they remain for a maximum of 12 hours. In the next stage, the slightly swollen cherries are fed into a pulper, there, the majority of the fruit pulp is separated from the pellicle membrane of the beans. The remaining, slimy fruit flesh residues are separated from the coffee beans through brief fermentation (12-24 hours, or up to 2-4 days during cool weather). Finally, the coffee beans are washed, and dried out on large racks in the sun, or with hot air in drying drums. In order to correctly store the coffee beans, it is useful to reduce their water content down to 10 %.

- **Shelling**

The pergamin coffee, which has been dried to a glass-hard finish, is then shelled and polished in the same way after the 'wet and dry procedures', in order to remove the skin and shell.

- **Sorting into trading categories**

Before the raw coffee can be traded on the world market, it needs to be graded according to established criteria. The coffee is mechanically sorted, by sieving it to

obtain beans of the same size. Not the length of the beans, but their width is important for the size of the holes in the sieve (waist). The sieves are graded from size 20 with holes that are around 8 mm across, down to size 10 with 4 mm holes for the beans. Sieve number 17 is viewed as the average size.

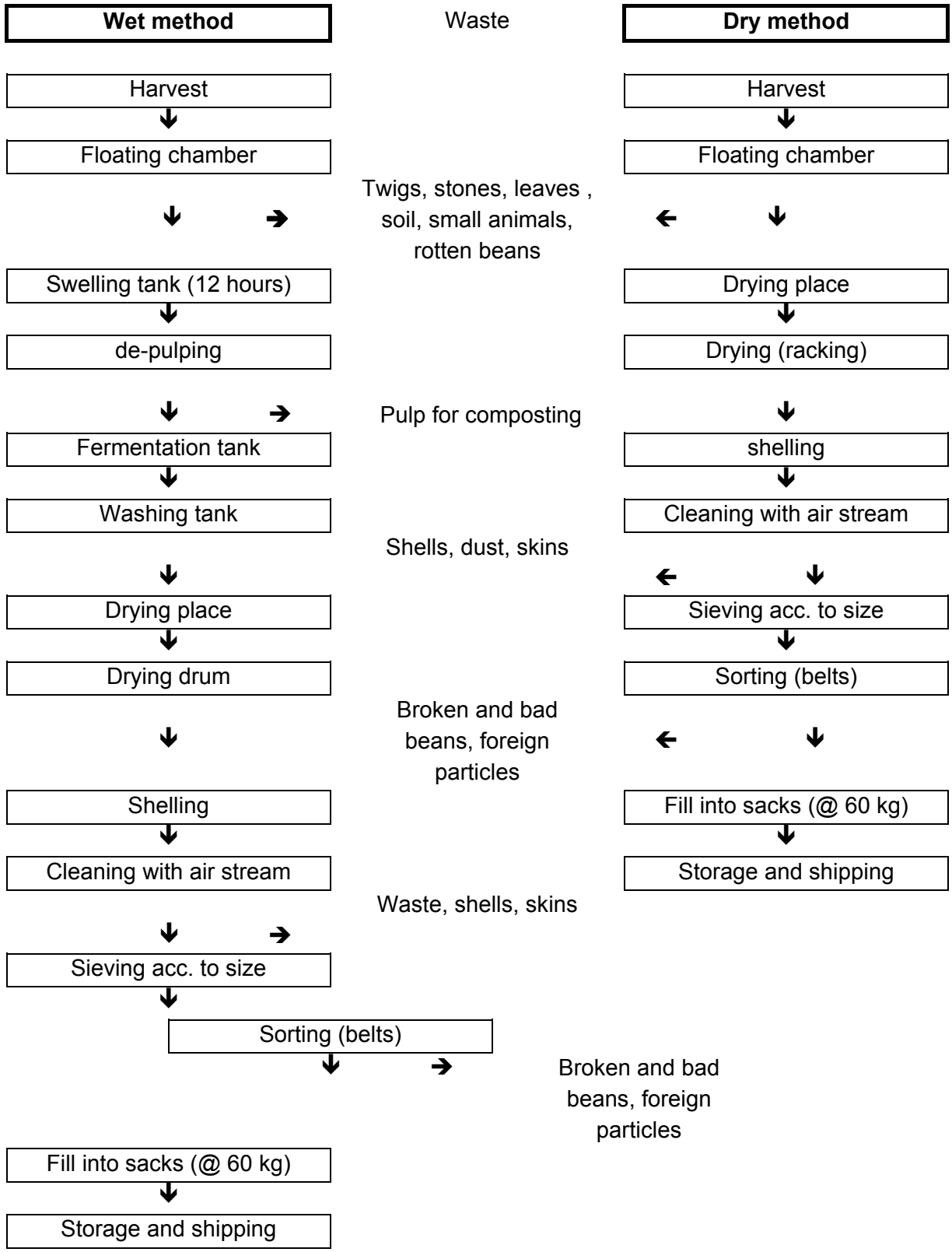
- **Cleansing, sorting and filling**

After sieving, the coffee reaches a large ventilator. All of the foreign particles, such as skins and shells from the polishing process, still remaining are blown off by a stream of air. Then the coffee is selected. This is necessary, because normal sized bad beans cannot be sorted out by the mechanical process. The so-called bad beans (grass beans, frost beans, 'stinker' etc.) are transported via conveyer belt to be manually sorted. The final processing step is to fill and pack the raw coffee into sack units of 48 kg or 60 kg, and then store them.
Raw coffee is traded according to certain quality criteria. Certain individual characteristics have emerged for most of the producing countries, which are used to assess the requisite quality, and for the buyers to choose their wares. The authorities and farmer associations in the producing countries are responsible for establishing the characteristics for each coffee grade. These are then only applicable for one particular variety.

The following aspects need to be heeded when the beans are sorted into grades:
- Processing method (wet or dry)
- Colour of the beans (green, blue-green)
- Growing site (district, altitude)
- Style (outward appearance)
- Number of defects (foreign particles, broken, shells, grass beans etc)

In order that the quality requirements are upheld, and no contamination of the raw coffee occurs, preparation should take place under clean, hygienic and ideal conditions. The following aspects should be adhered to:
- Equipment (tubs, knives etc.), as well as working and drying surfaces (racks, mats etc.) and preparing and storage rooms, should be cleaned regularly.
- Personnel should be healthy, and have the possibility to wash themselves, or at least their hands (washrooms, toilets) and wear clean, washable overgarments.
- Water used for cleansing purposes must be free from faeces and other contaminants.
- Animals or animal faeces must not come into contact with the fruits. If the fruits are to be dried in the open, then fences must be erected to guard the racks against birds and nearby animals.

Task list for the processing of coffee cherries



3.1.2. Quality requirements

The following is a list of quality characteristics with minimum and maximum values for raw coffee, that are usually required officially or by importers. Different minimum and maximum values can be agreed between importers and exporters, providing these do not clash with official regulations.

Quality characteristics	**Minimum and maximum values**
Cup quality	• aromatic • clean • free from foreign tastes and smells
Bean shape	homogenous
Water content	max. 13 %
Residues	
Pesticides	Not measurable
Bromide and ethylene oxide	Not measurable
Mycotoxins	
Aflatoxin B1	max. 2 µg/kg
Total aflatoxins B1, B2, G1, G2	max. 4 µg/kg
Ocratoxin A	max. 2 µg/kg (4-437)
Patulin	max. 50 µg/kg

3.1.3. Packaging and storage

Bulk packaging

In order to be exported to Europe, the raw coffee is usually packed in sacks in units of 48 kg or 60 kg.

Information printed on the sacks

The sacks should display details of the following:

- Name and address of the manufacturer/packer and country of origin
- Description of the product and its quality class
- Year harvested
- Net weight, number
- Batch number
- Destination, with the trader's/importer's address
- Visible indication of the organic source of the product 2 3

[2] When products from organic farms are being declared as such, it is necessary to adhere to the requisite government regulations of the importing country. Information concerning this is available from the appropriate certification body. The regulation (EEC) 2092/91 is applicable to organic products being imported into Europe.

Storage

The raw coffee should be stored in dark areas at low temperatures and relative humidity. Under optimum conditions, dried fruits can be stored for up to 1 year.
If the organic product is being stored in a single warehouse together with conventional coffee mixing of the different qualities must be avoided. This is best achieved using the following methods:

- Training and informing of warehouse personnel
- Explicit signs in the warehouse (silos, pallets, tanks etc.)
- Colour differentiation (e.g. green for the organic product)
- Incoming/dispatched goods separately documented (warehouse logbook)

It is prohibited to carry out chemical storage measures (e.g. gassing with methyl bromide) in mixed storage spaces. Wherever possible, storing both organic and conventional products together in the same warehouse should be avoided.

3.1.4. Ecological aspects of coffee processing and quality control

Under ideal conditions, the water which results from the wet process should be cleansed in a sewage treatment plant. Under no circumstances should the waste water be allowed to enter the settling tank (mechanical cleansing stage which uses sieves and a settling chamber).
Only organically produced coffee is allowed to be processed in a central processing depot for the wet method. Parallel processing (shelling, fermentation and drying) of conventional and organically produced coffee is not permitted.
In some coffee producing regions, malaria – combating methods are often carried out in the villages (e.g. with DDT). Farmers cultivating organically must then take appropriate precautions when this occurs during the time of the coffee harvest (and the coffee is maybe lying around unprotected on the drying places in the village).
Raw coffee is often filled into jute sacks, whereby no sacks that have been treated with pesticides may be used. Otherwise, there is a risk of contaminating the coffees.
It is prohibited to carry out chemical storage measures to help combat storage pests (e.g. gassing with methyl bromide). Special care should be taken when the sacks are to be stored at shipping ports. Because gassing is subscribed by law in some countries, special authorisation will need to be applied for in time.

[3] For organic products, a contamoination with non-ecological products must be prevented at each of the processing stages, during packaging, storage and transport. For this reason, products that originate from certified organic plantations should be labelled as such.