Coffee

***Coffea* spp.**

agriculture,
forestry & fisheries

Department:
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– PRODUCTION GUIDELINE –

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CONTENT

GENERAL ASPECTS

Classification

Scientific name: *Coffea arabica*

Common names: Coffee (English), koffie (Afrikaans), likhofi (siSwati), Ikofu (isiXhosa, Ikhofi (isiZulu)

Origin and distribution

Coffee originated in Africa, in the Ethiopian region known as Kaffa. From Ethiopia, coffee was taken to Arabia and finally brought into Europe. Coffee houses started emerging in Europe in the mid 1600s first in Italy and later in England. Coffee reached America in 1607.

An important milestone in 1727 was the planting of coffee in Brazil, which is now the world's dominant producer (at the beginning of the 1900s, Brazil produced 97% of the world's coffee). In 1893, the coffee from Brazil was introduced into Kenya and Tanzania, not far from its place of origin in Ethiopia, 600 years prior, ending its transcontinental journey.

The first coffee in South Africa was planted in KwaZulu-Natal at a missionary station during the late 1880s. During the 1930s, experimental plantings were done at the old government research facilities in Rustenburg in the North West Province. Very few commercial plantations existed, but during the 1950s some plantations were known to have existed north of the Magaliesberg near Silkaatsnek in the North West Province.

During this time, the first coffee in the Magoebaskloof region was planted and in 1963 coffee was planted on a commercial basis on the Grenshoek tea estate near Tzaneen, Limpopo Province. Little expansion of the industry occurred during the next few years, but high international prices during the 1970s linked with political imperatives of the time, forced the government to seriously consider coffee production.

Production levels

South Africa

By 1988, 1 525 ha of Arabica coffee were already planted

and a further 380 ha were approved. In principle, the former Cabinet also approved possible further expansions of up to 5 400 ha. During 1987, South Africa produced 1 800 t of green coffee and production of more than 6 600 ton by the year 2000 was projected. Altogether by 1990 a total of around 700 ha were planted. Presently, 200 ha of coffee are under production in South Africa, mostly in the KwaZulu-Natal and Mpumalanga provinces. An average yield did not exceed 1,2 t/ha, therefore the maximum South African production during the last decade was approximately 120 t (2 000 bags of 60 kg). In the year 2011, the production of (dried chicory root) coffee was 28 300 t.

International production

In 2012, the top ten coffee producing countries are as indicated in the table below.

Country	Production (million bags)
Brazil	225
Colombia	105
Indonesia	67
Vietnam	58
Mexico	5
Ethiopia	38
India	38
Guatemala	35
Côte d'Ivoire	33
Uganda	3

Major production areas in South Africa

Coffee is cultivated in the following districts in South Africa:

Province	District
KwaZulu-Natal Province	South and North coast (near Oribi George)
Mpumalanga Province	Barberton Hazyview Bosbokrand
Eastern Cape Province	East London
Limpopo Province	Grenshoek Tea Estate near Tzaneen

Cultivars

The principal coffee species grown today in the most important coffee producing countries are:

Coffea arabica

Coffea arabica is a valued species and has been grown and selected for several centuries. It currently represents three-quarters of the world coffee production. *Coffea arabica* originates from Arabia, and thrives in land that is rich in minerals. Its better-known sub-varieties include Moka, Maragogipe, San Ramon, Colomnaris and Bourbon.

The Arabica makes a flavoury, full-bodied coffee that is sharp in taste with a rather low caffeine content. As a group, Arabica coffee consists of many cultivars that differ in respect of origin, climatic requirements, tree size, yield pattern, quality of end product, berry size and disease resistance. In fact, some low-quality Arabica species are inferior to the best *Coffea robusta* varieties.

Arabica beans look slightly elongated and have a range of greenish-blue shades.

Coffea robusta

Coffea robusta is a variety that can grow to more than 12 m in height. It grows quickly in altitudes up to 600 m, and is more resistant to pests and diseases.

This variety was discovered in the Congo in 1898 and is widely spread, especially in Africa, Asia and Indonesia where the climate is unsuitable for the cultivation of *Coffee arabica*. It represents approximately 25% of the total world coffee production.

Because of their higher caffeine content (about twice as much as Arabica) and strong character, Robustas are used mostly as blends. Robusta beans are typically small, rounded and brownish yellow in appearance.

Description

Coffee (*Coffea arabia*) is a tropical plant, which belongs to the genus *Coffea L*. of the family Rubiaceae.

Mature plant

It can grow to a height of 10 to 15 m at maturity, but is kept at 3 m in plantations for harvesting purposes. The shrubs remain productive for 15 to 20 years.

The leaves

The elliptical leaves of the coffee tree are shiny, dark green, waxy and up to 15,24 cm long. The leaves are simple, petiolate and have persistent stipules. Their underside is marked by small cavities or domatia.

On the trunk and suckers, the opposite leaves are in crossed pairs, whereas on the branches they are on the same plane.

The flowers

The white to pinkish flowers are very fragrant and arranged in glomerules of 3 to 16, which, in turn, are grouped together in the axils of the leaves or above the leaf scars.

The flowers are ephemeral, withering a few hours after they have bloomed. Flowers occur in large bunches on old-growth wood, are generally self-fertile and will produce fruit without pollination.

The roots

The roots of the coffee tree can extend 2,0 to 2,5 m in total length. The taproots can penetrate to a depth of 2,5 to 4 m in plantation situations.

The fruit

The coffee fruit is oval, similar in size and shape to a small olive and turns red from green during ripening. The fruit is a fleshy berry, in which two seeds are imbedded. Blossoming and fruit setting occurs mainly 2 to 3 times a year. About 6 to 7 months are required to ripen the fruit. The interim period between the flowering and ripening of the fruits varies, being determined by a number of factors (climate, latitude and altitude).

Essential part

The fruit are the essential part of coffee.

Climatic requirements

Temperature

Temperature is an important aspect in coffee production. The suitable temperature range for coffee in South Africa is 4 °C to 32 °C with average temperature ranges of 12 °C to 26 °C.

Although this crop can tolerate temperatures well outside this range, extreme temperature variation usually affects the crop and the coffee bush. Low temperatures retard growth and below 12 °C the growth of the plant is inhibited. The cold period must be short. The prolonged cold period, adversely affects the growth, flowering, fruit development, fruit ripening and eventually the yield.

Higher summer temperatures are necessary for proper fruit development and fruit ripening. Coffee plants cannot tolerate frost and windy areas. The effect of frost can be minimised by planting on broad ridges and by mulching while the effect of wind can be minimised by windbreaks.

Rainfall

Coffee is sensitive to water shortages and adequate well-distributed precipitation of about 1 500 mm a year should occur. Rainfall also influences flowering and coffee should therefore be produced in areas with adequate spring rains. A dry period during winter (June to August) is important for flowering.

Soil requirements

Coffee has been successfully produced in many parts of the world on a wide range of soils, but the ideal soil type is sandy-loam. It can do well in

any fertile soil, provided the weather conditions are favourable. To produce a high yield, the coffee tree requires deep permeable soil, of good structure, that contains enough organic matter and it is also requires a favourable water balance. In very sandy or clayey soils, the clay content of the soil should be between 15 and 35%. The optimum pH is between 5,0 and 6,0, but the coffee plant can still grow around neutrality. Coffee grows well where natural forests occur.

CULTIVATION PRACTICES

Propagation

Seed propagation

Propagation is usually by seed and cuttings. The propagation of seed from the Arabica varietals gives plants that are true to type. Arabica trees are self-pollinating.

Vegetative propagation

To obtain a good plantation, coffee trees within a plantation with high yield and resistance to leaf rust characteristics can be selected and propagated vegetatively by means of leaf cuttings. A coffee plantation can, by this method, gradually be replaced with better trees or a new plantation consisting of potentially good trees established.

Soil preparation

The soil should be well cultivated. Soil preparation for coffee involves the removal of rocks, debris and vegetation. Plough and harrow the open field twice to check weed growth. After the initial land preparation, collect a soil sample for analysis and determine the need for soil amendments that must be incorporated before planting, as well as any fertiliser nutrients that should be applied before planting. A well-prepared, fine level seedbed is required.

Where the land can be cultivated, fertiliser amendments such as phosphorus and lime, should be thoroughly incorporated into the soil by ploughing and disking several months before transplanting. Where the land cannot be ploughed, holes must be dug instead. The holes should be large and deep enough to allow plants to be transplanted without bending the taproot. Subsequently, the planting holes are dug and the seedlings are planted.

Field layout and design

Planting distance depends on a combination of factors such as variety, topography, soil fertility and management. Varieties with big plant characteristics grown on good soil and in a favourable climate require wide spacing between plants. The usual distancing of the different varieties are Arabica 2x3 m and Robusta 3x3 m. Straight row planting with an east-west orientation is the recommended layout.

Planting

Coffee is planted during spring time or the beginning of the rainy season, when the soil is moist and under cool conditions. The spacing width between the rows can be 15 cm to 20 cm. In the rows the seeds are placed 3 cm to 5 cm apart, 0,5 cm to 1 cm deep and with the flat side down. If the flat side faces upwards, the radical will have to emerge around a curve and this leads to poor seedlings.

Transplantation of the seedlings is done about six months after they were grown in nursery beds or plastic bags or when they are about 20 cm tall, and they are planted in the fields. Before planting the coffee seedlings, holes must be dug in order to stir the soil and loosen it. The holes should be dug two months before planting the coffee trees and they should be about 50 cm long, 50 cm wide and 50 cm deep. For dryland planting, it is recommended that planting be done when the soil profile is moist and during the rainy season.

Fertilisation

The coffee plant ranks among the tropical crops with the highest nutrient demands. The kind and quantity of fertiliser would vary depending on the type and initial fertility of soil, climate, plant age, cost and availability of fertiliser on a few representative plants. It is recommended that leaf and soil analyses be made every year once the trees start producing. This would make it possible to obtain an accurate and complete fertilisation programme. It is important to apply the correct types and quantity of fertilisers according to the soil analyses recommendation. Leaf collection for analysis should be done in spring when the plant is in full bloom. Soil samples should be taken after the rains when the soil has dried out before planting.

Fertiliser application should be done four to eight weeks after planting and every year in August/September for plant establishment. Nitrogen is impor-

tant to increase growth, prevent leaf fall thereby maintaining the photosynthetic area of the plant. Its shortage may affect production. Potassium, zinc and boron are some of the essential elements in coffee production. Boron and zinc deficiencies result in shortening of internodes and smaller leaves. Potassium deficient plants defoliate. Potassium and nitrogen should be applied from September to April. Zinc should be applied when necessary during November and February annually. Boron is needed for cell division and it can be applied at the beginning and towards the end of the flowering period.

Irrigation

The main purpose of irrigation is to supplement rainfall. Under irrigation 50 mm should be applied before planting, followed by 25 mm afterwards. An irrigation interval of 25 mm every 10 days is essential. Keep the soil moist, but not too wet. Over-irrigation will enhance the risk of fungal diseases. Irrigate the plants twice a week in hot weather, and once a week in cool weather. Different types of irrigation systems can be used, such as hose and basin, drag-hose sprinkler system, drip irrigation and micro jet.

Weed control

Weeds should be controlled before planting either mechanically or with a registered herbicide. During the early stages and to facilitate establishment, mulch could be placed around the young seedling for weed control. Mulch should not be placed closer than 100 mm from the main stem. An integrated weed control method should also be considered. When land has been burnt, for the first two or three months there are practically no weeds to control, but after the first rains they appear. Hand weeding is generally sufficient.

Pest control

Coffee is attacked by a number of insects, which have the potential to seriously disrupt production. Management of coffee insects is therefore critical and the following insects must be monitored very closely.

White stem borer (*Xylotrechus quadripes*)

SYMPTOMS

The larvae bore through the stem of young trees (one or two years old) and the trees usually die off. Three or four-year-old trees wilt and turn yellow

and yield either a poor crop or nothing at all. Adult coffee trees do not die off immediately, but continue to form roots as the original roots are destroyed.

Control

Chemical control: The chemical solution may be sprayed or painted onto the stems up to a height of 450 mm annually from December to February. It is important to rub off the loose bark around the stems before applying the insecticide. The chemicals must not be applied on leaves or berries. Stem treatments must be with a chemical with a long residual action. It will also help if the loose flaky bark is removed superficially. Full-cover sprays with most insecticides will kill adult beetles.

Cultural control: Sanitation—removal of all plants showing symptoms of stem borer attack.

Antestia stink bug (*Antestiopsis sp.*)

It is a dangerous pest for coffee and it can destroy up to 50% of the crop in a season.

Symptoms

The bug transmitting spores of the fungus Namatospora to developing beans causes severe damage. In the adult stages the insect feeds on flower buds, young shoots, growth points and coffee berries. This could cause the drop of young, immature berries or rotting of the coffee beans. When the insect is feeding with berries it can transmit fungi to the seeds, which may lead to rot.

The affected flower buds turn brown or black while affected seeds are usually malformed and produce lighter berries. In the absence of coffee berries, the insect feeds on the growth tips, leading to a fan-shaped growth habit, which is very detrimental because the tree can assume a dense, bushy shape, resulting in crop losses.

Control

Monitor bushes every week by shaking the branches and by counting the number of Antestia stink bugs that are collected. Visual monitoring alone is

not reliable as these bugs are very well camouflaged. Antestia bugs can be sprayed with contact insecticides. In the absence of any control measures, the bug population will increase fast and economic damage will result.

Cultural practice: by keeping the plants open through maintenance pruning, Antestia bugs will do less damage.

Natural enemies: all stages of the pest are attacked by parasites, mostly egg parasites. Two egg parasites that have been found in South Africa are *Asolcus seychellensis* and A. mopsus (*Hymenoptera: Scelionidae*).

Chemical control: spraying with a registered insecticide is necessary from the first summer rains, before the main flowering period and during the developmental stage of the green berries. When infestations are heavy, a second spray can be applied a fortnight after the first.

Leafminer (*Leucoptera caffeine)*

Symptoms

Dark brown dead patches on the upper surface of the leaves occur. On close inspection, H-shaped white silken cocoons are often found on the underside of the leaves which leads to sunburn on shoots and berries. If branches are shaken early in the morning the tiny grey-white moths will be observed. Severe outbreaks of leafminer usually coincide with heavy foliar spraying and could cause total defoliation.

Control

The use of registered chemicals is essential and effective insecticides registered to control this insect are recommended.

Mealybug (*Planococcus* sp.)

Symptoms

White, woolly clusters of mealybugs may be found on the green wood, cherry cluster and suckers. The mealy bug exudes a sticky substance called honeydew, which attracts ants and encourages the growth of “sooty mould” fungus. When multiplication to pest proportions is rapid, fruit fail to develop, leaves are shed and the trees are debilitated.

Control

Control may be obtained by removal of unwanted sucker growth and by the use of insecticidal sprays. Direct control of mealybugs can be achieved by spraying registered chemicals.

Black coffee stem borer (*Apate* spp.)

Symptoms

The adult beetles cause damage to coffee trees.

Control

The beetles may be caught in the plantation by means of a light-trap or collected by hand from the sunny side of the trunk in the early morning. An effective method of control is to kill the beetles by pushing a sharpened piece of wire into the tunnels.

Grey coffee snout beetle (*Ellimenistes laesicollis Fahrs*)

Symptoms

Immature fruit may be damaged at the pinhead stage while on more matured fruit the beetle eats into the peduncle (fruit stalk), causing the fruit to fall. Holes or cavities may be eaten into the green berries, and if that happens the flowers will be damaged, resulting in malformation and blossom fall. The beetles will also eat the soft, succulent suckers, retarding sucker growth or causing the suckers to snap in a light wind. Feeding damage may cause bifurcation or distortion of the stem and branch terminals. The beetles also feed on the leaves.

Coffee berry moth

Symptoms

Coffee berries are usually spun together with white silk eventually turning black. Upon closer inspection, holes (± 4 mm in diameter) will be noticed in the fruit. This fruit contains a larva of the berry moth, and most fruit in the cluster are usually destroyed.

Control

This insect is usually under very good biological control. By following an integrated insect control programme, problems should be minimal. The use of registered insecticides is recommended.

The variegated coffee bug (*Antestiopsis* spp.)

Symptoms

Two species *A. lineaticollis* and *A. faceta* have caused a great deal of damage in coffee. The adults appear to breed more prolifically when the

coffee berries are young and green and when the young 'Antestia' as they are called, feed voraciously by piercing the fruit and sucking the inner saps. However, the bugs will feed on berries in all stages of growth, causing a good deal of berry shedding. When there are no berries, the adult insects will attack the young buds, shoots, and even the leaves.

Control

The use of a registered chemical insecticide is recommended.

Other pests of coffee include: leaf rollers, stinging caterpillar, coffee thrips, green scale, star scale, coffee berry borer, flute-holding and shot-holding beetles, twig borers, caterpillars, lacewing coffee bug, cutworms, capsid plant bugs, berry boring insects, moths and butterflies, nematodes and noxious weeds.

Disease control

Coffee leaf rust

Two species of *Hemileia* fungus have been reported as causing rust on coffee, viz. *H. vastatrix* and *H. coffeicola*, but *H. vastatrix* is regarded as the more potent pathogen of the two.

Symptoms

Symptoms are mainly confined to the leaves and start as small, yellow spots on the under surface of the leaves. As the lesions increase in size, they darken to a typical orange colour. Brownish blotches eventually make their appearance on the upper surface of the leaves.

As the lesions mature, the centre of the lesions on the lower surface becomes necrotic. Heavy infections can lead to the defoliation of the trees. With *H. coffeicola*, the orange powdery lesions which cover the lower surface remain green for some time.

Control

The use of available contact and systematic fungicides for the control of this disease is recommended.

Control through plant resistance: Because of the cost of spraying, resistant varieties have been developed.

Coffee berry disease

SYMPTOMS

The fungus *Glomerella cingulata* causes a dark-brown rot, which destroys the beans and causes the berries to dry out. The spots appear on the lateral surface of the green berry, which enlarges rapidly to produce roughly circular, slightly sunken, dark-brown spots. Several spots develop on the fruit to form irregular, necrotic areas. Infection can also start at the base of the berry. Pinkish masses of asexual spores (Collectotrichum) can be produced on the surface of the lesion. Diseased berries, with or without their fruit stalks, often drop. Lesions, which tend to become ash grey (except for a dark brown margin) tend to develop at the onset of the dry season and are referred to as scab lesions.

CONTROL

The use of fungicides for the control of this disease is recommended. The use of resistant cultivars is also effective.

Tracheomycosis wilt (*Fusarium xylarioides*)

SYMPTOMS

The symptoms are yellowing and collapsing. The disease enters through a low surface wound or a shallow root. Afterwards the connecting vascular strands in the stem are discoloured violet brown to black in a broad, hardened band.

CONTROL

The best control is to choose the correct environments for cultivation of coffee, to use mulches and to cultivate coffee with implements. A sharp look-out should be kept for infected trees and they should be thoroughly uprooted at once. All infected material should be burnt to fine ashes.

American leaf spot (*Mycena flavida*)

SYMPTOMS

The young spots destroy the leaf tissue. Defoliation can be severe, branch tips are killed off and the fruit may also be affected.

Control

The only effective method of control is choosing the correct environment for cultivation of coffee and the use of proper cultivation practices. The use of fungicides for the control of this disease is recommended.

Root rot diseases

Various fungi cause root rots and gaps/holes in mature trees.

Control

To uproot both coffee and night shade, burn off the material, treat the soil and start again.

Rosellinia bunodes

This disease affects coffee planted on forest land.

Symptoms

Wilting of the leaves. This is accompanied by fungus growth and internal discolouration of the roots at the collar, and it is hence often called a collar-rot disease. The tree eventually dies off.

Armillaria mellea

This disease is a common saprophyte in forest soils where it lives on dead stumps and roots. Under natural conditions, it spreads to weak and dying trees and others that are susceptible.

Symptoms

Yellowing and wilting of the foliage followed by die off. The perfect fungus is a cluster of pale yellow toadstools, which grow at the base of a dead or dying trunk.

Control

All trees marked for destruction should be killed off a year beforehand. The soil should be thrown inwards, the trees within the encircled ground up-rooted and burnt and the soil cultivated deeply and sown with vigorous green manure crops such as Crotalaria or Tephrosia.

Cercospora spot

Symptoms

Smooth, round, dark brown lesions appear on the upper surface of the leaves. In severe cases, necrotic lesions become visible on the fruit and can lead to significant losses.

Control

This disease is only serious under conditions of high humidity. The use of registered chemicals will be effective to control this disease.

Other cultivation practices

Mulching

Coffee can be grown using mulching (e.g. grassland/types and crop residue) for positive effect on yield in unshaded coffee. The mulch should be spread around the coffee trees. This enriches the soil, conserves moisture, moderates of excessive soil temperature, minimises soil erosion, improves soil textures and controls weeds.

Harvesting

Harvest maturity

Coffee berries/fruit mature from May to October, depending on the climatic zone and the cultivars. The berries are mature when they are red and soft. The coffee berries are ready 8 to 9 months after the plant flowers.

Harvesting methods

There are four different methods of harvesting coffee, the first of the four types being the stripping method. This form of harvesting is done by hand, and it removes all of the berries, flowers, green berries and deeply over-ripened berries.

The second method uses a comb to brush the trees. This method does remove all ripe berries, leaving the unripe berries as well as the green leaves that are still connected to the branches of the tree. This is a time-consuming process, but it is worth the time invested. However, this process of harvesting would be more profitable because the unripe berries will eventually become ripe, increasing the future yield.

The third process used for harvesting is mechanical. A vibrator fixed to the trunk of the tree is used to shake the ripe berries loose so that they fall to the ground where they can be reached with ease.

The last method is the most expensive because it requires hand picking the berries when they become ripe. The reason for this expense is that it must be done as many times as necessary until all the berries are picked. Picking should start from the centre of the plant, using both hands.

For the wet processing of coffee, the mature berries are picked selectively by hand either weekly or every second week. There are no machines that can pick the berries selectively.

POST-HARVEST HANDLING

Drying

Drying can be done by either sun drying or mechanical hot air drying, and preferably on shade netting. By drying, 13% to 15% moisture content is reduced. Sun drying is cheap and makes a slightly higher-quality product but it requires much labour, space and time. The coffee must be laid 2,5cm thick and turned every hour.

Grading

The dry, green, hulled coffee beans are graded according to size and shape by means of a rotating sieve. In the first place, the beans are pushed along by a spiral plate, or moved along an inclined horizontal rotating sieve where holes or bars vary in size or width to allow the required sizes of beans to fall through into separate compartments as they pass from one end of a grader to the other. Otherwise, grading is three-dimensional for the flat beans, i.e. width, thickness and length.

Packing

Coffee must be packed into the coffee basket firmly, otherwise the pressurised water will break the coffee apart during brewing and will not permeate the coffee evenly. The packer must be sized correctly to the coffee basket chosen. The aluminium-free packaging is

also characterised by highest environmental compatibility.

Storage

The storage room must be well ventilated and dry. This is because coffee is hygroscopic. Dried coffee (dry processing) and parchment coffee (wet processing) less readily absorb moisture, but their storage requires large premises.

Transport

Coffee is transported still packed in the original bags by the trucks at the roasting facilities.

PRODUCTION SCHEDULES

Activities	January	February	March	April	May	June	July	August	September	October	November	December
Soil sampling										X	X	X
Soil preparation								X	X	X	X	X
Planting	X									X	X	X
Fertilisation	X	X	X						X	X	X	X
Irrigation	X	X	X	X	X	X			X	X	X	X
Pest control	X	X	X						X	X	X	X
Weed control	X	X	X	X	X	X	X	X	X	X	X	X
Harvesting						X	X	X	X	X		

UTILISATION

Dried seeds “beans” are roasted, grounded and brewed to make one of the two most important beverages. Coffee is widely used as a flavouring, as in ice cream, pastries, candies and liqueurs. It is a source of caffeine and dried ripe seeds are used as a stimulant, nervine and diuretic, acting on the central nervous system, kidneys, heart and muscles. Coffee pulp and parchment are used as manures and mulches, and occasionally they are fed to cattle.

Coffelite, a type of plastic, is also made from coffee beans. Caffeine has been described as a natural herbicide, selectively inhibiting the germination of the seeds of *Amaranthus spinosus*. Caffeine is a widespread additive in over-the-counter diet pills, painkillers and stimulants.

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