Organic Farming in the Tropics and Subtropics

Exemplary Description of 20 Crops

Pepper

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Naturland would like mention the following authors and thank them for their contributions:

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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Organic Cultivation of Pepper

1. Introduction

Pepper originates from the Malabar coast of Southern India, and was spread from there by emigrating Hindus to Indonesian and Malaysia. Pepper was an important and popular spice to trade with in Oriental countries, even as early as 2000 years ago. The most popular variety was the long pepper *(Piper longum L.)* from Bengal. Pepper was being used in Europe as a spice as early as the middle ages. During the 16th century, the Portuguese empire secured a monopoly in trading with the spice, which was later broken up by the English and Dutch imperial powers. During the present day, only black pepper *(Piper nigrium)* plays an important role in global trading.

1.1. Botany

Pepper belongs to the piperaceae family. Among the 700 different varieties there are bushy types, as well as tree-like, creeping, climbing and epiphytic sorts. *Piper nigrum* is a climbing plant, which, so long as it is not trimmed, can reach up to 10 m in height. The long stems turn to wood at the bottom, yet remain green towards the top. The system of shoots are distinguished between the main shoots, that grow upwards, and lateral, fruit-bearing shoots that grow horizontally. The main shoots form numerous nodes, on which grow adventitious roots for climbing, as well as lateral shoots, the stemmed, heart-shaped leaves and the blossom ears.
The different varieties range from single-sexed to hermaphrodite, and are self-pollinating. Their up to 15 cm long syncarpy produce berry-like fruits (bot. drupes). These take around 6-8 months to develop from blossom to ripe fruit.

1.2. Varieties and countries of origin

Only the following selection of pepper varieties is of any importance as a spice amongst the 700 or so varieties:

- Black pepper *(Piper nigrum)* from India, Malaysia and Indonesia,
- Bengal pepper (*Piper longum L*.) from the mountains of the lower Himalayas,
- Java pepper (*Piper retrofractum Vahl*) from Malaysia and Indonesia,
- Ashanti pepper (*Piper guineense Schum. et Thonn*) from tropical Africa, and
- Kubeben pepper (*Piper cubeba L.f.*) which grows in Indonesia and Malaysia.

Other spices termed “pepper” – such as red pepper, Jamaica pepper, Melegueta pepper (grains of paradise/Guinea grains) and the seeds of the pepper tree (*Schinus molle* L), that grows in California and Chile – have only begun to be termed

pepper due to their peppery aroma. Nonetheless, they do not belong to the piperaceae family.
Black pepper is processed and traded in a number of different ways, and there are many local varieties. Nevertheless, two main groups can be distinguished:

- Pepper varieties with large leaves

They have large syncarpy with small fruits. These include the very productive varieties “Balamacotta” from India, “Kuching” from Malaysia – which is very susceptible to stalk rot – and “Belantung” from Indonesia.

- Pepper varieties with small leaves

Produce smaller syncarpies with larger single fruits, are more resistant against diseases and not as demanding. The most prominent varieties include “Kalluvalli” from India (relatively resistant to drought), “Cheriakaedan” (Highly resistant to stalk rot), “Bangka” from Indonesia and many more.

Currently, the largest producers of black pepper are still India, followed by Indonesia, Malaysia, Thailand and Sri Lanka. In Latin America, Brazil, followed by Mexico are the two largest producers.
Organically grown pepper mostly comes from India, Madagascar, Tanzania and Sri Lanka.

1.3. Uses and contents

Pepper is one of the oldest classic spices, and is an ingredient in many spice mixtures (e.g. curry). Black, white and green pepper all come from the same plant *(Piper nigrum),* and are the result of harvesting at different stages of ripeness and the different processing techniques used (compare 3.1).
Peppr seeds contain 1-2.5% essential oil, 5-9% piperine, 1% chavicine, 8% piperidine, 6-8% fatty oils, 0,5% resin, 22-42% starch and 8-13% water. The alkaloid piperine is responsible for the sharp taste.

2. Aspects of plant cultivation

During the boom-years of cultivation pepper, cultivation areas (especially in rainforests) were eroded in all of the producing countries to establish pepper plantations. As a rule, monoculture supported by wooden stakes were set up, instead of using living tutors. During the first few years, the pepper grew relatively well. Yet the lack of additional vegetation soon had an adverse effect, as the mineralization of the soil’s organic substance took its toll on the yield. Attempts were made to combat the upsurge in diseases and nutrient problems with intensive utilisation of fungicides and mineral fertilisers. On many plantations, though, these measures proved to be economically unprofitable, and the sites were abandoned.

2.1. Site requirements

Pepper originates from the tropical, warm, humid latitudes, where temperatures of 25°C and 2.000-4.000 mm annual rainfall predominate. The plant places heavy demands on the soil. The best types are nutrient-rich, well-drained alluvial soils, or volcanic soils with a high organic material content. Pepper plants grow especially often in young secondary forests (where new trees grow in clearings and on the forest's edge), where they are growing up to the lower part of the middle storey.
The plant may reach 20 years old in a crop (and sometimes even 40). This is significantly shortened on conventional plantations (e.g. cultivation at wooden stakes). The pepper's natural sites indicate the requirements the plant has in order to achieve and maintain an organic production site. One of these elements is dynamic additional vegetation, as they naturally often occur in secondary forests – along with suitable tutors.

2.2. Seeds

The following methods of producing seeds should be considered:

2.2.1. Propagation using seeds

Propagation by seed is out of the question on conventional plantations, as germination and the raising of young plants takes too long. In addition, in the case of pepper, sexual propagation causes a genetic splitting, which can also lead to plants with separated sexes being produced (male and female separate).
Seeds are won by soaking fully-ripened berries in water for 2-3 days, then removing the meat and drying them in the shade. Afterwards, they are planted out in moist, shaded beds filled with a mixture of humus and lots of sand, at a distance of one hand-width to one-another. They will begin to germinate after 30 days, and can be transplanted to their final sites after a further 6 months – when they have produced 4 leaves.

2.2.2. Propagation using cuttings

The most widely spread form of propagation is with the use of cuttings. They should be selected from the terminal area of the main shoot of a strong, healthy and highly-productive parent plant. Before the shoot is cut from the main shoot, the vegetation apex, as well as the leaves and lateral shoots from the 3rd to the 7th knots, should be removed. As soon as the plant's apex has regenerated, the shoot underneath the 7th knot is removed and planted in a seedling bed. The seedlings should be set in the soil at and angle of 45° with 3-4 knots. The uppermost leaves on the shoot can be left.

The shoots' bed must be kept moist and shaded. The shoots will have taken root after 2 months, whereby only a 30 % rate of success should be expected. They can then be planted at their final sites.

2.2.3. Rooted pepper cuttings

Another method of producing plants is to use root cuttings, whereby the shoots are directly attached to the plant itself. The shoots are prepared in the same way described above. Yet instead of cutting the shoot off, a layer of moist moss or humus is bound around the 7th knot, and secured with plastic foil at both ends. After around 2 months, the shoot is cut away and allowed to acclimatise in a polyethylene bag in the planting bed before being transplanted to its final site. Although a higher percentage of shoots take root then with cuttings, this method involves more work.

2.3. Planting methods

On traditional cultivations, living tutors are used for the pepper plants, and the crop integrated into diversified agro forestry systems. This should also be the basis of production in an organic cultivation system. The use of wooden, or even concrete, posts on such plantations is unacceptable. The eco-physiological requirements of pepper can provide tips on how to integrate them within diverse agro forestry systems, such as they have already been described for, e.g. cacao, bananas, papaya and vanilla.

2.4. Diversification strategies

Pepper can be integrated within a variety of mixed cultivation systems that have been established at humid, tropical sites, and which have already been described in the appropriate chapters on e.g. cacao, mango, banana, papaya and coconut. Yet as is the case for the cultivation of vanilla, before planting of pepper plants can begin, the additional vegetation must already be established.
Plants that can serve as tutors include Jackfruit (*Artocarpus heterophyllus Lam*); Kapok (*Ceiba ssp*.); *Erythrina ssp*; Betel nut palms (*Areca catechu L*.), *Gliricidia sepium, Garuga pinnata, Spondias mangifera* and *Grevillea robusta*. On young plantations, plants which are suitable for use as ground coverers include *Calopogonium mucunoides, Arachi pintoi, Canavalia ensiformis* and many more besides.
The tutors are planted on small earth mounds 15 cm high with a diameter of 50 cm, which should be constructed out of layers of organic material taken from the plantation. The planting density can be around 600 and 1200 pepper plants/ha. A stick should be provided as support for the plant until it is tall enough to reach the tutor plant.

2.5. Nutrients and organic fertilisation management

On traditional pepper cultivations, the plants will produce around 2 kg of green peppercorns per year. On intensively cultivated conventional plantations, this can be increased to a yield of around 10 kg between the 5th –7th years. Although, the life-span of conventional cultivation systems is significantly shorter.
In order to be able to satisfy the high nutrient demand of pepper in organic cultivation systems, it is necessary to concentrate on achieving a high level of organic material production. It is nonetheless important that the organic material stems from a diversified supply of support vegetation. Organic mulch material should always be produced on the plantation itself, as this is the surest way of maintaining the plantation's long-term viability, and of keeping production costs at an economical level.
Green manure produced from the bio-mass within the system will be sufficient. As long as the system is still relatively open, during its early phases, the species referred to above can be planted as bottom crops. A large amount of bio-mass can be produced in a relatively short time by planting seedlings of the rapid-growing common mallow (*Malvaviscus aroreus*). Regular trimming will produce valuable foliage material with a very narrow C:N ratio. The mulberry tree (*Morus alba*) is also very useful as a green fertiliser. They can easily be raised from seedlings, and also be planted quite close together(1 x 0.5 m).

2.6. Biological methods of plant protection

In the cases of demanding cultures such as pepper, a system of production that is not suited to the crop will very quickly lead to phytosanitary problems. During the past few years, different fungi strains have led to heavy fluctuations in production in Brazil, and to the loss of large cultivation areas in Malaysia. On conventional cultivation systems, the chemical methods of control with fungicide sprays used (benomyl, benlate, copper chloride) have either proven to be useless or uneconomical.

The following measures can be taken to prevent and regulate infestations of pests and diseases on organic systems of pepper cultivation:

- Choice of site (no water-logging, lots of organic material),
- Establishment of a diversified mixed cultivation system,
- Continuing production of a large amount of bio-mass,
- Only plant the pepper after the tutors and additional vegetation have become established, and enough distance between the plants has been adhered to,
- Removal of diseased plant material,
- Management of light/shade, and enrichment of organic material with tree pruning,
- Constant renewal of the site (compare. 2.7.),

- Lignin-rich mulch material will stimulate the actinomycetes in the soil, which in turn are antagonists of fusarium.

2.6.1. Diseases

Soil-borne fungi are the most important cause of disease to peppers. They possess a wide spectrum of hosts, and can affect practically all of the crop types.

The most important diseases in pepper cultivation include:

Germ	Symptoms	Appearance
Phytophtera palmivora (pepper wilt)	Leaf wilt, yellow discolouring with loss of leaves, shoots and finally, entire plant.	In all producing countries, especially in Asia
Fusarium solani var. Piperi (root rot)	dto.	Latin America
Ganoderma lucidum (red root rot)	dto.	World-wide
Colletotrichum; Rhizoctonia	Leaf flecks	World-wide
Pseudomonas (Bacteria)	Leaf flecks	World-wide

2.6.2. Pests

Nematode infestation by *Meloidogyne spp*. causes the main problem on conventional pepper cultivations. Greater damage, especially in Indonesia, are caused by various bugs; scales and green flies, beetles, as well as butterfly caterpillars.
If the plantations are situated near to houses, then free-roaming pigs and chickens will often cause considerable damage to the plants. These animals must be kept out of the plantations.

2.7. Crop monitoring and maintenance

This sensitive crop requires special care of the soil, whereby, the surface roots can make this type of work more difficult. During harvesting, the ground beneath the plants must be kept clean, in order to be able to collect any ripe berries that have fallen. Careful maintenance is essential for a reasonable yield. Vines must be regularly tied back and pruned, and diseased or withered plants replaced.

2.7.1. New plantations

Young pepper plantations form blossoms within the first year. Yet it is recommended to remove these during the first two years, in order not to inhibit vegetative growth. The main shoots must be attached to the tutor.

To stimulate growth of the main shoot and lateral shoots, they should be regularly pruned during the first few years. Pepper plants generally grow three shoots. After the main shoot has developed 8-10 internodes, it should be pruned back to 2-3. As soon as the other shoots have developed 8-10 internodes, then these are pruned as well. Every time 8-10 internodes have developed, the same process should be repeated. After 7-8 prunings, the tree will have reached a height of around 3 m. This height should now be maintained by regularly cutting off the apex shoots.

2.7.2. Established crops

After the production phase has begun, maintenance is limited to pruning of the additional vegetation and tutors. The system is thereby continually renewed, and sufficient mulch material produced. Flowering herbs, grasses or Cyperaceaen are removed with a bush knife.
The additional vegetation and tutors should be pruned during the season with least sunshine before they begin to fructify. In particular those species of trees included in the secondary forest system which are not deciduous (these include most of the species recommended as tutors), must be pruned. The trees in the upper reaches of the primary forest do not usually need to be pruned.
The resulting branch material should be chopped up and spread around the ground as a mulch layer. In addition to regulating lighting conditions on the plantation, pruning measures also provide a continual source of organic material and a sufficiently thick layer of mulch.

2.8. Harvesting and post harvest treatment

The following types of pepper result from different harvesting times and processing methods

Black pepper
The half-ripe berries are harvested when they have attained their final size. On small farms, these are then laid out on mats or concrete areas to dry out in the sun – whereby they take on their typical dark brown colour.

White pepper
White pepper is produced by cutting down the ripened red berries from the syncarpy. The correct time for harvesting is crucial, as over-ripe berries will fall to the ground of their own accord.

Green pepper
In order to manufacture green pepper, immediately after the harvest the berries are separated from the syncarpy, washed and conserved in brine (salt water, vinegar[1], citric acid).

[1] Vinegar from certified organic production.

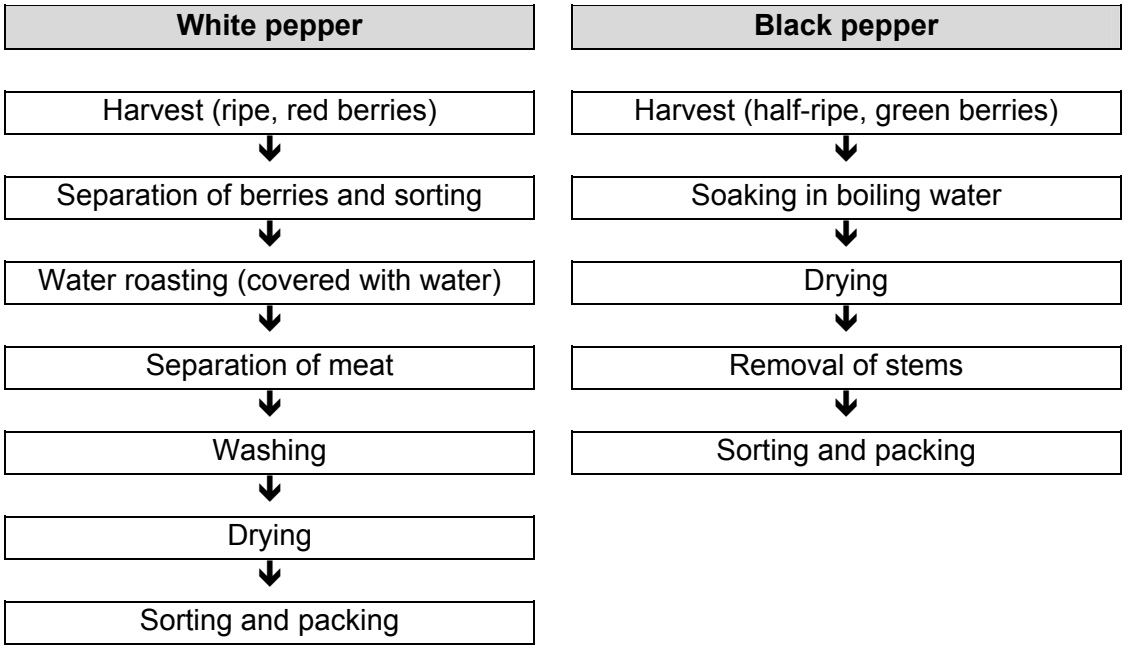
3. Product Specifications and Quality Standards

3.1. White and black pepper

3.1.1. Preparation

Black and white pepper are both traded as whole corns, or fine/coarsely ground.

The following is a systematic depiction of the steps necessary to manufacture white and black pepper, a more detailed description follows below:



3.1.2. Manufacturing white pepper

In order to manufacture white pepper, the berries are picked when fully ripened, when they take on a yellow-red colour. Firstly, the berries are separated from the ears and foreign particles, and then placed in sacks lying in cold, flowing water, in order to be 'water-roasted'. They need to stay there until the fruit meat can be removed from the seeds, which usually takes between a week and ten days. He sacks are removed from the water, and the meat separated by treading on them or rubbing them. Then, the corns are washed carefully again in water to remove residues of meat, dirt and slime. The remaining grey corns are then laid out on flat areas to dry in the sun for several days, until they have turned yellow-white. Before they are packed, the dried pepper corns are sorted through again to remove any damaged corns.

The sun-bleached white pepper corns are round, with a smooth surface, somewhat flattened at the poles, and are about 2-4 mm in diameter. The drying process

causes a loss of weight, meaning that only a yield of 28 % can be expected when processing fresh berries into white pepper.

3.1.3. Manufacturing black pepper

In order to manufacture black pepper, the berries are picked when half-ripened, when the lower berries on the panicle begin to turn red. Occasionally, the panicles are placed briefly in boiling water in order to cleanse them. The harvest is then spread out in the sun to dry, either still on the panicle or as separated berries. Before they are packed, the pepper corns might be de-stalked and have any foreign particles or damaged corns removed (stones, stems).
The drying process leaves the corns looking shrivelled and dark brown, with a diameter of 3-6 mm. The process causes a loss of weight, meaning that only a yield of 32 % can be expected when processing fresh berries into black pepper.

3.1.4. Manufacturing green pepper

The fully-developed, green berries are removed from the rachis and immediately immersed in brine. In this way, the oxidation process, which causes the brown colouring, is prevented, and the berries become soft. The pepper's aroma substances remain entirely intact. The corns taste highly aromatic, yet not as spicy as black or white pepper. Because of their softer consistency, green pepper corns are easier to incorporate in meals, and can be eaten immediately without needing to be crushed.
White, Black and green pepper are not permitted to be treated with methyl bromide or ethylene oxide, nor irradiated with ionising rays.

3.2. Quality requirements

The following is a list of quality characteristics with minimum and maximum values for white and black pepper corns 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
Smell	aromatic not musty
Taste	Variety-specific, very spicy
Purity	Free of foreign matter, i.e. sand, stones, plant parts, insects etc.
Water content	max. 10-12 %
Essential oil (whole white pepper)	min. 1.0 %
Essential oil (whole black pepper)	min. 1.2 %
Piperine (whole white and Black pepper)	min. 3.5 %
Ash (whole black pepper)	max. 7.0 %
Ash (whole white pepper)	max. 3.0 %
Ash soluble in hydrochloric acid (white pepper)	max. 1.0 %
Ash soluble in hydrochloric acid (black pepper)	max. 2,0 %
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
Micro-organisms	
Mould fungi	max. 100,000/g
Escherichia coli	max. 10,000/g
Bacillus cereus	max. 10,000/g
Sulphite-reducing clostridium	max. 10,000/g
Staphylococcus aureus	max. 100/g
Salmonella	Not measurable in 20 g

In order that the quality requirements are upheld, and no contamination of the pepper corns 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 garments.
- Water used for cleansing purposes must be free from faeces and other contaminants.
- Animals or animal faeces must not come into contact with the product.

3.2.1. Packaging and storage

Bulk packaging

Pepper corns intended for export to Europe are usually packed in bulk in shrink-packaging made out of steam-impermeable, saleable foils (e.g. polyethylene, polypropylene). Before the bags sealed, nitrogen can be added as an inert gas

Information printed on transport packaging

If the pepper is packed into consumer units, the packaging must display details of the following:

- Product name ('trade name)

  Name of the product e.g.: white pepper from organic cultivation[2]

- Manufacturer

  Name and address of the manufacturer, importer, exporter or trader, and country of origin

- Weight

  Details of the total weight in grams. The numbers describing the weight of the contents must be of the following size:

Weight of contents	Letter size
Less than 50 g	2 mm
More than 50 g to 200 g	3 mm
More than 200 g to 1000 g	4 mm
More than 1000 g	6 mm

- Best before date

  The 'Best before' details must include day, month and year; e.g. best before 30.11.2001

- Batch number

Consumer packages

If the pepper corns are not to be packaged in bulk containers in the country of origin, but sealed in consumer packages, then this packaging should fulfil the following functions:

- Protect the pepper corns from loss of aroma and against undesirable smells and tastes from its surroundings (aroma protection).
- Protect the contents against damaging.
- Offer sufficient conservation properties, especially against loss or gain of moisture.
- Provide a surface area for advertising and product information.
- Be easy to open and re-seal, so that the remaining pepper remains fresh.

The following materials can be used as **product packaging**:

- Glass jars with screwable lid

[2] When products from organic plantations 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 for organic agriculture (EEC) 2092/91 are applicable to organic products being imported into Europe.

- Specially-covered paper bags
- Single-layer plastic bags (polyethylene or polypropylene)

Transport packaging

Some form of transport packaging is required in order to ship the bulk or product packed for consumers. In choosing a type of packaging, the following should be heeded:

Transport packaging made, for example, out of cardboard, should be strong enough to protect the contents against being damaged by outside pressure.

- The packaging should be dimensioned to allow the contents to be held firmly, but not too tightly in place.
- The dimensions should be compatible with standard pallet and container dimensions.

Information printed on transport packaging

The transport packaging 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[3]

Storage

Packaged pepper should be stored in a dark place at temperatures up to 15-20°C (optimum: 5°C) and a maximum relative humidity of 60°C. At higher relative humidity, mould and aflatoxins may grow. Under optimum storage conditions, pepper can be stored for between 12 and 18 months.

If the organic product is being stored in a single warehouse together with conventional pepper 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] Organic products must be protected from contamination by non-compliant substances at each stage in the process, i.e. processing, packaging, shipping. Therefore, products originating from a certified organic farm must be recognisably declared as such.