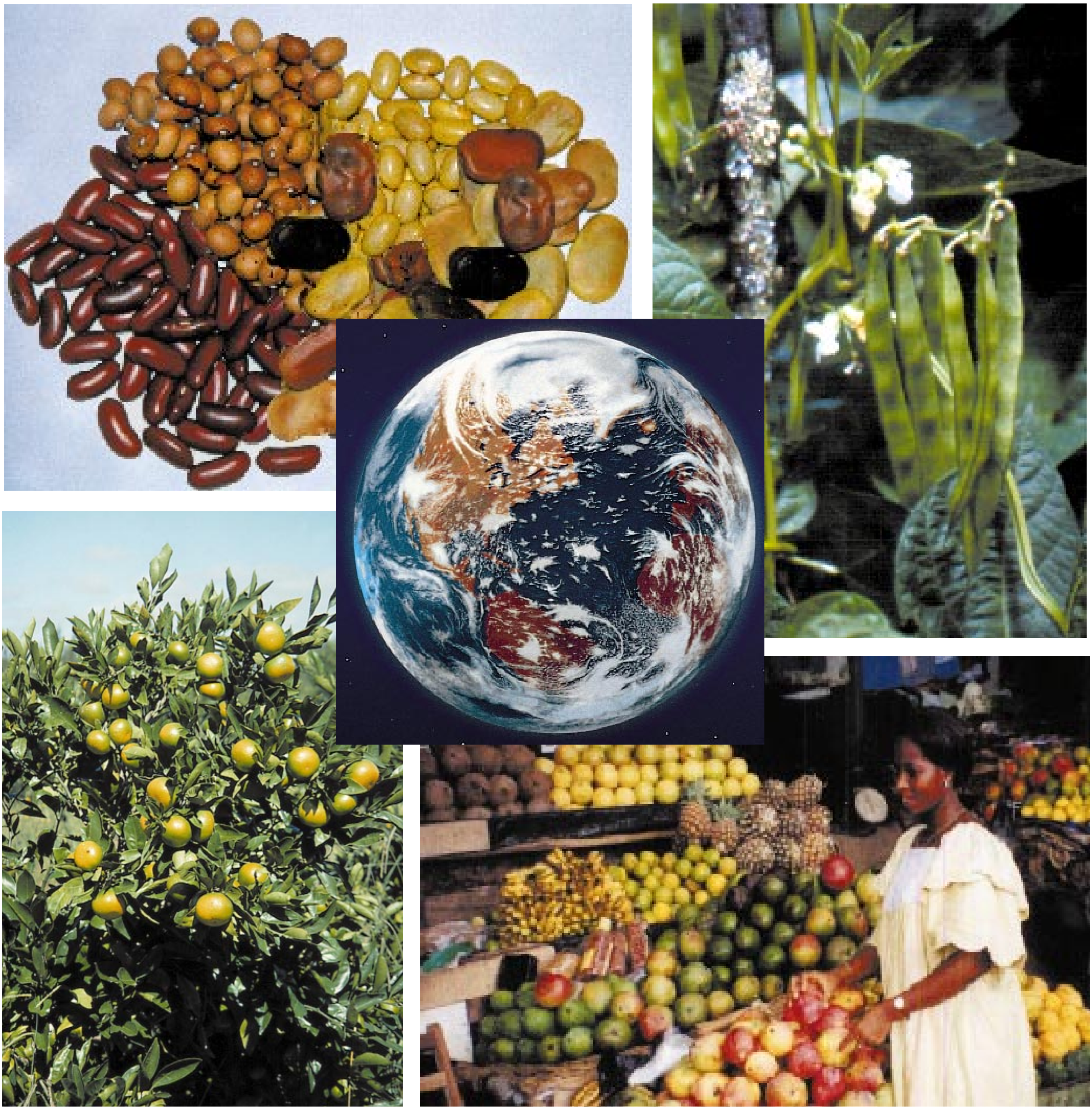
UNCTAD/DITC/COM/2003/2

# Organic Fruit and Vegetables from the Tropics

## *Market, Certification and Production Information for Producers and International Trading Companies*



United Nations

United Nations Conference on Trade & Development

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## Market, Certification and Production Information for Producers and International Trading Companies

United Nations
New York and Geneva, 2003

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# Foreword by Rubens Ricupero, Secretary-General of UNCTAD

Food safety and quality issues are receiving a great deal of attention today. Never has the safety of the food supply come under such scrutiny. Consumers are becoming better educated and more demanding about food-related issues, and regulators are increasingly active in safeguarding food products.

At the same time, confidence in food quality has been shaken in recent years by such incidents as the discovery of salmonella in poultry and eggs and the probable link between bovine spongiform encephalopathy (BSE) in cattle and new variant Creutzfeldt Jacob Disease (CJD) in humans. Consumers have become somewhat distrustful of their Governments' ability to assure food safety and are demanding more transparency and traceability in the food chain. There is every indication that these requirements will increase in the future, especially in relation to food containing genetically modified organisms (GMOs).

Primary producers, processors, retailers and catering establishments now recognize the need for independent monitoring of their products, procedures and services. Implementation of food quality and safety programmes is seen as one way to strengthen the ability of companies to protect and enhance brands and private labels, promote consumer confidence and conform to regulatory and market requirements. Food safety and quality standards are seen as a key element in international trade in food products. Calls from such institutions as the WTO for food processing companies to establish quality control systems have acquired a new urgency.

Organic markets are growing at the rate of 20% a year. The United States and Europe are leading the way. It is estimated that the United States accounts for US$ 6.6 billion, the UK for US$ 2 billion and Japan US$ 3 billion. Some 21% of all milk in Denmark; 10% of all farms in Austria, 0.5% of all food sales in France are organic. This sudden interest of consumers in organic products has led to significant gaps between domestic supply and demand in many developed countries. Thus, in the United Kingdom, demand for organic products is currently increasing by 40% annually, whereas supply is expanding by only 25%[1]. Moreover, 80% of organic fruits and vegetables sold in the United Kingdom are imported. This might give developing-country producers of organic products an opportunity to expand their market shares in developed countries. That prospect could be further enhanced by the fact that in many developing countries, traditional agriculture uses few or no agrochemical inputs. In India, for example, 70% of the arable land is mainly rain-fed and fertilizers have not been used. Similarly, about 10% of the cultivated land in Brazil is farmed by using "alternative" agriculture methods. Developing countries may thus have a relative comparative advantage in the world market for organic fruits and vegetables.

Price premiums for organic products can play a key role in developing countries. In Brazil, for instance, the production cost for organic oranges is nearly 50% higher than for conventionally produced oranges. However, these higher costs do not prevent producers and middlemen from realizing higher profits, based on price premiums of organic products at the retail level. The share of producer prices in retail prices of organic products rarely exceeds 10-20%. Theoretically, then, even significantly higher producer costs can be compensated by moderate premiums at retail level, provided importers, wholesalers and retailers do not appropriate all or most of the extra income.

Francophone and anglophone regional workshops have been organized in Africa through UNCTAD's project on Capacity –building for Diversification and Commodity–based Development. They have aimed at assisting developing countries' efforts toward horizontal, vertical and geographical diversification of production and trade structures. Agriculture, particularly the horticultural sector, has been the main focus of this project.

Workshop participants paid close attention to options for enhancing production and trading opportunities for organic agriculture. Workshop recommendations emphasized the importance of well-defined policies, including institutional support and export promotion, to strengthen the capacities of developing countries to take advantage of production and trading opportunities for organic products. Governments were invited to implement supportive policies and play a proactive role in promoting development of the organic sector. Participants also expressed concern that the plethora of standards and regulations at the national, regional and international levels creates difficulties for exporters, particularly those from developing countries. The need for readily accessible reference material on production and market opportunities was repeatedly voiced.

Producers and exporters in developing countries expect to increase organic exports, to seek new markets and, more generally, to acquire greater competitiveness. This publication on *Organic fruit and vegetables from the tropics: market, certification and production information for producers and international trading companies* attempts to respond to these concerns by identifying ways and means of enhancing the production and export capacities of developing countries in organic agriculture. We hope our readers find it useful and welcome their comments.

Rubens Ricupero

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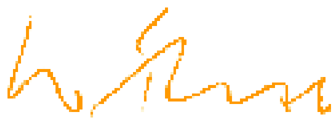
1 See Press release issued by BIOFACH Trade Fair, Nüremberg, Germany, February 2001.

# Foreword by Walter Fust, Director General of Swiss Agency for Development and Cooperation (SDC)

This book on "Organic Fruit and Vegetable Production in the Tropics, and International Trade" fills a gap: on the one hand, organic production methods are not yet very well established in the tropics, on the other hand, the largest share of the emerging markets for organic products have gone to the farmers in the North. If this book can enhance the knowledge on both these lines, it may contribute to better incomes and a fairer share of trade for developing countries, and especially for West Africa.

It was often argued that – in order to avoid risks – small farmers should focus on traditional products such as millet for home consumption and for local markets. Such a risk avoiding strategy is certainly recommendable, but if small farmers in tropical countries produce only low value crops, their incomes will remain low and so will poverty continue to persist. The new markets for high value crops and especially high quality organic food remain to be conquered and may be the only growth factor for rural areas, especially if commodity prices (cotton, sugar, coffee, cocoa) remain at the present levels of all time lows. The same is true with many staple crops such as rice, maize where imports of (often still highly subsidized) products are shipped at lower costs to the urban agglomerations than what local production and transportation over bumpy roads can compete with. In this sense, the market for organic products from the tropics is a new opportunity which small farmers should not miss out, despite the higher risks associated with this.

It is SDC's concern that export crops do not only favor large plantations but many small farmers in even remote rural areas. This requires the special attention of policy makers, of extension services, of NGOs and of a responsible private sector: although small farmers can only participate in the World markets if they provide quality, quantity at the right time and the right price, small farmers should not become the object of speculation and short term trade interests. This book does not provide any insurance against such risks, but it provides a good knowledge base on the level of production, of markets and of regulations and specifications to all the stakeholders who will make use of this book. We hope that this book will contribute to generate new and sustainable incomes for many small farmers and also a good business for all the links in the supply chain towards the emerging markets.



Walter Fust

# Foreword by Markus Stern, Director of Swiss Import Promotion Programme (SIPPO)

The major organic markets are expected to grow with growth rates between 10 to 30% or even more in the next 5 to 10 years. In all major organic markets, the fruit and vegetable product group plays an important role. In Europe and the USA, production of organic products has increased tremendously within the last 20 years. Today almost every product can be purchased in organic quality. However, the choice of exotic products is rather limited today and demand exceeds supply. Accordingly, organically grown fruits and vegetables from subtropical and tropical areas are facing good marketing perspectives. At export level, organic price premiums of about 10 to 50% are reported.

In the field of production in general, the primary sector continues to play a significant role (mining, fishing, coffee, petroleum, etc.). The degree of industrialization is fairly low as is, therefore, the export of products processed with higher levels of added value within the country. However, raw-material prices are subject to price fluctuations to a substantially greater degree than semi-finished, finished products or outstanding products with a special certificate – an organic certificate. The inflow of resources and foreign exchange earnings from foreign trade/exports are of major importance for an emerging market or market in transition. Both trade promotion measures as well as a lasting increase in their involvement in trade support the competitiveness of these countries in their active integration into global trading. Access for their export products to industrial markets is therefore of decisive importance. SIPPO (Swiss Import Promotion Programme – a Swiss funded programme in favour of emerging markets and markets in transition) therefore believes that the market for exotic organic fruits and vegetables is a great opportunity for many emerging markets and markets in transition and can contribute to meaningful socio-economic and ecologically sustainable development.

With this guide, the publishers aim to help emerging markets exploit this opportunity to the full. The aim of this guide is to provide producers and trading companies from emerging markets with:

- Information on market potential and conditions for access to European, American and Japanese markets for organic products.
- Details of production and processing requirements as well as best management practices in a selection of organic tropical fruits and vegetables.
- A list of useful addresses and contacts in selected European, American and Japanese countries.

The international market for organic food in general is booming, worth a total of approximately 20 billion US$ (2000); Europe leads with sales of about USD 9 billion followed by the USA with around USD 8 billion and Japan with USD 1.5 billion.

Markus Stern

# PART A

# Production and Basic Principles of Organic Agriculture

# 1

# General Aspects of Organic Farming in the Tropics and Subtropics

## 1.1. Philosophy and Principles of Organic Agriculture

### 1.1.1 Definition and Principles

**What is Organic Agriculture?**

For some people organic agriculture is "farming without chemical fertilizers and pesticides". This is short and concise, but misses important characteristics. Organic agriculture follows the logic of a living organism in which all elements (soil, plants, farm animals, insects, the farmer etc.) are closely linked with one other. Organic farming therefore must be based on a thorough understanding and clever management of these interactions and processes.

The US Department of Agriculture has framed the following definition: "Organic farming is a production system that avoids or largely excludes the use of synthetically compounded fertilizers, pesticides, growth regulators and livestock feed additives. To the maximum extent feasible, organic farming systems rely on crop rotations, crop residues, animal manures, legumes, green manures, off-farm organic wastes, and aspects of biological pest control to maintain soil productivity and tilt, to support plant nutrients and to control insects, weeds and other pests."

Organic Agriculture is often defined by standards that explain what the principles are and which methods and inputs are not permitted. Standards define a minimum common ground. However, they do not provide guidelines on what an ideal organic farming system should look like.

**Principles and Aims of Organic Agriculture**

In a process of several decades, the international organic community, organized in the IFOAM movement (International Federation of Organic Agriculture Movements), agreed on a common understanding of what the principles of organic agriculture are. IFOAM clearly formulated the minimum requirements in the "IFOAM Basic Standards". These standards are based on a number of principles that show that organic farming is much more than renouncing the use of agro-chemicals.

**A System Approach**

Conventional farming puts its focus on achieving maximum yields of a specific crop. It is based on a rather simple understanding: crop yields are increased by nutrient inputs and are reduced through pests, diseases and weeds – elements that must be combated. Organic agriculture is a holistic way of farming: besides production of goods of high quality, an important aim is the conservation of the natural resources fertile soil, clean water and rich biodiversity. The art of organic farming is to make the best use of ecological principles and processes. Organic farmers can learn a great deal from studying the interactions in natural ecosystems such as forests.

**Agroforestry Systems**

Trees and other plants take up nutrients from the soil and incorporate them in their biomass. The nutrients go back to the soil when leaves fall or plants die. Part of the biomass is eaten by various animals (including insects), and their excrements return the nutrients to the soil. In the soil, a huge number of soil organisms are involved in the decomposition of organic material which makes nutrients available to plant roots again. The dense root system of forest plants collects the released nutrients almost completely. Forests host a high diversity of plant varieties of different size, root systems and requirements. Animals are also part of the system. If one organism drops out, it is immediately replaced by another one that fills the gap. Thus "space" light, water and nutrients are used to the optimum. The result is a very stable system.

**Recycling Nutrients**

Organic nutrient management is based on biodegradable material, i.e. plant and animal residues. Nutrient cycles are closed with the help of composting, mulching, green manuring, crop rotation etc. Farm animals can play an important role in the nutrient cycle: their dung is of high value and its use enables nutrients provided with the fodder to be recycled. If carefully managed, losses of nutrients due to leaching, soil erosion and gasification can be reduced to the minimum. This reduces the dependency on external inputs and helps to save costs. However, nutrients exported from the farm with the sold produce need to be replaced.

### Soil Fertility

Soil and its fertility constitute the center of the natural ecosystem. A more or less permanent soil cover prevents soil erosion and helps build up soil fertility. The continuous supply of organic material feeds a huge number of soil organisms and provides an ideal environment for them. As a result the soil becomes soft and capable of taking up and storing large quantities of nutrients and water. Organic farmers give central importance to the improvement of soil fertility. They stimulate the activity of soil organisms with organic manures. Mulching and cover crops are used among other methods to prevent soil erosion.

### Crop Diversity

Organic farms grow several crops including, trees, either as mixed cropping or in rotation. Animals are an integrated part of the farm system. The diversity of crops not only allows optimum use of the resources but also serves as an economic security in case of pest or disease attack or low market prices for certain crops.

### Eco-balance and Bio-control

Pests and diseases do occur in natural ecosystems, but they rarely cause large-scale damage. Due to diversity, it is difficult for them to spread. Many pests are controlled by other organisms such as insects or birds, and plants usually can recover from an infestation on their own. Organic farmers try to keep pests and diseases at a level which does not cause economic damage. The main focus is on supporting the health and resistance of the crop. Beneficial insects are promoted by offering them a habitat and food. If pests reach critical levels, natural enemies and herbal preparations are used.

### Back to Nature?

Organic farming aims at following the laws of nature. Does this mean that organic farms must be as close to natural systems as possible? Within the organic movement one will find farmers who focus on natural farming, and others who take a purely commercial approach. The majority of organic farmers probably lies somewhere in between these two extremes. Most farmers will expect sufficient production from the farm to make a living. For them, the challenge is to follow the principles of nature to achieve a high productivity.

### Organic by Neglect?

In some areas, perennial plantations are farmed with low intensity by merely stopping any nutrient supply or pest management while continuing to harvest the produce. While maintenance costs are as such low, yields decrease after some time. Some of these neglected plantations achieved organic certification as they fulfill the minimum criteria of the standards. However, it is rather doubtful whether this approach offers a long-term perspective for farmers. As organic farming seeks to contribute to food security, organic by neglect is not the right strategy.

### Sustainability Aims

Organic agriculture claims to be sustainable. In the context of agriculture, sustainability refers to the successful management of resources of agriculture to satisfy human needs while at the same time maintaining or enhancing the quality of the environment and conserving natural resources. Sustainability in organic farming must therefore be seen in a holistic sense, which includes ecological, economical and social aspects. Only if the three dimensions are fulfilled, an agricultural system can be called sustainable.

### Ecological Sustainability

- recycling the nutrients instead of applying external inputs
- no chemical pollution of soil and water
- promote biological diversity

- improve soil fertility and build up humus
- prevent soil erosion and compaction
- animal friendly husbandry
- using renewable energies

### Social Sustainability

- sufficient production for subsistence and income
- a safe nutrition of the family with healthy food
- good working conditions for both men and women
- building on local knowledge and traditions

### Economic Sustainability

- satisfactory and reliable yields
- low costs on external inputs and investments
- crop diversification to improve income safely
- value addition through quality improvement and on-farm processing
- high efficiency to improve competitiveness

### Bio-dynamic Agriculture

Bio dynamic farming is a special type of organic agriculture. It fulfils all principles and standards of organic farming but goes a step beyond: bio-dynamic farming includes a spiritual dimension of agriculture. It is based on the concept of “anthroposophy” developed in the 1920’s by the Austrian philosopher Rudolf Steiner. He aimed at a new approach to science which integrates observation of natural phenomena and spiritual dimensions. In the words of Steiner: “Matter is never without spirit, and spirit never without Matter.”

### Some foundations of bio-dynamic farming are:

**Cosmic Rhythms:** The rhythms of the sun, moon, planets and stars influence the growth of plants. By timing the activities of tillage, sowing and harvesting, the farmer can use this influence to the crops´ advantage.

**Vitality:** Besides the physical and chemical characteristics, matter has a vital quality which influences organisms. Thus, bio-dynamic farmers and gardeners aim at quality, and not only quantity.

**Biodynamic Preparations:** Certain naturally occurring plant and animal materials are combined in specific preparations and applied in highly diluted form to compost piles, to the soil or directly to the plants. The forces within these preparations shall organize the elements within the plants and animals.

**The Farm Organism:** A farm is considered as a whole organism integrating plants, animals and humans. There should be just the right number of animals to provide manure for fertility, and these animals should be fed from the farm itself.

For product marketing services, bio-dynamic farmers are organized in a world wide certification system named “Demeter”. The "Demeter"-label is used to assure the consumer that the product has been produced by biodynamic methods.

## 1.1.2 Distinction From Other Farming Systems

### Is Traditional Farming Organic?

Agro-chemicals have been used on a large scale only since the 1960’s. Therefore, farming communities which have not been influenced by the so-called “Green Revolution” automatically meet the most important criteria of organic agriculture, i.e. the non-use of any chemical fertilizers, pesticides and genetically modified organisms. These agricultural systems are referred to as “Traditional Farming”.

In many countries, the population density increased tremendously and many traditional farming systems have been unable to meet the yield expectations of the farmers. Due to reduced fallow periods, overgrazing or exploitative cultivation, many traditionally farmed areas face severe degradation. At the same time, higher yielding crop varieties have been introduced which are more prone to diseases. Organic farming tries to meet the increased needs of the growing population while not risking the long-term productivity of the farmland.

Many methods and techniques of organic agriculture have originated from various traditional farming systems all over the world. However, not all traditional systems make use of these methods, sometimes for the simple reason that they are not known in a specific region. In addition, organic farming disposes of a range of rather modern technologies such as the design of intensive orchards, use of antagonistic microbes in pest management, high yielding but disease resistant varieties or the use of highly efficient green manure plants.

Whether a certain traditional farming system can be called organic will depend on whether all the organic standards are fulfilled. For instance, some traditional systems are in conflict with the requirements of organic animal husbandry (e.g. sufficient space and free movement), the necessary prevention of soil erosion, the ban on cutting forests and burning biomass (e.g. slash and burn systems).

### "Sustainable" Agriculture

As the negative environmental impact of green revolution in agriculture became more and more obvious, sustainability in agriculture became a widely accepted objective. Sustainable kinds of agriculture claim to be environmentally sound, resource-conserving, economically viable, socially supportive and commercially competitive. As far as goals are concerned, sustainable agriculture therefore has much in common with organic agriculture.

However, there is no general agreement to what extent sustainability must be achieved and which methods and inputs can be accepted. Therefore, systems which do use chemical fertilizers, pesticides or genetically modified organisms are classified as sustainable. Integrated Production (IP) or Integrated Pest Management (IPM), for example, only avoids certain highly toxic pesticides and reduces the application of others to a certain extent.

Systems such as Low External Input (Sustainable) Agriculture (LEIA or LEISA) or eco-farming partially renounce the use of agrochemicals. They seek to optimize the use of locally available resources by interlinking the components of the farm system so that they complement each other and have the greatest possible synergistic effect. External inputs shall only be used to provide elements that are deficient in the ecosystem and to enhance available biological, physical and human resources.

It is not always possible to draw a clear line between different systems. There are sustainable agriculture systems that are also organic, and there are even organic farms which are not really sustainable, though they fulfill the minimum requirements of the standards.

### Integrated Production (IP)

Integrated Production (IP) has gained importance over the last few years, especially in economies of transition and in industrialized countries. It does not refrain from using agro-chemicals, but aims at a reduction of its application. For plant protection, a combination of bio-control methods and chemical pesticides is used (Integrated Pest Management). If damage by pest or disease reaches defined threshold levels, chemical pesticides are applied. For plant nutrition, chemical fertilizers can be used, but usually maximum amounts are defined. Herbicides also are used.

The regulations on IP are not always very clear and vary from country to country, if formulated at all. A few countries have developed labels and a control system for integrated production. In some countries integrated systems are called "green production". Above all, integrated production follows the same approach as conventional agriculture, and is far from the holistic understanding of organic agriculture. However, it can contribute to a healthier environment as it is easier for a large number of farmers to follow.

### 1.1.3 Why Organic Agriculture?

After the initial success of the "Green Revolution" it became evident that this kind of farming has many unwanted side effects, both on natural resources (soil, water, bio-diversity) and on human health:

- **Soil:** Vast areas of once fertile lands were degraded due to soil erosion, salinization or a general loss of soil fertility.
- **Water:** Freshwater resources have been polluted or overexploited through intense use of agro-chemicals and excessive irrigation.
- **Bio-diversity:** Many wild and cultivated plant and animal species were wiped out and landscapes became dull.
- **Human Health:** Residues of harmful pesticides in food or drinking water endanger both farmer's and consumer's health. Further health risks from antibiotics in meat, BSE infection (mad cow disease) and genetically modified organisms (GMO).
- In addition, this kind of agriculture is based on an excessive use of external inputs and consumes a lot of energy from non-renewable resources.

It must be acknowledged that with the help of the Green Revolution technologies crop yields increased tremendously, especially in the temperate zones. Several Southern countries also experienced the Green Revolution as a success story. However, the success of the Green Revolution in the South was unevenly spread: while technology brought considerable yield increase in fertile river plains or irrigated land, it rather failed on marginal soils, which constitute the major part of the land in the tropics. As the fertile lands usually belong to the wealthier farmers, marginal farmers did not benefit greatly from the new technologies.

One reason for its failure on marginal lands is the low efficiency of fertilizer application on tropical soils: Unlike soils in temperate regions, many tropical soils do not retain chemical fertilizers well. The nutrients are easily washed out from the soil or evaporate as gas. The major part of the applied fertilizers may subsequently be lost.

In countries where labor is comparatively cheap but inputs are expensive, expenses for agro-chemicals can make up a large proportion of the production costs. Frequently, these inputs are purchased on loans which are to be paid back when the harvest is sold. If yields are lower than expected (e.g. because soil fertility decreased) or crops entirely fail (e.g. due to attack of an uncontrollable pest or disease), farmers still have to cover the costs of the agro-chemicals they used. Thus, indebtedness is a widespread problem among farmers in the South. As prices for agricultural products tend to decrease continuously while prices for inputs increase (e.g. due to reduced subsidies), it is becoming difficult for many farmers to earn sufficient income with conventional agriculture.

**Benefits of Organic Agriculture**

- soil conservation and maintenance of soil fertility
- less pollution of water (groundwater, rivers, lakes)
- protection of wildlife (birds, frogs, insects etc.)
- higher biodiversity, more diverse landscape
- better treatment of farm animals
- less utilization of non-renewable external inputs and energy
- less pesticide residues in food
- no hormones and antibiotics in animal products
- better product quality (taste, storage properties).

## 1.1.4 Development of Organic Agriculture

Alternative ways of farming were already developed before the invention of synthetic agro-chemicals. Some innovative pioneers tried to improve traditional farming systems with methods characteristic of organic farming. These were new approaches at the time, and focused on soil fertility based on humus that aim at an ecological balance within the farm. When the use of agro-chemicals combined with the introduction of high yielding varieties and intense mechanization became widespread, a few people opposed this new development and set out on organic farming practices like composting, improved crop rotations or green manuring. As the negative impact of the Green Revolution on health and environment became more evident in the 1970's and 80's, the awareness of "organic" issues slowly increased both among farmers and consumers. Related farming systems like "Permaculture" or "Low External Input Agriculture (LEIA)" were developed.

Only in the 90's did organic farming experience a strong rise. A number of environmental disasters and food scandals supported a growing consumer awareness and an increasingly supportive policy in some countries. At the same time, a range of innovative organic technologies were developed. Still, organic agriculture constitutes only a slight percentage of a country's farming sector. Governmental support for research, extension or marketing in organic farming is still very low in most countries. Nevertheless, organic farming at present has promising growth rates all over the world.

### Organic Farming Worldwide

Organic Agriculture is currently practiced in more than 120 countries. It is estimated that worldwide about 17 million hectares are managed organically. A large part of this area consists of extensive pastures managed by a few farmers. The share of land area under organic management per country is highest in some European countries, where it takes a considerable share of the total agricultural land. The success of organic agriculture in these countries is mainly due to the increased consumer awareness of health and environmental issues, the mainstreaming of the marketing (e.g. supermarkets) and increasingly favorabe national policies.

In most countries in the South, official data relating to land under certified organic management is scarce, and one may assume that organic farming is still very much a minority activity. However, there are some traditionally farmed areas where few or no agro-chemicals are used. Some of them could be easily brought to full compliance with organic standards' requirements.

Organic trade is growing rapidly. According to estimates by the International Trade Center UNCTAD/WTO (ITC) the world retail market for organic food and beverages reached an estimated US dollars 21 billion in 2001. ITC estimates that annual sales growth rates will range from five to twenty percent over the medium term, depending on the market. Organic food sales could jump from one percent up to ten percent of total retail food sales in major markets during the next few years.

Though export markets are difficult to access, there are good market opportunities for developing countries for exporting organic products that are not produced in Europe or North America, such as coffee, tea, cocoa, spices, tropical fruits, certain vegetables and citrus fruits. The biggest markets for organic products world-wide are in the USA, Europe and Japan. Dependency on export markets constitutes a high risk to Southern countries as world market prices for organic products can fluctuate too. Therefore, it is important for national organic movements to also develop a domestic market for organic products. As in many tropical countries food security is not assured many small holders depend on their own food production, as such, focusing on export markets is perhaps even dangerous.

## 1.2 Soil Management and Soil Nutrition

### 1.2.1 The Soil – A Living Organism

Soil is the most important production factor for crops and at the same time is also the most influenced by the farmer. Soils are very diverse and complex systems full of life. The soil itself can be viewed as a living organism, because it is a habitat for plants, animals and micro-organisms that are all interlinked.

Soil fertility is an important element of organic agriculture.

#### The Composition and Structure of Soils

Soil consists in mineral particles, organic matter and pores. Mineral particles originate from subsoil and rock, which gets crushed to smaller and smaller pieces (sand, silt and clay) through physical and chemical weathering processes. Mineral particles contain nutrients that are slowly released in the process of weathering. Plant roots and some micro-organisms can actively dissolve nutrients from mineral salts and use them for their growth.

In addition to mineral salts, soil contains organic matter, resulting from the decomposition of biomass. In most agricultural soils of the tropics this decomposition represents only a small percentage, perhaps less than one percent of the total solid material of the soil. It is however of tremendous importance for the soil fertility. Organic matter is mainly present in the top layer of the soil, which is subject to continuous transformation processes. Soil organic matter can be further decomposed by soil organisms. The resulting structures can recombine to form very stable humus structures, which can remain in the soil for many years and contribute significantly to the improvement the soil structure.

#### Why Organic Matter Is so Important?

- Soil organic matter helps to build up a loose and soft soil structure with a lot of pores. This leads to better aeration, better infiltration of water and an easier penetration of roots.
- The visible parts of organic matter act like tiny sponges which can hold water up to five times their own weight. Therefore, in dry periods more water is available for the plants for a longer time. This is especially important in sandy soils.
- The non-visible parts of organic matter act like a glue, sticking soil particles together, thus forming stable crumbs. Such aggregates improve the soil structure, especially in clay and sandy soils.
- Beneficial micro-organisms and other soil organisms such as earthworms also feed on organic material, thus decomposing it. As these organisms require sufficient humidity and aeration, soil organic matter provides a suitable environment for them.
- Organic matter has a great capacity to retain nutrients and release them continuously (nutrient exchange capacity CEC). It thereby increases the capacity of the soil to supply the plants with nutrients and reduces nutrient losses by leaching. This is especially important in ferralitic and sandy soils as they naturally retain very few nutrients.
- Organic matter also prevents soils from becoming too acidic.

### Soil Structure

Besides mineral particles and soil organic matter, soils also consist of minute pores filled with air or water. The spatial arrangement of particles and pores is summarized as "soil structure". Small pores are good in preserving moisture while the larger ones allow a fast infiltration of rain or irrigation water, but also help to drain the soil and ensure aeration. In soils of good structure, mineral particles and soil organic matter form stable aggregates. Organic matter works as a kind of glue, sticking together soil particles. This process is supported by soil organisms such as earth worms, bacteria and fungus. Thus, the soil structure can be improved by supplying organic matter to the soil. But it can also be ruined by improper management e.g. tilling the soil in wet conditions causes compaction.

### Soil Testing

Chemical soil testing may yield valuable information to specific questions. However, there are some inherent problems related to analyzing nutrient contents: For the plant, the total content of a certain nutrient in a sample is not always relevant, as the nutrient may be absorbed so strongly that it is not available to the plant roots (e.g. Phosphorus). Therefore, some tests treat the sample with solvents in order to simulate the fraction of the nutrient available to plants. This might be a realistic simulation for conventional farming. In organically managed soils, however, the higher activity of soil organisms can result in a better availability of the nutrient, thus the result of the test is not fully appropriate. The content of other nutrients, such as nitrogen, fluctuates considerably within a few days, so that it highly depends on the point of time when the sample is taken.

Still, chemical soil analysis can be useful in some cases, e.g. to analyze the level of acidity of the soil (pH) or to detect deficiency of nutrients such as Potassium (K) or micronutrients. Organic farmers might be especially interested in knowing and monitoring the content of soil organic matter.

Physical testing, e.g. related to water retention capacity or soil structure can yield interesting information, but samples must be taken very carefully. Biological analysis, e.g. of the activity of soil organisms, must be done in specially equipped laboratories and is rather costly. Chemical soil analysis on pesticide residues is highly complicated as one must know which pesticide to look for, and analysis are very costly. If soil tests are used, make sure that the relevant aspects are investigated and that the results of the tests are critically discussed.

### The Soil-Microcosm

A teaspoon of active soil is the habitat of millions of soil organisms! Some are of animal origin, some are of plant origin. The organisms vary greatly in size. Some are visible to the naked eye, such as earthworms, mites, spring-tails or termites. Most of them, however, are so small that they can only be seen with a microscope, thus they are called micro-organisms. The most important micro-organisms are bacteria, fungus and protozoa. Micro-organisms are the key elements to the quality and fertility of soils, but for humans, they do their work invisibly. The greater the variety of species and the higher their number, the greater the natural fertility of the soil.

**Table 1:**
**Different Types of Organisms Living in the Soil**

| Some larger soil organisms | Some soil micro-organisms |
|---|---|
| Earthworms | Bacteria |
| Spiders | Algae |
| Slugs and snails | Fungus |
| Beatles | Protozoa |
| Spring tails | Actinomycetes |
| Mites | |
| Millipedes | |
| Slaters | |

Soil organisms are important because they:

- help to decompose organic material and build up humus
- mingle organic matter with soil particles and thus help to build stable crumbs
- dig tunnels, which encourages deep rooting of plants and good aeration of the soil
- help to release nutrients from mineral particles
- control pest and disease organisms affecting the roots of crops.

As the plant roots and the soil organisms consume air, good air circulation within the soil is crucial for their development. Soil organism activity is generally low when soils are dry, very wet or too hot. Activity is highest in warm, moist soils when food (i.e. biomass) is available.

Earthworms accelerate the decomposition of biomass by removing dead plant material from the soil surface. During the digestion of organic material, they mix organic and mineral soil particles and build stable crumbs, which help improve the soil structure. Their excrements contain 5x more nitrogen, 7x more phosphate, 11x more potash and 2x more magnesia and calcium than normal earth. Last but not the least, their tunnels promote infiltration and drainage of rainwater and thus prevent soil erosion and water logging. Earthworms need sufficient supply of biomass, moderate temperature and sufficient humidity. That's why they are very fond of mulching. Frequent tillage decreases the number of earthworms in the soil, as does the use of pesticides.

### Mycorrhiza – A Beneficial Fungus

Important representatives of the soil fungi are the "mycorrhizae" that live in association (symbiosis) with plant roots. Both the plant and the fungus profit from the association: the plant gets nutrients collected by the fungus and the fungus receives assimilates ("food") from the plant in exchange. Mycorrhizae are present in all types of soils, but not all crops are symbiotic with the fungus. Mycorrhizae have several functions that are of great interest to the farmer:

- They enlarge the rooting zone of plants and can enter into small soil pores.
- They dissolve nutrients such as phosphorus from mineral particles and carry them to the plant.
- They make soil aggregates more stable thus improving the soil structure.
- They preserve moisture and improve the water supply to the plants.

Mycorrhiza formation depends on the soil conditions, the crops that are grown and the management practices:

- Soil tillage and burning of biomass drastically harm the mycorrhizae.
- High nutrient levels (especially phosphorus) and chemical pesticides suppress symbiosis.
- Mixed cropping, crop rotation and the cultivation of perennial plants encourage mycorrhiza.
- Practice mulching to stabilize soil temperature and moisture.

Among the naturally occurring species of mycorrhizae, not all show the same efficiency to derive phosphorus from the soil. That is why artificial inoculation of specific mycorrhiza varieties can improve their use. Inoculation, however, does not reduce the importance of offering appropriate living conditions for these organisms.

### How to Improve and Maintain Soil Fertility?

Farmers can improve the fertility of their soil by various management practices:

- Protection of the soil from strong sunlight and heavy rain by means of plant cover or mulch in order to prevent soil erosion and to preserve moisture.
- A balanced crop rotation or mixed cropping: a suitable sequence of annual crops grown on a field for preventing a depletion of the soil.
- An appropriate tillage method for obtaining a good soil structure without causing erosion and compaction.

- A good nutrient management: application of manures and fertilizers according to the demands of the crops in their respective growth stages.
- Feeding and protection of soil organisms: enhancing the activity of beneficial soil microbes and organisms like earth worms by supplying organic material.
- To stabilize the structure, it is important to protect the soil surface with mulch or plant cover and to apply organic material (ideally compost).

### How to Produce More Biomass on the Farm?

- Integrate green fallow periods with green manures in the crop rotation.
- Applying compost and animal manures.
- Aim at having the soil covered with plants the whole year round.
- Integrate fodder cultivation in the farm (grass, fodder hedges).
- Use unproductive space (e.g. along paths, field borders, steep slopes) for planting trees or hedge rows.
- Use unproductive fields and unproductive time in a rotation (in between two crops) for planting vigorous nitrogen fixing crops (such as Canavalia spp. and Cayanus cayan).
- Establish agroforestry systems where appropriate.
- Leave single trees standing in the field (e.g. nitrogen fixing trees), manage them with intense pruning.
- Let cattle graze or spend some nights on harvested fields (it can also be the neighbor's cattle) in order to profit from their droppings.

## 1.2.2 Soil Cultivation and Tillage

Careful soil cultivation can improve the soil's capacity to retain water, its aeration, capacity of infiltration, warming up, evaporation etc. But soil cultivation can also harm the soil fertility as it accelerates erosion and the decomposition of humus. Depending on the cropping system and the soil type, appropriate soil cultivation patterns must be developed.

Aims of Soil Cultivation:

- Loosen the soil to facilitate the penetration of plant roots.
- Improve the aeration (nitrogen and oxygen from the air).
- Increase infiltration of water.
- Reduce evaporation.
- Encourage the activity of the soil organisms.
- Destroy or control weeds and soil pests.
- Incorporate crop residues and manures into the soil.
- Prepare the site for seeds and seedlings.
- Repair soil compaction caused by previous activities.

### Minimum and Zero-tillage

In tropical soils, regular tillage accelerates the decomposition of organic matter which can lead to nutrient losses. The mixing of soil layers can severely harm certain soil organisms. Soil after tillage is very prone to soil erosion if left uncovered before the onset of heavy rains. Zero-tillage systems help to build up a natural soil structure with a crumbly top soil rich in organic matter and full of soil organisms. Nutrient losses are reduced to a minimum. Soil erosion won't be a problem as long as there is a permanent plant cover or sufficient input of organic material. Last but not least, farmers can save a lot of labor. However, zero-tillage is a challenge for organic producers: tillage is – especially in annual crops – one important tool for weed management and therefore widely practiced in organic agriculture. To minimize the negative impact of soil cultivation while benefiting from its advantages, the organic farmer should aim at reducing the number of interventions to the minimum and choose methods that conserve the natural qualities of the soil.

### Types of Soil Cultivation

Depending on the aim of the soil cultivation, different cultivation practices are implemented during different stages of the cropping cycle:

- **Post-harvest:** In order to accelerate decomposition, the residues of the previous crop are incorporated into the soil (15 to 20 cm) before preparing the seedbed for the next crop.

- **Primary Tillage:** In annual crops or new plantations, primary tillage is usually done with a plough or a similar instrument. In principle, soil cultivation should achieve a flat turning of the top soil and a loosening of the medium deep soil.
- **Seedbed Preparation:** Before sowing or planting, secondary soil cultivation is done to crush and smoothen the ploughed surface. If weed pressure is high, seedbeds can be prepared early thus allowing weed seeds to germinate before the crop is sown.
- **In-between the Crop:** Once the crop is established, shallow soil cultivation is applied to suppress weeds, enhances the aeration of the soil, to reduce the evaporation of soil moisture from the deeper soil layers and to stimulate the decomposition of organic matter thus making nutrients available.

Tools should be chosen considering the soil cultivation purpose, the soil type, the crop and the available power source:

- primary cultivation: pole plough, mouldboard plough, digging fork, spade
- secondary cultivation: cultivators, harrows, rakes
- inter-row cultivation: inter-row cultivators, hoes
- land forming: ridgers, hoes.

### Soil Compaction

If soils are cultivated in wet conditions or burdened with heavy machinery, there is a risk of soil compaction which results in suppressed root growth, reduced aeration and water logging. Where soil compaction is a potential problem, farmers should be aware of the following aspects:

- The risk of compaction is highest when the soil structure is disturbed in wet conditions.
- Do not drive vehicles on your land soon after rains.
- Plowing of wet soils can lead to a smearing of the plough sole.
- Soils rich in sand are less prone to soil compaction than soils rich in clay.
- High content of soil organic matter reduces the risk of soil compaction.
- It is very difficult to restore good soil structure once soil compaction has taken place.
- Deep tillage in dry conditions and the cultivation of deep rooted plants can help to repair soil compaction.

### Soil Erosion

Many tropical countries have distinctly dry and wet seasons. During the dry season, ground vegetation usually becomes scarce and thin, leaving the soil uncovered. As a result, when the rains arrives, large amounts of valuable topsoil can be washed away, leaving the land uneven with gullies and low fertility soil. Not only steep slopes but plain fields are also prone to soil erosion, and can be severely affected. Besides rain, excessive irrigation can also cause soil erosion.

Strategies for preventing soil erosion should ideally be combined:

1. Reducing the erosive power of the rain drops by keeping the soil covered (with vegetation or mulch). Cropping systems should be designed in such a way that the soil is almost permanently covered with plant canopy.
2. Improving the infiltration of the rain water into the soil. The way to improve the infiltration is improving the soil structure.
3. Reducing the speed of the water flowing down the slopes with the help of construction such as bunds, stone walls, living barriers, trenches, terraces.

## 1.2.3 Green Manures and Cover Crops

Green manures, cover crops and mulching are related to each other and the difference between them can not be clearly distinguished. With mulching and cover crops emphasis is on protecting the soil, the main aim of green manures is to provide nutrients to subsequent crops and to increase soil fertility through addition of organic matter. Cover crops have similar benefits as green manure, and in many cases the same crops and management methods are used. There is a way to distinguish cover crops from green manure:

- Cover crops are in most cases perennial and not incorporated into the soil. After cutting, plant-material is left on the soil surface or harvested as animal fodder or compost material.
- Green manures are mostly temporary. They are worked into the soil, where the fresh plant material releases nutrients quickly and will be fully decomposed within a short period of time.

Cover crops and green manures have a number of benefits:

- They penetrate the soil with their roots, make it more friable and to bind nutrients that would otherwise be washed away.
- They suppress weeds and protect the soil from erosion and direct sunlight.
- If leguminos plants are used, nitrogen is fixed from the air into the soil.
- Some green manures and cover crops can be used as fodder plants or even to provide food for human consumption (e.g. beans and peas).
- By decomposing, green manures and cover crops release all kinds of nutrients for the main crops to utilize, thus improving their yield.
- The incorporated plant material builds up organic matter in the soil and activates soil organisms. This improves soil structure and water holding capacity.

The following aspects must be considered before growing green manures and cover crops:

- Labor is required for tillage, sowing, cutting and incorporation of plants into the soil, and is most intensive where the amount of helpful equipment available is limited.
- If green manures and cover crops are intercropped with the main crops, they might compete for nutrients, water and light.
- When old or coarse plant material is incorporated into the soil, nitrogen may be temporarily immobilized and therefore unavailable for plant growth (nitrogen immobilization).
- If food and space are in short supply, it may be more appropriate to grow a food crop rather than a green manure and recycle the crop residues, or to intercrop a green manure crop with the main crop.
- The benefits of green manures and cover crops occur over the long term and are not always immediately visible.

### Nitrogen Fixing Plants

Air offers potentially endless amounts of nitrogen. Plants of the legume and mimosa family are capable of fixing nitrogen from the air with their roots to use as a nutrient. Legumes do this by living in association (symbiosis) with bacteria called rhizobium that are hosted in nodules growing on the roots. These bacteria take nitrogen from the air, transform it and make it available for the host plant. Bacteria take the necessary energy from the plant roots (sugars, the products of photosynthesis). The blue-green algae, e.g. “azolla” growing in rice fields, produce the energy through their own photosynthesis. The partnership between plant and rhizobia is usually very specific. For this reason, it may be necessary to introduce (inoculate) the bacteria the first time legume plants are grown in a field. The better the nutrient and water supply, soil qualities including soil acidity, temperature and light for the plant, the better the legume can supply the bacteria with energy and satisfy its own nitrogen needs.

Among nitrogen fixing plants the annual and the perennial species can be distinguished. In 'alley cropping', perennial shrubs are grown in rows between the main crop. The benefits of nitrogen fixing trees and shrubs are:

- The leaves and twigs of nitrogen fixing trees are rich in nitrogen and other plant nutrients and are a valuable free source of fertilizer. With their roots, they directly increase the nitrogen content of the soil and build up soil organic matter.
- Wood and timber: Some luxury timbers are provided by nitrogen fixing trees. Fast-growing nitrogen fixing trees also produce excellent fuel wood and charcoal.
- Fodder and food: The highly nutritious and digestible leaves of some nitrogen fixing trees make them

excellent feed for animals. Several species of nitrogen fixing trees produce food for humans (e.g. carob, drumstick and tamarind).

- Protection and support: Nitrogen fixing trees can be grown as living fences and hedges to protect crops from wildlife, domestic animals, and people. Trees with dense canopies can be grown as a windbreak or to protect organic farms from conventional neighbors. Nitrogen fixing trees may be grown to provide shade for cacao or coffee or to provide support for climbing crops such as yams, vanilla and black pepper.

Leguminose. The picture shows a plant with nodules

### Sowing the Green Manure and Cover Crops

- If grown within a crop rotation, the sowing time must be chosen to enable the green manure to be cut down and worked into the soil before the next crop is sown.
- Green manures and cover crops need water for germination and growth.
- The ideal seed density must be tested for each individual situation.
- In general, no additional fertilization is necessary. If legumes are grown in a field for the first time, inoculation of the seeds with the specific rhizobia may be necessary to profit from nitrogen fixation of the legume.
- If under-sown, the green manure is sown at the same time as the main crop. If it grows faster than the main crop and competition is too high, it can also be sown later when the crop has been established. Later sowing may be combined with a weeding passage.

### Working the Green Manure into the Soil

- **Timing:** The time gap between digging in the green manure and planting the next crop should not be longer than 2 to 3 weeks so as to prevent nutrient losses from the decomposing green manure.
- **Crushing:** Green manures are worked in most easily when the plants are still young and fresh. If the green manure plants are tall or contain bulky and hard plant parts, it is preferable to chop the plants into pieces to allow for easier decomposition. The older the plants, the longer decomposition will take. The best time to dig in green manure plants is just before flowering.
- **Depth of incorporation:** Green manures should not be ploughed deeply into the soil. Instead, they should only be worked in to the surface soil (in heavy soils only 5 to 15 cm deep, in light soils 10 to maximum 20 cm deep). In warm and humid climates the material can also be left on the soil surface as a mulch layer.

### How to Choose the Right Species?

There is a large variety of plants, especially legumes, that can be used as green manure crops. The following characteristics make an ideal green manure or cover crop:

- The seeds are cheap, easy to get, to harvest, to store and to propagate.
- Is adapted to the local growing conditions.
- Fits into the crop rotation or fits with the main crop (e.g. fruit trees, coffee, cocoa).

- Possesses a rapid growth rate and be able to cover the soil in short time.
- Is resistant to pests and diseases.
- Is competitive with undesired spontaneous vegetation (e.g. aggressive grasses).
- Does not pose a risk of transmitting diseases and pests to other crops.
- Produces large amounts of organic matter and dry material.
- Fixes nitrogen from the air and provide it to the soil.
- Has a de-compacting root system and regenerate degraded soils.
- Is easy to sow and to manage a single crop or associated with other crops.
- Can be used as fodder, grains as food grains.

An alternative to sowing a green manure or cover crop in the field is to collect fresh plant material from elsewhere and work it into the soil as a mulch.

## 1.2.4 Mulching

Mulching is the process of covering the topsoil with plant material such as leaves, grass and crop residues. A mulch cover enhances the activity of soil organisms such as earthworms. They help to create a soil structure with plenty of smaller and larger pores through which rainwater can infiltrate easily into the soil, thus reducing surface runoff. As the mulch material decomposes, it increases the content of organic matter in the soil. Soil organic matter helps to create good soil with a stable crumb structure. Thus, the soil particles will not be easily carried away by water. Therefore, mulching plays a crucial role in preventing soil erosion.

### Selection of Mulch Materials

The kind of material used for mulching will greatly influence its effect. Material that easily decomposes will protect the soil only for short time, but will provide nutrients to the crops while decomposing. Hardy materials will decompose more slowly and therefore cover the soil for a longer time and protect against erosion. If the decomposition of the mulch material should be accelerated, animal manures may be spread on top of the mulch, thus increasing the nitrogen content.

Sources of mulching material can be the following:

- Cover crops, grass and weeds
- Crop residues (straw etc.)
- Pruning material from trees and hedges
- Wastes from agricultural processing or from forestry.

Mulch is good for protecting the soil. It should be applied before the rainy season, with not too thick a layer.
The application should be done in rows or around single plants or spread evenly on the filed.

### Constraints of Mulching

- Slugs, snails, ants or termites may find ideal conditions for living under a mulch layer and can multiply quickly. They may cause damage to the crops.
- When crop residues are used for mulching, there is an increased risk of sustaining pests and diseases. Damaging organisms such as stem borers may survive in the stalks of crops like cotton, corn or sugar cane. Plant material infected with viral or fungal diseases should not be used if there is a risk that the disease might spread to the next crop.
- When carbon rich materials such as straw or stalks are used for mulching, nitrogen from the soil may be used

by microorganisms to decompose the material. Thus, nitrogen may be temporarily unavailable for plant growth if the applied plant material does not contain sufficient nitrogen (risk of N-immobilization).

- The major constraint for mulching is usually the availability of organic material. Its production or collection normally involves labor and may compete with the production of crops.

### Application of Mulch

- If possible, the mulch should be applied before or at the onset of the rainy season, when the soil is most vulnerable.
- If the layer of mulch is not too thick, seeds or seedlings can be directly sown or planted in between the mulching material. On vegetable plots it is best to apply mulch only after the young plants have become somewhat hardier, as they may be harmed by the decomposition products from fresh mulch material.
- If mulch is applied prior to sowing or planting, the mulch layer should not be too thick in order to allow seedlings to penetrate it. Mulch can also be applied in established crops, and is best down directly after digging the soil. It can be applied between the rows, directly around single plants (especially for tree crops) or evenly spread on the field.

## 1.2.5 Associating Crops and Crop Rotation

In many traditional agricultural systems, a diversity of crops in time or space can be found. There are different reasons why farmers do rotate or associate crops: Different plant species respond to the characteristics of the soil, have different root systems and have different needs for nutrients, water, light, temperature and air.

### Associating Crops

Associating crops is defined as the growing of two or more crops in the same field at the same time. If suitable crops are combined, mixed cultivation can lead to a higher total yield per area. This is basically due to the more efficient use of space (over and under ground) and because of beneficial interactions between the mixed crops. A greater diversity of crops can be grown in the fields. This helps the farmer to avoid dependence on only one crop, ideally achieving a continuous supply of products from the field. Associating crops have agro-ecological benefits, too:

- The diversity makes it more difficult for pests and germs to attack a certain species.
- Mixed cropping with legumes improves nitrogen supply of non-legumes.
- Associated crops cover the soil faster and grow more densely, thus suppressing weeds more efficiently.

There are different possibilities to associate crops:

- **Mixed cropping:** Two or more crops are sown at the same time sharing the same space, or they are sown at the same time in neighboring rows. One crop may also be sown as a border crop.
- **Cropping in lines:** Two or more crops are sown at the same time in neighboring lines with wide spacing.
- **Graduate cropping:** A second crop is being sown before the harvest of the first one.
- Combined cultivation of trees and annual crops.

How can mixed cropping be set up?

- Crops and species grown in association should have different growth habits and different needs for light: Crops with strong rooting should be associated or alternated with crops with a weak root growth. Crops with deep rooting are best grown together with species with shallow root growth. The periods of most active nutrient uptake should not coincide.
- Plant distances should be such that nutrient competition between plants can be minimized.

- Perennial plants can be well associated with seasonal plants.
- Leguminous crops may be grown in association with crops or before crops that have a high demand for nitrogen.

### Crop Rotation

If the same crop is grown for several consecutive years on the same land yields will normally decline (or more fertilizer will be needed to reach the same yield) and health problems will arise in the crop or field. Weeds that are well adapted to the conditions offered by the crop (e.g. good light conditions, typical soil cultivation), may spread and require increased efforts to be controlled.

Benefits of Crop Rotation:

- When different crops are grown in sequence in the same field, each crop uses the soil in its own particular way and thus reduces the risk of nutrient depletion. A well-balanced alternation of crop species also prevents the development of soil-borne diseases. Therefore, cultivation pauses must be respected for the same crop and among crops of the same plant family.
- To avoid the development of persistent weeds, plants with a slow youth growth should be grown after crops possessing good weed suppression. A change between deep and flat rooting crops and between crops building high stalks and species producing a great leaf mass that covers the soil quickly also helps to suppress the weeds.
- Crop rotation is also an important instrument to maintain soil organic matter. Ideally, crop rotation should maintain, or even raise, the content of soil organic matter.

## 1.2.6 Soil and Plant Nutrition

The approach to plant nutrition in organic agriculture is fundamentally different from the practices of conventional agriculture. While conventional agriculture aims at providing direct nutrition to the plants by using mostly easily soluble chemical fertilizers, organic farming feeds the plants indirectly by feeding the soil organisms with organic matter.

Organic soil fertility management is based on rational use of agro ecosystem native resources achieved through crop rotation, cultivation of legumes, green manures or deep routing plants and reutilization of organic farm by-products. Use of auxiliary resources in soil fertility management, i.e. fertilizers and soil improvers that are not obtained directly from the agro-ecologic system involved and are acquired on the market, should only be employed as a second choice.

### Plant Nutrition and Plant Health

Plant nutrition and plant health are closely linked. Chemical fertilization has the following negative impact on soil and plant health:

- Chemical fertilization reduces the colonization of plant roots with the beneficial root fungus mycorrhiza.
- High nitrogen fertilization stops symbiotic nitrogen fixation by rhizobia.
- Oversupply of nitrogen leads to a softening of the plants' tissues resulting in plants which are more sensitive to diseases and pests.
- The exclusive use of NPK-fertilizers leads to a depletion of micro-nutrients in the soil as these are not replaced by such fertilizers. This results in a decline of yields and a reduction in plant and also animal health.
- Decomposition of soil organic matter is enhanced, which leads to a degradation of the soil structure and a higher vulnerability to drought.

### Nutrient Supply by Managing Soil Organic Matter

Plant nutrition in organic farming focuses on sound management of soil organic matter. The organic farmer uses three approaches to ensure a continuous nutrient supply from soil organic matter:

- **Varying the Input of Organic Material:** The amount and the quality of organic matter influences the content of organic matter in the soil. A regular supply of organic matter provides the best conditions for balanced plant nutrition. Estimates say that in humid tropical climates 8.5 tones, in sub-humid climate 4 tones, and in semiarid 2 tones of biomass is needed per hectare and per year to maintain soil carbon levels of 2, 1 and 0.5 % respectively.

- **Suitable Crop Rotation:** The crops being grown determine the amount of nutrients the soil needs in order to maintain its fertility. The farmer arranges the rotation in such a way that demand and supply of nutrients (e.g. nitrogen from legumes, nutrients from a green manure crop) fit in the best possible way (chapter 1.2.5).

- **Influencing Nutrient Mobilization:** The farmer can influence the nutrient release from humus by cultivating the soil at the appropriate time, to the appropriate depth, and with the appropriate intensity and frequency (chapter 1.2.2). Soil cultivation improves aeration of the soil and enhances the activity of soil micro-organisms. If the micro-organisms find suitable conditions for their growth, they can be very efficient in dissolving nutrients and making them available to plants. Therefore, in organic agriculture, it is important to encourage plant health by creating biologically active soil.

**What Do Organic Standards Say on Plant Nutrition?**

IFOAM Basic Standards as well as national regulations and local standards define how plant nutrition should be approached in organic agriculture and which materials are allowed, with restrictions and which are prohibited:

- Biodegradable material builds the basis of the fertilization program.
- The total amount of biodegradable material brought onto the farm unit is limited.
- Animal runs should be prevented from becoming over-manured where there is a risk of pollution to rivers or groundwater.
- Brought-in material shall be in accordance with a positive list (list of allowed fertilizers).
- No manures containing human excrements can be used as fertilizer on vegetation for human consumption if not first sanitized.
- No chemical fertilizers containing nitrogen can be used; Chilean nitrate and all synthetic nitrogenous fertilizers, including urea, are prohibited.
- Restricted use of chemical magnesium and trace elements and/or fertilizers with unwanted substances, e.g. basic slag, rock phosphate and sewage sludge. Chemical magnesium and trace elements shall be used only after soil analysis, with prior permission of the certifier and as a supplement to organic sources.

## 1.2.7 Nutrient Recycling on the Farm

Organic growers aim to achieve a more efficient use of farm-own nutrients and to reduce external inputs to a minimum. This idea leads to the concept of closed nutrient cycles. It is clear that the export of nutrients with market goods and losses through leaching and volatilization and erosion cannot be avoided completely. In organic farming, the big question is: "How to optimize nutrient management on the farm?" There are three principles of how to optimize nutrient management.

### Principle 1: Minimize Losses

- High losses of nutrients result from leaching due to the low exchange capacity of the soil. Leaching can be reduced by raising the content of soil organic matter.

- If dung or compost is kept in water-logged conditions or is exposed to the sun, high losses of nitrogen may occur. Washout of soluble nutrients from stored dung and compost can be prevented by proper sheltering and storage.
- Dung or compost are often stored in pits where water collects during the rainy season. Nitrogen gets lost through leaching (if the bottom of the pit is permeable) or through volatilization (if the water gets logged in the pit).
- Soil erosion robs the soil of its most fertile part: the top soil, which contains the majority of nutrients and organic material. This can be prevented by maintaining a dense plant cover and with constructions such as terracing.
- Avoid burning biomass.
- To prevent losses of nitrogen fixed by leguminous plants, practice mixed cropping or crop rotation with species of high nitrogen demand.
- Nutrient release from soil organic matter when there are no plants present or able to take it up leads to considerable nutrient losses.
- Nitrogen is easily lost by volatilization. The highest losses occur during the first two hours after manure is applied to the field. Therefore, farmyard manure should be applied in the evening as cool night temperatures and the higher humidity reduce the losses. Farm yard manure and slurry should be brought out in quantities that the plants can take up in a short time. It should be worked into the topsoil soon after application.

### Principle 2: Closed Nutrient Cycles

- Maximize recycling of plant residues, by-products, dung and farm wastes. Recycled or saved nutrients also mean money saved.
- Deep-rooting trees and shrubs planted in spare corners collect leached nutrients and can supply a great deal of mulch material if intense pruning is done.
- Compost can be made out of almost any organic material from the farm. It is not only a means of recycling nutrients but also increases the exchange capacity of the soil.
- Mulching is a simple way of recycling nutrients. It helps to keep moisture in the soil and feeds soil organisms.
- Ashes of stoves are a highly concentrated mixture of nutrients like potassium, calcium, and magnesium and may be applied to fields or mixed into the compost.
- Different plants have different requirements for nutrients; mixed cropping and crop rotations help to optimize the use of nutrients in the soil.

### Principle 3: Optimize Inputs

- Introduce external organic “wastes”, if available. Several cheap organic wastes like coffee husks, sugarcane bagasse, rice husks, cotton stalks etc. may be available in the region and could be used to prepare compost.
- Chemicals like rock phosphate or dolomite help to supply scarce nutrients, and are less prone to leaching and less harmful to the soil than concentrates.
- Nitrogen fixing plants provide cost-free nitrogen. They can be planted as cover crops, food grains, hedges or trees, and also provide firewood, mulch and fodder.

**Burning Plant Materials – Why is it so Disadvantageous?**

Burning is common in shifting cultivation and in the process of destroying agricultural wastes, as it saves labor. The ash contains nutrients, which are directly available to the plants. However, burning has many disadvantages:

Large amounts of carbon, nitrogen and sulphur are released as gas and are therefore lost.

The nutrients in the ash are easily washed out with the first rain.

Plant materials are too valuable a source of soil organic matter to be burned.

Burning harms beneficial insects and soil organisms.

In organic agriculture, plant materials shall only be burned as an exception (e.g. crops affected by diseases or hardy perennial weeds). Instead, they should be used for mulching or composting.

## 1.2.8 Composting

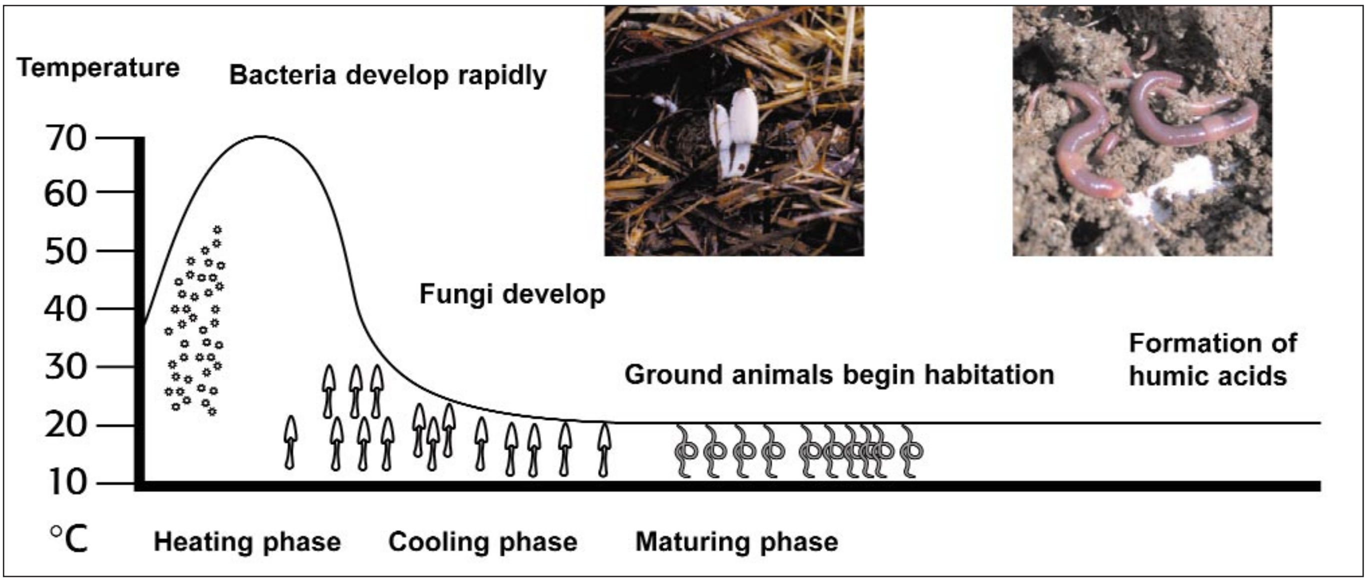
Compost is the most important fertilizer in organic agriculture. Organic growers are therefore very much concerned with producing good compost. Composting is the process of transforming organic material of plant or animal origin into humus in heaps or pits. Compared with uncontrolled decomposition of organic material, decomposition in the composting process occurs at a faster rate, reaches higher temperatures and results in a higher quality product.

### Why to Make Compost?

During the composting process, some organic material is transformed into humic substances that are relatively resistant to microbial decomposition. Composting thus helps to maintain or increase soil organic matter content. The other components of compost provide nutrients and micro-nutrients in the right proportion (as compost is built from plant materials) for plants to utilize. Compost has both a long and short term effect on plant nutrition as nutrients are permanently released. Due to its neutral pH, compost improves the availability of nutrients in acid soils. When mixed with soil, compost can suppress soil borne disease pathogens. Mature compost is good for plants and does not impede plant roots and micro-organisms in the soil as do substances released during a rotting process. Before starting compost production, the farmers should take into consideration that during the decomposition process some organic matter and nutrients will be lost. Also, compost production is labor intensive and demands regular attention.

### How to Make Good Compost

There are different methods to make compost: There are "continuous" (continuous supply of raw materials) and "batchfed" (all material is composted at once) systems. An "Indore-method" exists as well as "Bokashi"-method and Vermi-Composting. These methods are successful, taking into consideration the "ABC´s" on how to make a good compost: create optimal conditions for fermentation and development of micro-organisms (for details about the phases of the composting process please refer to specific literature):



Compost.

**A) Selecting the Primary Materials**

The composition of the composting material is of major importance. The C/N-ratio and the structure of the material have a major influence on the composting process: Material that is rich in nitrogen (low C/N-ratio) does not usually contribute to a good structure and thus does not allow for good aeration if composted separately. Material which has a good structure usually has a low nitrogen content (high C/N-ratio) and does not offer enough nitrogen for the bacteria to feed on. The mixture of different materials should contain an average C/N-ratio of 30:1. Smaller material must be mixed with more bulky material. To allow an ideal composting process, the mixture should consist of approximately:

- One third bulky material with a rich structure (chopped branches and tree bark, bulky material separated from previous composts)
- One third medium to fine material with a high C/N-ratio (straw, crop residues etc.)
- One-third fine material with a low C/N-ratio (fresh leguminous, manure etc.)
- 5 to 10 % soil.

Material Suitable for Composting:

- Plant material: a balanced mixture of N-rich and C-rich material.
- Animal dung: cow, pig (rich in K and P), poultry (very rich in P), goat, horse etc.
- Wood ash: contains K, Na, Ca, Mg etc.
- Rock phosphate: the phosphorus binds to the organic material and is thus less fixed to soil minerals;. it is therefore better applied to the compost heap than directly to the soil.
- Small quantities of soil, especially soil rich in clay, or groundrock improve the composting process and the quality of the compost. They are mixed with the other material or used to cover the heap to reduce nutrient losses.

Material Not Suitable for Composting:

- Plant material affected by diseases like rust or virus.
- Persistent perennial weeds unless first dried in the sun.
- Material with hard prickles or thorns.
- Waste such as metal or plastic.

The process of composting. It shows how waste is turned into humus.

**B) Setting up a Compost Heap**

- Prepare the composting material properly: Chop coarse woody material to increase its surface area and encourage decomposition by fungi and bacteria.
- If dry, soak the composting material before mixing it.
- At the bottom of the heap, put twigs and branches to allow for good drainage of excess water.
- Pile up coarse carbon rich and nitrogen rich material in alternating layers.
- Manure or old compost applied to each layer enhances the composting process.
- Thin earth layers between the compost help to prevent nitrogen loss.
- A 10 cm thick cover of straw or leaves in the initial stage, and an impermeable cover (sacks, plastic sheet etc.) in the final stage prevent potassium and nitrogen being washed out of the heap. In dry climates, cover the heap with a 15 cm thick layer of mud.
- If the heap is not moist enough, from time to time pour water or liquid manure over the compost.

### C) Turning the Compost

Two to three weeks after building up the compost heap, it will have decreased to about half its original size. This is the right time to turn it. Turning has a number of advantages:

- Turning the compost helps to accelerate the process.
- It improves aeration and encourages the process of composting.
- It ensures that material from the outside of the heap can decompose properly when placed in the center.
- It allows the quality of the composting process to be checked and for any non-ideal conditions to be improved.

### Vermi-Composting

Earthworms are highly efficient in transforming biomass such as leaves into excellent humus. They usually become very active in a compost heap after the heating phase. Vermi-Composting is mainly based on the activity of worms and does not go through a heating phase at all. As worms transform biomass into excrement within a short period of time, the process can be faster than ordinary composting. Worm excrement is stable crumbles of soil closely bound to organic matter. They have high nutrient levels and good water retention. In addition, the excrement has a growth promoting effect on plants. Some experienced farmers use "vermi-wash", the liquid collected from the compost heap after sprinkling, as a leaf fertilizer and plant tonic. This can even help plants to get rid of pests (e.g. aphids) and diseases. Worms are very sensitive to fluctuations in moisture and temperature. They need a continuous supply of "food", i.e. compost material. They are also attacked by ants and termites. Therefore, a solid base is needed to protect the worms from predators. To remove the compost, let the top of the heap dry out so that the worms move to the deeper layers. Though vermi-compost is definitely a very good manure, it requires more investment (tank and worms), labor and permanent care as compared to ordinary composting methods.

## Application of Compost

There is no one definite stage of maturity. Compost ripens in an endless process. Compost can be used as soon as the original composting material is not recognizable anymore. The compost has turned a dark brown or blackish color and has a pleasant smell.

Compost is a scarce and valuable manure for most organic farmers. Usually it is not possible to produce sufficient amounts for fertilizing all fields. Therefore, farmers should think carefully about where compost application would be most beneficial. High efficiency is achieved in nurseries and when planting seedlings or saplings. Quantities and timing of application depend on the compost quality and differ from crop to crop; some examples are explained in the following chapters.

Earth Worm working to produce humus.

## 1.3 Pest and Disease Management

Pest and disease management in organic agriculture consists of a range of activities that support each other. Most management practices are long-term activities that aim at preventing pests and diseases from affecting a crop. Management focuses on keeping existing pest populations and diseases low. Control, on the other hand, is a short-term activity and focuses on killing pest and disease. The general approach in organic agriculture is to deal with the causes of a problem rather than treating the symptoms, an aspect that also applies to pests and diseases. Therefore, management is of a much higher priority than control. For details and examples please consult the following chapters of this book.

### 1.3.1 Plant Health and Natural Defense

A healthy plant is less vulnerable to pest and disease infestation. Therefore, a major aim for the organic farmer is to create conditions that keep a plant healthy. In favorable conditions, the plants own protection mechanisms to fight infections are sufficient. This is why a well managed ecosystem can be a successful way of reducing the level of pest or disease populations. Certain crop varieties have more effective mechanisms than others, and therefore have a lower infection risk. The health condition of a plant depends to a large extent on the fertility of the soil. When nutrition is well balanced, the plant becomes stronger and is therefore less vulnerable to infection. If climatic conditions are not suitable, the plant can become stressed. Stress weakens the defense mechanisms of plants and makes them easy targets for pests and diseases. One of the most important points for an organic farmer is therefore to grow healthy plants.

#### Natural Defense Mechanisms

Plants have their own mechanisms for protecting themselves against pests and diseases denominated as their immune system. Some plants have the ability to prevent or restrict infection by one or several disease or pests. This is called resistance. The cultivation of resistant varieties is an important preventive measure in organic farming. There are several passive and active defense mechanisms of plants:

- a strong smell of aromatic oils or a color which keeps pests away,
- long or sticky hairs on the leaves which hinder insects' ability to walk or feed on a plant,
- leaves covered with wax which can not be penetrated easily,
- substances in the leaves which inhibit the pests' or diseases' metabolism.

#### Grafting

For perennial plants, grafting is a promising technique for obtaining resistant plants. It combines a shoot of a high yielding crop with a rootstock of a variety that is resistant to soil borne diseases, but fails to grow desired yields. This technique is applied in coffee, citrus (see chapter 2.1.2) and many other crops.

### 1.3.2 Preventive Measures

Knowledge about plant health and pest and disease ecology helps the farmer to choose effective preventive crop protection measures. As many factors influence the development of pest and disease, it is crucial to intervene at the most sensitive points. This can be accomplished through the correct timing of management practices, a suitable combination of different methods, or the choice of a selective method. Some important preventive crop protection measures are the following:

1) Selection of adapted and resistant varieties: Choose varieties that are well adapted to the local environmental conditions (temperature, nutrient supply, pests and

disease pressure), as it allows them to grow healthy and makes them stronger against infections of pests and diseases.

2) Selection of clean seed and planting material (certified seed and planting material from safe sources).
3) Use of suitable cropping systems (see chapter 1.3.3): Diverse cropping systems, crop rotation, green manuring and cover crops.
4) Use of balanced nutrient management (see chapter 1.3): moderate N-fertilization and steady growth makes a plant less vulnerable to infection.
5) Input of organic matter (see chapter 1.2): improves soil-fertility, stabilizes soil structure and supplies substances that strengthen the plant's own protection mechanisms.
6) Compost can reduce disease problems due to the presence of micro-organisms. They either compete with pathogens for nutrients, produce antibiotics that reduce pathogen survival and growth, or parasite on the pathogens. There is also an indirect effect on crop health.
7) Application of suitable soil cultivation methods (see chapter 1.2.2): Regulates weeds that serve as hosts for pests and diseases.
8) Use of good water management: Flood irrigation and water on the foliage encourages pathogen infections.
9) Conservation and promotion of natural enemies (see chapter 1.6.3): Provide an ideal habitat for natural enemies to grow and reproduce.
10) Selection of optimum planting time and spacing (see e.g. citrus production, chapter 2.1.2): Sufficient distance between the plants allows good aeration and reduces the spread of a disease
11) Use of proper sanitation measures: Removes infected plant parts from the ground to prevent the disease from spreading, eliminates residues of infected plants after harvesting.

### Treatment of Seeds

Seeds can be treated to control germs attached to the seed (seed-borne diseases), and/or to protect against pests and diseases in the soil that can attack seeds, emerging roots or young seedlings (soil-borne diseases). There are three main methods for seed treatment in organic farming:

1. **Physical:** sterilizing by soaking seed in hot water (typically 50–60 ºC),
2. **Botanical:** by coating seeds with a layer of plant extract, such as crushed garlic.
3. **Biological:** by coating seeds with a layer of antagonistic fungi.

When seeds are bought from seed companies, attention should be paid to the type of treatment they underwent, as chemical treatment is not permitted in organic farming.

## 1.3.3 Curative Crop Protection Methods

If all preventive crop protection practices fail to sufficiently prevent economic losses to the farmer, it may be necessary to take curative action. Curative action means controlling the pest or disease once it has already infested the crop. Several options exist in organic agriculture:

1) Biological control with natural predators or antagonistic microbes.
2) Natural pesticides based on herbal preparations or other natural products.
3) Mechanical control with traps or hand picking.

### Biological Control

Of all the methods and approaches presently used for the management of pests and diseases, biological control is by far the most complex and probably the least understood. Bio-control is the use of natural enemies to manage populations of pests and diseases. This implies that we are dealing with living systems that are complex and vary from place to place and from time to time. Knowledge about and observation of the ecology of pests and diseases, as well as population dynamics of pest and predators, are the basis of successful application of this method.

Biological control is the use of natural enemies to manage populations of pests and diseases.

Natural enemies – the biological control agents – can be divided into four groups:

- Predators – such as spiders, lady beetles, ground beetles, and syrphid flies – usually hunt or set traps to catch a prey to feed on.
- Parasitoids of pests are commonly wasps or flies. They are usually smaller than their host and are parasitic.
- Pathogens are entomophagous fungi, bacteria, or viruses that can infect and kill insects, causing a disease in pest organisms. Examples are Bacillus thuringiensis (Bt), Beauveria bassiana and NPV virus. Pathogens require specific conditions (e.g. high humidity, low sunlight) to infect insects and to multiply.
- Nematodes are commonly used insect-pathogens. Some nematodes attack plants (e.g. rootknot nematode). Entomopathogenic nematodes attack insects and are usually only effective against pests in the soil or in humid conditions.

Active populations of natural enemies can effectively control pest and disease organisms and thus prevent their mass multiplication. Therefore, the organic farmer should conserve natural enemies already present in the crop environment and enhance their impact by:

- Minimizing the application of natural pesticides such as copper and sulfur (chemical pesticides anyway are not permitted in organic farming).
- Allow some pests to live in the field that will serve as food or host for natural enemies.
- Establish a diverse cropping system (e.g. mixed cropping).
- Include host plants providing food or shelter for natural enemies (e.g. flowers which adult beneficial insects feed on).

### Releasing Natural Enemies

If populations of natural enemies present in the field are too small to sufficiently control pests, they can be reared in a laboratory or rearing unit. The reared natural enemies are released in the crop to boost field populations and keep pest populations down. There are two approaches to biological control through the release of natural enemies:

1) Preventive release of the natural enemies at the beginning of each season. This is used when the natural enemies could not persist from one cropping season to another due to unfavorable climate or the absence of pests. Populations of the natural enemy then establish and grow during the season.
2) Releasing natural enemies when pest populations start to cause damage to crops. Pathogens are usually used in that way, because they can not persist and spread in the crop environment without the presence of a host ("pest"). They are also often inexpensive to produce.

### Using Pathogenes

Natural enemies that kill or suppress pests or diseases are often fungi or bacteria. They are called antagonists or referred to as microbial insecticides or bio-pesticides. Some commonly used antagonistic microbes are (more examples see following chapters of this book):

- Bacteria such as Bacillus thuringiensis (Bt). Bt has been available as a commercial microbial insecticide since the 1960s. Different types of Bt are available for the control of caterpillars and beetles in vegetables and other agricultural crops, and for mosquito and black fly control.

- Viruses such as NPV (nuclearpolyhedrosis virus) are effective for control of several caterpillar pest species. Every insect species, however, requires a specific NPV-species. An example: The armyworm Spodoptera exigua is a major problem in shallot production in Indonesia. Since experiments showed that SeNPV (NPV specific for S. exigua) provided better control than insecticides, farmers have adopted this control method. Many farmers in West-Sumatra are now producing NPV on-farm.
- Fungi that kill insects, such as Beauveria bassiana. Different strains of this fungus are commercially available. For example: strain Bb 147 is used for control of corn borers (Ostrinia nubilalis and O. furnacaiis) in maize, strain GHA is used against whitefly, thrips, aphids and mealybugs in vegetables and ornamentals. Several species of fungi can occur naturally in ecosystems. For example, aphids can be killed by a green or white colored fungus during humid weather.
- Fungi that work against plant-pathogens. For example Trichoderma sp., widely used in Asia for prevention of soil-borne diseases such as damping-off and root rots in vegetables.
- Nematodes such as Steinernema carpocapsae control soil insects such as cutworms (Agrotis spp.) in vegetables.

**Natural Pesticides**

In some cases, preventive and bio-control measures are not sufficient and the damage by a pest or a disease may reach a level of considerable economic loss. This is when direct control measures with natural pesticides may become appropriate. Contrary to conventional farming practices, where it has become a widely held view that pesticides are the best and fastest means to reduce pest damage, organic farmers know that preventive methods are superior and that only if prevention is not sufficient, natural pesticides should be applied.

Some plants contain components that are toxic to insects. When extracted from the plants and applied on infested crops, these components are called botanical pesticides or botanicals. The use of plant extracts to control pests is not new. Rotenone (Derris sp.), nicotine (tobacco), and pyrethrins (Chrysanthemum sp.) have been used widely both in small-scale subsistence farming as well as in commercial agriculture. Most botanical pesticides are contact, respiratory, or stomach poisons. Therefore, they are not very selective, but target a broad range of insects. This means that even beneficial organisms can be affected. Yet the toxicity of botanical pesticides is usually not very high and their negative effects on beneficial organisms can be significantly reduced by selective application. Furthermore, botanical pesticides are generally highly bio-degradable so that they become inactive within hours or a few days. Once again, this reduces the negative impact on beneficial organisms; botanical pesticides are relatively environmentally safe.

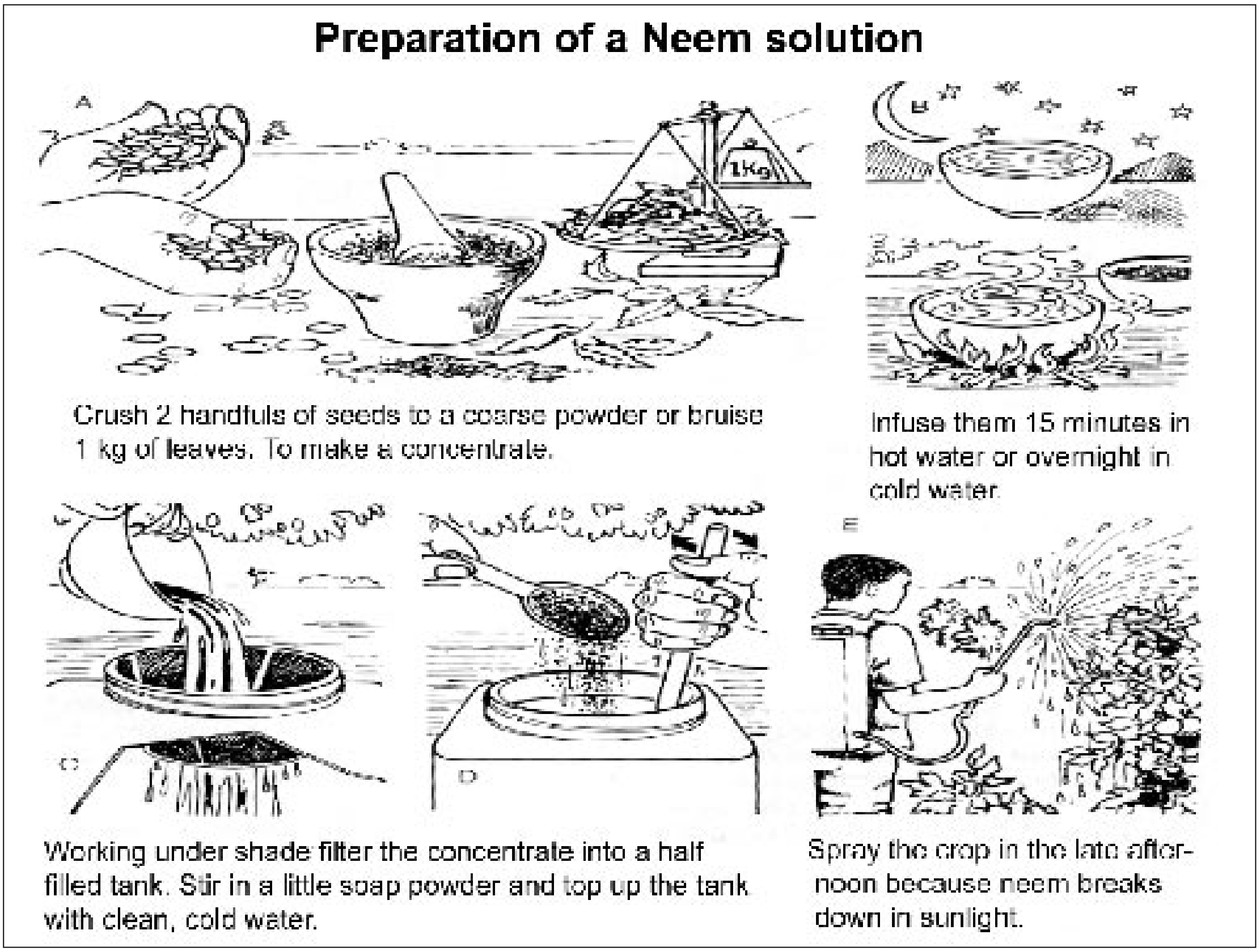
**Preparation of Neem**

The preparation and use of botanicals requires some know-how, but little material and infrastructures. It is a common practice under many traditional agricultural systems. Neem, for example, which is derived from the neem tree (Azadiracta indica) of arid tropical regions, contains several insecticidal compounds. The main active ingredient is azadiractin, which both deters and kills many species of caterpillars, thrips and whitefly. Both seeds and leaves can be used to prepare the neem solution. Neem seeds contain a higher amount of neem oil, but leaves are available all year. A neem solution loses its effectiveness within approximately 8 hours of preparation, and when exposed to direct sunlight. It is most effective to apply neem in the evening, directly after preparation, under humid conditions or when the plants and insects are damp. There are different recipes for the preparation of a neem solution. One is the Neem seed kernel extract:

Pound 30 g neem kernels (that is the seed of which the seed coat has been removed) and mix it in 1 liter of water. Leave that overnight. The next morning, filter the solution through a fine cloth and use it immediately for spraying. It should not be further diluted.

**Preparation of Pyrethrum**

In the tropics, pyrethrum is grown in mountain areas because it needs cool temperatures to develop its flowers. Pyrethrins are insecticidal chemicals extracted from the dried pyrethrum flower. The flower heads are processed into a powder to make a dust. This dust can be used directly or infused into water to make a spray. Pyrethrins cause immediate paralysis to most insects. Human allergic reactions are common. Pyrethrins break down very quickly in sunlight so they should be stored in darkness. Liquid formulations are stable in storage but powders may lose up to 20 percent of their effectiveness in one year. Attention: Pyrethroids are synthetic insecticides based on pyrethrins, but more toxic and longer lasting. They are not allowed in organic farming!




The preparation of a Neem solution.

Apart from plant extraction, there are some other natural pesticides that are allowed in organic farming. Although some of these products have limited selectivity and are not fully biodegradable, there are situations when their use is justified. However, in most cases, the desired effect is best reached in combination with preventive crop protection methods[5]:

- **Sulphur:** against fungal disease
- **Copper:** against fungal disease (accumulates in the soil and harms soil organisms!)
- **Sulphuric acidic argillaceous earth:** against fungal disease
- **Ashes:** against soil-borne disease
- **Slaked lime:** against soil-borne diseases
- **Clay:** against fungal diseases
- **Baking soda:** against fungal diseases
- **Soft soap solutions:** against aphids and other sucking insects
- **Light mineral oil:** against various insect pests (harms natural enemies!)
- **Sulphur:** against spider mites (harms natural enemies!)
- **Plant ashes:** against ants, leaf miners, stem borers etc.

[5] For detailed information please consult the positive lists of organic standards and regulations; all allowed substances and products for pest and disease management are listed there..

## 1.4 Weed Management

Weeds are plants that grow in places where they are not wanted or in unwanted periods of the cropping season. In a field, weeds are usually unwanted because they compete with the crop for water, nutrients, and sunlight and therefore prevent the crop from an ideal growth. Weeds may also directly reduce profits by hindering harvest operations, lowering crop quality, and by producing seed or rootstocks that infest the field and affect future crops.

On the other hand, weeds have a number of benefits:

- Weeds are often useful indicators of soil fertility and structure.
- They can serve as host plants for certain beneficial organisms.
- Several weeds are edible for farm animals or suitable for human consumption.
- Some weeds have a medicinal use.
- Weeds have taken up nutrients from the soil and these can be returned to the soil by using weeds as mulch or as green manure.
- Weeds can help to prevent soil erosion.

### Management of Weeds

A basic working principle in organic farming is to prevent problems, rather than to cure them. This applies equally to weed management. Good weed management in organic farming includes creating conditions which hinder weeds from growing at the wrong time and in the wrong place and then become a serious problem for the crop cultivation. Competition from weeds doesn't harm the crop throughout the whole cultivation period in the same way. The most sensitive phases of a crop with reference to weed competition is in its early growth and harvest stages. Organic weed management measures aim to keep the weed population at a level that doesn't result in economic loss of the crop cultivation or harm its quality.

### Preventive Measures and Suppression of Weeds

Several preventive measures may be applied at the same time. The importance and effectiveness of the different methods depend to a large extent on the weed species and the environmental conditions. However, some methods are very effective for a wide range of weeds and are therefore regularly used:

1) Living Green Cover (see chapter 1.2.3): The cover competes successfully with the weeds for light, nutrients, and water and therefore helps, especially in perennial crops, to prevent weed growth by winning the competition for resources.
2) Mulching (see chapter 1.2.4): the weeds find it difficult to receive enough light to grow and may not be able to pass through the mulch layer. Dry, hardy material, that decomposes slowly, keeps its effect longer than fresh mulch material.
3) Crop Rotation: Rotation of crops is the most efficient measure to regulate seed and root weeds in annual crops. Changing the conditions of the crop interrupts the living conditions of the weeds thus inhibiting their growth and spread.
4) Sowing Time and Density: Weed pressure during the critical period (youth stage of the crop) can be reduced by choosing an optimal sowing time and by increasing sowing density.
5) Balanced Fertilization: it can support an ideal growth of the crop, which promotes the growth of the crop over the weeds.
6) Soil Cultivation: weed cures before sowing, apply superficial stubble treatment works against persisting weeds under dry weather conditions. Minimum-tillage systems can increase the weed pressure.
7) Prevent Dissemination of weeds by eliminating them before seed dispersal.
8) Prevent Insemination of weeds by avoiding the introduction of weed seeds into the fields through tools or animals and by using only weed free seed material.

### Mechanical Control

With the necessary preventive measures, weed density can be reduced, but it will hardly be enough during the critical periods of the crop at the beginning of cultivation. Therefore, mechanical methods remain an important part of weed management.

Manual weeding is probably the most important one. As it’s very labor intensive, reducing weed density method in the field as much as possible will bring less work later on, and should therefore be aimed for. Using the right tool can increase work efficiency significantly.

Flame weeding is another option: Plants are heated briefly to 100°C and higher. This provokes coagulation of the proteins in the leaves and a bursting of their cell walls. Consequently, the weed dries out and dies. Although it is an effective method, it is quite expensive, as it consumes a large amount of fuel gas and needs machinery. It is not effective against root weeds.

Organic growers apply a specific combination of preventive and mechanical control methods for each crop. Some examples are explained in the following chapters.

## 1.5 Seeds and Planting Material

The use of adapted varieties and quality seeds and transplant is essential for good harvest in organic farming. Organic producers strive to use organic seeds and transplants, and are required to do so. International organic standards already require the use of organic seeds and transplants, provided these are available. From 1 January 2004, organic seeds and transplants must be exclusively used in the European Union.

Producers also use them because they desire to avoid genetic engineering completely, and because they need plants that are adapted to organic farming conditions.

### 1.5.1 Conservation Varieties and On-farm Propagation

Organic agriculture strives to extend the scope of conservation varieties to old varieties and landraces, as well as new varieties/populations for small areas and special purposes. This is of interest for the authenticity of regional, organic products. New can mean either selections out of old varieties, or a "changed" old variety through on-farm management of conservation, or a population of old varieties mixed/crossed with modern lines.

### 1.5.2 What Do the Standards Say?

General principles of the IFOAM Basic Standards regarding seeds and plant material: All seeds and plant material should be certified organic. Species and varieties cultivated should be adapted to the soil and climatic conditions and be resistant to pests and diseases. When choosing varieties genetic diversity should be taken into consideration.

#### Other Private Label Standards

When organic seed and plant materials are available, they should be used. Most certification body and standard setting organizations (producer organizations, authorities) set time limits for the requirement of certified organic seed and other plant material.

When certified organic seed and plant materials are not available, chemically untreated conventional materials may be used. Where no other alternatives are available, chemically treated seed and plant material may be used. The certification body/ standardizing organization shall define conditions for exemptions and set time limits for any use of chemically treated seeds and plant materials. The use of genetically engineered seeds, pollen, trans-gene plants or plant material is not permitted.

Growing containers for young plants for trees.

### 1.5.3 www.organicXseeds.com – More than 3500 Products Online

At present, it is very difficult to find seeds and transplants of organic quality. The aim of the database organicXseeds.com is to transparently display the current availability status of this rare merchandise. Each producer, consultant and inspector should be able to receive information quickly and efficiently regarding European suppliers of organic GM-free seeds.

www.organicXseeds.com considerably simplifies the search for organic seeds and transplants. This Website is open to the public and is free. The two search options (quick search and advanced search) enable the user to precisely search the up-to-date availability of e.g. organic salad seed or apple standard tree. As search results, you will receive a list of available varieties and their suppliers in Europe. Some suppliers allow you to request a quote directly by e-mail as a further service.

On one hand, the database serves as a fast and informative instrument for organic producers to search for organic seeds and transplants. On the other hand, organicXseeds allows suppliers to provide their clientele with up-to-date information on the availability of their products, in a way that is also very effective for advertising purposes. Interested suppliers can apply online and contract with BioGene (see below) on the terms and conditions for the presentation of their products on the web. Subsequently, the suppliers can register their seed range online. The principal information in the database concerns the availability of the seed. The company can update its information if their seed program has changed. In this way, the seed inventory remains always up-to-date. Suppliers pay an annual fee of 100 Euro.

At present, more than 3500 products of over 104 seed suppliers from 10 countries are listed. The range of products covers amongst others cereals, vegetables, fruits, spices, fodder crops and ornamentals

Currently, Soil Association in co-operation with NIAB collects the data of all the British seed suppliers and their seed program. Hence, the whole British offering of organic seeds and transplants is available online on the database organicXseeds.com! In the near future, the database shall be used as a control tool, too.

### 1.5.4 Organic Plant Breeding Techniques

Seeds form the basis for agricultural production, but most organic growers know little about how their seedstocks have been produced. Within the organic movement the discussion on the compatibility of plant breeding techniques has been accelerated by the public discussion on genetic engineering. This decision-making is important in the development of a framework for organic plant breeding and in facilitating investments by breeding companies.

It is important that breeding, multiplication, and maintenance techniques are identified and examined to assess their compatibility with the technical, ethical and environmental objectives of organic agriculture. This process will assist the ongoing national and international discussions on this topic and will also be of value in light of the requirement for all organic producers to use organic seed by 2004 (EU Regulation 2092/91; see above).

The issue of plant breeding techniques and their compatibility with organic farming is complex due to the range of techniques available, balanced against the different demands for variety and crop performance. Appropriate organic plant breeding will serve to develop improved varieties for organic systems without jeopardizing the ethical and environmental integrity of organic agriculture.

Currently, only the use of varieties obtained by genetic engineering is forbidden in organic agriculture across Europe (EU Regulation 2092/91). The regulation also requires that parent plants of annual crops have to be grown at least one generation under organic conditions, while biannual plants and perennials have to be grown for at least two generations under organic conditions. Guidelines for determining the appropriateness of breeding and multiplication techniques for organic breeding are formulated in the FiBL-dossier “Plant Breeding Techniques”.

Until now, organic farmers have made use of these traditionally bred varieties but the question being asked more and more regularly is "do these varieties truly fulfill the needs of organic production?" Are the seeds and vegetative multiplication material, usually results of traditional and conventional breeding programs, adapted to the conditions of organic agriculture? And, what do consumers expect from an organic variety? Healthy, tasty, and unique products? Furthermore, the quality of organic products is not simply determined by what they are, but also by taking into account how these crops have been produced. This aspect should also be considered when judging breeding lines for agricultural and horticultural production.

**How Plant Breeding and Multiplication Works**

In general, plant breeding can be described as the total of activities to improve the genetic properties of a cultivated crop. A breeder develops a new variety with one or more specific aims. Therefore, he has to search for parental plants (other varieties or wild relatives) with the desired traits. To obtain plants with the combination of desired characteristics, the breeder makes crosses with the parental plants. The result of a cross is a large number of seeds with different genetic make-ups (population). In the next plant generations, the breeder has to select for individual plants with the best combinations. To facilitate selection he has different techniques available, the choice of which will depend on the crop (self pollinator, cross pollinator, or plant with vegetative multiplication) and the traits he selects. In official field trials, the usefulness of the new varieties will be compared to existing standard varieties. If the new variety is distinguishable from all other varieties and its appearance is uniform and stable enough over time, the breeder will maintain and multiply it for the market.

## 1.6 Management of Semi-natural Habitats

For hundreds of years, agriculture has contributed substantially to the diversity of species and habitats, and has formed many of today's landscapes. Over the last century, however, modern intensive agriculture, with its high input of synthetic pesticides, fertilizers and monocrop specialization, has been detrimental to the diversity of genetic resources of crop varieties and livestock breeds. This has also adversely affected the diversity of wild flora and fauna species and the diversity of ecosystems.

Organic farming is dependent upon stabilizing agro-ecosystems, maintaining ecological balances, developing biological processes to their optimum and linking agricultural activities with the conservation of biodiversity. Wild species perform a variety of ecological services within organic systems: pollination, pest control, maintenance of soil fertility. Thus, higher levels of biodiversity can strengthen farming systems and practices. By respecting the natural capacity of plants, animals and the landscape, organic agriculture aims to optimize quality in all aspects of agriculture and the environment. Biological pest control on organic farms, for example, relies on maintaining healthy populations of pest predators. Organic agriculture is thus committed to the conservation and enhancement of biodiversity within agricultural systems, both from a philosophical perspective and from the practical viewpoint of maintaining productivity.

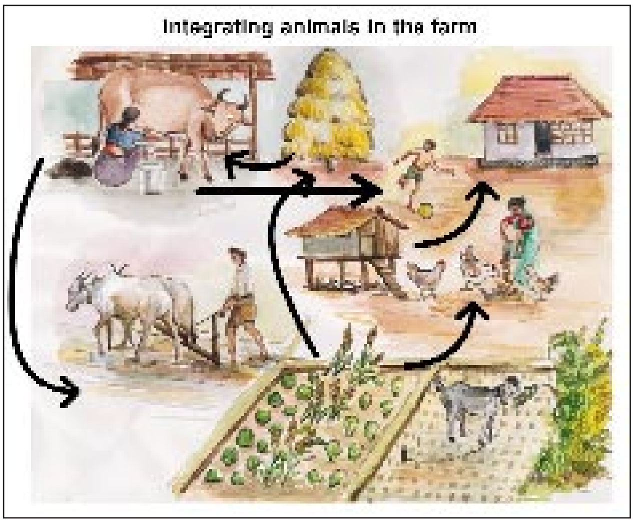
Biodiversity in organic farming is generally assessed at four distinct levels:

1. Diversity of Genetic Resources (the variation between individuals and between populations within a species): Higher crop diversity on organic farms, integrating animal husbandry with crop production, using vast and diverse rotations, intercrops and green cover crops etc (see chapters above).

2. Species Diversity (the different types of plants, animals and other life forms within a region or community): Floral diversity contributes to ecosystem stability whilst the invertebrate community associated with field boundaries performs many ecosystem functions including biological control of pests and diseases, pollination and food resource for higher trophic levels. The higher floral diversity in organic arable fields is generally due to the ban of synthetic N-fertilizers and herbicides. Flowering plants are also important for the diversity of pollinators (butterflies, bees and wasps) and many beneficial arthropods such as predators and parasitoids. Hedges and other semi-natural habitats enhance faunal diversity are and therefore an important element in organic crop systems. Many bird species feed on insects, and may thus also contribute to a better natural pest control. Further, organic growers promote earthworms through the application of organic matter and green manure practices. Earthworm casts greatly help to improve soil structure providing high concentration of nutrients in an accessible form to plants.
3. Ecosystem Diversity (the variety of habitats found within an area): Organic farming aims to contribute beneficially to ecosystems and facilitate biodiversity and nature conservation (IFOAM standards). The conservation and the management of semi-natural habitats plays an important role in organic farming. Semi-natural habitats are refuges for endangered plant species that, in former times, were found in meadows and arable fields: hedges, solitary shrubs, trees, low-input orchards, ponds, corridors, habitat networks, wildlife refuges and devices. Semi-natural habitats and field margins are also essential for the survival of many invertebrates, especially due to favorable food and overwintering conditions. They also function as habitat cross-links between meadows, fallows and different field margins. The improvement of landscape infrastructure in combination with organic farming may be an important factor for the conservation and enhancement of species-rich communities on agricultural land.
4. Buffer Zones: A secondary and closely connected link between ecosystem diversity, protected area management and organic farming is in the buffer zones. Buffer zones are areas where land management aims to help maintain the integrity of the ecosystem. The use of organic farming in protected buffer zones has been explored in the Meso-American Biological Corridor, a projected complex of protected areas and sustainable management stretching over seven countries. The initiative envisages a range of sustainable land uses within the buffer zones and linking areas, including certified forest management and organic agriculture.

## 1.7 Livestock Husbandry

Integrating animal husbandry into crop producing farms is one of the principles of organic farming. In temperate and arid zones, animal husbandry plays an important role in the recycling of nutrients, while it is less emphasized in the humid tropics. The caring, training, and nurturing of animals is considered an art in many farming communities. Animal husbandry in organic farming are both differentiation extensive animal husbandry, which is often environmentally damaging (e.g. overgrazing of common lands), and from intensive animal husbandry, which keeps animals under ethically unacceptable conditions.




Integrating animal husbandry into crop producing farms is one of the principles of organic farming.

### 1.7.1 Keeping Animals

Many farm animals have a multi-functional role. They can:

- Produce dung which is of great importance for soil fertility.
- Yield continuously products such as milk or eggs for sale or own consumption.
- Recycle by-products such as straw or kitchen waste.
- Serve as draught animals for tillage or transport.
- Produce meat, hides, feathers, horns etc.
- Serve as an investment or a bank.
- Help in pest control (e.g. dugs) and weed management (e.g. grazing on barren fields).
- Have cultural or religious significance (prestige, ceremonies etc.).
- Produce young stock for breeding or sale.

**What Animals Need**

Organic farmers try to achieve healthy farm animals that can produce satisfactorily over a long period of time. To achieve this goal, various needs of farm animals have to be considered:

- Fodder in adequate quality and quantity; for non-ruminants: diversity in fodder is usually required.
- Sufficient access to clean drinking water.
- Clean sheds of sufficient size and with adequate light and fresh air.
- Sufficient freedom to move around and perform their natural behavior.
- Healthy conditions and veterinary follow up, if needed.
- Sufficient contact with other animals, but no stress due to overcrowding.
- For herd animals: an appropriate age and sex distribution within the herd.

There is a range of standards in detail, regulating the organic management, shedding, feeding, veterinary treatment, breeding, purchase, transport, and slaughter of farm animals. The IFOAM Basic Standards say: "Organic animal husbandry means not only feeding organic food and avoiding synthetic food additives, but also putting a focus on satisfying the various needs of the farm animals. Good health and welfare of the animals is among the main objectives. Suffering due to mutilations, permanent tethering or isolation of herd animals must be avoided as much as possible. For various reasons, landless animal husbandry (i.e. fodder purchased from outside the farm, no grazing land) is not permitted in organic farming."

### How Many Animals to Keep?

In order to identify the appropriate number for a specific kind of animal on a farm, the following points should be considered:

- Availability of fodder on the farm, especially in periods of scarcity (e.g. dry season).
- Carrying capacity of pastures.
- Size of existing or planned sheds.
- Maximum amount of manure the fields can bear.
- Availability of labor for looking after the animals.

Free range for the animals.

In tropical countries, farm animals are frequently found to be underfed. When defining the number of farm animals, keep in mind that the economic benefit will be higher when fewer animals are kept, but fed well. Not only the amount, but also the quality of the available food must be taken into consideration.

### Sheds

With the exception of nomadic lifestyles, most farm animals are temporarily kept in sheds. The combination of animal husbandry and farm activities requires control of their movements so as to avoid damage to crops. For the welfare and health of the animals, sheds must be cool and aerated, and protect from rain. They should be constructed in a way ensuring:

- Sufficient space to lie down, stand up, move and express natural behavior (e.g. licking, scratching etc.).
- Sufficient light (as a rule, one should be able to read a newspaper in the shed).
- Protection from sunlight, rain, and extreme temperatures.
- Sufficient aeration, but no draught.
- Appropriate beddings (see section below).
- Elements to exercise natural behavior (e.g. for poultry: perching rails, sand baths and secluded laying nests).
- Sheltered pits or heaps to collect and store manure.

For economic reasons, sheds can be built with simple, locally available materials. Many countries have a rich tradition of shed constructions, and have developed the most efficient and appropriate shed systems for the conditions of the region. If techniques of this heritage are combined with the above principles, a locally adapted and at the same time animal friendly system may be obtained.

Beddings are used in sheds for keeping the floor soft, dry, and clean, which is important for animal health. They absorb the excrements of the animals and need to be replaced from time to time. Beddings can be of straw, leaves, twigs, husks or other locally available material. They can be replaced daily or kept for several months while adding fresh material on top.

## 1.7.2 Feeding Animals

The availability of fodder is one of the limiting factors in animal husbandry. Unlike landless systems in conventional farming, organic husbandry should be mainly based on the fodder produced on the farm itself. As is the case with humans, there is a direct link between the quantity and composition of the food and the health status of the animals.

## Food Requirements of Animals

A balanced diet will keep an animal healthy and productive. The appropriate quantity and the mix of feed items will of course depend on the type of animal, but also on its main use (e.g. chicken for meat or egg production, cattle for milk, meat or draft etc.). In milk production for example, cows producing milk should be given fresh grass and possibly other feed items of sufficient protein content. On the same diet, draught animals would rapidly become exhausted. Whether or not a farm animal receives the appropriate amount and kind of fodder usually can be seen by the shine of its hair or feathers.

For ruminants, a majority of the fodder should consist of roughage (grass, leaves). If concentrates or supplements are used (e.g. agricultural by-products and wastes), they should not contain growth promoters and other synthetic substances. Instead of buying expensive concentrates, there are a variety of leguminous plants rich in protein which can be grown in the farm as cover crop, hedges or trees. If mineral content in the available fodder is not sufficient to satisfy the animal's requirements, mineral salt bricks or similar feed supplements can be used as long as they do not contain synthetic additives.

## Grazing Versus Shed Feeding

In many regions of the tropics, favorable periods with abundant fodder alternate with less favorable periods when there is almost nothing to feed to the animals. However, keeping animals means providing fodder throughout the year. Fodder can be produced on the farm as grazing land or as grass or tree crops used for cutting. While grazing requires less labor than shed feeding, more land is needed and appropriate measures to keep the animals away from other crops must be undertaken. Grazing may lead to a lower productivity (milk, meat) but usually is the more favorable option concerning health and welfare of the animals. Shed keeping, however, has the advantage that the dung can be easily collected, stored, or composted and applied to the crops. Whether grazing or shed feeding is the more suitable option will mainly depend on the agro-climatic conditions, the cropping system, and the availability of land. A combination of shed feeding and grazing in a fenced area may be an ideal combination of high productivity and animal friendly husbandry. In extensive grasslands of semi-arid areas, however, grazing may be the only suitable option.

In most smallholder farms, fodder cultivation will compete for space with the cultivation of crops. There are some options for integrating fodder crops in farms without sacrificing much land:

- Grass or leguminous cover crops in tree plantations
- Grass fallows or green manures in the crop rotation
- Hedges of suitable shrubs
- Shade or support trees
- Grass on bunds against soil erosion
- Crops with by-products such as paddy straw or pea leaves.

Animal incorporation in organic production.

## Management of Pastures

The management of pastures is crucial for a good herd management. Overgrazing is probably the most significant threat to grass land. Once the protective grass cover is destroyed, the top soil is prone to erosion. Degraded pastures or land with little plant cover are difficult to re-cultivate. Therefore, it is important that the use and intensity of grazing on a particular piece of land is appropriate to its production capacity. Sufficient time must be given to a pasture to recover after intensive grazing. Fencing off of areas and rotation of the grazing animals on several pieces of land is a suitable option. This will also reduce the incidence of infection from parasites encountered while the animals graze. In some cases it may be worth considering tilling the grazing site and sow grass varieties that are more appropriate to the animals' needs

## 1.7.3 Animal Health

Disease causing germs and parasites are present almost everywhere. Like humans, animals have an immune system that is usually able to cope with these germs. And as with humans, the efficiency of the immune system will be disturbed if animals are not properly fed, can not practice their natural behavior, or are under social stress.

Health is a balance between disease pressure (the presence of germs and parasites) and the resistance (immune system and self healing forces) of the animal. The farmer can influence both sides of this balance: reduce the quantity of germs by maintaining good hygiene, and strengthen the animal's ability to cope with germs.

Organic animal husbandry puts its focus on improving the living conditions of animals and on strengthening their immune systems. Of course: if an animal becomes ill it must be treated. But the farmer should also think about why the immune system of the animal was not able to fight off the disease or the parasite attack. Additionally the farmer should think of ways to improve the animal's living conditions and hygiene in order to strengthen it.

### Prevention Before Curing

Similar to crop health, organic animal husbandry puts the main emphasis on preventive measures in order to keep animals healthy, rather than on curative methods:

- This starts from keeping robust breeds rather than high performing but very susceptible ones.
- Next, the conditions in which the animals are kept should be optimal ones: sufficient space, light and air, dry and clean bedding, frequent exercise (e.g. grazing) and proper hygiene.
- The quality and quantity of fodder is of crucial importance for the health of the animal. Instead of feeding commercial concentrates that make animals grow faster and produce more, a natural diet appropriate to the requirements of the animal should be achieved.

Where these preventive measures are taken, animals will rarely fall sick. Thus, veterinary treatment should play only a secondary role in organic farming. If treatment is necessary, alternative medicine based on herbal and traditional remedies should be used. Only if these treatments fail or are not sufficient, then synthetic medicines (e.g. antibiotics) may be used.

### Veterinary Treatment

The main principle for veterinary treatment in organic animal husbandry is: get to know the causes of (or factors that favor) diseases in order to enhance the natural defense mechanisms of the animal and to prevent its manifestations (see above).

**What the Organic Standards say on Veterinary Medicine**

Unlike in crop production, synthetic means are permitted to cure sick animals if alternative treatment is not sufficient. Here, reducing the suffering of the animal is given priority over the renunciation of chemicals. However, the standards clearly demand that priority be given to management practices which encourage the resistance of the animals, thus preventing the outbreak of a disease. Therefore, an outbreak of a disease should be considered as an indicator that the conditions under which the animal is kept are not ideal. The farmer should try to identify the cause (or causes) of the disease and prevent future outbreaks by changing management practices. If conventional veterinary medication is applied, withholding periods must be adhered to before the animal products can be sold as "organic". This shall ensure that organic animal products are free from residues of antibiotics etc. Synthetic growth promoters are not allowed under any circumstances.

**Controlling Parasites with Herbal Remedies**

Herbal medicines are widely used in many countries. Some traditional farming communities possess a vast knowledge of local plants and their healing properties. Plants can definitely support the healing process, even if they do not directly eliminate the germ of the disease. Still, farmers should not forget to identify the cause of the disease and also to re-think their management practices. For parasite problems, changing the living conditions or the management of pastures will be more effective in the long run than any treatment. One example to use a herbal remedy against parasites is sweet flag (Acorus calamus). This plant grows both in tropical as well as subtropical regions and is found on the banks of rivers and lakes and in swampy ditches or marshes. The powdered dried rhizomes (thick root parts) act as an effective insecticide against fowl lice, fleas and house flies. Caution! Herbal remedies against parasites can also have a toxic effect on the farm animals! Therefore, it is important to know the appropriate dose and application method!

Feeding of Animals.

## 1.7.4 Breeding in Organic Animal Husbandry

As preventive measures for maintaining good animal health are of considerable relevance in organic farming, the selection of breeds suitable to local conditions and to organic feeding is of crucial importance. This requires that suitable breeds are available. Traditional breeds of farm animals may be a good starting point for organic animal breeding. Animals can be improved by selection of individuals especially suitable for organic conditions. They can be crossbred with suitable new breeds, thus achieving an animal with the positive aspects of traditional breeds and the satisfying production of the new breeds.

For breeding, organic farming uses natural reproduction techniques. While artificial insemination is allowed, embryo transfer, genetic manipulation, and hormonal synchronization are not permitted according to organic standards.

**Breeding Goals**

Over the last decades, traditional breeds have been replaced by high performing ones in many regions. Similar to high yielding plant varieties, these new breeds usually depend on a rich diet (concentrates) and optimal living conditions. As high performing breeds in general are more susceptible to diseases than traditional varieties, they need frequent veterinary interventions. Thus, these new breeds might not be the right choice for small farmers, as the costs of food concentrates and veterinary treatment are too high compared with what can be earned by selling the products.

Breeding activities should attempt to optimize the overall performance of the animal, taking into consideration the different goals of an organic farmer. For example, a poultry breed suitable for organic smallholder farms might not be the highest egg producer, but one in which meat production is good, and kitchen wastes and whatever is available on the farm yard can be used as feed. Suitable cattle breeds would produce sufficient milk and meat while feeding mainly on roughage and farm by-products (e.g. straw), and be of high fertility and good resistance against diseases; if required, they can also be used for draught and transport.

**Maximum Performance or Life Production?**

When comparing the production of different breeds of cows, usually only the production per day or year is taken into consideration. However, high performing breeds usually have a shorter life span than traditional ones with lower production. The life milk production of a cow giving, for example, 8 liters per day, but over 10 years, therefore would be greater than one of a high-breed cow yielding 16 liters per day, but dies after 4 years. As the investments involved in a milk producing cow are quite high, i.e. the rearing and feeding of a calf or the purchase of an adult cow, continuous production over a long life span should be of great interest to the farmer. This should be reflected in the breeding goals, which so far mainly focus on the maximum short term production.

## 1.8 Water Conservation and Irrigation

Scarcity of water for agriculture is a common phenomenon in tropical countries. In some regions it is almost impossible to grow crops without irrigation. Even in areas with large amounts of rainfall in the rainy season, crops may be short of water during dry periods. Organic farming aims to optimize the use of on-farm resources and the sustainable use of natural resources. Active water retention, water harvesting and storing of water, therefore, are especially important topics for organic farmers.

### Keeping the Water in the Soil

In conventional agriculture, the first idea to overcome water storage is usually to install irrigation facilities. Organic farmers know that it is more important to first improve the water retention and the infiltration of water into the soil. The ability of a soil to absorb and store water largely depends on the soil composition and on the content of organic matter. Soil organic matter acts as a storage of water, just like a sponge. Soils rich in clay can store up to three times more water than sandy soils.

While it is not possible to increase the clay content with agricultural techniques, soil organic matter may be increased through appropriate management. To increase the content of organic matter, the application of organic manures, compost, mulch or green manure can be used as described in chapter 1.2.3 and 1.2.4. A thin layer of mulch can considerably reduce the evaporation of water from the soil. It shades the soil from direct sunlight and prevents the soil from getting too warm. Shallow digging of the dry top soil can help to reduce the drying up of the soil layers beneath.

**Attention!!**

A green manure or cover crop is not always a suitable way of reducing evaporation from the soil. While a plant cover provides shade and thus reduces sunshine directly reaching the soil, they are themselves evaporating water through their leaves even more efficiently than mere soil. When soil moisture becomes scarce, plants competing for water with the main crop can be pruned or cut down, thus serving as mulch.

### Harvesting Water

During strong rains, only a part of the water filters into the soil. A considerable part flows away as surface runoff, thus being lost for the crop. In order to get as much of the available rainwater into the soil, the infiltration of rainwater needs to be increased. Most important for achieving a high infiltration is to maintain good topsoil structure containing many cavities and pores, e.g. from earthworms. Cover crops and mulch application are suitable for creating such a favorable top soil structure. Further, they help to slow down the flow of water, thus allowing more time for the infiltration.

On slopes, the infiltration of rainwater can additionally be encouraged through trenches dug along contour lines. Surface runoff is caught in the trench where it can slowly infiltrate into the soil. Semi-circular bunds, e.g. around tree crops, have a similar effect. They collect water that is flowing down the slope and encourage its infiltration near the root zone of the crop. On level fields, plant pits can be used. The effect of these “water traps” can be increased if a layer of mulch is also integrated.

Excess water in the rainy season may be used during dry periods. There are many possibilities for storing rainwater for irrigation, but most of them are labor intensive or costly. Storing water in ponds has the advantage that fish may be grown, but water is likely to be lost through infiltration and evaporation. The construction of water tanks may avoid these losses, but needs appropriate construction materials. To decide whether or not to build water storage infrastructure, the benefits should be weighed against the costs, including the loss of arable land.

A type of drip irrigation.

### Crop Selection

The major factors that determine the necessity of irrigation are the selection of crops and an appropriate cropping system. Obviously, not all crops (and not even all varieties of the same crop) require the same amount of water, and not all need water over the same period of time. Some crops are very resistant to drought while others are highly susceptible. Deep rooting crops can extract water from deeper layers of soil and hence they are less sensitive to temporary droughts.

With the help of irrigation, many crops can be grown nowadays outside their typical agro-climatic region. This may bring about not only the above mentioned negative impacts, but also some advantages. It may make it possible to cultivate land which would otherwise be unsuitable for agriculture without irrigation. Or the cultivation of sensitive crops can be shifted into areas with less pest or disease pressure.

### The Impact of Irrigation

Even in organic agriculture, large areas of land nowadays are under irrigation. While the opportunity for irrigation may help farmers to improve their income and livelihood, there are also some potential negative impacts of irrigated agriculture:

- When the amount of water extracted from a lake, river or groundwater table exceeds its replenishment, depletion of the water resource can be the result, with its well known impact on the eco-system.
- Excessive irrigation in dry or semi-arid areas can cause salinity of the soil, which in the worst case can make the soil unsuitable for agriculture.
- Intense irrigation can cause soil erosion.
- Irrigation by sprinkling or flooding can harm the structure of the topsoil. The crumb structure of the soil may be destroyed and soil particles may accumulate in the pores, resulting in the formation of a hard crust. This will reduce the aeration of the soil and harm the soil organisms.
- Improper irrigation may cause stress to the crops, making them more vulnerable to pests and diseases. Most dry land crops are affected by water logging even if it is of short duration. Application of irrigation water during the hot period of the day can cause a shock to plants.

### Water Saving Irrigation Systems

There are irrigation systems of higher or lower efficiency and with more or less negative impact. If irrigation is necessary, organic farmers should carefully select a system that does not overexploit the water source or harm the soil and has no negative impact on plant health. One promising option is drip irrigation systems. From a central tank, water is distributed through thin perforated pipes directly to the single crop plants. There is a continuous but very light flow of water, thus allowing sufficient time to infiltrate in the root zone of the crops. In this way, a minimum of water is lost and the soil is not negatively affected.

The establishment of drip irrigation systems can be quite costly. However, some farmers have developed low cost drip irrigation systems from locally available materials. Whatever irrigation system the farmer chooses, he will reach higher efficiency if it is combined with accompanying measures for improving the soil structure and the water retention of the soil, as described above.

## 1.9 Agroforestry

Agroforestry is one of the best uses of agro-biodiversity that also generates multiple benefit, including erosion control and moisture retention (see chapter 1.6). In many tropical countries certified organic products are produced successfully in agroforestry systems. The system includes a diversity of cash and subsistence crops (e.g. bananas, coffee, cocoa, pineapple, yams, beans) as well as livestock. Cattle and pigs are kept in stables ("zero grazing") and the manure is recycled, providing fertility. The home gardens are designed to maximize diversity. Elaborate patterns of vertical zonation provide a range of sunny and cooler conditions for different species.

### Tropical Rainforests and Agro-ecosystems

Tropical rainforests are complex and dynamic ecosystems that are optimally adapted to the prevailing site conditions. The vast diversity of species is important for the stability of the system. Each individual occupies an appropriate niche and thereby fulfils a particular eco-physiological function within the system. The so-called diseases and pests in these systems are nothing but necessary regulation mechanisms that take their turn when there are tensions within the system. The function of the so-called weeds is to occupy niches since natural systems always strive to cover bare soil as quickly as possible with a plant cover.

The more complexly designed an agro-ecosystem is, the fewer interventions required to regulate diseases and pests in the system. Massive problems with pests and diseases point to errors in the system that should not be fought, but corrected. Apart from agronomic considerations, the successful development of sustainable systems incorporating cash and subsistence crops requires that further principles of forest dynamics be taken into account.

### Forest Dynamics

Where clearfelling or the collapse of a giant tree has damaged or removed part of the forest canopy, this gap will quickly be closed under natural conditions. The forest "organism" passes through a number of phases in this process that can be compared to the metamorphosis of an insect that only obtains its final form as an adult "individual" after shedding its skin and changing its exterior form a number of times. Simply speaking, the following phases can be distinguished:

**Phase 1 – Pioneer Phase:**
Following the removal of the forest canopy the forest floor is covered by pioneer plants within a few weeks. These pioneer species have a short life cycle of only a few months. The species composition is dependent on site conditions (soil type, slope, solar irradiance, distribution of rainfall etc.).

**Phase 2 – Secondary Forest Phase (Up to 10 Years):**
A multitude of tree species with a variety of life cycles and ultimate heights germinates at the same time as the pioneer species. This phase is characterized by fast growing tree species with a life cycle of only a few years. The dynamic of these fast growing species literally drags all the other species in the system along. The resultant high biomass production enhances soil dynamics and thus the cycling of nutrients and matter.

**Phases 3 (Up to 50 Years) and 4 (Up to 80 Years):**
Secondary forest phase – medium and long cycle: During these phases the forest formations characteristic of the site develop with tree species that can reach ages of up to 80 years.

**Phase 5 – Primary Forest:**
All the preceding phases ultimately lead to the establishment of those tree species that characterize the mature primary forest, with species whose life cycle can span centuries and up to a thousand years.

Coffee and cocoa production for example has gone into crisis because the basic principles outlined above have not been observed. Most of the shade trees for cocoa and coffee belong to the group of secondary forest species with a medium life cycle of between 20 and 50 years (e.g. *Ingas spp.*). If cocoa for example is being grown in the understory of such an ageing and not very diverse secondary forest system, the cocoa with its much longer life cycle ages prematurely together with its shade trees and is eliminated by the system's diseases and "pests" because it can no longer fulfill its function in such a system. Only through understanding and implementing these interconnections will it be possible to breed for resistance and pursue alternative approaches to the control of pests and diseases in such a way that real solutions are provided.

### Selection of Shade Trees

A challenge is the selection of shade trees that originate from other ecosystems or which require different site conditions. Each crop grows best under different shade conditions and shade tree species. Trees of the family *Leguminosæ* such as *Leucaena, Glyricidia, Cordia aliodora* are of great interest since they fix nitrogen from the air.

Agroforestry.

Cocoa farmers in the eastern part of Cuba usually use a shade density of around 40% in cocoa plantations. Generally suitable shade trees are:

- **Leguminous trees:** *Samanea saman* (Algarrobo), *Gliricidia sepium* (Júpiter, Piñon Florido), *Erythrina poeppigiana* (Búcaro), *Guazuma tomentosa* (Guasima), *Leucaena spp., Spondias mombin* (Jobo), Lipi-Lipi
- **Palms:** *Roystonea regia* (Palma real)
- **Fruit trees:** mangoes, zapote, *Citrus*, avocadoes, guapén, breadfruit (Fruta de Pan)

## The Selection of Companion Crops

When selecting the companion crops and native forest tree species to be planted in a cocoa, coffee or banana plantation, it is important to select species from each of the guilds that allow for a multi-tiered vertically diverse forest system. There will only be competition between individual plants if within the same guild more than one species occupies the same stratum (grows to the same height). Depending on the crops a maximum number of trees per square meter are planted[6]. The more densely planted the system is, the less the maintenance work will be required and the more dynamically the system will develop. The continuous thinning of maturing individual plants as well as harvesting open up the system and at the same time continuously add organic matter and woody material to it.

**Table 2: Example of the Progression of a System over Time**

| Year 1 | Year 2 | Year 3 | Years 5-10 | from Year 11 |
|---|---|---|---|---|
| Maize/Beans<br>Pigeon pea (*Cajanus cajan*)<br>Papaya | Pigeon pea<br>Papaya | | | |
| Pineapple | Pineapple | Pineapple | | |
| Bananas | Bananas | Bananas | Bananas | |
| Cocoa | Cocoa | Cocoa | Cocoa | Cocoa |
| Forest trees/<br>Rubber/<br>Fruit trees<br>Palms | Forest trees/<br>Rubber/<br>Fruit trees | Forest trees/<br>Rubber/<br>Fruit trees<br>Palms | Forest trees/<br>Rubber/<br>Fruit trees<br>Palms | Forest trees/<br>Rubber/<br>Fruit trees<br>Palms |

**Harvest Periods**

- Beans (60 - 70 days)
- Maize (90 -120 days)
- Pigeon pea (10 months – 24 months)
- Papaya from 8 months – 24 months
- Bananas from 13 months – several years (depends on varieties planted)
- Pineapple from 12 months – 36 months
- Cocoa and other fruit bearing trees (from 60 months – 100 years)

The example shows that with such a systems the first harvests can be taken from the planted crops after only a few months. Cultivation and maintenance measures should always be combined with harvesting operations and thus be economically supported by the latter. Combinations consisting of a mix of fruiting trees such as avocado, carambola, mango and jackfruit (higher understory) and a density of

[6] For details please consult the handbook Organic Coffee, Cocoa and Tea; chapter 1.11; Editor SIPPO, Naturland, FibL.

Banana in combination with cocoa. (Picture: Joachim Milz).

150 trees per hectare enhance cocoa production. Additionally, sapote (overstory) and para rubber trees (*Hevea brasiliensis*) can be interspersed. For the overstory, particularly trees which shed their leaves should be planted (e.g. *Ceiba pentandra*).

### Improvement and Conversion of Established Plantations into Agroforestry Systems

Existing coffee or cocoa plantations can be converted into agroforestry systems in a number of ways. This question often arises along the conversion of organic coffee or cocoa. The approach taken depends primarily on the existing situation of the plantation. It is not possible to simply plant extra trees into an existing plantation with established shade trees (I*ngas ssp., Erythrinas ssp.*).

One possibility of improving the system is to create small islands of more complex plantings within the plantation. To this end cocoa trees, for example, are identified as deficient or unproductive, or gaps are identified. The unproductive trees are felled and adjoining cocoa trees are heavily pruned. All the shade trees in the sphere of influence of the "island" are pruned back to the remaining crown and the prunings are evenly shredded and dispersed on the ground. All the guild members are planted into this gap (if the area is big enough pioneer plants such as maize can also be planted). In this case it is better to use seedlings started off in a nursery. Bananas and palms should definitely not be left out. The plants of the different guilds as well as those of different heights can be planted at distances of 0.5 – 1m. A number of these "agroforestry islands" will have a positive influence on the dynamics of the entire plantation.

As long as such plantations are of good productivity and do not have pest or disease problems, no major interventions should be undertaken. Such plantations can be converted to organic cocoa plantations with the normal conversion processes, i.e. by abandoning the use of all chemical-synthetic aids and by correctly carrying out all maintenance operations.

### Alley Cropping

Alley cropping is an agroforestry practice adopted in many cases in tropical organic agriculture. Fast-growing trees and shrubs are established in hedgerows on arable cropland and annual food crops cultivated in the alleys between the hedgerows. The hedges are pruned prior to and periodically during cropping cycles to prevent shading of the companion crop, with the prunings applied to the soil as green manure and/or mulch. Hedgerows are allowed to grow freely to cover the land between cropping cycles. Although the majority of hedgerow species are nitrogen fixing, leguminous species, several non N-fixing species have also shown promise. By continuously retaining fast-growing, particularly nitrogen-fixing woody perennials on croplands, it is hoped that their productivity-restoring attributes (e.g., nutrient cycling, weed suppression, erosion control) would create soil conditions similar to those in the fallow phase of shifting cultivation. Thus, in an alley cropping system, the cropping and fallow phases can take place concurrently on the same land, allowing the farmer to crop the land for an extended period when socioeconomic conditions do not allow adequately long fallow periods for sustaining soil productivity.

Alley cropping is based on the hypothesis that trees improve the nutrient status of soils beneath them. In alley cropping, hedgerow woody perennials can improve soil fertility by adding nutrients to the soil and reducing nutrient losses from the system. The practice of periodic lopping of the hedgerows and addition of the harvested biomass to the alleys facilitates the transfer of nutrients from trees to crops and can minimize the tree-crop competition for light, water and nutrients. It is important to note, however, that most farmers place higher values on economic and social factors than biophysical factors when selecting trees for their crop lands.

Commonly used hedgerow species in the humid tropics for alley cropping:

- *Cajanus cajan*
- *Calliandra calothyrsus*

- *Erythrina spp.*
- *Flemingia macrophylla*
- *Gliricidia sepium*
- *Inga edulis*
- *Leucaena leucocephala*
- *Paraserianthes (Albizia) falcataria*
- *Sesbania sesban.*

*G. sepium* and *L.leucocephala* are the two species most suitable for use in alley cropping because they can be established easily by direct seeding, withstand repeated prunings, produce large amounts of biomass and nutrients, and are relatively long-lived. *Flemingia macrophylla* has performed well in the humid zone on acid and low base soils.

## 1.10 Conversion to Organic Farming

The conversion from a conventionally managed farm to organic farming should not only improve the farm ecosystem, but also assure the economic survival of the farm. Therefore, the adjustments that are required on the farms for a conversion and the related chances and risks have to be analyzed carefully. Conversion to organic farming requires a new way of thinking, too. The whole farm family should get ready for the conversion in many aspects. The first and probably the most important conversion has to take place in the mind of the farmer.

### 1.10.1 The Conversion Process

Regulations concerning the conversion period vary. Below, the conditions for the IFOAM Basic Standards and EU Regulation for producers are listed. The EU regulation, for example, demands a conversion period of 2 years for annual plants and three years for perennials. In some private standards, partial farm conversion or step by step conversion are not allowed.

National Regulations may, however, still be different; therefore it is necessary to consult them in advance (see Part D).

According to IFOAM Basic Standards, the totality of crop production and animal husbandry shall be converted to organic management. Step by step conversion is possible as long as the different production units are clearly distinct and organic products cannot be mingled with conventional ones. Products can be certified after the farm has finished a conversion period, during which all the relevant standard requirements must have been met from the beginning. For certification of annual crops, the standards ought to be met at least for twelve months prior to the start of the production cycle, i.e. before planting or sowing the crop. For perennial plants, at least eighteen months of fully organic management is required before the first harvest.

The start of the conversion period is usually calculated from the date of application to the certification body, when farmers commit themselves to following the standards. However, a full conversion period is not required where de facto full standards requirements have been met for several years and where this can be verified through numerous means and sources. Still, inspection needs to be carried out prior to the first harvest. During the conversion period, products can be labeled as "produce of organic agriculture in the process of conversion" or the like, provided standard requirements have been met for at least 12 months.

#### Social, Technical and Economical Adaptations

The changes in the conversion period concern social, technical and economic aspects. Each sector poses its own challenges to the farming family.

**Socially:** Organic farming is more than an innovative technology but involves a holistic way of thinking. Therefore, farmers should compare their personal values with the principles of organic farming. The more they match, the easier it will be to follow organic farming, as the motivation needs to come from inside rather than from mere economic considerations. For many farmers, it is also important how relatives, neighbors and friends perceive organic farming, because not everybody has the strength to oppose his/her social environment.

**Production Techniques**: New farming methods need to be introduced and applied. These concern soil management, nutrient management, weed management, pest and disease control, animal husbandry, fodder cultivation etc. In order to be successful, the necessary know-how has to be acquired. The farmer will need to exchange information with experienced organic farmers, attend trainings, test methods and observe their effect, read publications etc.

**Economically:** For some adaptations on the farm level, new materials are needed, therefore requiring some investments. Some adaptations also involve an increase in the work load or labor requirement. As the quantity of the production may decrease at least in the first years of conversion, farmers needs to find ways to overcome the constraints. New marketing channels may be explored in order to receive a premium price for the products, which again requires a very different kind of know-how.

**Favorable Conditions for a Conversion Include:**

- Motivation for a sustainable farm management
- Readiness to try new things
- Interest in continuous learning
- Harmony among the generations about the orientation on the farm
- Solid knowledge on organic farming methods
- Ability to secure livelihood if the income drops in the conversion period
- Farm system is appropriate to the location site of the farm

### 1.10.2 Ready for Conversion?

Before taking a decision on whether to convert the farm to organic management, farmers should have a clear understanding of what organic management will mean to their farm. Training courses, suitable print materials and professional advice are possible sources of knowledge. It is important that all persons involved in the farm, usually the farmer's family, are involved in the decision making process. In the next step, the situation of the farm should be analyzed carefully, considering the requirements of organic farming. Thus, the necessary adaptations can be identified. Support from field advisors or experienced organic farmers can be of great help in this analysis. In order to become familiarized with the methods of organic farming and to see whether they would work in the prevailing conditions, some methods can be tested on a small scale.

## Defining the Aims of the Farm

Do all family members have the same idea about conversion to organic farming? What are their individual expectations? The farming family needs to define what they wish to achieve through a conversion. Many questions need to be taken into consideration:

- What are the aims of each family member concerning income?
- Shall the products be sold at a premium price or not? If the farmer wants to use an organic claim or label when selling the products, certification becomes an important issue (see chapter 6).
- Shall food for own consumption (cereals, tubers, fruits, vegetables, milk, eggs, meat etc.) be produced? What is the work load for each family member?

## Farm Analysis

In order to improve the conversion process and to overcome the possible obstacles, the present situation of the farm should be analyzed carefully. Some aspects of the present farm may be favorable for a conversion, while others can be obstacles for which solutions must be identified. The following aspects should be analyzed:

- The farming family, their capacity to try new things, the know-how and motivation.
- Size and quality of the land holding, the climatic and environmental conditions.
- Soil type, fertility and structure, water availability, and present management.
- Present cropping system, crops suitable to the conditions, dependency on single crops.
- Nutrient supply with own manures from the farm and fertilizers brought from outside.
- Present pest, disease and weed management, and the pressure of infestations.
- Number and kind of farm animals, significance of farm yard manure, fodder cultivation.
- Mechanization (tools, machines), constructions (sheds, pits, terraces etc.).
- Marketing of products, subsistence.
- Availability of labor, overall work load, peak seasons.
- Economic situation of the farm, its sources of income, depths, access to loans.

### Testing Organic Farming Methods

The closer the present farming system is to organic farming principles, the easier the conversion will be. Before taking a decision to convert to organic farming full-scale, farmers may make some trial runs with organic methods in their farm. If new methods are applied, it is always advisable to try them first on a small scale, as this allows the farmers to check their suitability to local conditions and it avoids large losses in case of failure. The following methods could be tested:

- Integrating a new crop in rotation or as a mixed crop.
- The effect of commercial organic manures.
- Use of a leguminous cover crop in perennial cultivations.
- Use of natural pesticides to control pests and diseases.
- Increasing the outdoor and pasture access of the animals.
- Growing a fodder crop to replace feed concentrates.
- Trying herbal remedies for veterinary treatment.

### 1.10.3 Conversion Planning

Once a decision is taken to go for organic farming, the implementation of the necessary adaptations identified in the farm analysis needs to be planned. The conversion plan should prevent the transition period from being too tough: it should prevent major problems, minimize the risks, avoid bad investments and, last but not least, encourage the concerned persons in their endeavors. Generally, one should be aware that the higher the investments and the more adaptations needed on a farm, the higher the risk and greater the need for adequate planning.

The first step of a conversion plan is to carefully analyze the necessary adaptations on the farm based on the current situation, examining the farm aims and the requirements of an organic system. As an 'ideal' system cannot be established immediately; single steps to achieve the necessary adaptations are defined, if possible, with a schedule. In order to obtain; organic certification, the conversion period officially starts only after all minimum requirements of the standards are met.

## 1.11 The Economic Performance of Organic Farms

The motivation of farmers for organic agriculture are manifold, such as sustainable use of nature, healthier food production or more efficient use of farm own resources. Yet, in order for organic production to be a feasible option for farmers, not only their motivation is important, but also economic aspects. Only if the farm production allows to fulfill the subsistence and income needs of the farmers, are able they to make a living from organic farming.

Several factors influence the economic condition of a farm. Changes in expenses and income need to be analyzed. As the factors vary from farm to farm and from country to country, it is necessary to analyze the economic potential of the farm in order to reduce risks and avoid disappointment. In general, the more changes and adoptions are needed on a farm, the higher is the economical risk of conversion.

### 1.11.1 Costs and Returns

The economic performance of a farm can be measured by the profit which remains for the farmer as his income. This profit depends on production conditions and marketing possibilities, and it is the difference between costs and returns. Production conditions and marketing possibilities vary from country to country, and even from farm to farm. Fixed costs (which do not directly depend on the size of the production) are costs for buying or renting land, buildings or machinery and salaries of permanently employed laborers. Wages for labor hired for specific tasks (e.g. harvesting) depend on the production size and are therefore variable costs, as costs for inputs are (e.g. seeds, manure, pesticides). A farm will only be economically viable if the returns exceed the total variable costs and the depreciation of the fixed costs. The main returns are the money earned by selling the products in the market. In a few countries, the government provides direct subsidies to organic farmers. But in order to understand a farm family's benefit from the farm activities, the savings on food expenses and the income possibly earned from outside the farm (e.g. as hired labor or from other business activities) must be taken into consideration, too.

### Lower or Higher Costs?

Will production costs go up or down when changing to organic farming? The factors influencing the costs during and after a conversion are diverse and depend on the type of farm (‘traditional’ or 'intensive'), the kind of production (which are the main crops? is the animal husbandry included?) and the environmental and socio-economic conditions. A generalization is therefore questionable. In typical cases of tropical smallholder farms, input costs initially go up because farmers have to purchase organic manures to build up soil organic matter, and besides machinery and labor costs for distributing the organic manure, for weeding and for adapting the farming system may increase. Once good soil fertility has been achieved and the farm system has reached a certain balance, production costs usually go down to the pre-conversion level or even below, provided the costs for agro-chemicals were high and the farm manages to rely mostly on its own resources.

### Lower or Higher Returns?

In temperate zones, where conventional agriculture manages to produce very high yields, conversion to organic farming usually results in lower yields (10 to 50 % lower), depending on the crops and farming system. Many farmers in tropical smallholder farms, however, reported that their yields returned to the previous level after the conversion process was complete, and some even achieved higher yields than with conventional agriculture. This may be possible under certain conditions, especially where the soil fertility decreased due to high pesticide and herbicide use, causing conventional farming to achieve lower yields each year. It is dangerous, however, if false expectations are raised among farmers. Hence the situation must be assessed individually in each region and on each farm. To be on the safe side, farmers interested in converting to organic agriculture should expect a drop in yields in the initial years and a certain recovery after some three to five years. It seems that this recovery of yields can be higher the more humid the climate is and the more the soil fertility depends on its organic matter content.

Returns depend not only on the yield quantities, but also on the price achieved in the market. If the quality of the product decreases after conversion to organic farming because of more damages due to pests or diseases, it may be difficult to sell the harvest at the same rate as before. Many farmers, however, hope to get a premium price for their organic products once the farm is certified. Whether this is realistic will depend on the market situation and on whether the farmer manages to access premium price markets (see below). To be on the safe side, farmers should not depend too much on the expected premium price when converting their farms. Positive economic results can also be achieved e.g. when selling the same amount of yields at the same rate, but produced with less costs.

## 1.11.2 Reducing Expenses

The income of a farmer is the difference between cost of production and returns. Consequently, the income can not only be improved by achieving higher yields, but also by reducing the cost of production. Some ways to reduce expenses are given below.

### Optimizing Recycling

An effective way to reduce expenses on manure inputs is to recycle a maximum of material on the farm. Most important for an efficient recycling of nutrients, is the management of the farmyard manure. Whatever nutrients the farmer manages to recycle do not have to be purchased from outside. Another example: Pruning from trees and hedges can be used as firewood and their twigs and leaves as mulching material, and kitchen waste, together with organic materials from the fields can be turned into compost.

### Minimizing External Inputs

Organic farming is a kind of low external input agriculture. However, some organic farms are heavily dependent on purchased organic manures, commercial organic pesticides and other inputs. Besides a better recycling of nutrients (see above), there are some more ways to reduce expenses:

- Use local plants to prepare your own botanical pesticides.
- Produce your own crop seeds and seedlings.
- Look out for locally available sources of manures, e.g. by-products from agricultural processing plants.
- Grow your own food, e.g. vegetables, staple food, fruits, cereals.
- Keep animals to produce your own manure, milk, eggs, meat etc.
- Produce fodder from your own farm instead of buying (organic) fodder from outside.
- Share equipment and machines with your neighbors and get them assembled locally instead of buying or importing.
- Use locally available materials for constructions (e.g. compost pits, sheds, tools etc.).
- Join with other farmers to form saving groups in order to avoid relying on loans with high interests.

### Reducing the Work Load

Even if labor compared to input costs may be cheap in many tropical countries, farmers will in the long run invest their own or hired labor only if there is sufficient benefit in the results acquired. There are many ways to reduce the amount of work on the farm. Preventive measures of organic pest and disease management, for example, help to reduce future work. Reduced soil cultivation through the use of mulch, partial weed tolerance or the clever arrangement of shed systems in animal husbandry are other frequently practiced methods. Certain activities however should not be neglected even if they pay off only after a certain period of time, as it is the case with measures to build up organic matter contents, in soil.

## 1.11.3 Ways to Increase the Returns

A positive balance between costs and returns is the base for an economically sound way of doing organic farming. The returns are the product of the total outputs and their price achieved in the market. Therefore, to increase the returns, the following approaches can be used:

### Increasing the Production

Total farm productivity can be improved by using more suitable varieties of crops which give good yield in local conditions. Crop yield can sometimes be increased through better nutrient management and more efficient pest and disease management. Additional crops can be integrated in the cropping system through mixed cropping or crop rotation, thus using the available space more efficiently. Another option is to integrate animal husbandry on the farm to achieve additional products.

### Value Addition on the Farm

- In order to increase the market value of the farm products, farmers can:
- Choose products which are of high market value (e.g. medicinal plants, spices).
- Achieve a better quality for the products, e.g. by improved handling.
- Engage in simple on-farm processing like threshing, milling, fermenting, grading, cleaning.
- Produce processed goods, e.g. jams, dried fruits, pickles.
- Produce dairy products (cream, butter, cheese, yogurt, curd etc.).
- Store products, as off-season prices are sometimes considerably higher for certain crops.

### Accessing Better Markets

The income depends on the quantity of yield and on the prices of the products paid in the market. In some countries, farmers get exploited by middle men who pay low but sell at a high price. If this is the case, direct marketing of products can be an option.

Many farmers expect to get a premium price for their organic products, as they are of better quality (less pesticide residues, better taste etc.). In many countries, however, the market for organic products with premium prices is still very small. The premium price for organic farm products varies considerably from product to product and depend on the market channel and selling region; from 0 premium to double price everything is possible. The average is around +25 % on the conventional price.

Wholesalers may offer sales guarantee in return for a regular supply of certain items. As a single farmer may not be able to provide a sufficiently large quantity to the wholesaler, forming a producers' association can be advantageous.

Export markets are promising due to the sometimes the high premium price sometimes paid for organic quality. However, it is very difficult to meet the requirements of these markets, and usually only groups of farmers linked with professional traders are capable of surpassing the hurdles.

Successful marketing requires specific know-how, which cannot be dealt with in this book due to limited space.

### Diversity to Reduce the Economic Risk

The income of many farmers depends directly on the sale of the harvest of one or two crops. If prices for these commodities drop, these farmers inevitably face tremendous problems. Even with stable prices, large losses can occur when yields suddenly drop, e.g. due to pest or disease incidence which could not be sufficiently controlled.

Diverse farms with a range of crops will suffer less from price fluctuations or yield reductions of single crops. Crop diversity therefore is not only helpful for establishing a balanced ecosystem and avoiding the spread of pests and diseases. It also helps the farmers to avoid taking a considerable economic risks.

# PART B

# Organic Cultivation of Fruits and Vegetables

2

# Organic Fruits

## 2.1 Citrus

Main production areas of organic citrus are Latin America, North America, Europe and Near East. Smaller quantities are produced in Africa and Asia. While fresh fruit is produced mainly in Mediterranean climate, citrus for juice is predominant in tropical and subtropical climates because of higher possible sugar contents.

The production of organic citrus is still less than 1% of global citrus production. However, it is increasing year-by-year, in parallel with the increasing demand for organic products. Organic citrus for juice is mainly produced on large-scale plantations. However, especially in organic production, small holder and co-operative land use in the tropics offers opportunities in fruit juice production, and in some regions are a source for citrus juice production (e.g. Mexico, Cuba). Many tropical countries in the Americas are extending organic citrus production. Major importing countries include most European countries.

Citrus plantation in South Africa.

### 2.1.1 Agro-ecological Requirements and Site Selection

Although citrus trees can be grown over a wide range of climatic and edaphic conditions, proper site selection remains the key to successful organic production. Important factors are:

- Climate;
- Soil characteristics;
- Availability and quality of irrigation water;
- Proximity to packing or processing facilities;
- Availability of sufficient mechanization and labor for organic production;
- Costs associated with land and equipment purchase.

#### Climate

Citrus is en evergreen plant of subtropical and tropical origin. The magnitude of the commercial production is situated between the latitudes 40°N to 40°S where minimum temperatures are greater than –7°C. The climate has a significant effect on nearly all aspects of citrus growth and quality development. This is especially important for organic growers because their possibilities for direct measures in plant protection and plant nutrition are generally less effective compared to conventional management. Therefore, a successful organic grower must carefully choose a location for citrus production and adapt his management methods to the local climate. Some examples of how climate determines fruit yield and quality:

- Yields from Mediterranean climate increase gradually with the age of the orchards, peaking at 20-25 years. Many orchards in Mediterranean climate are over 200 years old. Yields in low tropical regions reach a maximum age of 10-15 years. Higher pest and disease pressure accounts for lower longevity in these regions.

- Highest yields are achieved in the humid subtropics. Yields in semiarid or arid subtropical regions are lower. Yield potential in tropical regions is influenced by poorly drained and nutrient-deficient soils, lack of irrigation, fertilization and pest control. Sweet orange yields vary from 50-100 tones per ha in humid subtropics to 15-30 tones per ha in tropical regions. Organic citrus growers' experiences show minor differences in yield in organically and conventionally managed citrus orchards.
- High temperatures and water deficit in early summer cause physiological drop of fruit (when they approach 0.5-2 cm diameter), especially in semiarid or arid subtropical regions.
- Yields vary considerably from year to year due to climatic factors.
- The percentage of marketable fresh fruit is generally higher in semiarid or arid subtropical climates than in tropical climates due to less disease and pest pressure and more intense peel color. In tropical regions, where average temperatures remain high all year, chlorophyll levels remain high for oranges and mandarins and the fruit peel stays green.
- In tropical regions (between 23.5° north and south), greater heat accumulation during the night increases respiration losses leading to decreased levels of soluble solids and acidity in the fruits.
- Adequate soil moisture by rainfall or irrigation significantly improves fruit size.

### Inducing Flowering

Water and temperature regulate the date, duration and extent of flowering. Flower bud induction starts during the winter at the end of the vegetative growth stage. Where winter temperatures are not cooling down, inducing water stress is a practical method for flower bud induction. Generally, trees will flower 3-4 weeks after irrigating. Application of hormones like gibberellic acid to inhibit flowering, or hormones to induce flowering, are not allowed in organic production. High nitrogen nutrition (leaf nitrogen levels around 2.8 – 3.0 % dry matter) promote vegetative growth rather than flower set. Low leaf nitrogen levels (around 2.2 – 2.4 % dry matter) are often combined with extensive flowering. Maintaining leaf N in the optimum range (2.5-2.7 % of dry matter) leads to a moderate number of flowers but greatest fruit set and yields.

### Soil Characteristics

Citrus can be grown over a wide range of edaphic conditions ranging from coarse sands of low nutrient content, sandy loams, moderate to heavy loam soils and even on ferralitic tropical soils. Citrus trees generally grow best at a soil pH between 5.5 and 7.0, due to the generally adequate availability of nutrients there. Soils with a pH lower than 5.5 can be subject to aluminum toxicity or phosphorus deficiency; pH can be increased by liming. Remark: pH measured in water is usually 0.7 to 1.1 units higher than measured in calcium ammonium acetate CAL.

Choosing a site with adequate drainage is important for successful citrus production. Citrus trees growth is reduced in poorly drained soils or where compacted soil layers are present in the root zone. Furthermore, poor drainage causes problems with phytophthora and other soil borne diseases. Root and tree growth are also restricted in soils whose clay contents exceed 50%.

### Availability and Quality of Irrigation Water

Availability of good quality irrigation water is important for economically viable yields, especially in semiarid and arid regions. In many arid regions, water quality is marginal for organic citrus growing due to salinity and contamination with heavy metals or other toxic substances. Before selecting a site for organic citrus production, a water analysis is essential.

**Characteristics of a Successful Site Selection for Organic Citrus**

- Climate which permits a good development of the orchard;
- Deep and well drained soil with adequate biological activity;
- Topography which permits use of mechanization;
- Irrigation water of low salinity, heavy metal content and absence of human toxic microorganisms e.g. coli bacteria.

## 2.1.2 Establishing an Organic Citrus Orchard

### Suitable Cultivars

Most citrus orchards consist of budded trees that combine favorable attributes of the scion and rootstock. The choice of the rootstock is a major consideration for organic citrus growers: the choice should be based on the most important limiting factors, in particular local climate, soil conditions, cultivar and intended use (fresh or processed). Sour orange (*Citrus aurantium L.*) is the most widely planted rootstock in the world. It is an excellent rootstock for areas free of Citrus tristeza virus. Rough lemon should be avoided in areas known to have blight. Carrizo is a widespread rootstock but burrowing nematodes are a problem. Genetically modified Citrus rootstocks and culitvars are not allowed in organic production.

Choosing the cultivars for organic production, factors like disease resistance, drought resistance and quality are as important as yield performance. Navels and Valencias are the predominant orange cultivars. In the tropics, where oranges are grown mainly for juice, the predominant combination is Valencia late orange trees [*Citrus sinensis* (L) Oesbeck] grafted on sour orange rootstock (*C. aurantium L.*).

When providing trees, it is highly important to order certified trees where the absence of diseases, pests, viruses and authenticity of rootstock and cultivar are guaranteed. In different organic label regulations, the use of trees from certified organic nurseries is compulsory from 2004 on. At present, the detailed regulations e.g. for the case where organic trees are not available, are very dynamic. Therefore, the actual regulations should be checked carefully with the certification body before ordering any plantlets.

### Propagation and Nursery Management

Dissemination of diseased or unsuited cultivars or rootstocks can have catastrophic effects on the productivity of citrus orchards. Therefore, most countries have stringent regulations for nursery management and the quality of the plantlets. Citrus rootstocks are propagated by seed. GMO-free seeds are compulsory for organic production. Citrus seedlings are susceptible to soil-borne diseases and pests as phytophtora, pythium or nematodes. The use of virgin sites is very important in organic production; it reduces the risk of soil-borne diseases and pests. Before planting the rootstock in the nursery, well fermented compost (according to soil analysis, e.g. 10 tones per ha) should be applied. At sites low in phosphorus, the application of mycorrhizal fungi supports the uptake of phosphorus. Fertilization, irrigation and pest control practices must comply with organic standards.

### Orchard Design

Pest and disease management tools in organic citrus production are less effective than conventional (chemical-synthetic) products. The organic citrus grower cannot count on a single product to solve one specific pest or disease attack. He depends much more on a successful combination of indirect and direct management methods (see chapter 1.6). The first and most important measure is the design of the organic orchard based on the ecological principle: the higher the diversity of present species, the higher the stability of the agro-ecosystem in the orchard.

The overall objective of any orchard design in organic fruit production is to improve bio-diversity in order to maximize the self-regulation forces of nature. This is done by:

- Creating a diverse mosaic of citrus units, mixed with ecological compensation areas such as specific cover crops in the alleyway and under the trees as well as hedges and wild flower fallow plots around and in the orchard (see chapter 1.8);
- A plant density that permits optimal light interception and aeration. This shortens the duration of leaf wetness and thus disease development;
- Use of environmental friendly equipment and construction materials for the orchard.

The establishment of ecological compensation areas around the orchard and between the plots with a stable and high degree of biodiversity to form ecological connection corridors is essential in creating a habitat for natural enemies of pests. Furthermore, an ecologically diversified orchard with a high degree of bio diversity is aesthetically very attractive. A value point that is also highly regarded by the (organic) customers.

Generally, citrus grows successfully in a wide range of plating systems. Tree spacing ranges from 8 x 8 m (156 trees per ha) in Cuba or Florida to as close as 1.5 x 3 m (2222 trees per ha) in central China. Usually, lower density plantings (156-300 citrus trees per ha) are better adapted to the organic production system than high density plantings (> 300 citrus trees per ha), mainly for three reasons:

- Organic cultural practices are considerably more troublesome in high-density plantations: often it is not possible to saw in a cover crop (see chapter 1.2.3).
- Mechanization in narrow alleyways is more complicated and expensive (spray application, soil management, compost application, harvest).
- High-density plantings reduce ventilation and light interception and thus increase disease pressure.

**Transplanting and Plant Density**

In tropical areas with high rainfall, the juvenility period is considerably shorter than in arid subtropical regions with suboptimal irrigation. Growth retardants to accelerate flowering (e.g. paclobutrazol) are not allowed in organic farming.

Some months before planting citrus trees, organic growers can saw in vigorous legumes (e.g. Canavalia sp. or Cayanur cayan) and later mulch them shortly before planting the citrus trees. Through this measure, the soil will be enriched with organic matter and nitrogen, both of which stimulate soil microbial activity. The next step is to lay out the irrigation system and dig out the planting holes. The trees should be planted at the same depth as they were grown in the nursery. Often, citrus trees are planted too deep. This exposes the susceptible scion to root rot diseases. Also the scion can start to root itself, neutralizing the beneficial effect of the rootstock.

Citrus soil cover with leguminose plants.

## 2.1.3 Soil Management

The building-up and maintenance of a high soil fertility is a central goal of organic agriculture. In the grower's practice there are three main agronomic questions related to soil management and the conversion to organic management of citrus orchards:

- How to improve soil fertility?
- How to cover the soil and how to control undesired plants?
- How to provide sufficient nutrients to the soil and citrus trees?

Careful soil management is especially important in the tropics, where heavy rainfall and strong solar radiation accelerate soil degradation, leaching of nutrients and erosion. Relevant soil management techniques for organic citrus orchards include:

- Use of cover crops (understorey) plants, mulching, agroforestry and intercropping methods;
- Composting, and the use of natural mineral fertilizers (e.g. rock powder, rock phosphate, potassium sulphate);
- Mechanical techniques for weed control.

These basic tools of organic soil management are interdependent and influence tree health, tree development, yield and fruit quality.

### Soil Cover Systems

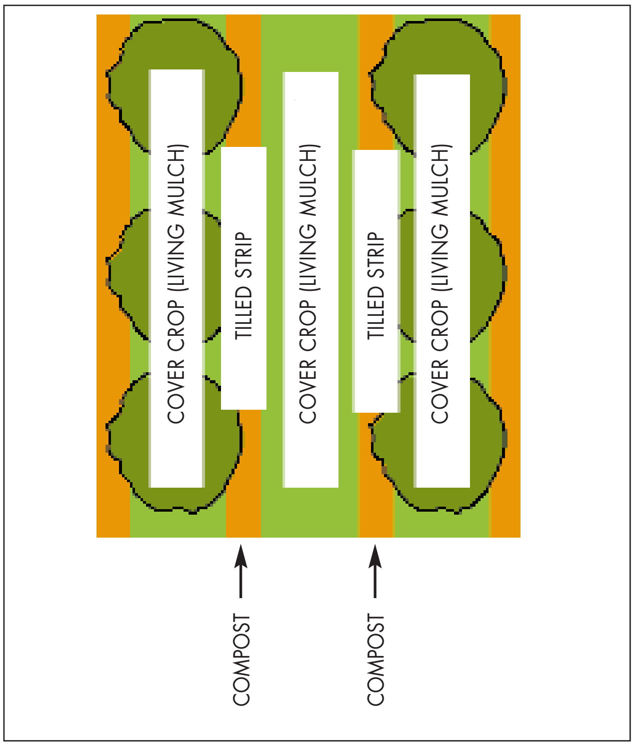
While in conventional citrus production in the tropics even flat soils can suffer from erosion due to the abundant use of herbicides and the lack of soil cover, in organic orchards a long term – if possible permanent soil cover – is an important component of the system. Locally adapted leguminous crops, such as *Teranamus labialis, Arachis pintoi, Neonotonia wightii,* can help restore degraded soils very quickly; they successfully suppress weed, fix nitrogen and prevent erosion (experiences of a project in Cuba).

### Cover Crops Have a Number of Important Agroecological Advantages in Citrus Orchards. Cover Crops:

- Balance the soil climate (temperature, humidity);
- Improve soil structure;
- Increase water and nutrient retention capacity;
- Protect from erosion;
- Deliver primary energy (root exudates) energy and organic matter for soil microbial life;
- Suppress undesired vegetation;
- Cover crop plants serve as habitats for natural predators. Leguminous cover plants fix air-bourne nitrogen that becomes available in parts for citrus crops.

Cover crops may compete with citrus for water, but rarely for nutrients. This competition can be minimized by suitable management of the cover crop: mulching the cover crops before the dry season and by utilizing optimal adaptation of the soil cover system to the soil, crop and climate conditions. One possible solution is the sandwich-system, which is in testing phase. The sandwich-system and the traditional cover system are two soil cover variants that are applied in organic citrus growing. Intercropping and agroforestry are more suitable for small farmer co-operatives and subsistence farming.

**Figure 1: Sandwich-System**



The Sandwich-System was developed by the Swiss Reasearch Insitute for organic agriculture (FibL). It consists of a narrow strip (30-60 cm wide) of cover plants in the middle of the tree strip. At the left and right side of the middle strip, the soil is cultivated for weed control with relatively simple tools. Thus, in the case of trees, the soil volume without weed competition is the same as in the traditional cultivation over the whole width of the tree strip. However, the mechanization necessary is much simpler and cheaper.

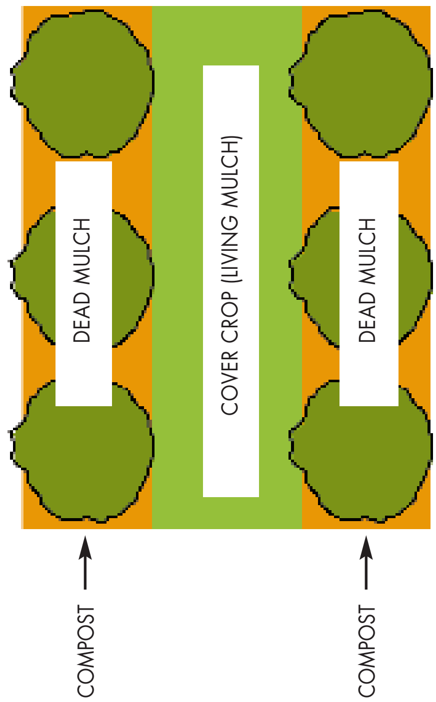
The Sandwich-system allows a fully organic nutrition concept with application of compost on the tilled strips. Composts, mulches and fertilizers are applied mechanically on the tilled strips and tilled-in to 5 cm depth.

The alleyway is covered by a (preferentially) leguminous cover crop. In dry areas it is often not possible to have a permanent crop cover. In these areas it is therefore recommendable to have a green cover crop during the rain season that should be supplemented with dead mulch during the dry season.

The Sandwich-system achieves several goals of organic farming: Soil cover with valuable crops, avoidance of erosion, target-oriented organic fertilization, avoidance of competition in the main rooting zone.

The Sandwich-system is highly feasible for young plantations, and in orchards with deep soils where tree roots are not too close to the soil surface. However, in orchards formerly established with herbicides and soil erosion, "dug out" citrus roots are sometimes present. In the above mentioned case, it would be too harmful for the trees to change to a cultivation system. In these cases systems, cover crops or organic mulches should be used. In such orchards, the traditional cover crop system is the suitable method.

**Figure 2:**
**Traditional Cover Crop**




The traditional cover crop system still is known by older citrus growers and was widely applied in citrus-plantations before the green revolution. Compost and other fertilizers are applied in the tree strips.

- The alleyway is covered by a leguminous cover-crop.
- The traditional cover crop system needs specific, relatively expensive equipment for the mulching under the trees.

## Intercropping

For smallholders, it is useful not to rely on citrus production alone. However, other tropical fruit trees species presently lack a production level that permits real market potential. Thus, space to grow additional crops is limited to the alleyway. Successful examples are beans and corn for self-sufficiency supply (e.g. in Cuba) or Aloe vera (e.g. in Mexico). The Aloe vera extract finds multiple uses in the cosmetic, pharmaceutical and fruit juice industry. The advantage of Aloe vera is that it is quite shade tolerant and has been planted among citrus and other fruit trees with great success. Producers who select an intercropping system have to be aware that cultural practices can be considerably affected compared to a orchard with citrus only. Much more hand work is necessary in intercropping systems.

**Agroforestry**

As examples in Eastern Cuba or the Mexican peninsula of Yucatan show it is possible to produce organic citrus successfully also in agroforestry systems. In agroforestry systems, citrus trees are mixed with other fruit trees, leguminous trees, banana, palm trees, coffee and cocoa, beans and other species covering the soil. The high degree of diversity decreases the risks of disease infestation and enhances ecological pest control through the appearance of a highly diverse bird and insect communities that are abundant in the different layers of the trees and bushes. Of course, citrus yields per ha in such a system are considerably lower than in classical orchards. But as a compensation, the grower can count on a large number of crops throughout the year for his self-sufficiency. With an agroforestry system; market success is only obtainable if at least one high quality product (cash crop) can be grown. The high socio-economic and ecological value of agroforestry systems is obvious, but market access for its products is often difficult. Furthermore, the effects of agroforestry systems on citrus fruit and juice quality have yet to be studied further.

## 2.1.4 Tree Nutrition and Fertilization

Fertilization practices in conventional citrus production aim to guarantee yields and fruit quality. Tree nutrition in organic citrus growing has additional objectives:

- To strengthen plant vitality
- To minimize pest and disease problems
- To avoid nutrient losses by leaching or volatilization
- To improve soil microbial life

Therefore, organic fertilization is based primarily on organic material, such as farmyard manure, compost from plant residues, green manure. Only if necessary – on basis of soil or leaf analysis – additional commercial organic fertilizers are brought into the system. Consequently, there is an important mass of aerobically decomposed organic matter cycling in the system. Materialization and decomposition processes are influenced by humidity, temperature and availability of oxygen. Under the humid tropical conditions these processes run faster and continuously all year long, whereas under colder climate conditions these processes are slower and come to a standstill during the colder months. Soil type also plays a role. Sandy soils dry out fast, slowing down the decomposition processes; ferralitic soils, on the other hand, are generally not very fertile but usually show fast decomposition and building-up of stable organic matter.

Citrus fertilization with compost.

**Table 3:**
**Importance, Needs and Application of Nutrients in Organic Citrus Production**

| Nutrients | Important to Know | Fertilization |
|---|---|---|
| Nitrogen (N) | • Important for vegetative growth, yields and fruit quality;<br>• N-deficient leaves become yellow and pale. Fruit quality decreases: higher acidity, lower in sugar and vitamin C;<br>• Highly soluble and mobile in soil and (40-70% of mineral can be lost because of leaching and volatilisation);<br>• Antagonist of Cu; | Organic regulations limit annual N-applications. BIO-SUISSE for example currently allows maximum 160 kg N per ha and year for citrus orchards. This corresponds to the N export of 33 t/ha oranges (1,6 kg N/t fruit plus tree growth plus losses). The N-fertilization of each farm is evaluated individually.<br><br>Example of N fertilization in organic citrus production on basis of farm-own – sources:<br>1. Compost (below): With 10 t/ha around 150 kg Ntotal/ha and 75 kg Neffective/ha are applied (1-2 applications, mainly in mid-winter);<br>2. N-fixation through leguminous cover crops yields between 40 and 60 kg N/ha;<br>3. In addition, azotobacter bacteria fix additional air bourne N;<br>4. If necessary and based on soil and leaf analysis other, commercial N-sources can be applied, such as: algae products, vinasse (malt extract) fish meal or oil, horn meal and guano. |
| Phosphorus (P) | • Essential element for cell structure and energy systems. Enhances productivity and fruit quality;<br>• P-deficiencies: very rarely demonstrate symptoms; reduction in bloom intensity and fruit size;<br>• Citrus trees require relatively low quantities;<br>• Immobile in the soil and tends to accumulate;<br>• Annual application mostly not needed;<br>• Antagonist of Zn; | Compost applications mostly bring enough P. In combination with micorhizza-application, enough P is accessible for the trees.<br><br>In case of P deficiencies, materials with high P-content should be used in compost production (e.g. citrus-pulp and peel, chicken or pig-manure). However, in many cases compost is high in P and problems of Zn-antagonism are of greater concern that P-deficiencies.<br><br>If compost application does not solve deficiency problems, the application of rock phosphate is a solution. However, in citrus production, are mostly not needed. |
| Potassium (K) | • Regulates ionic balances in the cell, fruit size, quality and peel thickness;<br>• K-deficiency: small fruits with thin peel, splitting of fruit;<br>• Naturally high in some soils; no annual application needed;<br>• Mobile, losses by leaching can occur;<br>• Antagonist of Ca and Mg; | Compost applications mostly provide enough K.<br><br>In case of deficiencies, materials with high K-content should be used in compost production (e.g. wood-ashes).<br><br>Other potassium sources allowed in organic farming, such as pot-ash, potassium sulphate or stone powder are needed very rarely in citrus production. In case of deficiency symptoms, soil and leaf analysis are recommended. |
| Calcium (Ca) | • Important for enzyme functioning and quality;<br>• Ca-deficiency: rare, not distinguishable symptoms;<br>• Calcium is an important element to stabilize soil aggregates and thus soil physical and soil biological properties;<br>• Excessive Ca contents in soils (pH in CAL > 7) reduce the availability of Iron, zinc and boron; | Soils with pH (CAL) lower than 5.5 should be limed to pH 6.5. If the soil is very alcaline (pH higher than 7.5) contact your adviser to discuss whether and which measures should be taken. |
| Magnesium (Mg) and Micro-nutrients | • Essential for enzyme functioning;<br>• Mg-deficiencies: causes chlorosis and should be corrected;<br>• Zn- (smaller leaves) and Fe-deficiencies (chlorosis) are very widespread, especially in soils of high pH;<br>• Mn-deficiencies only require corrections in severe cases;<br>• Cu: sufficient applied with fungicides;<br>• Mo-deficiencies are very rare (low pH); | Magnesium and Micronutrients generally are abundant in soils of pH 5.5-7. Deficiency symptoms also appear, when soil conditions are not favorable and therefore may be corrected by:<br>• Optimizing pH;<br>• Improving soil structure and aeration;<br>• Avoid antagonisms (avoid exaggerated N, P and K-applications).<br><br>Furthermore, abundant quantities of micronutrients are applied through compost. In most cases it is not necessary to apply additional micronutrients<br><br>If after soil amendments and compost applications deficiency-symptoms still appear, magnesium and foliar micronutrients may be applied (e.g. Algae, ground shells, ZnSO4, MnSO4, Borax). Organic certifiers only accept their application under the following conditions:<br>• Existance of visual symptoms;<br>• Deficiency is proven in soil or/and leaf analysis;<br>• Before application, such proof needs to be presented to the certifier together with a request for application;<br>• Effects of application have to monitored and evaluated (inclusive not treated parcel). |

To plan the tree nutrition concept of the orchard, it is essential to conduct, in advance, an assessment of the chemical, physical and biological condition of the soil. The results found will show the weak points of the soil and its need for improvement. Only then can a strategy be planned with which on-farm fertilizers or commercial fertilizers can best achieve optimum tree nutrition and soil conditioning. Most organic fertilizers, especially compost, mineralize nitrogen at a slower rate than mineral nitrogen fertilizers. Applications therefore have to be applied 2-4 weeks before the expected nitrogen demand of the trees (2-4 weeks before flowering). If nitrogen demand is important (> 50 kg /ha) nitrogen supply cannot be achieved with compost only because it would lead to an excessive phosphorus and potassium supply.

In most soils, primarily nitrogen and potassium fertilization is needed to obtain acceptable yields. Leaf and soil analysis are important tools in monitoring soil and plant nutritional status and in planning fertilization. It involves basic measures to improve crop yields and quality and to maintain soil fertility and minimize environmental pollution. In different regulations of organic labels, a yearly and equilibrated nutrient balance of phosphorus, potassium and nitrogen is required for farm certification.

Table3 describes the basic requirements of the macro, meso and micro nutrients of citrus and explains how to apply these nutrients in an organic management.

**How to Produce an Optimal Compost with the Existing Raw Materials?**

Compost is the main element of organic fertilizing. Through application of organic matter and microorganisms, compost improves not only soil microbial live, but also physical and chemical soil properties such as water and nutrient retention capacity. Moreover, well fermented compost contains antibiotics and contributes in this way to the control of diseases. Organic citrus growers therefore are highly concerned with producing an optimal compost on the basis of locally available raw materials such as citrus filter press cake, animal manure, cover crop residues. Poultry manure has a high content of mineral nitrogen. Some organic citrus producers use dried poultry manure only; however, the risk of excessive N supply combined with leaching losses etc. is very high. Mixing the poultry manure with plant waste materials and producing good compost will practically avoid these risks. The initial mixture of the raw material should have a carbon to nitrogen ration (C:N) relation of 30:1, a proper structure and allow enough aeration. The fermentation process should be frequently observed and attended permanently (roturation of compost). The application (around 10 t/ha and year) should be as close as possible to the active root system of citrus trees.

## 2.1.5 Weed Control = Soil Cover + Management of Undesired Plants

Conventional citrus growers have mostly a very superficial opinion on weeds: they compete with the citrus trees for nutrients and water. Therefore, they have to be removed with herbicides and mechanical methods. Organic growers prefer to distinguish between desirable and undesirable cover plants instead of weeds, and speak of cover crop management instead of weed control: Weed management is part of the multipurpose soil cover management (see above). The goal of organic citrus growers is to create a system and enhance conditions in which competitive cover crops (planted legumes and other desired spontaneous plants) dominate undesired plants like perennial grasses as *Panicum sp., Paspalum sp., Amaranthus*. There is a large number of desired plants that under conventional management are killed by herbicides, but in reality provide worthwhile habitats for beneficial insects or/and improve soil conditions without competing citrus trees (e.g. *Centrosema pubescens, Desmodium, Cassina obtusifolia and Alysicarpus vaginalis*). Such soil cover plants are not removed, but enhanced in organic citrus production. However, soil cover plants also can be habitat for pests and have to be selected carefully.

The organic management of cover plants consists in regular mowing of the leguminous cover crops and – if necessary – hand weeding of undesired plants that start to dominate with cover crops or citrus trees (especially ranking herbs and tall grasses). Different types of mowers are available, most of them operated by a power take-off from the tractor. Specially constructed mowers are available for organic orchards that permit mowing in the alleyway and under the trees with sensor controlled "bat wings". Mulching and traditional discing are also feasible techniques for organic production. Biological weed control e.g. with *Phytophthora palmivera* to control *Morrenia odorata* and Allopathy e.g. with extracts of Lantana to control rye grass may have a potential for future but have not yet been developed for practical use. Cover crop management and weeding of undesired plants requires additional man power and has to be considered carefully in the conversion planning.

## 2.1.6 Water Management and Irrigation

The leaves of citrus trees are covered with epicuticular wax. Citrus trees are therefore water-conserving plants capable of withstanding long periods of drought. However, severe water stress inhibits vegetative growth and fruit development (size and quality). The key to successful water management is to reduce the duration of stress. Even in humid subtropical and tropical regions with sufficient total rainfall, irrigation is important during the dry periods to achieve good yields. Irrigation also reduces physiological fruit drop, improves flowering, fruit set, fruit size and juice content. On the other hand, excessive irrigation can affect fruit quality negatively: contents of soluble solids and acidity decrease due to a dilution effect.

Most citrus growers irrigate based on a calendar; only a few utilize soil-based considerations. Important concerns of organic growers are:

- To minimize the use of limited water resources;
- To use good quality irrigation water;
- To minimize negative effects of irrigation to the soil (salinization, contamination) and to fruit quality.

Water saving micro-irrigation is preferred in organic farming to flood or overhead sprinkler irrigation. Some citrus farms have had good experiences with furrow irrigation. Drip irrigation is even more water efficient than micro-irrigation. However, drip irrigation moistens only a small soil volume resulting in fairly restricted root extension that requires liquid fertilization with synthetic fertilizers (fertigation) that are not permitted in organic growing. Micro-irrigation systems are subject to clogging by particles, calcium stain, insects, bacteria and algae. Therefore they require high water quality (filtration) and intensive maintenance. Adding Chloride to the irrigation water to control bacteria and algae is not permitted in organic production. An alternative is phosphoric acid.

A well controlled irrigation system is important in order to avoid the proliferation of soil-born fungi such as phytophtora and phytium. Mikrosprinklers should not wet the trunk. Excessive flood irrigation, besides affecting soil conditions (anaerobic), may promote soil-born fungi. For all irrigation systems high quality water is crucial. Organic growers are responsible for avoiding microbial or chemical contamination of the crop by irrigation water. Regular water analysis is compulsory for organic certification.

### 2.1.7 Freeze Protection

Freeze-damage is a concern in some subtropical regions, but never in tropical regions (since citrus tissues are damaged only when ice forms, it seems appropriate to use the term "freeze" rather than "frost"). The most effective method of freeze protection is careful site selection: choice of areas where temperatures remain above –2°C effectively avoid fruit and tree losses. Other passive protection measures include wind breaks and clean cultivation. Clean cultivation means a surface free of cover plants (a bare soil can store more heat during the day and release more of this heat during the night than a surface with vegetation). But for the reasons explained above, bare soil is not desirable in organic production. An alternative may be the use of tree covers to avoid radiation losses (planting of high standing trees). However, citrus growers do not consider this method as economically viable for commercial production (even if such systems have been used since Roman times and still exist in southern Europe).

Active frost protection methods like orchard heating and wind machines are expensive and consume considerable amounts of energy. Frost irrigation with overhead sprinklers may be more suitable for organic farming. The water releases some energy when it turns to ice; this crystallisation energy keeps the temperature of the tree organs above zero degrees and prevents freeze damage. The water may not be turned off before air temperature is above zero again; often large quantities of water are required.

### 2.1.8 Pruning

As trees grow, inner and lower branches become shaded. In large citrus trees most of the fruiting occurs in the outer periphery of the canopy whereas the inner parts suffer from shading having bad or no fruit set and quality. The shading problem can become even more severe in high-density plantings. Therefore, a yearly pruning is essential to maintain light penetration through the canopy. Organic citrus growers must pay special attention to optimal light and air penetration because good aeration also contributes to the prevention of pests and diseases.

As a general rule, it is advisable to maintain tree height at no more than twice the planting distance in the row. The most commonly used methods of tree size control include hand pruning and mechanical hedging and topping. The three major types of pruning cuts are heading-back, thinning out and selective pruning to remove damaged or dead limbs, for example after phytophtora infections, freeze or storm damages.

Pruning with the objective to regenerate citrus trees is carried out in winter or during the vegetative rest of the trees. Hedging and topping to control tree growing takes place during the vegetation phase, and fruit regulation is handled after flowering in case of alternate fruit bearing.

Products to paint and protect cutting wounds based on copper are permitted in organic fruit growing. Growth regulators as 2,4-D and synthetic hormones are also not permitted in organic fruit production.

### 2.1.9 Pest and Disease Management

Organic pest and disease management places priority on indirect control methods. Direct control methods are applied as a second priority.

Indirect Control Methods:

- Promotion of beneficial insects and plants by habitat management: organic orchard design, ecological compensation areas with hedges, nesting sites etc.;
- Soil management: Organic compost and plant slurry to improve soil structure and soil microbial activity;
- Pruning: good aeration of the orchard.

Direct Control Methods:

- Biological control: release of antagonists, natural predators and entomophagous fungi;
- Mechanical control methods;
- Organic pest and disease control products (see positive-lists of organic regulations).

### Examples of pests and organic control methods

Most mites, insects and nematodes that attack citrus cause economic damage only occasional. Many pest problems in conventional citrus production are related to the almost complete elimination of natural enemies through the excessive use of synthetic pesticides. Organic growers make use of natural control agents to the maximum. Many pest problems can be controlled effectively with biological

**Table 4:**
**Citrus Pests and Organic Control Management**

| Pests | Important to Know | Biological Control Methods |
|---|---|---|
| ERIOPHYIDAE: *Phyllocoptruta oleivora* (Citrus rust mite) | • Damage results from feeding by piercing and sucking;<br>• Causes formed twigs, leaves and fruit;<br>• Mite must be observed with lens; | • Application of *Hirsutella thompsonii*, an entomophagous fungi (in many cases this fungus is naturally present);<br>• Introduction of predatory mites; |
| THRIPIDAE: *Heliothrips haemorrhoidalis* (Greenhouse thrips) | (a) Cause fruit blemishes;<br>(b) Orchards with ground cover have fewer thrip problems (natural enemies in the ground litter); | • Introduction of predatory mites (Euseius hibisci and Anystis agilis) and the minute pirate bug;<br>• In case of high infestation pressure rotenone and pyrethrum may be applied; |
| ALEYRODIDAE: *Dialeurodes citrifoli* (Citrus white fly) | • Attack young flushes;<br>• Serious problem for young trees;<br>• Produces honey dew that attracts ants, causes sooty mould and "dirty" sticky fruit; | • Introduction of parasite wasps (but this control is easily disturbed by ants defending the honeydew); |
| APHIDIDAE: *Toxoptera citrisidus* (Brown citrus aphid) | • Population increases very fast on spring leaves and flushes;<br>• Usually not an economic pest, but important vector of Citrus *tristeza virus* (CTV); | • A number of predators, parasites and fungi can help to control brown citrus aphid;<br>• Bio-control methods and agents usually help to decrease the level of a pest rather than to eradicate it; |
| COCCIDAE: *Coccus hesperidum* (Brown soft scale) | • The young scale settles on all parts of the canopy, adults on twigs;<br>• Produce honeydew which attracts ants and causes sooty mould;<br>• Natural predators – such as ladybird beetle larvae and parasite flies contribute to soft scale control; | • Parasitized by *Metaphycus spp.*;<br>• Application of ladybird beetle larvae and parasitic flies (pest species are specific and differ from location to location); |
| DIASPIDIDAE: *Unaspis cirti* (Snow scale) | • Primarily a limb and trunk feeder;<br>• Soil cover provides a habitat for natural predators; | • Application of ladybird beetle and parasites; |
| CURCULINOIDAE: *Pachneus citri* (Citrus root weevil) | • Larvae fall to the ground and infest the root system; | • Application of entomophagous fungi such as *Beauveria bassiana, Metarrhizium anisopliae;* they attack the larval stage in the ground;<br>• Application of predators and parasites; |
| FORMICIDAE: *Atta spp.* (Leaf-cutting ant) | • Cause severe leaf loss; | • Application of *Beauveria bassiana* to the soil; they parasitize the fungi in the nests of the ants; |
| LEPIDOPTERA (ORDER): *Phyllocnistis citrella* (Citrus leaf miner) | • Generally not an economic pest;<br>• Occasional leaf or fruit damage; | • Release of several predators and parasites; |
| TRYPETIDAE: *Ceratitis capitata* (Mediterranean fruit fly) | • Adults oviposit in the immature fruit and the larvae feed and develop in the fruit pulp; | • Mass trapping (combination of food baits with organic insecticides, such as Spionosad);<br>• Release of the braconid parasite Diachasmimorpha tryoni and nematodes;<br>• Sterile insect technology (STI) is not permitted in organic agriculture. |

control methods. Generally, bio-control methods and agents usually help to decrease the level of pests rather than to eradicate them. The following table is not complete and shows just one important species for some pest families.

In some cases, preventive and bio-control measures are not sufficient and the damage by a pest or a disease may reach a level of considerable economic loss. This is when direct control measures with natural pesticides, such as pyrethrum, derris, neem, soaps, mineral and plant oil as well as mass trapping and confusion techniques may become appropriate.

### Examples of Diseases and Organic Control Methods

There are a large number of citrus diseases caused by bacteria, mycoplasma, fungi and viruses. Table 5 contains some important examples. The organic citrus disease management consists in a three-step system:

- Use of disease-free planting material to avoid future problems;
- Choosing rootstocks and cultivars that are tolerant or resistant to local diseases;
- Application of organic fungicides such as and copper, sulfur, clay powder and fennel oil. Cu can control several disease problems. However, it must not be forgotten that high Cu accumulations are toxic for soil microbial life and reduce the cation exchange capacity.

**Table 5:**
**Citrus Pests and Organic Control Management**

| Disease | Important to Know | Indirect Control | Direct Control |
|---|---|---|---|
| *Xanthomonas campestris* (Citrus canker) | • bacterial infection of fruit and leaves, dissemination by wind, rain and injuries;<br>• Affects fruit quality and causes fruit losses; | • Planting windbreaking trees or headges; | • Cu applications during spring flush; |
| *Capnodium citri* (Sooty mould) | • Fungus that grows on leaf surface;<br>• Honeydew from insects promotes Sooty mould; | • Control of honeydew producing insects (Dialeurodes citrifoli, Coccus hesperidum etc.); | • Cu applications, |
| *Mycosphaerella citri* (Greasy spot) | • Causes serious yield loss in humid climates;<br>• Yellow moddle on the upper and lesions at the lower surface;<br>• Blotchy areas on grapefruit; | • Removal of leaf litter if natural decomposition is not sufficient (this practice may not be economically feasible); | • Applications of Cu and other fungicides oil; |
| *Phytophthora parasitica* and *Phytophthora citrophthora* (Gummosis) | • Causes root rot and gummosis;<br>• Root and trunk infections decrease tree vigour and productivity; | • Resistant and tolerant rootstocks (Trifoliata, Swingle, Cleopatra, Sour orange, rough lemon etc.);<br>• Good soil drainage;<br>• Careful irrigation (avoid flood irrigation and irrigation directly on the trunk); | • Good pruning practice;<br>• Cu applications on wounds (Bouille bordelaise 2% and cover with wax); |
| *Citrus tristeza virus* CTV | • Virus is transmitted by budding and by aphid vectors;<br>• Trees are stunted and remain small, leaf chlorosis, reduced fruit size; | • Avoid sour orange rootstock;<br>• CTV-free budwood programs;<br>• Control vectors like *Toxoptera citrisidus*; | • Remove infected trees; |
| Citrus blight | • Probably caused by a pathogen;<br>• Transmitted by root grafts or peaces from infected trees;<br>• Trees are weakened and become infected by *Phytophthora*; | • Choice of tolerant rootstock (very small choice available); | • Pruning or removal of infested trees; |

## 2.1.10 Harvesting and Post Harvest Handling

### Harvest

All citrus must ripen on the tree; different from some other fruit species, citrus does not ripen any further once removed from the tree. Before harvest, samples of oranges from a particular block should be tested for Brix (= content of soluble sugars = total soluble solids TSS) and acidity content. The ratio of Brix to acidity content is a measure of the maturity. With oranges the ratio varies during the season, but generally a minimum of 8.50 Brix and a ratio to acidity content of 10.00 to 1 is required. Many juice processing plants ask for even higher maturity standards. Once a tested block is ready for harvest, a crew of pickers is sent to harvest the entire block. Currently, almost all orange orchards are harvested by hand. There are a few experimental mechanical harvesters in use (e.g. trunk shaker) but so far, these are not more economic than hand harvestors. Fruit is loaded in packing containers and transported to the packing house (for fresh fruit) or processing plant (for juice).

Selection of vegetables for packaging.

### Packing House Procedures

Most packing houses follow the same procedure. However, certain treatments applied to conventional fruit are allowed for organic fruit:

- **Degreening:** Conventional citrus are treated with ethylene in order to remove chlorophyll so carotenoid pigments of the skin become brightly visible. This treatment is not allowed for organic citrus. Most customers of organic citrus accept a reduced homogeneity of fruit color. If they don't, fruit has to be graded for color.
- **Dumping:** Conventional citrus may be dumped into water that usually contains chlorine and a fungicide to prevent post harvest diseases. This treatment is not applied with organic fruit (both products are not allowed for organic fruit handling).
- **Pre-size:** Fruit is pre-sorted manually to remove trash and fruit with obvious defects.
- **Wash:** Fruit are washed with a mild detergent and water spray rinsed in order to remove dirt, insects and loosely adhering mould.
- **Waxing:** Wax is applied to the fruit after drying. Only natural carnauba waxes are allowed for organic citrus. Any synthetic waxes or waxes with fungicides are not allowed for organic products.
- **Selection:** Fruits are selected by hand for packing.
- **Packing:** Fruit is packed into several types of containers. Some organic label regulations require or forbid specific packing material.
- **Storage:** Citrus can be cold stored for 2 months at 0-4°C with very little loss of fruit quality. Controlled atmosphere (CA) storage is an alternative to cold storage, but in many cases it is not interesting because of high costs.

### Juice Processing

Generally, juice processing is – compared to fresh fruit handling – quite simple under organic rules because juice processing does not require any additives. However, it is important to consult all processing regulations of the specific label before starting a project (see step j.):

(a) At the processing plant, the trailer load of oranges will be unloaded onto a conveyor belt. A random fruit sample from this belt is tested for juice content and maturity. The most desirable quality for orange juice contains > 12 % Brix, a 14-16 sugar: acidity ratio, and a juice color score of at least 36.

(b) The fruit is then transferred to storage bins and labeled according to the juice specification. Later, quality oranges are selected to achieve optimal juice quality and blended from the most suitable bins.

(c) The fruit is conveyed on a transport belt through a washing process.

(d) Then it enters into the processing plant where it is graded for bad or damaged fruit. The fruit is then sorted by size and sent to the juice extractors.

(e) Inside the extractors, before juicing, the peel is pricked to gain, in a separate process, the aetheric oils found in the peel, then the juice is extracted.

(f) As a next step, the pulpy juice is pumped through a finisher (screen) where the pulp and seeds are separated, which, together with the peel, are used for by-products, such as cattle feed or compost (important for organic citrus production).

(g) From this point on, the juice may either go directly into a pasteurizer in the case of Not From Concentrate (NFC), or it goes on to the evaporators where most of the water is taken out of the juice by heating it under a vacuum; then the juice is chilled to produce frozen concentrated orange juice (FCOJ). This process also strips out certain essences and oils.

(h) The concentrated juice contains between 60 to 70° Brix is pumped to the tank farm where the concentrate is stored at about -28° C, separated by variety and by the Brix (acidity ratio).

(i) When ready to ship, the frozen orange is blended from the various tanks to meet the customer’s demand.

(j) The juice is transported deep frozen in 200 liter barrels or in bulk tank ships to the destination port, and from there to the packager where juice is bottled and labeled. A few organic label organizations do not allow the reconstitution of concentrate with water to single strength juice. In this case, single NFC-juice has to be produced right from the start.

## 2.2. Guava

Guava (*Psidium guajava L., Myrtaceae*) is a small tree with a spreading, broad top that develops from a short trunk. It is native to the American tropics but has become naturalized in practically all tropical and subtropical climates of the world. Guava is an important fruit for some countries and is an popular dessert in Latin America. Further, guava is cultivated as fence, ornamental plant and for timber products.

Guava.

As a general rule, guava requires little attention. Therefore, guava is easily feasible under organic management. Organic guava as a main crop or as part of mixed fruit gardens is produced in many tropical and subtropical countries. However, organic guava in much less demand by the international market compared to banana, citrus or mango. Therefore, production and trade of organic guava and guava products never will reach the volumes of other tropical fruit.

## 2.2.1 Agro-ecological Requirements and Site Selection

### Climate

Because it is of tropical origin, guava grows best in tropical and subtropical areas that are frost-free. Mature trees survive light frosts. A warm, humid condition is most optimum for guavas. However, it thrives well in both humid and dry climates from sea level to 2000 m. The optimum temperature required for guava cultivation and high yield of good quality fruit ranges from 20° to 30°C. Low winter temperatures during the dry season lead to natural defoliation, and flowering will commence as soon as warm weather and rainfall induce new growth flushes and fruit set.

The ideal rainfall pattern for guava is alternating dry and wet conditions. Drought and low humidity during flowering can drastically reduce fruit set. Guava does best with abundant moisture (1,000 to 2,000 mm rainfall), although is tolerates drought. Guavas develop the best eating quality when they mature during dry period (mostly in winter). Some guava cultivars produce more heavily in areas with distinct winter seasons than in the deep tropics. Further, the guava can benefit from windbreaks because new flushes grow more vigorously after windbreaks.

### Soil

The guava is a hardy plant that grows in most soil types. It responds well to soils with good drainage and high organic matter. Loam and alluvial types of soil is most ideal. Guava prefer a well-drained soil in the pH range of 5 to 7. Guava is fairly tolerant to soil salinity. While guava trees tolerate poor soils, fruit production is substantially enhanced when grown in rich soils under proper management.

## 2.2.2 Establishing an Organic Guava Orchard

### Suitable Races and Cultivars

The common guava is a diploid (2n = 22), but natural and artificial triploids (2n = 33), tetraploids (2n = 44; species El Salvador), hexaploids (2n = 66; species from Costa Rica) and aneuploid exist. Triploids generally produce seedless fruits. Seedlings from hexaploid var. littorale are extremely uniform in plant and fruit characteristics. Seedling trees of most guava cultivars vary in vigour and size, bearing habit, and fruit yield, shape, size, quality, maturity season, and storage ability. Natural cross pollination so common in guava cultivars is responsible for the variability observed in seedling trees

There are three distinct types guava cultivars:

- **Dessert Types:** produce less acidic fruits with mostly white flesh and appealing surface colors. This group includes many national and local cultivars, such as “Mexican Cream”, “Ruby X”, “Hong Kong Pink”, “Klom Toon”, “White Indian”, “Allahabad Safeda”, “Lucknow 49 (Sardar)”, “Red Fleshed”, “Chittidar”, “Nasik”, “Tathem White”, “Supreme” and “Elisabeth”.
- **Processing Types:** They produce strong acidic fruit usually with red or pink flesh and a high percentage of pulp recovery, for example, “Pink acid”, “Patillo” and “Ka Hua Kula”.
- **Dual Purpose** yield fruits with a compromise between the processing and the dessert types like “Beaumont”, “Etheridge Selection”, “Oakey Pink”, and “Fanretief”.

Selection objectives in breeding programs include yield, fruit quality (aroma, vitamin C content, number of seed etc.), vigorous spreading and low-growth type as well as resistance to pests and diseases. For organic producers, the last two selection objectives are of basic importance. However, still only a few specific resistant cultivars are available.

### Flowering Induction and Pollination

Guava produces flowers on new vegetative shoots arising from mature wood. Thus, in mild tropical or subtropical climates, guava flowers and fruits continuously throughout the year if water and temperatures do not become limiting factors. Rainfall after drought induces tree growing and flowering. Therefore, in many tropical countries, guava has two flowering peaks parallel to the rainy seasons. These natural peaks can be altered by cultural manipulations. Since flowers are produced on new branches, factors that stimulate new growth, such as pruning, irrigation and fertilization, stimulate flowering. It is beneficial to give guava trees rest (an off season) by withholding irrigation water periodically. The practice of pruning, irrigation and fertilization at the end of harvest is essential in cycling that concentrates harvest periods. Defoliation with hormones (e.g. gibberellic acid, ethephon) in order to induce new growth is not allowed in organic guava production.

Few problems with pollination and fruit set occur with most guava clones. Fruit set in the triploid cultivars is good when grown together with diploid clones as a pollen source. Bees are the principal pollinators of guava. Organic standards do not permit the application of plant hormones to increase fruit set and reduce seeds.

### Propagation and Planting

Guava is easily grown from seeds but seedling trees are variable in fruit quality and take longer to fruit. Seed germination is used to produce seedlings in breeding programs or to produce rootstocks for grafting of desirable cultivars. Propagation is largely by vegetative means and the most satisfactory method is budding. In budgrafting the stock plants are first sown from seeds directly into individual polythene bags. After they have attained pencil size the stock plants are ready for grafting. The grafted seedling is ready for transplanting 2 – 3 months later. Several clonal methods are applied.

When providing trees, it is of crucial importance to order certified trees where the absence of diseases, pests, viruses and authenticity of rootstock and cultivar are guaranteed. In different organic label regulations the use of trees from certified organic nurseries is compulsory from 2004 on. Currently, the detailed regulations e.g. for the case where organic trees are not available, are very dynamic. Therefore, the actual regulations should be checked carefully with the certification body before ordering any plantlets.

### Establishment of Orchards

Two basically different guava production systems are applied by organic growers: Growing guava in orchards or in fruit gardens and agroforestry systems.

In orchards, trees can be planted from 2.5 to 8 m in any combination for rows and tree spacing. Commonly tree spacings in organic guava orchards are wider compared to conventional orchards – for example 5 x 6 m – with trees established along the contours. Intensive systems for guava growing (up to 73,000 trees/ha with 45 x 30 cm distance) are practiced in the combination with the use of growth regulators for plant size control. Organic standards prohibit growth regulators, therefore such intensive systems are not suitable for organic guava production.

A few months before planting guava trees, organic growers can saw in vigorous legumes (e.g. Canavalia sp. or Cayanur cayan) and later mulch them shortly before planting the guava trees. Planting holes of 0.6 m x 0.6 m x 0.6 m are dug and into each hole compost or organic manure is incorporated and – if necessary – rock phosphate. Trees have to be hardened in the direct sun for several weeks before transplanting. Shade is provided for the young plants immediately after planting, and watering is done regularly during dry weather until the trees are well established.

Guava trees also are grown in extensive fruit gardens and as one of the mixed crops in agroforestry systems.

## 2.2.3 Soil and Weed Management

Weed management is crucial during the first 2 – 3 years of orchard establishment. After that, the canopy of the trees provides adequate shade to minimize interference by weeds.

The soil underneath and around the young tree should be maintained free of all weeds and grasses, since the young tree cannot compete well for water and nutrients until it is much larger. Organic mulches, such as straw, dried grass or compost, are excellent for use under guava trees to eliminate weeds and to conserve moisture.

Organic mulches are also suitable for adult bearing trees and the method of choice of most organic guava growers. Some organic growers cover the soil with leguminous cover plants in order to enrich the soil with nitrogen, organic matter and to promote soil-microbial life (see chapter 1.2).

## 2.2.4 Tree Nutrition and Fertilization

When trees in an orchard begin to produce commercial quantities of fruit, fertilizer is usually given after harvest, together with pruning and irrigation to encourage new growth. It takes about 4.5 – 5 month from floral initiation to fruit maturation. Organic fertilizer should therefore be applied around 4 – 4.5 month before expected harvest period, adjusted to the prevailing temperatures and moisture. Organic fertilizer is applied around 2 weeks before highly soluble chemical fertilizers in order to give to the soil-micro-organisms time to mineralize organically bound nitrogen. In subtropical climates where winter temperatures are relatively low, only one major crop season occurs and fertilization is adjusted accordingly.[7]

[7] For more details in organic fertilization techniques please refer to chapter 1.2

The following optimal foliar levels guide guava fertilization (% on the basis of dry matter):

- Nitrogen: 1.7 %;
- Phosphorous: 0.25 %;
- Potassium: 1.5 %:

## 2.2.5 Water Management and Irrigation

Although the guava can tolerate low moisture condition and long dry periods, a constant availability will promote fast growth and leaf flushes. Lack of moisture will delay bloom and cause the fruit to drop.

Drip irrigation is increasingly being used to satisfy daily water needs. In large orchards, where irrigation is done by sections, the microjet or a low-sprinkler system is more suitable. Both systems are suitable for organic guava production. However, fertigation is not permitted.

## 2.2.6 Freeze Protection

Freeze protection is essential for survival of young guava trees in subtropical regions with cold winters. Soil banks are excellent for freeze protection for several years: put them up in late autumn and remove them in spring. Protection of the top can be achieved using covers such as blankets or loans; the cover is draped over the tree, the corners pulled outward and anchored to the ground. It is neither necessary nor desirable that the cover reach the ground.

In regions with severe cold, an additional heat source would be needed. This is not desirable in organic agriculture due to high energy consumption. If the climate is not suitable for guava production, other crops should be planted.

## 2.2.7 Pruning and Fruit Thinning

The guava plant grows symmetrically dome-shaped with broad, spreading, low-branching canopy and a shallow-rooted small tree of 3 to 10 m in height, branching close to the ground and often heavily suckering from the base of the trunk. A single trunk tree is developed by proper pruning and training.

The young guava tree is usually trained 3 to 4 months after field planting. Pruning begins at an early stage of plant growth to develop single trunk trees with well-spaced branches.

Bearing guava need constant training and pruning to provide the desired tree shape for ease of management and for the health of the tree and to maximize fruit production. Larger fruit are primarily produced on vigorous shoots of two to three years of age. Most guava trees, whether propagated from seed or grafts, produce an abundance of suckers which should be removed from the trunk up to 50 cm above ground. A framework of four branches representing four quarters of the tree should be established. The crotch angles between the branches and the main stem should be wide enough to facilitate adequate light penetration and provide physical strength to support fruit load at maturity. A flat tree shape reduces labor for orchard management such as fruit thinning, fruit bagging and harvesting.

Some growers prefer intense pruning immediately after harvest, other growers prefer regular but light pruning of unwanted wood. Since guava bears fruit on new growth from mature wood, it is important to keep a balance between the amount of vegetative growth and mature wood to ensure production the next season, and maintain fruiting regularity. Pruning induces growth of new flushes upon which flowers will be produced. Branches grown horizontally are more productive than vertical ones.

Since healthy guava trees grow and fruit abundantly, there is always a chance for breakage of branches supporting the heavy loads of fruits. Thinning in the early stages of fruit growth increases the size of remaining fruits, reduces trunk breakage, and promotes regular bearing. Hand thinning is the only applied procedure for organic guava production, since chemical thinning agents are not allowed in this production method.

## 2.2.8 Pest and Disease Management

### Pest Management

A number of pests attack the guava such as the fruit fly, thrips, mealy bugs, scale insects, spider mites, aphids etc. There are several species of parasitic wasps and predators that keep scale insects and mealy bugs under reasonable control. However, some insects cause damage to guava cultivars, in particular thrips and fruit flies. Birds or fruit bats also usually attack mature guava fruit.

Organic pest and disease management prioritizes indirect control methods. Direct control methods are applied with second priority (see chapter 2.1.9).

### Disease Management

Some diseases are specific to certain countries and others are widespread where guavas are grown. In many cases, they do not cause economic damage. Anthracnose and Mucor fruit rot are widespread and considered important diseases in most countries. Organic growers first make use of indirect center methods before applying direct control methods.

Fruit rots (Phytophthora parasitica, Botryodiplodia sp., and Dothiorella sp.) and fruit canker (Pestalotia psidii) can be serious pests on rainy season guava crops in humid areas.

**Table 6:**
**Examples of Guava Pests and Organic Control Methods**

| Pests | Important to Know | Organically Control Methods |
|---|---|---|
| *Ceratitis capitata* (Mediterranean fruit fly), *Dacus dorsalis* (Oriental fruit fly), *Dacus cucurbitae* (melon fruit fly), *Ceratitis rosa* (Natal fruit fly), *Anastrepha suspensa* (Caribbean fruit fly), *Anastrepha ludens* (Mexican fruit fly) | • Flies are attracted to the maturing fruit where they deposit their eggs<br>• The eggs hatch and develop within the fruit, causing a break down of the fruit tissue<br>• Cause fruit rot | 1. Fruit bagging along with thinning 2 month after flowering can significantly reduce the attack<br>2. Field hygiene<br>– Mass trapping (combination of food baits with organic insecticides, such as Spionosad)<br>– Release of the braconid parasite *Diachasmimorpha tryoni* and nematodes<br>– Sterile insect technology (STI) is not permitted in organic agriculture |
| *Selenothrips rubrocinctus* (Read-banded thrips) | • Attacks leaf and fruit<br>• Cause silvering of leaves and scarification of the fruit<br>• Fruit become mummified | 3. Natural enemies can keep thrips under fair control<br>4. Resistant cultivars: Allahabad Safeda; for example Ruby x Supreme, Lucknow-49 |
| *Cosinoptycha improbana* (guava moth or fruit drilling caterpillar) | • has the potential to produce a population explosion | • Use lures containing pheromones. Pheromones.are produced by the female guava moth to attract males for mating. Traps containing these pheromone lures can disrupt the mating ability of the moth |
| *Indarbela quadrinotata* (Bark-eating caterpillar) | • Attacks bark | • Naturally occurring parasites |

**Table 7:**
**Some Guava Diseases and Organic Management**

| Disease | Important to Know | Indirect Control | Direct Control |
|---|---|---|---|
| *Colletotrichum gloeosporioides* (Anthracnose) | • Small brown to black spots on the fruit;<br>• rotting of ripe fruit mainly in the rainy season; | • Adequate drainage; | • Spraying with Bordeaux mixture; |
| *Botrytis cinerea* (Blossom end rot) | • Attacks fruit; | • Calcium application to guavas largely alleviates this disease; | • Spraying with Bordeaux mixture; |
| *Mucor hiemalis* (Mucor rot) | • Water soaked areas on fruit, later covers with yellowish mycelina;<br>• Commonly associated with fruit-fly oviposition wounds; | • Removing fallen fruit from the field at 2-4-day intervals;<br>• Crushing under foot during harvest or light rolling the orchard floor;<br>• Low acid, sweet cultivars are more tolerant than acid types; | |
| *Fusarium solani* (Fusarium wilt) | • Attack root; | • Avoid planning on infected soils; | |
| Fruit scab | • Affects immature fruits by causing a corky brown layer all over the fruits;<br>• This will cause the fruits to be unattractive and unmarketable; | • All preventive measures; | • Spraying with Bordeaux mixture; |
| *Cephaleuros virescens* (Algal spots) | • Causes rust-like blemishes on the fruit and leaf surface;<br>• Dark necrotic blemishes are left on the fruit | • Suitable pruning will help to reduce these diseases (ventilation); | • Spraying with Bordeaux mixture; |

## 2.2.9 Harvesting and Post Harvest Handling

In tropical regions, guava is available throughout the year, although not always in the same quantities. Guava fruits are harvested when they change color from green to light green. Depending on guava cultivar and the growing conditions, it takes about 100 to 150 days from bloom to fruit harvest. Ripe guava fruits measure 4 to 10 cm and weight from 100 to 450 g. Ripe fruit has a thin greenish-yellow skin and a flesh of varying thickness that may be white, yellow-pink or red. Flavor and aroma vary widely, from low-acid, sweet to low sugar and high-acidity types. Most of the famous cultivars contain numerous small, hard, yellowish-cream colored seeds that are imbedded in the soft pulp (there are a few seedless cultivars).

Where labor is available, young fruit destined for the fresh-fruit market are wrapped with newspaper or bagged in paper when about one and a half months old. This not only protects them from fruit fly attacks, but also improves their color and protects them from abrasion during fruit development. However, bagging promotes conditions for fungal diseases and therefore has to be done with care when dealing with organic guava growths. Plastic bags are not suitable in organic guava production for the same reason.

Harvesting is done manually. Dessert fruit are harvested mature green and carefully handled to avoid injury, graded to size and packed carefully in the carton for shipment. Processing fruit should be picked at the firm yellow half-ripe stage. Harvesting intervals should not exceed 3 – 4 days or losses from over-ripe fruits occur. Immature guavas do not ripen off the trees; fruits may soften, but never develop abundant color, and typical flavor associated with good eating enjoyment. Over-ripe fruits drop; they should be collected and destroyed rather than left to rot in the field in order to remove sources of new pest and disease infection.

Fruit yields depend upon cultivars, design of the orchard (density) and weather conditions. The yield may start at 10 tons per hectare in the third year of production and increase to 30 tons per hectare after the tenth year. The average lies around 80-90 kg/tree. Experiences in organic managed guava orchards do not show a significant yield reduction after conversion.

### Post-Harvest Handling

Guava is well suited to processing. The sweeter selections are more commonly eaten fresh, while the stronger flavored selections are more commonly used in jam, jelly, paste and other products.

**Fresh fruit**

Mature green fruit held at 20°C develops fully-yellow skin color in 6-8 days. Fruit packed in polyethylene bags can be stored at temperatures of 8 – 10 °C for 14 days and be 100% marketable. Ethylene can be used on mature green fruit to accelerate ripening (ethylene for ripening is allowed in organic agriculture).

Guava fruits should be packed in the natural posture (with the pedicel end of the fruit kept upward) in order to retain better quality for longer periods of time. Fruits for the fresh fruit market should be wrapped individually in paper towels and packed in padded layers before shipping or refrigeration. Wrapping of guava fruits suppresses weight loss and preserves glossiness. Storage of wrapped guavas at cool temperatures extends post-harvest life up to 5 weeks, with retention of healthy fruit quality and no significant reduction in nutrient contents; however, fruits stored unwrapped lose moisture and shininess. Desiccation, browning of fruit skin tissue with concomitant loss of flesh firmness, and the high rate of physiological weight loss limit the storage life of guava fruit.

**Juice Processing**

Fruit for processing should be held at 15°C to allow for gradual ripening. Organic processing requires aseptic methods or hot filling of containers as wells as freezing as a means of preserving the products without the addition of preservatives. Aseptic methods are advantageous as no refrigeration is required.

## 2.3. Lychee

The lychee is the most renowned of a group of edible fruits from the soapberry family, Sapindaceae. It is botanically designated *Litchi chinensis* Sonn. (*Nephelium litchi* Cambess) and widely known as litchi.

This fruit originates from southern China, where more than 100 varieties are known. Nowadays, it is grown in almost all subtropical regions where the climate and soil is suitable. However, China is the leading center of lychee production.

### 2.3.1 Ecological Requirements

Lychees require seasonal temperature variations for best flowering and fruiting. Warm, humid summers are best for flowering and fruit development, and a certain amount of winter chilling is necessary for flower bud development. Lychees thrive best in regions with dry and cool winters but without heavy frost. Most cultivars are sensitive to frost except for the centuries-old “Chen-Tze” or “Royal Chen Purple” cultivar, renamed “Brewster” in Florida. This variety originates from the northern perimeter of the lychee-growing area in China. It is able to withstand light frost and has proven very successful in the Lake Placid area of Central Florida.

The summer should not be too hot, and humidity during fruit development should not be too high. Water requirements are high (about 1.500 mm), thus in areas with long dry periods, irrigation is necessary. In China and India, lychees are grown between 15° and 30° N. The lychee thrives best on the lower plains where the summer months are hot and wet and the winter months are dry and cool.

Heavy frosts will kill young trees but mature trees can withstand light frosts. The cold tolerance of the lychee is intermediate, lying between that of sweet orange at one extreme and mango and avocado on the other. Location, land slope, and proximity to bodies of water can make a great difference in the degree of damage inflicted by frost.

Heavy rain or fog during the flowering period is detrimental, as are hot, dry, strong winds that cause shedding of flowers and also splitting of the fruit skin. Splitting also occurs during spells of alternating rain and hot, dry periods, occuring with frequency on the sunny side of the tree.

**Soil**

Lychees prefer an acidic soil, as do most tropical fruit trees. A soil pH between 5.5 and 7.5 is acceptable, but plants grow much better in soils with a pH at the low end of this range. Soil pH plays an important role in the nutritional health of a tree, particularly with respect to the trees’ ability to absorb minor elements such as iron. Organic material in the soil generates humic acids as it breaks down. These naturally occurring acids help to lower the soil pH and promote a healthier growing environment.

The soil should be fertile, profound and well drained. However, lychees grow well on a wide range of soils. In China they are cultivated in sandy or clayey loam, “river mud”, moist sandy clay, and even heavy clay.

However, in an early experiment in a greenhouse in Washington, D.C., seedlings planted in acid soil showed superior growth and the roots had many nodules colonized by mycorrhizal fungi. This caused some to speculate that inoculation might be desirable.

The lychee attains maximum growth and productivity on deep alluvial loam but flourishes in extreme southern Florida on oolitic limestone providing it is placed in an adequately sized planting hole and irrigated in dry seasons. If lychee trees are grown in limestone (high pH) soil it may be necessary to apply a foliar spray of minor elements, of which chelated iron is the most important component.

The Chinese often plant the lychee on the banks of ponds and streams. In low, wet land, they dig ditches 10 to 15 ft (3-4.5 m) wide and 30 to 40 ft (9-12 m) apart, using the excavated soil to form raised beds on which lychee trees are planted so that they have perfect drainage and permanently moist soil. Though the lychee has a high water requirement, it cannot tolerate waterlogging. The water table should be at least 1.2-1.8 m below the surface and the underground water should flow as stagnant water induces root rot. The lychee can occasionally stand brief flooding better than citrus. It will not thrive under saline conditions.

The root crown of a lychee tree must not be buried. This general rule applies to almost all trees. The root crown is the zone of plant tissue at the base of the tree between where the roots leave off and the trunk begins. If this area is buried by non-porous soil it will lead to the death of the tree.

## 2.3.2 Establishing of Organic Lychee Orchard

### Suitable Varieties

Professor Groff, in his book: The Lychee and the Lungan tells us that the production of superior types of lychee is a matter of great family pride and local rivalry in China, where the fruit is esteemed as no other. In 1492, a list of 40 lychee varieties, mostly named for families, was published in the Annals of Fukien.

The Chinese claim that the lychee is highly variable under different cultural and soil conditions. Professor Groff concluded that one could catalog 40 or 50 varieties as recognized in Kwangtung, but there were only 15 distinct, widely known and commercial varieties grown in that province, half of them marketed in season in the City of Canton. Some of these are classed as "mountain" types; the majority are "water types" (grown in low, well-irrigated land). There is a special distinction between the kinds of lychee that leak juice when the skin is broken and those that retain the juice within the flesh. The latter are called "dry- and -clean" and are highly prized. There is much variation in form (round, egg-shaped or heart-shaped), skin color and texture, the fragrance and flavor and even the color of the flesh, the amount of "rag" in the seed cavity and, of prime importance, the size and form of the seed.

### Propagation and Nursery Management

Lychees do not reproduce faithfully from seed, and the choicest have abortive, not viable, seed. Furthermore, lychee seeds remain viable only 4 to 5 days, and seedling trees will not bear until they are 5 to 12, or even 25, years old. For these reasons, seeds are planted mostly for selection and breeding purposes or for rootstock.

Attempts to grow the lychee from cuttings have been generally discouraging, though 80% success has been claimed with spring cuttings in full sun, under constant mist and given weekly liquid nutrients. Ground-layering has been practiced to some extent. In China, air-layering (marcotting, or gootee) is the most popular means of propagation and has been practiced for ages. In this method, a branch of a chosen tree is girdled, allowed to callus for 1 to 2 days and then is enclosed in a ball of sticky mud mixed with chopped straw or dry leaves and wrapped with burlap. With frequent watering, roots develop in the mud and, in about 100 days, the branch is cut off, the ball of earth is increased to about 30 cm in width, and the air-layer is kept in a sheltered nursery for a little over a year, then gradually exposed to full sun before it is set out in the orchard. Some air-layers are planted in large clay pots and grown as ornamentals.

The Chinese method of air-layering has many variations. In fact, 92 modifications have been recorded and experimented in Hawaii. Inarching is also an ancient custom, selected cultivars being joined to "Mountain" lychee rootstock.

In order to make air-layering less intensive-intensive, to eliminate the watering, and also to produce portable, shippable layers, Colonel Grove, after much experimentation, developed the technique of packing the girdle with wet sphagnum moss and soil, wrapping it in moisture-proof clear plastic that permits exchange of air and gasses, and tightly securing it above and below. In about 6 weeks, sufficient roots are formed to permit detaching of the layer, removal of the plastic wrap, and planting in soil in nursery containers. This is possible on air-layer branches up to 10 cm thick, where 200 to 300 layers are taken from a large tree.

Studies in Mexico have led to the conclusion that, for maximum root formation, branches to be air-layered should not be less than 15 mm in diameter, and, to avoid undue defoliation of the parent tree, should not exceed 20 mm. The branches of any age around the periphery of the canopy and exposed to the sun make better air-layers with greater root development than branches taken from shaded positions on the tree. The application of growth regulators at various rates has shown no significant effect on root development in the Mexican experiments. In India, some of the various auxins tried stimulated root formation and forced early maturity of the layers; contributing, however, to high mortality. South African horticulturists believe that tying the branch up so that it is nearly vertical induces vigorous rooting.

The new trees, with about half of the top trimmed off and supported by stakes, are kept in a shade house for 6 weeks before setting out. Improvements in Colonel Grove's system later included the use of constant mist in the shade house. Also, it was found that birds pecked at the young roots showing through the transparent wrapping, made holes in the plastic and caused dehydration. It became necessary to shield the air-layers with a cylinder of newspaper or aluminum foil. As time went on, some people switched to foil in place of plastic for wrapping the air-layers.

The air-layered trees will fruit in 2 to 5 years after planting. Professor Groff said that a lychee tree is not in its prime until it is 20 to 40 years old; it will continue bearing a good crop for 100 years or longer. One disadvantage of air-layering is that the resultant trees have weak root systems. In China, a crude method of cleft-grafting has long been employed for special purposes, but, generally speaking, the lychee has been considered very difficult to graft. Bark, tongue, cleft, and side-veneer grafting, also chip-and shield-budding, have been tried by various experimenters in Florida, Hawaii, South Africa and elsewhere with varying degrees of success. The lychee is peculiar in that the entire cambium is active only during the earliest phases of secondary growth. The use of very young rootstocks, only 6 mm in diameter and wrapped at the union with strips of vinyl plastic film, have given good results. A 70% success rate has been achieved in splice-grafting in South Africa. Hardened-off, non-terminal wood from young branches 6 mm thick is first ringed and the bark-ring removed. After a delay of 21 days, the branch is cut off at the ring, defoliated but leaving the base of each petiole, then a slanting cut is made in the rootstock 30 cm above the soil at the point where it matches the thickness of the graftwood scion. As many leaves as possible are retained. The cut is trimmed to a perfectly smooth surface 2.5 cm long; the scion is then trimmed to 10 cm long, making a slanting cut to match that on the rootstock. The scion should have 2 slightly swollen buds. After joining the scion and the rootstock, the union is wrapped with plastic grafting tape and the scion is completely covered with grafting strips to prevent dehydration. In 6 weeks the buds begin to swell, and the plastic is slit just above the bud to permit sprouting. When the new growth has hardened off, all the grafting tape is removed. The grafting is performed in a moist, warm atmosphere. The grafted plants are maintained in containers for 2 years or more before planting out, and they develop strong taproots.

## 2.3.3. Soil and Weed Management

The first step in establishing a lychee orchard is to examine the soil for suitability in respect of depth, drainage and compacted layers. It should preferably be 1 to 2 m deep. Subsequently, the soil needs to be prepared according to the results of the soil analysis, especially when large quantities of lime are required.

If the soil is suitable for lychee production, it must be prepared well in advance. Before planting, the soil must be tilled as deep and as thoroughly as possible so that it will not be necessary to make the planting holes too big. If the soil is very acid, heavy lime applications may be necessary. Two-thirds of the recommended quantity of lime must be scattered over the planting area, mixed with the topsoil and then ploughed in as deep as possible, at least 9 to 12 months before planting. Calcium (lime) moves very slowly downwards into the soil and must therefore be worked in to the depth of the root zone.

A cover crop can then be planted and ploughed in about 6 months to improve the organic matter content of the soil. The remaining lime (one third) and all the required phosphate must be scattered and incorporated at the same time. The trees can be planted 3 months later.

If a lighter lime application (2- 4 t/ha) is required, the lime can be worked into the soil at least 3 months before planting and phosphate 1 month before planting.

### Planting and Spacing

It should be remembered that lychee trees have a long life and grow tall. A 25-year-old tree can reach a crown diameter of 12 m. If trees are too widely spaced and later become uncontrollably large, an economic yield will not be possible. If the trees are to be spaced closely together, size must be controlled from the start by pruning.

Young trees should not be planted too close together. Portions of the tree shaded by other trees will not bear fruit. For maximum productivity, there must be full exposure to light on all sides. For a permanent orchard, the trees are best-spaced 12 m apart each way. In India, about 9 m spacing is considered adequate, probably because the drier climate limits the overall growth. In South Africa the ideal planting distance is 9 x 6 m. In the Cook Islands, the trees are planted on a 12 x 6 m spacing–56 trees per acre (134 per ha)–but in the 15th year, the plantation is thinned to 12 x l2 m.

In Florida, it has been reported that the optimal spacing for a lychee tree is a 15’ (4.5 m) radius from the center of the trunk in all directions. If you leave 10 or more feet (3 m) access between rows, a row spacing of 40’ (12m) is implied.

Contrary to the above, it is reported that dense plantings have become popular in China. The number of trees per ha was increased from 150 to 330 or 495 by reducing tree spacing to 6m x 5m and 5m x 4m, respectively. Such a dense plantation requires more frequent fertilization, irrigation and pruning. Lychee trees are compressed to a height and diameter of approximately two meters by means of heavy pruning after harvest. This results in the trees reaching peak production earlier (after six years).

### Planting theTrees

Lychee trees can be transplanted any time of the year, but the best time is during spring or at the beginning of the rainy season. Planting holes should be square (in deep-ploughed soil 300 x 500 mm and in nonploughed soil 500 x 500 mm) and the bottom of the hole should be filled with a mix of topsoil and compost.

The roots of young trees must not be damaged during planting. After planting, the soil is slightly compressed by standing on it and wetted before mulch is placed around the newly-transplanted tree. Subsequently, the young trees have to be irrigated regularly. They must never suffer from a water shortage or too wet conditions.

## Blooming and Pollination

Lychee flowers best with days below 20°C. The inflorescence is determinant. Small white to greenish-yellow flowers are produced on the current season's wood in terminal clusters. They are present from mid-February through March in the northern hemisphere and mid-August-September in the southern hemisphere.

There are 3 types of flowers appearing in irregular sequence or, at times simultaneously, in the lychee inflorescence: a) male; b) hermaphrodite, fruiting as female (about 30% of the total); c) hermaphrodite fruiting as male. The latter tend to possess the most viable pollen. Many of the flowers have defective pollen, and this fact probably is the main cause of the abortive seeds and also the common problem of shedding of young fruits. The flowers require transfer of pollen by insects.

In India, L.B. Singh recorded 11 species of bees, flies, wasps and other insects as visiting lychee flowers for nectar. But honeybees, mostly Apis cerana indica, A. dorsata and A. florea, constitute 78% of the lychee-pollinating insects, and they work the flowers for pollen and nectar from sunrise to sundown. A. cerana is the only hive bee and is essential in commercial orchards for maximum fruit production.

A 6-week survey in Florida revealed 27 species of lychee-flower visitors, representing 6 different insect Orders. Most abundant, morning and afternoon, was the secondary screw-worm fly (Callitroga macellaria), an undesirable pest. Next was the imported honeybee (Apis mellifera) seeking nectar daily but only during the morning and apparently not interested in the pollen. No wild bees were seen on the lychee flowers, though wild bees were found in large numbers collecting pollen in an adjacent fruit-tree planting a few weeks later. Third in order, but not abundant, was the soldier beetle (Chauliognathus marginatus). The rest of the insect visitors were present only in insignificant numbers. Maintenance of beehives in Florida lychee groves is necessary to enhance fruit set and development. The fruits mature 2 months after flowering.

Fruit set in lychee is climate dependent and profoundly affected by temperature and humidity. It varies greatly within panicles, and ranges from 1-50 percent of the female flowers produced. Reproductive failure is common and not always explainable. In some years, certain cultivars produce few, or only male flowers; as a result, little or no fruit is set. This problem can be minimized through the use of better-adapted varieties and management methods to retard growth and induce flowering. Winter/spring temperature extremes that affect bloom phenology and unsettled weather that limit bee flight during bloom have been identified as other causes of reproductive failure.

## Wind Protection:

Perhaps the single greatest enemy of developing lychee trees is wind. Even a moderate amount of wind (> 15mph) will damage new branches and leaves. Young trees benefit greatly from wind protection. This can be provided by placing stakes around each small tree and stretching cloth around them as protection against wind. In very windy locations, the entire plantation may be protected by trees planted as windbreaks, but these should not be so close as to shade the lychees. Some growers report that they have successfully used bananas as wind breaks between the trees because they grow fast and are hardy. Besides acting as attractive wind breaks, bananas produce a lot of organic material that falls on the ground adjacent to the lychees. The lychee tree is structurally highly wind-resistant, having withstood typhoons, but shelter may be needed to safeguard the crop. During dry, hot months, lychee trees of any age will benefit from overhead sprinkling; they are seriously retarded by water stress.

## 2.3.4. Soil Nutrition and Fertilization

Newly planted trees must be watered but not fertilized, apart from enriching the planting hole with compost well in advance of planting. Fertilizer should only be applied about 1 year after transplanting. The applications must be very light and broadcast evenly, but not against the stems of the trees. The orchard should be irrigated after applying fertilizer.

In China, lychee trees are fertilized only twice a year with organic material. The use of organic matter is recommended for improved fruit quality. The major sources of organic amendments in Southern China are chicken and pig manure as well as peanut cake.

**Table 8: The Use of Kraal or Chicken Manure in South Africa for Lychee Trees**

| Tree age (years) | Kraal manure (kg/tree/year) | Time of application |
|---|---|---|
| 1 | 5 | ± 1 kg every 6 weeks during summer |
| 2 - 3<br>4 - 5 | 15<br>25 | Give 5 equal dressings during summer |
| 6 - 7<br>8 - 9<br>10 - 11<br>12 - 13<br>Maximum | 40<br>55<br>70<br>80<br>100 | Give 1/2 the quantity before blossoming and the remainder after harvesting |

In limestone and alkaline soil, it may be necessary to use soil sulphur and chelated iron to avoid chlorosis. Bronzing of the leaves is evidence of zinc deficiency.

In certified organic production, according the EU-Regulation 2092/91, the need for applying sulphur and trace elements like boron, cobalt, copper, iron, manganese, molybdenum and zinc must be recognized through the inspection body.

### Mulch

Organic mulch, such as that derived from yard waste and chipped material, helps to promote a uniform healthy microclimate above the roots. This reduces the stressful cycle of wetting and drying of the root system. These conditions also make for a healthy environment for soil building microorganisms such as bacteria and fungi.

Most lychees are propagated as air-layers, (vegetative) and as such develop a shallow root system that spreads across the surface without a deep taproot. The decaying organic matter in mulch assists in acidifying the soil, which is especially important in limestone soils.

Mulching effectively enhances the root shading properties of lychee trees.

## 2.3.5. Pruning

Ordinarily, the tree is not pruned after the judicious shaping of the young plant because the clipping off of a branch tip with each cluster of fruits is sufficient to promote new growth for the next crop. Severe pruning of old trees may be done to increase fruit size and yield for at least a few years.

However, it has also been reported that trees that have been pruned back about 15 cm after harvesting tend to produce more fruit in subsequent years. Pruning of the older growth stimulates new growth on all of the meristematic terminal ends. Remember that the bloom spikes form on recent growth that has “hardened off” within the last several months. V-shaped crotches should be avoided because of the wood’s brittle nature.

One objective of pruning should be to encourage the tree to achieve the optimal hemispherical growth habit. This shape will provide the best shade to the root system and encourage a healthier tree overall. Another benefit of shading the root system out to the drip line of the tree is that the shade deters the undergrowth of weeds, grass and undesirable volunteers that rob essential nutrients.

### 2.3.6. Water Management and Irrigation

The lychee will not tolerate standing water, but requires very moist soil, so the tree needs to be watered regularly when it is growing actively. In sandy soils, short irrigation cycles with small quantities of water are usually effective. In clay soils water is available for longer periods, but it is important that the soil does not become too wet or too dry. The trees are very sensitive to damage from salts in the soil or in water, which is why the soil has to be leached regularly.

Lychee trees need regular watering and therefore it is essential that enough water must be available from the flowering stage until after the flush of growth following the harvest. Because the edible portion of the lychee fruit has a water content of 86%, the availability of water remains important during fruit development. Water shortage will delay development of the fruit and adversely affect the size, mass and quality of the lychees.

During dormancy irrigation should be reduced, but the tree should not suffer drought. Producers normally stop irrigating the trees during the coldest months of the year so that they can have a proper dormant period. In areas where it is never very cold, irrigation should stop to force the trees into dormancy. Young trees that are not producing yet are irrigated throughout the year.

### 2.3.7. Pest and Disease Management

**Diseases**

Few diseases have been reported from any lychee-growing locality. The glossy leaves are very resistant to fungi. In Florida, lychee trees are occasionally subject to green scurf, or algal leaf spot (*Cephaleuros virescens*), leaf blight (*Gleosporium sp.*), die-back, caused by Phomopsis sp., and mushroom root rot, (*Clitocybe tabescens*) which is most likely to attack lychee trees planted where oak trees formerly stood. Old oak roots and stumps have been found thoroughly infected with the fungus.

In India, leaf spot caused by Pestalotia pauciseta may be prevalent in December. Leaf spots caused by Botryodiplodia theobromae and Colletotrichum gloeosporioides, that begin at the tip of the leaflet, were first noticed in India in 1962.

Lichens and algae commonly grow on the trunks and branches of lychee trees.

The main post-harvest problem is spoilage by the yeast-like organism that is quick to attack warm, moist fruits. It is important to keep the fruits dry and cool, with good circulation of air. Avoid conditions that favor rotting.

**Pests**

In most areas where lychees are grown, the most serious foliage pest is the erinose, or leaf-curl mite, Aceria litchii, that attacks the new growth causing hairy, blister-like galls on the upper side of the leaves, thickening, wrinkling and distorting them, and brown, felt-like wool on the underside. The mite apparently came to Florida on plants from Hawaii in 1953, but has been effectively eradicated.

The most destructive enemy of the lychee in China is a stinkbug (Tessaratoma papillosa) with bright-red markings. It sucks the sap from young twigs and they often die; or, in the very least, of high rate of fruit shedding occurs. This pest is combated by shaking the trees in winter, collecting the bugs and destroying them. Without such efforts, this pest works havoc.

The fruit flies, *Ceratites capitata* and *Pterandrus rosa* make minute holes and cracks in the skin and cause internal decay. These pests are so detrimental that growers have adopted the practice of enclosing bunches of clusters (with most of the leaves removed) in bags made of "wet-strength" paper or unbleached calico 6 to 8 weeks before harvest-time.

Birds, bats and bees damage ripe fruits on the trees in China and sometimes a stilt house is built beside a choice lychee tree for a watchman to keep guard and ward off these predators, or a large net may be thrown over the tree. In Florida, birds, squirrels, raccoons and rats are prime enemies. Birds have been repelled by hanging flowing metallic ribbons on the branches which move, gleam and rattle in the wind. Grasshoppers, crickets, and katydids may, at times, feed heavily on the foliage.

### 2.3.8. Harvesting and Post Harvest Handling

For home use or for local markets, lychees are harvested when fully colored; for shipment, only partly colored lychees are chosen. The final swelling of the fruit causes the protuberances on the skin to be less crowded and to slightly flatten out; thus, an experienced picker will recognize the stage of full maturity. The fruits are rarely picked singly except for immediate eating out-of-hand, because the stem does not normally detach without breaking the skin, causing the fruit to spoil quickly. The clusters are usually clipped

**Table 9:**
**Examples of Lychee Pests and Ways to Manage them Organically**

| Pests | Damage | Control |
|---|---|---|
| Elephant beetle (*Xylotrupes gideon*) | | CULTURAL: Beetles can be excluded with netting of a suitable mesh size e.g. 20 mm mesh or less. BIOLOGICAL: Manual removal from trees is sometimes undertaken. Larvae feed on rotting organic matter. Heavy mulching will attract beetles to lay their eggs in this material. This will increase the problem in subsequent seasons. |
| Lychee erinose mite or leaf-curl mite (*Eriophyes litchii*) | attacks the new grown leaves causing hairy, blister-like galls on the upper side of the leaves, thickening, wrinkling and distorting them, and brown, felt-like wool on the underside | In older trees prune as much of the infested foliage from the tree as possible and destroy it. The mite is easily spread on nursery plants especially marcots taken from infested trees. Use only clean, mite free planting material. Where possible obtain your planting material from mite free orchards. Spread can also occur by wind and bees. |
| stinkbug (*Tessaratoma papillosa*) | In China it sucks the sap from young twigs and they often die or produce high rate of fruit shedding | shaking the trees in winter, collecting the bugs and destroying them |
| false-unicorn caterpillar (*Schizura ipomeae*) | feeds on the leaves | is parasitized by a tachinid fly, (*Thorocera floridensis*) |
| red spider mites (*Paratetranychus hawaiiensis*). | infests the foliage | spray extract of *Tephrosia vogelii* (20 g of leaves for 100 ml of water soaked overnight) and add some soap as a sticker |
| Thrips (*Dolicothrips idicus*) | attack the foliage | preparations of neem, pyrethrum, tobacco, derris, ginger |
| The larvae of a small moth, *Acrocerops cramerella*. | eats developing seeds and the pith of young twigs | Sanitary practice of burning the fallen lychee leaves. A small parasitic wasp also helps to control this predator. |
| aphid (*Aphis spiraecola*) + citrus aphid (*Toxoptera aurantii*) + lychee bark scale, *Pseudaulacaspis* major + white peach scale, *P. pentagona*. | occur on young plants in shaded nurseries, preys on flush foliage | encourage natural enemies, spray plant extracts of derris, neem, chili or soap solution |
| fruit flies, *Ceratites capitata* and *Pterandrus rosa* | make minute holes and cracks in the skin and cause internal decay | enclosing bunches of clusters (with most of the leaves removed) in bags made of "wet-strength" paper or unbleached calico 6 to 8 weeks before harvest-time |

with a portion of stem and a few leaves attached to prolong freshness. Individual fruits are later clipped from the cluster leaving a stub of stem attached. Harvesting may need to be done every 3 to 4 days over a period of 3-4 weeks. It should never be done right after rain, as wet fruit is very perishable. The lychee tree is not suited to the use of ladders. High clusters are usually harvested by metal or bamboo pruning poles. A worker can harvest 25 kg of fruit per hour.

### Yield

Lychee yields are commonly unreliable and erratic and rarely approach the capacity of the tree. The yield varies with cultivars, age, weather conditions, presence of pollinators, and cultural practices. In India, a 5-year-old tree may produce 500 fruits, a 20-year-old tree 4,000 to 5,000 fruits – 73 - 150 kg. Exceptional trees have borne 455 kg of fruit per year. One tree in Florida has borne 544 kg. In China, there are reports of 680 kg crops. In South Africa, 25 years old trees have averaged 272 kg each in good years; and an average yield is approximately 10,000 kg per hectare annually.

### Keeping Quality, Storage and Shipping

Freshly picked lychees keep their color and quality only 3 to 5 days at room temperature.

Fresh fruits, picked individually by snapping the stems and later de-stemmed during grading, and packed in shallow, ventilated cartons with shredded-paper cushioning, have been successfully shipped by air from Florida to markets throughout the United States and also to Canada.

In China and India, lychees are packed in baskets or crates lined with leaves or other cushioning. The clusters or loose fruits are best packed in trays with protective sheets between the layers where no more than 5 single layers or 3 double layers are joined together. The pack should not be too tight. Containers for stacked trays or fruits not arranged in said manner must be fairly shallow to avoid too much weight and crushing. Spoilage may be delayed by moistening the fruits with a salt solution.

Lychee clusters shipped to France by air from Madagascar have arrived in fresh condition when packed 6 kg to the carton and cushioned with leaves of the traveler's tree (*Ravenala madagascariensis Sonn.*).

Boat shipment requires hydro cooling at the plantation at 0º-2º C, packing in sealed polyethylene bags, storing and conveying to the port at -20º to -25º C and shipping at 0º-2º C.

In Florida, fresh lychees in sealed, heavy-gauge polyethylene bags keep their color for 7 days in storage or transit at 1º-10º C. Each bag should contain no more than 15 lbs (6.8 kg) of fruit.

Lychees placed in polyethylene bags with moss, leaves, paper shavings or cotton packing have retained fresh color and quality for 2 weeks in storage at 7º C; for a month at 4º C.

At 0º-2º C and 85% to 90% relative humidity, untreated lychees can be stored for 10 weeks; the skin will turn brown but the flesh will be virtually in fresh condition but sweeter.

Frozen, peeled or unpeeled, lychees in moisture-vapour-proof containers keep for 2 years.

### Drying of Lychees

Lychees dehydrate naturally. The skin loses its original color, becomes cinnamon-brown, and turns brittle. The flesh turns dark-brown to nearly black as it shrivels and becomes very much like a raisin. The skin of "Kwai Mi" becomes very tough when dried; that of "Madras" less so. The fruits will dry perfectly if clusters are merely hung in a closed, air-conditioned room.

In China, lychees are preferably dried in the sun on hanging wire trays and brought inside at night and during showers. Some are dried by means of brick stoves during humid weather.

Sun drying on coir-mesh trays took 15 days and the results were acceptable although that thin-skinned fruits tended to crack. It was found that shade drying for 2 days before full exposure to the sun prevented cracking.

Dried fruits can be stored in tins at room temperature for about a year with no change in texture or flavor.

## 2.4 Avocado

The center of origin of avocado (*Persea americana*) is in the highlands of Mexico and Guatemala. It is now widely distributed throughout the tropics and subtropics but the importance and use of fruit differs from area to area. In many countries avocado is not considered a major fruit and is planted mostly in home gardens and as shade tree in the orchards of high value. However, avocado is a popular fruit in Mexico, Central America, Greater Antilles, Chile, Spain, Canaries, Israel, South Africa, Sri Lanka, India, Indonesia, Philippines, Thailand, Vietnam and other countries. Only a small part of the production in developing countries is exported, and on the local market, the interest is limited due to the nature of its taste and the availability of many other tropical fruits throughout the year that are more palatable than avocado. However, avocado has great commercial possibilities thanks to its high nutritive value (rich in antioxidants, vitamins E, C and A; avocado fat consists predominantly of monounsaturated oleic acid etc.).

Organic avocado is grown in all major avocado production countries. In subtropical regions organic avocado is grown in orchards as a main crop, while in tropical regions it is a integrative part of most fruit gardens. Many hill-tribe organic farmers in mountainous areas of Central America and Asia have avocado trees on their farms.

Avocado generally demands only extensive crop husbandry practices and responds well to organic agriculture. A major limiting factor to avocado production in many developing countries is the lack of certified planting material of these good varieties. Reputable fruit nurseries are scarce. This specifically affects organic avocado production, because resistant varieties and high quality planting material is of basic importance in this production system. Another principal obstacle in the development of avocado is the poor recognition of avocado as a food crop by the local population in production countries.

## 2.4.1 Agro-ecological Requirements and Site Selection

### Climate

Avocado is a tropical to subtropical evergreen tree and has a wide ecological distribution in these climatic regions. The genetic diversity of the avocado, due to the three eco-races, (see below) enables the successful production of this crop over a wide range of environments from cool, summer-dry Mediterranean to sub-tropical and humid tropical. Diverse agro-climatic zones in the region offer the scope for exploitation of off-season production opportunities. Mexican races are tolerant to temperatures as low as –5°C. There are varieties having higher than usual cold tolerance (Gainesville, Winter Mexican and others), but they are not of notable fruit quality.

### Soil

Avocados can be grown on a wide range of soil types, but they are extremely sensitive to poor drainage and cannot withstand water-logging. They are intolerant to saline conditions. Optimum range of pH is from 5 to 7. West Indian seedlings are more tolerant to salt than Mexican seedlings, with Guatemalan having an intermediate tolerance.

**Table 10: Comparison of Selected Characteristic of three Avocado Races**

| Trait | West Indian | Guatemalan | Mexican |
|---|---|---|---|
| Climate | Tropical | Subtropical | Semi-tropical |
| Cold tolerance | Least | Intermediate | Most |
| Salt tolerance | Most | Intermediate | Least |
| Disease resistance | Higher | Susceptible to *Verticillium wilt* | Susceptible to diseases due to very thin skin |
| Fruit bloom to maturity | 5-9 months | 9-12 months or more | 6-8 months |
| Fruit size | Variable | Variable | Small |
| Fruit color | Green or reddish | Green | Green to purple or black |
| Skin thickness | Medium | Thick | Very thin |
| Skin surface | Shiny, leathery | Rough and warty | Waxy bloom |
| Seed cavity | Variable | Tight | Loose |
| Oil content | Low (3-10 %) | High (8-15 %) | Highest (up to 30 %) |
| Pulp flavor | Sweet, mild, watery | Rich | Anise-like, rich |

SOURCE: NAKASONE ET AL. 1998

All three horticultural races adapted to tropical and sub-tropical conditions. The West Indian race is well-adapted in the humid tropics, but its hybrids with Guatemalan (e.g. Booth selection) perform well and are considered valuable for extending the harvest season.

In subtropical regions, hybrids of Guatemalan and Mexican races predominate since they combine the cold hardiness of the latter with the superior horticultural traits of both while bringing the two seasons of maturity.

Breeding programs include the universally desired objectives (yield, fruit quality, vigour, adaptability etc.) and some specific objectives for avocado. In avocado rootstock breeding, the need of Phytophthora-resistance is recognized as the most important objectives. Duke 7 shows moderate resistance. In many tropical countries, locally collected seeds are used to raise seedlings as rootstocks.

There is a large number of avocado cultivars. Hass and Fuerte are the most widely grown cultivars. Other important cultivars are Bacon, Zutano, Booth 7, Booth 8, Sharwil, Ettinger etc...

## 2.4.2 Establishing an Organic Avocado Orchard

### Suitable Races and Cultivars

There are three distinct horticultural races of avocado: West Indian (*var. americana*), Guatemalan (*var. drymifolia*) and Mexican (*var. guatemalensis*), plus hybrids between them. Hybrids of the Guatemalan race with the other two races include many of the more important varieties in commerce. Pure West Indian types are generally unsuitable for export market but preferred by local consumers.

### Flowering Types and Flowering Induction

The flowering habit of avocados is unique in that the flowers are perfect, having both male and female organs, but the parts do not function together. Flowers of type A varieties (e.g. Hass, Guatemala, Simmonds, Nadir, Lula) open in the morning as receptive females, then close in the afternoon until the following afternoon when they reopen for pollen shed. In contrast, flowers of type B avocados (e.g. Fuerte, Bacon, Zutano, Hardee) open in the afternoon as receptive females, close overnight and reopen the following morning to shed pollen. If an avocado plantation is to be established in a relatively new area, the varieties to be selected for planting should belong to both A and B groups and their flowering must overlap to assure good pollination. The proportion of A and B group varieties can be 1:1 or 2:1. Under some conditions, there is sufficient overlap between the phases of a flower type that pollination and fruit set are rarely a problem. Flowering occurs from late autumn to spring, depending upon the cultivar and climate. Dry conditions during flowering and fruit set can cause flower and young-fruit drop.

### Propagation and Planting

Planting materials may come in the form of grafted plants or seedlings for rootstock use. The commonly used and preferred method for large-scale propagation is grafting. This method is less demanding, faster and economical in the use of scion materials. In the case of cleft-grafting, 6-12 month old seedlings are used as rootstocks. Budwood sticks are obtained from the season's mature growth with well-developed terminal buds. New shoots are formed within three to four weeks. While in conventional agriculture many avocado trees are produced in containers of soilless media, organic growers use compost/earth-mixtures as media.

The use of grafted plants is limited, especially in countries that do not have specialized avocado nurseries. There, propagation of avocado is mainly carried out by seed. The seeds taken from mature fruits are sown directly in the nursery or in polyethylene bags. When 6-8 months old, the seedlings are ready for transplanting. In many cases, the resulting seedlings are used as rootstocks. Such seedling trees produce 300 to 400 fruits at 10-15 years.

When providing trees, it is of crucial importance to order certified trees where the absence of diseases, pests, viruses and authenticity of rootstock and cultivar are guaranteed. In different organic label regulations the use of trees from certified organic nurseries is compulsory from 2004 on. At present time, the detailed regulations e.g. in cases where organic trees are not available are very dynamic. Therefore, the actual regulations should be checked carefully with the certification body before ordering any plantlets.

### Establishment of Avocado Orchards

For orchard planting in flat to gently rolling terrain, the land is cleared, ploughed deeply to break the hard subsurface soil layer and harrowed two or three times to achieve the desired soil tilt and to level the field. A few months before planting avocado trees, some organic growers saw in vigorous legumes (e.g. *Canavalia sp.* or *Cayanur cayan*) and later mulch them shortly before planting the avocado trees. By this measure, the soil will be enriched with organic matter and nitrogen that in turn stimulate soil microbial activity.

For rolling land and steep slopes, plowing and harrowing are not practiced in organic agriculture. Instead, hand forking and hoeing are carried out so as to minimize erosion. Stakes are then set, following the desired planting distance. Depending upon the cultivar, the plants are set at 8-10 m apart to give a population of 100-156 trees per hectare (see below).

Holes are dug that are deep and wide enough to accommodate the root system (60 x 60 x 60 cm to 90 x 90 x 60 cm) in early spring. The holes are filled with compost or farmyard manure and top soil (1:1 ratio) before planting. As most of the wet zone soils are acidic, pH adjustment (to 5.5 - 6.5) is achieved by liming, according to the organic standards. The places are then occupied by the stakes. Planting is done in summer.

The plants should be subjected to hardening under full sunlight before transferring to the field. Before planting, the leaves of the planting materials are pruned in half to reduce transpiration. After removal from the container or polyethylene bag, the plants are set in the prepared holes, with soil mixture filled and firmed to ensure good contact with roots. The holes are then filled up with top soil that is packed firmly around the stem. The plants are then watered immediately after planting. After establishment, the young plants are shaded by bamboo sheet, banana leaves, etc. Tree basins are mulched by dried weed and straw during the next dry season. The plants are protected from wind by planting windbreak trees as well as by using stakes for supporting newly planted trees.

Where avocados are vegetatively propagated by means of budding or grafting, it is common practice to plant the tree deeper than normal so that the graft is at or below ground level. In addition, soil is mounded around the trunk as the tree grows to assure that the graft union is below ground. Thus, trees killed to the ground by severe cold will regenerate from varietal wood rather than from rootstock.

In areas prone to excess water, they should be planted on mounds as avocados cannot withstand waterlogging.

Planting usually takes place at the beginning of the rainy season to minimize the need for frequent watering of the newly set plants in the field. However, in areas where there is a uniform distribution of rainfall or where irrigation water is readily available, planting takes place at any time of the year.

### Design of New Organic Avocado Orchards

Avocado is planted out to a distance of 6 to 12 meters depending on the vigour of variety and its growth habit. For varieties having a spreading type of growth, like Fuerte, a wider spacing should be given. Most organic growers generally prefer a wider spacing compared to their conventional colleagues in order to guarantee good ventilation and to prevent fungal diseases. Pollinizer trees are placed so that adequate pollinization is guaranteed (e.g. one pollinator for every nine trees). To limit the erosion on sloping land and to collect water from rainfall, organic growers install water traps surrounding the tree basins. On hills slopes planting is preferred on half-moon terraces in order to prevent erosion. The shallow, triangular path connecting to the tree pit is dug with its open mouth on the reverse slope direction to collect rainwater.

**Avocado in Agroforestry Systems**

Some organic growers plant avocado as one of the mixed crops in agroforestry systems. In such systems, avocado is a good shade tree for tea and coffee production. In other cases, organic avocado is inter-cropped with other perennial crops such as coconut, banana, jackfruit, rambutan, mangosteen and other fruit trees. Avocado are also planted along fences.

Such production systems are of great importance in organic agriculture because they can be effective in limiting pests and diseases, thereby enhancing production efficiency. Another advantage of inter-mixing: avocado trees benefit indirectly from the cultural practices applied to the main crop. Therefore, in many cases no special attention is necessary after planting or throughout the lifetime of avocado trees. Generally, fertilizer application, weeding and irrigation regimes for avocado trees are practices to be varied from orchard to orchard, depending on what main crop is grown in mixed orchards.

**Conversion of orchards to agroforestry systems**

In order to convert monocrop orchards to organic agriculture, some organic growers reduced the original high density of avocado trees (156 trees/ha) by thinning to allow for the development of other crops like coffee, durian, mulberry, rambutan, etc. Such avocado orchards have a density of 50-80 trees/ha. Organic growers prefer taller and bigger trees as they are more convenient in mixed gardens.

### 2.4.3 Soil and Weed Management

The elimination of weed and grass competition can be important during the first two or three years after planting. Organic growers perform weed control in young plantations by slashing and using the weeds for mulching. When weeds are slashed and removed, they are used as a mulch that helps with moisture retention during the dry season. As the avocado is a surface feeder, clean weeding (plowing, disc-harrowing) is not recommended as any damage to the root system can accelerate Phytopthora infection. Weeding is usually carried out manually with the use of a scythe or mechanically with the use of a grasscutter. Once competition is eliminated, organic mulches can effectively prevent further problems. Organic materials such as straw, rice husk and wood chips are commonly used as mulching material.

In bearing orchards, the canopy provides enough shade to prevent weed growth. In inter-rows up to the periphery, a green mulch is recommended to control weeds. Peuraria is a suitable leguminous cover plant for humid tropics. In well-established agroforestry systems, the shoots of coffee (or other main crops) overlap and weed control is no longer considered necessary, both for the host and for intercrop plants.

### 2.4.4 Tree Nutrition and Fertilization

Fertilization practices in an organic avocado orchard are generally more intensive than in a fruit garden or in agroforestry systems. However, in both cases, fertilization of organic avocado growths is based on the application of compost (based on animal manure and/or vegetable materials). Compost is applied at the onset of the rainy season, before summer leaf flush. A second application is advisable – if feasible – near the peak of fruit set. It is usually applied in a ring around the trunk of the tree or in shallow holes dug beneath the tree canopy. Many avocado trees in home-gardens and backyards are grown without the benefit of fertilizer. This may be the reason why fruit yield and quality tend to decline after fruiting for several years.

Avocados need moderate fertilization-levels. Too high or too low nitrogen-levels reduce yields. The optimum range of foliar nitrogen level is 1.6-2.0%, optimum phosphorous levels are 0.07-0.20%, and optimum potassium levels are 0.75-2.0%.

Various micronutrients (Fe, Zn, B) have profound influences on tree growth, nutrient uptake and yield of avocado. Compost applications generally provide enough micronutrients. Deficiencies can be corrected by applying a commercial product containing these elements in accordance with the organic certifier[8]. Avocados benefit from liming: Every 2 to 3 years apply 200 g of dolomite a square meter in the winter.

### 2.4.5 Water Management and Irrigation

The avocado can tolerate neither water stress nor excess moisture, especially when drainage is inadequate. Water stress causes high flower and fruitlet drop during early spring, and heavy fruit drop during autumn. Any means of providing supplementary irrigation to the crop could easily minimize flower and fruit drop during these dry spells. Most organic orchards minimize water loss by using cover plants or mulches.

[8] The procedure is described in chapter 2.1.4

Soil drainage, soil management, tree density and canopy size determine irrigation frequencies. Only 50% of the tree's requirements should be given in the middle of the cool season and spring, in order to favor flowering rather than vegetative growth. When fruit set is completed, irrigation reverts to normal amounts. High rates are necessary during flowering and as the fruit approach maturity, and if the weather is too dry.

In drier climates and regions with longer dry periods, irrigation at intervals of three to four weeks during the dry months is beneficial to avocado. To avoid moisture stress during winter season, mulching with dry grass/dry leaves is desirable. On level land, sprinkler irrigation can be used. Most efficient in water use are mikrosprinklers or drip irrigation: mature trees require eight or more drip emitters around the tree. On steep hills, the microirrigation systems are the most appropriate. Flooding is undesirable as it promotes root rot incidence.

## 2.4.6 Freeze Protection

Organic growers make maximum use of indirect measures before heating an orchard, such as:

- Use of freeze-tolerant races, rootstocks and cultivars;
- Deep planting.

Deep planting and subsequent soil mounding around the trunk are the best assurances that the avocado will survive a severe freeze, even if the top is completely killed. When a severe freeze is being forecast, mound additional soil around the trunk for extra protection, then water thoroughly two or three days before the cold weather is expected. Young trees can be draped (not wrapped) with a blanket during the freeze event. Any additional heat source under the tented tree will probably save the leaves as well.

Freeze-damaged wood should be cut out in the spring. If only limb damage occurs, wait until re-growth commences and cut back to live tissue. If the tree is killed to the ground, cut it off at ground level; the regenerated tree will be naturally multi-trunked or the excess sprouts can be removed to permit only one to reform the tree.

## 2.4.7 Pruning

The avocado tree is variable in shape, from tall, upright trees to widely spreading forms with multiple branches. Trees can attain heights of 15-18 m. Training and pruning is not an adopted practice in home gardens. In large-scale cultivations, however, training and pruning are adopted as trees get closer.

Young avocado trees are normally trained under a modified leader or open center system. When plant height of newly established plants is about 70 cm, the growing tips are pinched off to allow development of more side shoots to form a round-shaped tree. When the trees are still young, especially during the first few years, the plants are trained to a desirable shape by allowing three well-spaced branches to develop, and eliminating the rest.

Once the trees have attained the desired form, pruning is confined to the removal of diseased, infested and interlacing branches and water sprouts. After harvesting, the trees should be pruned. The upright branches, water sprouts, dead wood, infected branches, and the branches that are not exposed to the sun should be pruned off. Sometimes root pruning is carried out on avocado trees to minimize their nutrient competition with the main crop (in agroforestry and mixed cropping systems).

In spreading varieties like Fuerte, branches are thinned and shortened. Heavy pruning has been found to promote excessive vegetative growth, consequently reducing the yield. Topping and tree thinning is practiced to rejuvenate a crowded orchard; it is essential to avoid a loss of bearing volume in the lower third of the tree.

Generally, in organic avocado orchards, trees are pruned more frequently and more consequently than in conventional orchards due to the importance organic growers give to good orchard ventilation.

## 2.4.8 Pest and Disease Management

In general, no serious pests and diseases are found in avocado trees in most production regions. In mixed fruit gardens pest attacks are sporadic. In addition, protecting the trees through spraying organic preparations such as clay powder or copper in a home garden is not feasible. In agro-forestry systems and home-gardens, population explosion of the pest seldom occurs, and elimination is progressively accomplished through natural enemies. However, in intensive organic orchards, management of pests and diseases becomes more important. Organic pest and disease management prioritizes indirect control methods. Direct control methods are applied with second priority (see chapter 2.1.9).

### Pest management

Few insects have been documented on avocados, although mites sometimes occur on the foliage. None has been severe enough to warrant control measures. Possums apparently thrive on mature avocado fruit and will climb the tree to feed in the absence of fruit on the ground.

### Disease Management

A number of diseases appear on avocado production areas around the world. The most serious is root rot. The following measures will help keep an organic avocado orchard free of this disease:

- Obtain trees only from a reputable nursery manager who has grown it in a sterile potting mixture;
- Plant only in deep, well-drained soil, particularly in high-rainfall coastal areas;
- Water the tree carefully. Over-watering increases the risk of root rot;
- Establish and maintain a permanent organic mulch, 5 cm to 8 cm thick, under the tree canopy and extending 60 cm beyond the canopy. Straw makes a good mulch, but keep the material 20 cm away from the tree trunk to avoid bark rots.

**Table 11:**
**Examples of Avocado Pests and Organic Control Methods**

| Pests | Important to Know | Organically control Methods |
|---|---|---|
| *Ceratitis capitata* (Mediterranean fruit fly) and *Dacus dorsalis* (Oriental fruit fly) | • Adults oviposit under dry conditions and attack the mature fruits that are about to ripen; | • Mass trapping (combination of food baits with organic insecticides, such as Spionosad);<br>• Release of the braconid parasite Diachasmimorpha tryoni and nematodes;<br>• Sterile insect technology (STI) is not permitted in organic agriculture. |
| *Niphonoclea albata, Niphonoclea capitoe, Xylosandrus compactus* (Borers) | • Attack the trunk, pith and branches by boring their way through and cutting off the plant's tissues; | • Lime wash and lime sulphur are used as repellents; |
| *Asphidiutus destructor* (Scale Insects); (Mealy Bugs) | • Suck the sap from the leaves, shoots and fruits, causing premature falling of the fruits; | • Natural enemies provide satisfactory control;<br>• In case of high pressure: mineral oil spray; |
| *Heliothrips haemorrhoidalis* (Greenhouse thrips) | • Cause fruit blemishes;<br>• Orchards with ground cover have fewer thrip problems (natural enemies in the ground litter); | • Introduction of predatory mites (Euseius hibisci and Anystis agilis) and the minute pirate bug; |

**Table 12: Some Guava Diseases and Organic Management**

| Disease | Important to Know | Indirect Control | Direct Control |
|---|---|---|---|
| *Phytophthora cinnamomi* (Root rot) | • Causes root rot and tree decline;<br>• Yellowing of leaves, sparse foliage, wilting of leaves and dieback of shoots;<br>• This soil borne disease is commonly found in acid soils with poor drainage; | • Use resistant rootstocks such as Morton Grandee, Thomas, Barr-Duke, Duke-9;<br>• Adequate drainage or avoiding planting in waterlogged areas;<br>• Build up heavy mulch with bagasse, grass, straw etc.;<br>• No plowing underneath the tree canopy;<br>• Careful irrigation (avoid flood irrigation); | • Good pruning practice;<br>• Cu applications on wounds (Bouille bordelaise 2% and cover with wax); |
| *Colletotrichum gloeosporioides* (*Glomerella cingulata var. minor*) (Anthracnose) | • Small brown to black spots on the fruit; spots can enlarge and cause the fruit to crack across the spot;<br>• Another strain of the same fungus causes leaf spot;<br>• Fuerte cultivar is most susceptible; | • Adequate drainage;<br>• Rarely causes significant losses on other thick-skinned fruits; | • Spraying with Bordeaux mixture; |
| Cercospora spot, powdery mildew, stem-end rot and scab | • Rarely encountered in semiarid regions, but are serious problems in the humid tropics;<br>• Affect leaves, young steams, fruit; | • All preventive measures; | • Spraying with Bordeaux mixture; |

## 2.4.9 Harvesting and Post Harvest Handling

Avocado plants raised from seeds start bearing five to six years after planting. Grafted varieties will produce a few fruit two years after establishment. Mature trees can produce two to three or more bushels of avocados with good management, depending upon variety. Mexican-race seedlings and varieties typically mature during the summer; "Lula" and most other hybrids mature in September or October.

### Indicators of Maturity

As the fruit approaches maturity, the percentage of fat in the pulp increases to reach the standard level characteristic of each cultivar. Parallely, the percentage of dry matter of the fruit comes to a constant level. Both can be used as indicators of maturity. Other indicators are the skin color and age: Mature fruits of purple varieties change their color from purple to maroon, whereas fruits of green varieties become greenish-yellow. Fruits are ready for harvest when the seed coat colors within the fruit changes from yellowish white to dark brown. In the case of loose-seeded varieties, an indication of fruit maturity is the production of a hollow sound when the fruit is tapped manually. Some pickers shake the fruits to see whether the seeds are no longer clinging, looking for signs of maturity.

Avocado fruits do not ripen on the tree; the fruits remain hard as long as they stay on the trees. Mature fruits ripen six to ten days after harvesting. Some cultivars – especially Guatemalan x Mexican hybrids – can be stored on the tree and harvested according to marketing schedules. However, on-tree storing can lead to biennial bearing and crop failure in the following year.

### Harvest

Fruits are harvested when they are still immature in order to prolong their shelf-life during long distance transportation, often under simple packaging and handling techniques. The harvesting is achieved manually by a picker climbing the tree and taking a basket or jute bag or by using a ladder. Fruits that cannot be reached by hand are harvested with the use of a long bamboo or aluminum pole fitted at one end with a wire hook and an net attached to catch the fruits. The fruits are then placed in bins, pallets, boxes or bamboo baskets lined with banana leaves for transport to the market. Avocado fruits on the same tree do not mature at the same time, so selective harvesting is usually practiced. This requires going over the tree several times until all the fruits are harvested.

Avocados give a commercial yield of 7.5 – 15 ha/ha. The yield ranges from about 100 to 500 fruits per tree (40-200 kg per tree), depending on cultivar and age of trees.

### Post-Harvest Handling

Fruits need to be picked carefully. They should be harvested at the correct stage of maturity, when they are still hard and have a minimum oil content of 12 %. Hard, mature fruits are harvested and allowed to ripen during transport and distribution. Up to 14 days transport time is considered satisfactory, though unripe avocados can be stored for up to four weeks if the temperature is kept between 5.5 and 8°C.

In the packing houses, fruits are cleaned with roller brushes. Cleaned fruit pass through graders, where all diseased, injured and defective fruit are removed and fruit are separated into size lots for packing. General size class standards may not be valuable for organic avocado; this has to be checked with the client. Packing cartons and labeling must comply with organic standards and regulations.

Storage temperature for delaying ripening varies with the cultivar:

- West Indian race: 12.5 °C
- Guatemalan race: 8°C
- Mexican race: 4°C.

A relative humidity of 80-90% is recommended.

Fruit can be ripened at 25°C or by exposure to ethylene at 15-17°C for 24 hours and then transported to the market. Both methods are allowed for organic marketing.

## 2.5. Coconut

Coco palms (*Cocos nucifera L.*) originate from Melanesia. South east Asia is still an important cultivation region. The coconut is a monocotyledon plant, and can therefore only proliferate via seeds. It can produce an inflorescence on each leaf axil, and can then have either male or female blossoms. These are formed on the side, so that generally, the coco palm is cross-fertilized by a variety of bee species, other insects and the wind. Coco palms live to an average age of 60 years.

Every part of the coco palm can be used. The juice from the inflorescence, which can contain up to 15% sugar, goes to make palm-wine. Half-ripened nuts (6-7 months old) are often harvested to be eaten fresh. The coco juice is drunk, and milk squeezed out of the meat (endosperm). Fully ripened nuts (after 11-12 months) provide the so-called copra, which is made from the firm meat of the nut. Copra is high in oil and protein content (65% oil, 25% protein). Coconut oil is produced from drying and pressing the copra. Grated coconut is made from fresh copra. The hard coconut shells are used to fire kilns used to dry the copra, and to make charcoal. When they have been finely grated, coconut shells are used as fillers for objects made of plastic, such as buttons, containers and other objects. Coconut fibers are used in the upholstery industry, to make ropes, as mulching material or as a substitute for peat. The leaves and wood are used as building material and to make household objects (e.g. brooms) and tools.

### 2.5.1. Ecological Requirements

The saying “the coco palm loves to stand with its feet in the water and its head in the sky”, offers a very characteristic description of the site requirements of coco palms. A continuous supply of adequate water which can be provided by regular rainfall of about 2000 mm per annum, or from ground water (at a depth of 1-3 m). It cannot tolerate water-logging, though.

These conditions are generally found in tropical and subtropical coastal regions with little rainfall. Coco palms can also grow on deep, water-logging free, alluvial soil, away from the coast – yet a low chlorine content in the soil could have negative effects. These conditions should be well-heeded when choosing a site.

### 2.5.2. Soil and Weed Management

#### Soil

Growth is stimulated by a sufficient supply of chlorine in the soil. The coco can withstand up to1% salt in the soil.

Coco palms can also grow on deep, water-logging free, alluvial soil, away from the coast – yet a low chlorine content in the soil could have negative effects.

#### Temperature

The coco palm grows best at average temperatures of around 26-27°C. Because of its temperature requirements it cannot grow above 750 m, even near to the equator.

#### Weed management

The tilling of weeds should be carried out according to which mixed crop system or agro forestry system is used. Measures need then to be taken when the following occurs:

- Legumes used for ground-coverage, such as e.g. *Pueraria phaseoloides, Glycine wightii, Arachi Pintoi, Desmodium ovalifolium, Mimosa invisa, Calopogonium muconoides* or *Centrosema pubescens*: these plants rapidly develop a dense layer of foliage, and can be mulched. The thick layer of mulching material, along with the shade provided by the crop itself (especially by pueraria), is an effective way of controlling weed growth by suppressing it. When planting *Pueraria phaseoloides* and *Glycine wightii*, care should be taken during the rainy months that the young plants are not overgrown by weeds. For this reason, a monthly check and trim is necessary.

- If forage is being produced, regular grazing (rotational grazing) should be interrupted by a hay pasture. Hay can be used for the dry season; and the crop as well as the weed growth (among others caused by animal movement) can be better controlled. In agroforestry systems, animal husbandry should never be practiced within the plantation.

- On young coco palm plantations, it may become necessary to remove climbers and epiphytes from the palms.

## 2.5.3. Organic Coconut Palm Production Systems

Depending on the site, coco palms can be suited to cultivation on agroforestry systems. As a plant of the upper storey, with requisite light requirements, the coco palm towers above such crops as citrus plants, cacao and others.

Organic coconut cultivation does not allow for monocropping. Existing plantations can be improved by sowing at least one bottom crop of plants that offer ground coverage. Legumes can be planted here as green fertilizers. In multi-level agroforestry systems, cacao, bananas, pineapples and many other crops can be used. Spices such as ginger and turmeric also thrive under palms. If animals are kept, fodder crops should be integrated in a crop rotation system underneath the coco palms.

If possible, large plants should be used from the nursery beds when setting up agroforestry systems that include coco palms. This applies not only to coco palms, but to all types of palms integrated within agroforestry systems. Coco palms will grow on any sites that are suitable for cacao, bananas, citrus (oranges) or papaya. On citrus plantations, a slightly lower density should be used (120-150 plants/ha) than for e.g. cacao (150-180 plants/ha).

**Table 13:**
**The tree phases in the life cycle of the coco palm**

| Life cycle | Shade | Mixed crops |
|---|---|---|
| 1st phase: up to 8th year | A full frond will only have developed after 8 years; during this time, only partial shade is available; | Cultivation of annual crops possible. |
| 2nd phase: from 8-25th year | Comparatively large amount of shade | Cultivation of shade-tolerant varieties. |
| 3rd phase: older than 25 years | Shade reaching to the ground diminishes as trees attain full height | High amounts of sunlight allows cultivation of plants needing lots of light. |

A variety of biotopes providing habitats for useful insects and special bees – which both contribute to the fertilizing of coco palms – can develop on diversified plantations. Coco palms cultivated in agroforestry systems receive significantly more protection against winds in very windy regions (cyclones).

The quality of the seeds is important to the forthcoming yield from the palm. For this reason, the seeds should originate from a healthy, and productive stock plant. Usually, the seedlings are raised in state tree nurseries. If no tree nursery can be found that is capable of working under the restrictions necessary for organic cultivation, then the seedlings will have to be raised on the site.

### Suitable Varieties

Two different main groups are cultivated in the commercial sector. The tall plants of the *Typica group*, which generally need to be cross-fertilized, and dwarf types of the *Nana* group, where self-pollination is the norm. Tall varieties should always be chosen for agroforestry systems, because these are the only sorts that can reach up to the upper levels intended for them, and thus fully develop. Dwarf palms grow very slowly, and are easily overshadowed in the system, hindering their full development. In addition, the Nana variety reacts more sensitively to drought and some diseases than *Typica* varieties.

### Propagation and Nursery Management

Stock plants that are suitable seed providers produce 100 nuts per year, 12-14 syncarpy of differing ages, and up to 180 g copra per nut. The fully-ripened nuts that are intended to provide seeds are harvested after 11-12 months. It should be noted that for the fruit setting at a later date, that the nuts germinate quicker at the lower end, or in the middle, of the syncarpy as at the upper end. The nuts should not be allowed to fall, but should be cut down, and carefully lowered, e.g. by rope. Following the harvest, the produce should be stored for a short interval in a covered, well-ventilated place.

Before sowing, the nuts are again sorted; only those nuts containing water are used. The shell is cut away on the germinating side of the nut to facilitate germination, then the nuts are soaked in water for 14 days, before being sown in loose soil that can drain easily. The nuts are laid in the soil lengthways with the upper side still visible. They are sown in nursery beds at a distance of 45 cm. Coconut fibers are used as mulching material between the rows. The planting area is nevertheless left uncovered. The nuts can also be sown in a glasshouse with 95% humidity. On smallholdings, the nuts are often merely set out in shaded areas, lightly dug in, and then covered over with organic material.

The nuts begin to germinate after 12 weeks in the nursery beds. There, they require no additional fertilizer, as the endosperm provides them with sufficient nutrients. When the seedlings are planted in beds outside the rainy season (and not in glasshouses), then the beds need to be irrigated twice a week with around 5 l water/m$^2$. After the 5th month, the strongest seedlings should be selected and labeled for transplanting. Around 20-40% of the seedlings will be unusable. Suitable seedlings germinate earlier, and have thicker leaf bases. Early leaf-development is a sure sign of a strong plant. The seedlings are transplanted after 9-10 months, by which time they should have developed 4-5 fully-opened leaves. When the seedlings are removed from the nursery beds, their roots are shortened, and then planted again as soon as possible.

The distances between the plants should be between 7.5 x 7.5 m and 6 x 9 m, depending on the cultivation method used and the other crops being grown, or similar distances resulting in an average density of 150-180 trees/ha. The seedlings are planted in a hollow 60-75 cm below the surface that is gradually filled with the coco palm's growth, while the lateral roots are at a greater depth. This means that the palms are less susceptible to drought periods. This method should not be used when the ground water is relatively high. The young seedlings also need to be protected from bites when animals are being raised.

## 2.5.4. Soil Nutrition and Organic Fertilization

The following amounts of nutrient extraction pertain to cultivation on conventional plantations:

**Table 14: Average nutrient extraction of coco palms (kg/ha)**

| | N[kg] | P [kg] | K [kg] | Ca [kg] | Mg [kg] |
|---|---|---|---|---|---|
| Nutrient extraction | 67.8 | 12 | 83.6 | 16.6 | 23.2 |

If the entire fruit – including fruit shell, husk, endosperm and the leaves – are to be used, then the values for nutrient extraction per hectare cultivated are much higher (232 kg N; 251 kg K; 51 kg Mg; 215 kg Cl).

### Fertilization

The level of nutrient extraction on a coco palms/mixed crop system can be balanced by encouraging the decomposition of organic material that is made available, e.g. through mulching material, green fertilizer and tree trimming. A dense crop of legumes such as *Glyricidia sepium, Pueraria phaseoloides, Calopogonium mucunoides, Centrosema pubescens, Arachi pintoi, Glycine wightii, Desmodium ovalifolium* or use of another plants providing ground coverage as bottom crops, and which are regularly supplied with mulching material, will provide a sufficient supply of nitrogen for the plants.

It is important to take care that all harvest and processing residues, such as coco fibers and press-cakes from the oil-extraction process, are returned to the plantation. This also applies to the potassium-rich ash resulting from burning the coco husks.

If insufficient organic material is produced on the plantation, the deficit can be balanced by regularly adding compost. The compost should be enriched with any wood ashes (or coco husk ashes) that are available.

The compost is spread out in a circle 3-5 m underneath the palms, and preferably covered over with coco shell mulching material. The latter may be especially necessary in systems lacking enough additional vegetation.

A deficiency in potash will result in a large reduction of yield for coco palms. The vast majority of the potassium is thereby contained in the fruit water of the coconuts. On cultivation systems which include cacao, returning the cacao shells to the site will supply sufficient potassium to balance out the extraction. The continual pruning of crops on diversified agroforestry systems provides an important source of nutrients (e.g. of potassium).

When providing a nutrient supply to coco palms, it should be noted that it can take up to 36 months before inflorescence begins. This means that measures to supply nutrients, or to counteract deficits or other morphological disturbances, will take 3 years before they have an effect on production.

### Conditions for the nutrient availability

Due to their symbiosis with endomycorrhizae fungi (phosphate supply), and their tolerance of soil salts (which are often harmful to the other crops), coco palms, as well as other varieties of palm, have a beneficial effect on the growth of the other crops in an agroforestry system.

## 2.5.5. Pest and Disease Management

In a balanced cultivation system, which includes middle and bottom crops, as well as nitrogen-fixing green manuring plants (legumes), diseases and pests requiring some form of counter-measures will rarely occur – especially when enough birds are present on the plantation. These are often present in multi-level cultivation systems.

Most of the problems concerning disease and pests have the following causes:

- Cultivation in a monoculture, or with too few different varieties.
- Too little distance between species that grow to the same height; failure to trim agroforestry systems.
- Degenerated or poor soil, lack of organic material.
- Unsuitable sites (water-logging, too dry, soil not deep enough for roots).

In most cases, the most effective cure is to alter the entire system of cultivation.

### Diseases

If a system is not yet in a state of ecological balance, **heart rot,** caused by *Phytophthora palmivora,* can occur in all of the producing regions – where it is widely spread. In cases of heavy infestation by *Phytophtora palmivora,* harvest-losses can be lessened by using Bordeaux mixture, or any other copper-rich spraying preparations, that are permitted in organic farming systems. These measures should only be undertaken in cases of emergency. In less harmful cases, removing any infested plants from the plantation will result in the infection being limited.

Considerable damage can be caused in regions with large coco palm monocultures by the **mycoplasmose,** a fungi that grows in cuts in the fronds. The disease can be brought under control by removing infested plant parts or whole palms.

### Pests

Amongst the young trees in tree nurseries, an attack of termites may occur. The **termites** can be effectively combated by pouring a thin layer of sand from the soil over the exposed parts of the buried nuts. Young coco palms are also susceptible to the **rhinoceros beetle** and **coconut caterpillars.** Pheromone traps have been successfully utilized in Sri Lanka against the rhinoceros beetle. In emergency cases, butterfly caterpillars can be regulated with *Bazillus thuringiensis.*

Coconut red weevil and Rhinocerus beetle only usually damage young palms, yet may also, in exceptional cases, cause damage to mature crops. In acute cases, they can be combated by closing the larvae tunnels, and with pheromone traps.

The trunks of young seedlings are often protected against pests by painting them with tar. This is not permitted on organic plantations, and the black covering also causes the plants to heat up unnecessarily. An alternative is to paint the trees with a mixture of sulphur, soil and lime, (1 : 2 : 1) added together with water to make a thick paste. If necessary, the paste may need to be renewed, as rain will wash it off.

In coco palm monocultures, rodents, and especially rats, can develop into a serious epidemic that is difficult to bring under control again. Metal plates fixed to the trunks will effectively stop them from climbing up the trees, though.

It was observed that interplanting coconut with citrus, mango, cashew, cloves etc. encourages the colonization of coconut groves by the weaver ant, *Oecophylla longinoda*, which is the most important enemy of the **coconut bug**, *Pseudotheraptus wayi.* Other fruit trees are suitable hosts for bugs and good nesting sites for the ants. The spread of the predatory weaver ant can be enhanced by making artificial bridges between trees that are already colonized by the ant and those trees that are to be protected from the coconut bug. Farmers can use any material as bridge (e.g. plastic or steel wires).

This method has received widespread acceptance in Tanzania, given that it is simple to implement, inexpensive and utilizes materials available locally.

## 2.5.6. Harvesting and Post Harvest Handling

The nuts ripen during the entire year. As a rule, a harvest is carried out every 1-2 months, when the ripened coconuts are harvested directly from the tree – farmers should not wait until the nuts fall from the tree. The nuts are fully ripened when the coconut water can be clearly heard sloshing against the inside when they are shaken. Harvesting too early can unfavorably affect the quality of the copra.

When the coco fibers are to be used to make ropes, the nuts should be harvested before they are fully ripened (about 12 months old nuts), because otherwise the fibers will be brittle. They should be harvested at an age of around 10-11 months.

An average harvest yields around 40-80 nuts per palm and year.

### Harvesting Methods:

In principle, there are three different possibilities:

1. The palms can be scaled, and the coconuts knocked down. The advantage here is that it is easier to tell which nuts are ripe. The palm crown can also simultaneously be trimmed (removing dead leaves).
2. The coconuts are cut down with a knife attached to a long bamboo pole (e.g. in Sri Lanka). This method can be used for palms up to about 8 m in height, and is the most usual method of harvesting.

3. The coconuts are broken off by trained apes (e.g. in Malaysia and Thailand).

**Post Harvest Treatment**

As a rule, the coconuts are separated from the fibrous husks on the plantation and sold as whole nuts ("balls"). Occasionally, the nuts are halved on the plantation, and dried in the sun. In the majority of cases, though, the coconuts are processed further industrially.

## 2.6. Bananas

Economically, the most important type of tropical fruit is the banana (*Musa x paradisiaca L.*). Marketing of bananas was begun largely by multinational companies, and has altered in this respect little to this day. These companies often maintain a production chain stretching from their own plantations to ripening stations at the final ports of destination. Certain types of banana, but especially the plantain, form part of the staple diet in many tropical countries.

Bananas grown organically have only appeared in recent years, and are invariably intended for shipment to the European markets.

### 2.6.1. Botany

The banana belongs to the Musaceae family and includes the genera Musa and Ensete. The economically important banana sorts belong to the Eumusa section. The name *Musa x paradisiaca* is generally retained for the entire group of fruit and cooking bananas, because many of the varieties are of a hybrid nature.

Edible bananas contain no seeds. Reproduction is carried out via its subterranean rhizome, the shoots of which regularly form fruitful buds. The banana plant possesses a so-called pseudo-stem, which is created by the leaf sheathes. Inflorescence usually begins around 7-9 months after planting, depending on climatic conditions and type of soil. Parthenokarpy (unfertilized) fruits, standing together in groups (clusters), develop from the female blossoms. Seed formation is still visible in the fruit as blackened bands. The development period of the fruit can last up to ca. 3-4 months, depending on weather conditions. After the bunch has been fully formed, the parent plant dies off.

Fruits and flower of a banana tree.

## 2.6.2. Varieties and Countries of Origin

As a tropical culture, the banana places heavy demands on temperature (opt. 25°C ) and rainfall (opt. 1500-4000 mm). Nevertheless, bananas are also grown in subtropical areas such as South Africa, Lebanon, Israel and on the Canary Islands, although additional irrigation is generally necessary in these regions. In practical terms, only cold-resistant dwarf bananas ("Dwarf Cavendish") are suitable for these regions.

Varieties of the Cavendish group currently dominate in commercial plantations, after the taller "Gros Michel" bananas were decimated by the Panama disease. In addition to the extensively grown commercial varieties, a large number of local varieties are found in the tropical regions world-wide. These can be utilized in various ways to accommodate different sites and production systems, and also combined with one another.

**Table 15: Overview of the Most Important Varieties and Their Characteristics[9]**

| Varieties | Characteristics and Genome |
|---|---|
| "Sucrier" | Around 60 varieties, mostly in SEA, resistant against Panama disease, low yield. Genome: AA |
| "Ney Poovan" | From South India, varieties barely described, highly resistant against Panama and Sigatoka diseases. Genome: AB |
| "Gros Michel" | Strong growth, fruitful, susceptible to Panama disease. Genome: AB |
| "Robusta" and "Lacatan" | Not as susceptible to Panama disease and wind break as "Gros Michel". Genome: AB |
| "Dwarf Cavendish" | Especially suited to unfavorable climatic conditions, resistant against Panama disease, but very susceptible to the Sigatoka disease, widely distributed, especially in Australia, South Africa, Israel and the Canary Islands, distributed world-wide |
| "Mysore" | Resistant against Panama disease and banana root borer, grown in India, strong growth. Genome: AAB |
| "Silk", | Grows fairly strong, widely distributed, resistant against Sigatoka disease, but not against Panama disease. Genome: AAB |
| "Pome" | Strong growth, medium harvest, resistant against Panama and Sigatoka diseases, distributed throughout southern India, Hawaii and E. Australia. Genome: AAB |
| "Bluggoe" | Strong growth, resistant against Panama and Sigatoka diseases, only a few clusters with large, green fruits, high starch plantain. Genome: ABB |
| "Pisank awak" | Very strong growth, resistant against Sigatoka disease, different mutations, red flesh, contains seeds after fertilization, grown in Thailand. Genome: ABB |
| "Bodles Altafor" | Fruitful, resistant to diseases, but not tested sufficiently yet, cross between "Gros Michel" and "Pisang lilin" (AA\ clone). Genome: AAAA |
| "I.C.2" | Found in West India, Honduras and the Pacific region, cross between "Gros Michel" and M. acuminata, resistant against Sigatka disease, less resistant against Panama disease. Genome: AAAA |
| "Klue teparod" | Only natural tetraploide variety, fruit is matt gray, mushy, stringy, sweet plantain in Thailand and Burma, a robust and disease-resistant variety. Genome: ABBB |

[9] LÜDDERS, P. (1989) in: Manual about Agriculture and Nutrition in Developing Countries, Volume 4, Ulmer.

There are many other local varieties, as well as common commercial varieties grown under different local names.

Organically produced bananas have become more widespread in the past few years. Most of the bananas intended for the European market are grown in the Canary Islands, as well as from Ecuador, the Dominican Republic, Costa Rica, Uganda and Israel. Smaller organic projects also exist serving regional markets (e.g. Bolivia).

## 2.6.3 Uses and Contents

The main form of the common edible banana is as fresh fruit; only a small proportion enter the market in dried form. In Europe and North America, the common edible banana, produced and marketed by a handful of major companies, is most widespread. Smallholders produce mainly for themselves and for regional markets, where the banana represents an important part of the daily diet. Plantains play a large role here, and a wide variety are thereby cultivated.

The following represents nutritional values of the common eating banana[10]

**Table 16: Nutritional value of bananas per 100g fresh weight of the edible parts**

| Contents | Amount |
|---|---|
| water | 75 g |
| Edible carbohydrates | 20 g |
| Raw fat | 0,3 g |
| Raw fibers | 0,3 g |
| Vitamin A | 400 I.E. |
| Vitamin C | 10 mg |
| Energy | 460 kJ |
| Reduction before eating | 33% |

[10] REHM, S. und ESPIG, G. (1976): Crops in tropical and subtropical regions, Ulmer Taschenbuch.

Flour is produced from both plantains and eating bananas in many regions, which can then be used in soups, baking or as a drink. The banana can also be used to make vinegar and to brew alcoholic beverages. The stamina flowers can be used as a vegetable, after briefly heating them in salty water (to remove the bitterness). Bananas can also be used as a starch-rich animal feed (pig farming). The fresh leaves are high in protein content, and are preferred for their taste by cattle and chickens. The leaves are also commonly used as packing material and for roofing. Along with the pseudo-stem they offer excellent mulching material.

## 2.6.4. Site Requirements

The ancestors of our commercial bananas originated from the Malaysian peninsula, New Guinea and South-East Asia. They grow in alluvial and volcanic soils, as well as in river deltas and forest perimeters, where the soil is rich in organic material. They are part of both young and old secondary forest formations, where they are located either at the top or the middle of the forest, according to variety and development stage. This means that they are more or less adaptable to shade, according to variety. In comparison with eating bananas, plantains require more soil fertility. They grow in the upper layers of natural vegetation, therefore requiring more light, and cannot tolerate extended periods of shadow. Commercially used varieties cannot endure stagnant water conditions, and are susceptible to wind break (especially when not grown in agroforestry system).

## 2.6.5 Seeds and Seedlings

Bananas are reproduced vegetatively. In accordance with availability, required amounts and transport possibilities, the following are suitable:

- Whole rhizomes
- Rhizome pieces

- Shoots with inflorescence in the pseudo-stem
- Shoots lacking inflorescence in the pseudo-stem.

Using whole rhizomes is laborious. It requires a large amount of starting material and generates high transport costs. Rhizome pieces and shoots lacking inflorescence in the pseudo-stem are less expensive.

It is very important that the shoots are undamaged, and originate from nematode-free plantations. Prior to planting, the roots and any damaged spots should be removed with a sharp knife.

Banana agroforestry.

## **2.6.6.** Methods of Planting

The distances between plants is determined by the variety, soil conditions and the type of planting system. Slow growing plants, such as the Dwarf Cavendish, can be planted in a density of 2500 plants/ha. The more robust Giant Cavendish, Robusta or other strongly developing varieties are set at 600-1200 plants/ha. Experiences culled in the different regions have led to a variety of recommendations regarding size and depth of hole required, which should be heeded. It is recommendable to cover the planted rhizome with mulching.

The most suitable planting period is towards the end of the dry season, or at the beginning of the rainy season, and is also dependent upon any accompanying crops. Several seeds from different local shrubs and trees should be dropped into each plant hole. Cuttings from varieties which reproduce vegetative can also be used (*Morbus albus, Malvaviscus arboreus, Gliricidia sepium,* etc.).

In regions of intensive banana production, it is important to ensure that no undesirable pesticide-drift from conventional neighboring plantations occurs. This is especially the case when aero spraying takes place. Under these circumstances, it is necessary to plant high, growing hedges of sufficient depth.

## **2.6.7.** Diversification Strategies

On conventional plantations, bananas are grown over large areas as part of a monoculture. A wide variety of combination possibilities is available for organic cultivation, especially in connection with permanent crops and agroforestry systems.

The following recommendations pertain to the common eating banana. Due to their high demands on soil (compare chapter 2.6.4.), an intensive accompanying vegetation is required. With sufficient foresight and planning, this can later be used to replace the bananas. Due to the fact that specific plantation systems with the suitable variety of plant need to be established for each region, site, and even for individual plots, it is only possible to provide an overview of the basic guidelines here.

In principle, bananas can be combined with practically any type of cultivated or wild plant which has similar eco-physiological requirements. Young banana plants are excellent “wet nurses” for other crops and forest plants, which can be planted very close to the bananas.

Three examples:

| 1 | | | | |
|---|---|---|---|---|
| **1. year** | **2. year** | **3. year** | **5.-10. year** | **from 11. year** |
| Maize | | | | |
| Papaya | Papaya | | | |
| Banana | Banana | Banana | Banana | |
| Cocoa | Cocoa | Cocoa | Cocoa | Cocoa |
| Forest trees | Forest trees | Forest trees | Forest trees | Forest trees |

| 2 | | | | |
|---|---|---|---|---|
| **1. year** | **2. year** | **3. year** | **5.-10. year** | **from 11. year** |
| Hibiscus | | | | |
| Banana | Banana | Banana | Banana | |
| Coffee | Coffee | Coffee | Coffee | Coffee |
| Forest trees | Forest trees | Forest trees | Forest trees | Forest trees |

| 3 | | | | | |
|---|---|---|---|---|---|
| **1. year** | **2. year** | **3. year** | **5. year** | **6.-10. year** | **from 11. year** |
| Maize/ Manioc | | | | | |
| Pineapple | Pineapple | Pineapple | Pineapple | | |
| Banana | Banana | Banana | Bananas | Bananas | |
| Forest trees | Forest trees | Forest trees | Forest trees | Forest trees | Forest trees |

If no other crops are to be integrated into the system, then it is sufficient to combine the bananas with forest trees and native fruit trees.

If other crops are to be introduced onto an existing monoculture plantation, then especially the fruit carrying pseudo-stems will need to be thinned out.

Depending upon which plantation system is used, the planting times for the different crops need to be co-coordinated, to ensure each receives its optimum location. Each crop can thereby be planted as if in a one-crop system.

The types of maintenance employed are most important in this approach. Native species with varying heights, as well as trees that can withstand frequent cutting – such as *Inga ssp.*, *Erytrina ssp.* etc, depending on the site – which have been tested in standard agroforestry systems, should be used as forest trees. A wide variety of species and high density of plants should be strived for. The high plant density can be useful for example in suppressing the growth of other vegetation (like grasses etc.). It also provides sufficient mulching material, which needs to be continually cut and added to the soil. Satisfactory banana production can only be achieved with a large amount of organic material produced on the plantation itself (compare chapter 2.6.5.).

## 2.6.8. Nutrients and Organic Fertilization Management

### Nutrient Requirements

On conventional plantations in prime locations, bananas are planted over many years as monocultures. This results in a continual loss of organic material, and to a general degeneration of the soil, which then needs to be compensated for with a high input of mineral fertilizers.

**Table 17: The "nutrient depletion" resulting for each 1000 kg bananas[11] (in kg)**

| N [kg] | P [kg] | K [kg] | Ca [kg] | Mg [kg] |
|---|---|---|---|---|
| 2 | 0,3 | 5 | 0,4 | 0,5 |

Understandably, the amounts of nutrients recommended vary quite strongly, depending on which literature one consults. The following refer to individual plant parts:

[11] JAKOB, A., u. UEXKÜLL, H.V. (1963): Fertilizer Use. Nutrition and Manuring of Tropical Crops. 3. Aufl. Verlagsgesellschaft für Ackerbau, Hannover.

**Table 18:
Required amounts of nutrients (in kg/ha) for a harvest of 1000 kg/ha of bananas** (adjusted acc. to)[12]

| Plant part | N [kg] | P [kg] | K [kg] | Ca [kg] |
|---|---|---|---|---|
| Pseudo-stem | 0,96 | 0,16 | 2,5 | 0,56 |
| Leaves | 6,38 | 0,6 | 10,5 | 3,43 |
| bunch | 2,13 | 0,26 | 4,53 | 0,1 |
| **Total** | **9,46** | **1,03** | **17,6** | **4,2** |

### Organic Fertilization Strategies

These values for nutrient depletion and fertilization are given from a viewpoint of conventional plantation systems. They are not capable of solving the problems of decreasing yield and soil fertility. The majority of banana varieties cultivated for export purposes require a high soil quality. In natural forest ecosystems, they appear towards the beginning of the new growth, and must be replaced by other species about every 10-15 years. If this is not carried out on the plantation, then sooner or later a crisis will occur, which can only be solved in the short term by applying fertilizers and pesticides.

Regular application of organic material gained from cutting work helps to maintain a layer of humus and activity in the soil. This includes adding dead leaves and pseudo-stems grown on the plantation as mulching material. It is important that the material is spread evenly throughout the entire plantation. Organic manure should only be seen as an additional fertilizer, and not as the main source of nutrients for the bananas. These measures will suffice to maintain the fertility of the soil on sites suited to growing bananas, despite continual harvests.

[12] BOUFFIL, in Franke, G. (1984): Nutzpflanzen der Tropen und Subtropen, Hirzel Verlag Leipzig.

## 2.6.9. Biological Methods of Plant Protection

### Diseases

The most important diseases in conventional banana plantations are:

- Panama disease (Fusarium oxisporum f. sp. Cubense)
- Black and yellow Sigatoka disease (Mycosphaerella musicola, Mycospheerella fijiensis)
- Root rot (Poria sp., Pytium sp., Armillaria mellea, Rhizoctonia solani)
- Bacterial rot (Pseudomonas solanacearum)
- Rhizome rot (Erwinia carotovora)
- Virus diseases (Mosaic virus, banana bunchy top virus, infectious chlorosis etc.)

The above mentioned diseases occur mainly in conventional plantation systems, and are combated by using resistant varieties (Cavendish instead of Gros Michel), or in conventional farms by spraying with mineral oil and fungicide by airplane. In organic plantation systems these phytosanitary problems must be prevented by cultivation methods and also the use of resistant plants (compare chapter 2.6.7.).

### Pests

The most important pests also occur mainly on monoculture plantations, these are:

- Root nematodes
- Banana root borer (Cosmopolites sordidus)

The exclusive use of healthy seeds, and application of appropriate measures, offer the most effective preventative and thus alternative methods of controlling insects and nematodes (compare chapter 2.6.7.). The application of waste from extensive shrimp farms in Ecuador (shrimp shells) has shown good results against nematodes beside being a good organic fertilizer.

In conventional plantations, the bunches are often protected by covering them with polyethylene sacks. When protective bags are used in organic systems, the following must be heeded:

- That the insides are pesticide-free (quite normal on conventional plantations), and
- That the plastic coverings are bio-degradable.

## 2.6.10. Monitoring and Maintenance

### Crop Establishment

Around 4-6 months after the bananas and additional crops have been planted, a primary selective weed regulation should be performed. The actual time depends largely on the type of additional crops (annual crops, annual or biannual under seeds), and also from the preliminary condition of the plot. Strong growths of Graminea and Cyperacea will occur in soils already degraded. These should be pulled up, and exchanged for seeds of the *Canavalis ensiformis, Crotalaria ssp*. or other similar under seeds from non-creeping plants. Foliage regulation consists in the main of cutting back the blossoms and removing grasses, as mentioned above, which are both then left on the surface as mulching material.

Surplus shoots need to be regularly cut away from the planted bananas. Three shoots should be left, which can then grow until they are ripe. Thereafter, only one shoot is left remaining, so that after one year three times the density has been achieved, which is then maintained.

The accompanying vegetation (bushes and trees which can be cut) is cut back, and the resulting material chopped up and spread around the surface as mulching material. This should be carried out once or twice a year, according to growth. This cutting regulation results in a continual supply of organic material in varying consistency, and also increases the amount of available light, thus stimulating new growth.

Trees which cast no foliage (e.g.. *Inga ssp, Glyricidia sepium, Leucaena leucocephala*), should be cut back at the banana plant's height once a year, so that around 15% of their leaves remain. Depending on which variety of bananas have been planted, more or less shade can then be controlled. The tall varieties such as Red, Green Red (manzano, manzano rojo) and Giant Cavendish belong to those that can cope with a lot of shade, whereas Dwarf Cavendish requires less.

### Crop Production

After around one to two years, usually no weeding activities are necessary, and pruning remains as the principal task. In addition to regularly removing the shoots, the inactive leaves should also be cut away (these usually hang bent downwards). In the course of time, the plantation will tend to "wander", in that the original gaps between the plants change. This means that it may be necessary to remove plants that now stand too close to one another. Depending on the initial situation at the site and the type of plantation, the production of bananas is lessened by the gradual coverage of accompanying vegetation. If the plantation has been established with additional economically interesting crops, then these can continue to be harvested. If there is no relevant alternative to the banana production, then the plantation can be cleared, and newly planted. In the latter case, the farmer now has soil with an improved fertility.

## 2.6.11. Harvesting and Post- Harvest Treatment

### Harvesting

Harvesting the banana bunches is usually spread evenly throughout the whole year. A slowing down in production, or even cessation, only generally occurs at sites which experience either a noticeable drop in temperature during the winter months, or distinctive dry periods.

Whilst still green, the fruits have a distinctly edged appearance, which gradually becomes almost round as they ripen. The fruits of a bunch do not ripen at the same pace. If some fruits have begun to turn yellow on the plant, then it is already too late to transport them any great distance, as they quickly become too soft and burst. The bananas must therefore be harvested while still green. The optimal cutting stage is established by the diameter of individual fruits. To simplify the harvest, the bushes are marked with different colored bands as the fruits appear. The workers will then only cut bananas of a particular color, which are now ripe enough. Terms which characterize the thickness of the fruit, such as “three-quarters”, “light full three-quarters”, “full three quarters” and “full”, are also used. The duration of a proposed transport determines in which stage a fruit destined for export is judged to be ripe.

In order to achieve a uniform ripeness during shipping, the maturity stage of an entire bunch should be as consistent as possible. Harvests are therefore usually carried out at one to two week intervals.

The bunches are harvested by cutting them away from the plant just above where the fruit begins. The tall varieties must also be freed of their pseudo-stems, which are bent back and cut off, in order for the bunches to become visible. Thereby, it is very important that the bunches do not fall, or are otherwise bumped during shipping, as this causes them to blacken and rot.

It is advisable to leave behind a ca. 2 m high stub (depending on the variety) of the pseudo-stem, because nutrients and water are still transported to the remaining shoots for several weeks, and thereby encouraged in their development. The cut away part of the pseudo-stem is lain with the cut side facing downwards directly next to the neighboring trees. This type of mulching prevents a damaging anaerobe oxidation by butyric acid bacteria inside the stalk, and encourages an intensive stimulation of the soil flora. The remains of the stalk are then cut off at the base during the next bout of maintenance work, and also lain on the ground. The large surface of the banana leaves should be trimmed away along the petiole and chopped up so that the secondary vegetation be allowed to develop.

Preparation of the harvested banans for transportation and storage.

### Preparation, Transport and Storage

On large plantations, the harvested clusters are transported to distant packaging sites by fastening them down with ropes, or hanging them from the lorries to avoid bruising. Once there, the clusters are prepared by cutting away any badly formed fruits at their tops and base. Any leaking milk which drops onto the fruit will cause it to blacken during ripening and sale will be impossible. This can be avoided when the individual, separated bunches are washed in cold water to then can be drained.

Conventionally, the fruit is washed with disinfectant (Na-Bisulfite, Na-Hypochlorite) and/or treated in a fungicide bath.

The use of fungicides is out of the question on organic plantations. Either alum salt (potassium alum) or extracts from lemons or orange pips (kernels) can be used to disinfect. So called crown rot (*Colletotrichum musae*) can be prevented by wetting the cut with vinegar.

The cleansing water that collects at preparation sites contains many organic compounds, and must therefore be biologically treated before allowing it to flow into a drainage ditch. Organic material that collects during preparation (e.g. unusable, damaged fruits) should be composted and returned to the soil.

The ratio of harvested to exportable fruits is between 1 : 1 and 1 : 1.7 , whereby the latter is more usual.

The individual bunches are packaged in cartons of 12 kg or 20 kg (Costa Rica), which are lined with polyethylene foil. Cooling equipment must then be used to delay the ripening process during shipping. Optimum temperatures are dependant on the variety, and vary between 12-15°C. At too low temperatures, frost damage can occur, such as lack of ripening, production of tannins, discoloring of the skins, inhibition of starch transformation as well as an increased production of ascorbic acid. An additional delay in the ripening process can be achieved by increasing the $CO_2$ content and reducing the $O_2$ content of the storage room atmosphere during shipping.

### Controlled Ripening

Special warehouses must be available at the destination port (ripening plant) in order to subject the fruits to a controlled ripening process. This takes place at about 20°C and at an atmospheric concentration of 0,1% ethylene. The use of ethylene to accelerate the ripening process, as well as the use of kalinite to delay the ripening of bananas, is allowed in the EEC-regulation for organic agriculture (EEC) 2092/91.

Organic banana plantation.

## 2.6.12. Product Specifications and Quality Standards

### Handling

The banana is the most commonly cultivated tropical fruit. It is used in many areas, in the form of plantains, horse bananas, common eating bananas and fibrous bananas. They can be turned into dried products, such as flour, starch, powder, flakes, chips, and dried fruit, as well as pulp, concentrate, juice and dried fruit or wine, spirits and liquor. A whole range of eating banana varieties in particular are exported fresh.

It is recommendable to harvest bananas for the export market whilst they are still green. After harvesting, the 30-45 kg heavy clusters are washed, whereby thyme extract can be added to the water to aid disinfecting. After drying, the bundles ("bunches") are separated, sorted, classified, packed in standard cartons of 12 kg or 18 kg and placed into cold storage.

The EU quality standards for Bananas are shown in the Annex.

### Packaging and Storage

**Packaging**

The regulations concerning carton labeling were dealt with in section VI of the "EU quality standards for bananas".

**Storage**

Unripe, original bananas can be shipped within 10-14 days by boat at 14-15°C and 90-95% relative humidity. The final ripening process takes place in special banana ripening plants, at temperatures from 14.5-18 °C and lasts 4-8 days.

Bananas cannot be stored for long. They can be stored for up to 10 days at 13-15°C and 90% relative humidity, just prior to being ripe enough to eat.

## Annex: Quality Requirements

The 'EU quality standard for bananas' clearly defines the quality requirements placed upon trade with fresh bananas. The regulations must be strictly adhered to until the fruit reaches the ripening plants.

**The following is an excerpt from the "EU quality standard for bananas":**

(I) DEFINITION

The standards apply to bananas of the following listed varieties of the genus *Musa (AAA) ssp.*, subgroups Cavendish and Gros Michel, to be transported in a fresh state to consumers. Flour bananas and Fig bananas, as well as bananas intended for industrial processing are not included.

| Group | Subgroup | Main variety |
|---|---|---|
| AAA | Cavendish | Petite naine (Dwarf Cavendish)<br>Grande naine (Giant Cavendish)<br>Lacatan<br>Poyo (Robusta)<br>Williams<br>Americani<br>Valéry<br>Arvis |
| | Gros Michel | Gros Michel<br>Highgate |

(II) QUALITY CHARACTERISTICS REGULATIONS

The standard regulates the quality characteristics that green, unripe bananas must exhibit after packing and processing.

*a. Minimum Characteristics*

Subject to the pertinent regulations and tolerances for each class, the bananas in all quality classes must be configured as follows:

- green, unripe
- whole, firm
- clean, practically free of visible foreign matter
- practically free of pests and the damage caused by them with a unbroken, intact stalk which is not dried out and is free of fungus
- the fruit must not be misshapen, and not abnormally bent
  - free of bruising and frost damage
  - free of strange smells and/or taste

Furthermore, the bunches or clusters must also have:

- a sufficient, healthy length of normally-colored coronet, free of fungus
- a clean cut of the coronet, without evidence of nicks or tearing

The development and ripeness of the fruit must be so that they:

- can withstand handling and transporting
- are in a satisfactory condition when they arrive at the port, and will achieve a reasonable state of ripeness after ripening has taken place.

*b. Classifications*

- Class Extra

  Bananas in this class must be of the highest quality. They must possess the characteristics typical of their variety and/or trading type.

  The fruits must be unblemished, with the exception of very light surface flaws that cover less than 1 $cm^2$ of the fruit's surface, and providing this does not detract from the fruit's general appearance, quality, the time it will keep and the presentation of the bunch or cluster in its packaging.

- Class 1

  Bananas in this class must be of good quality. They must possess the characteristics typical of their variety and/or trading type. The following blemishes are permissible, providing they do not detract from the fruit's general appearance, quality, the time it will keep and the presentation of the bunch or cluster in its packaging:
  - Slightly misshapen
  - Light flaws in the skin caused by friction or by other means, providing the area does not exceed 2 $cm^2$ of the total surface area of the fruit.

- Class 2

  This class is composed of those bananas that cannot be placed in the upper classes, yet fulfill the definitions of minimum requirements. The following faults are allowed, providing the bananas retain their essential characteristics in terms of quality, preserve ability and presentation:
  - Shape defects,
  - Skin flaws, caused by scratches, friction or other means, providing the less than 4 $cm^2$ of the total surface is affected.

The flaws are not permitted to affect the fruit's pulp.

(III) SIZE CLASSIFICATION REGULATIONS

Size classification is performed according to:

- The length of the fruit in cm measured along the outer curve from the stem to the blossom end.
- The thickness in mm, measured as the diameter of the middle, cutting across its longitudinal axis.

Size classification of a reference fruit is carried out by measuring the length and thickness

- Of the outer, middle fruit of a bunch
- Of the first fruit of a outer row of a cluster, next to the cut that separated the bunch.

The length must be at least 14 cm and the thickness at least 27 mm.

Deviations to the previous paragraph are allowed in the following regions: Madeira, Azores, Algarve, Crete and Laconia, where bananas measuring less than 14 cm may still be marketed within the union, providing they are classified as class II fruits.

(V) PRESENTATION REGULATIONS

*a. Uniformity*

The contents of a carton must be uniform, and may only contain bananas of identical origin, variety and/or trade type, and quality.

The visible part of the carton must be representative of the entire contents.

*b. Packaging*

The bananas must be packed in a way that ensures sufficient protection

Packing material used inside the carton must be new, clean, and so shaped that it cannot cause any damage to either the inside or outside of the fruit. The usage of materials such as papers and stickers with company details on them is permitted providing the no toxic inks, dyes or glues have been used.

The packaging must be free of all other materials.

*c. Presentation*

Presentation is in bunches comprising at least 4 fruits.

Clusters with a maximum of two fruits missing are permitted when the stalks have been cleanly cut off, and not torn, leaving the other fruits unharmed.

A maximum of one cluster with three fingers is permitted in each row, providing it conforms to the characteristics of the other fruits in the carton.

(VI) REGULATIONS OF CARTON LABELING

Each carton must display the following details in unbroken, legible, permanent letters visible from the outside:

*a. Identification*
Name and address of the packer

*b. Type of Product*
"Bananas", when the contents are not visible
Name of the variety

*c. Origin of Product*
Country of origin, and optionally, national, regional or local description

d. Commercial Characteristics
- Class
- Net weight
- Size, depicted as the minimum and (optionally) maximum length

*e. Official Stamp*
(optional)

The following characteristics are not laid down in the 'EU quality standards for bananas', but should nevertheless be adhered to:

**Table 19: Quality Characteristic for Banana**

| Quality Characteristics | Minimum and Maximum Values |
|---|---|
| HEAVY METALS | |
| lead (Pb) | max. 0.50 mg/kg |
| Cadmium (Cd) | max. 0.05 mg/kg |
| Mercury (Hg) | max. 0.03 mg/kg |
| RESIDUES | |
| Pesticides | not measurable |
| Sulphur oxide | not measurable |
| Bromide | not measurable |
| Ethylene oxide | not measurable |

## 2.7. Mango

The mango tree originates from the Indian/Burmese monsoon region. The Mango fruit (*Mangifera indica L.*) is the most important tropical fruit after the banana, yet due to its sensitivity to bruising, in terms of numbers, it plays only a small role in world trade (fresh mango). Mango has been disseminated for many years, and is cultivated in all warm countries down to the sub-tropics.

Mango tree with fruits

### 2.7.1. Botany

The mango belongs to the family of Anacardiaceous, a rapidly growing evergreen tree with a dense, outspread coronet. Its leaves grow alternately, and red-violet or bronze-colored in the early stages, then of a dark-green, leathery consistency. The blossoms are generally hermaphrodite, and pollination occurs through flies and other insects. Certain types of mango need to be manually pollinated. Mango blossom up to 3 times a year, depending on climate and fertilization conditions. If the first blossom is not pollinated, a new blossom is induced.

Ripe fruits are between yellow, orange-yellow, red or red-green in color, and contain a flat stone that is very difficult to separate from the thick fibers of the pulp.

Mango trees can reach a height of 40 m. In a diversified agro-forestry or mixed cultivation system, it belongs to the uppermost trees, alongside, or under which, according to site conditions (soil, rainfall, humidity etc.), a variety of cultures can be planted.

## 2.7.2. Varieties and Countries of Origin

The varieties differ in taste, size, shape and texture. India has the largest variety. But a variety of different trading types are also available in Florida. One typical characteristic of mangoes is its alternation, which is also strongly dependant on variety. Balanced nutritional and climatic conditions will have a positive effect on fruit development. For this reason, strongly alternating varieties can offer a steady harvest when the supply of nutrients is well-balanced.

In principle, it is possible to differentiate between two large groups of mango according to their origin: A group from Indo-china/Philippines, and one coming from India.

Latin American varieties are crossbreeds of both. Using the varieties "Mulgoba" and "Cambodiana" as an example, all of the different variety characteristics can be displayed:

**Table 20: Characteristics of the Two Different Varieties Mulgoba and Cambodiana**

| Characteristic | Mulgoba | Cambodiana |
|---|---|---|
| Country of origin | India | Indo-China/Philippines |
| Shape | variable, mostly round, elongated | Somewhat flat, elongated |
| Color | Bright red, purplish or bright yellow | Yellow-green when ripe, seldom purple |
| Fiber content | Variable, with/without fiber possible | No fibers |
| Taste | Sweet, little sour, very aromatic | Sweet, little sour, very aromatic |
| Seeds | One embryo | several Embryos |
| Susceptibility to anthracnose | very | Yes to not very |

Certified organic mangoes are mostly exported to Europe from the following countries: Burkina Faso, Burundi, Columbia (dried), Costa Rica, Dominican Republic (pulp), Ghana, Guinea, India (fresh, dried and pulp), Madagascar, Senegal (fresh and dried), South Africa, Togo, Uganda, USA, Venezuela (pulp).

## 2.7.3. Uses and Contents

Mango has many uses. Young fruits whose tegument have not yet hardened are used in Asiatic countries as a vegetable, fresh or pickled. In Latin American countries, slightly unripe pulp is eaten with some salt.

Ripened fruits are eaten fresh everywhere, can be made juice or marmalade, and also dried and made into candy (compare chapter 2.11). All remnants from the fruits can be used as animal feed (e.g. for pigs). The young leaves for example are very good as cattle feed, because they have a protein content of 8-9% and a high Ca content as well. The bark and leaves of mango trees can also be used as a dye for cloth. The wood of the trees is highly suitable for making charcoal.

**Table 21: Contents and amounts in 100 g fresh pulp[13]**

| Contents | Amount |
|---|---|
| Water | 87 g |
| Edible carbohydrates | 11 g |
| Raw fat | 0,7 g |
| Raw fibers | 0,7 g |
| Vitamin A | 1000-3000 I.E. |
| Vitamin C | 30 mg |
| Energy in kJ | 210 kJ |
| Reduction before eating (%) | 34% |

[13] REHM, S. und ESPIG, G.: (1996) Die Kulturpflanzen der Tropen und Subtropen, Ulmer Verlag.

## 2.7.4. Aspects of Plant Cultivation

### Site Requirements

The mango grows best in tropical summer rain regions, at temperatures between 24°C and 28°C. Despite being fully foliated, the trees are remarkably resistant against drying out. A dry period or cooler temperatures enliven the blossoming and the production of mangoes. A period of respite in the growth of vegetation is necessary to enable blossoming. The trees will therefore not produce any fruits in those moist tropical regions that lack a definite seasonal rainfall or temperature fluctuations.

Mango trees can also thrive in the sub-tropics (Egypt, Israel). Some varieties can even withstand a light frost. Young seedlings must nevertheless be protected from damage from frost (e.g. with straw or palm leaves).

Mangoes have few soil requirements. A healthy, high yielding plantation is nevertheless only possible on fertile, deep and well-drained ground.

Mango nursery.

### Seeds and Seedlings

There are many different varieties of mangoes. Different varieties are preferred in different regions (differences in the taste, texture and color of the pulp etc.). The most popular varieties have mono-embryonic seeds, and can therefore only be pollinated vegetative. This has the advantage of producing a uniform product, while seedlings (fruit with poly-embryonic seeds) can even segregate a parent plant very strongly, producing very heterogeneous fruit.

Seedlings are used on mango plantations as rootstocks, to which the scions are either grafted (diagonal cuts of the same size in both scion and rootstock are then bound together) or budded (the scions are cut diagonally, while the bark of the rootstock is cut and then pulled out to form a pocket. The scion is then pushed inside the bark and tied up again) in tree nurseries. This work requires much experience, and is therefore usually carried out by state propagation facilities. It is only worth setting up your own tree nursery when a large scale mango plantation is planned, and should then also only be carried out with the co-operation of an advisory center.

### Propagation

Propagation is usually carried out in the following way: Mango seeds are selected from the fruits of healthy, well-grown parent trees. In tree nurseries, polyethylene bags (PE bags) are used. The PE bags need to have a diameter of around 15 cm , and be about 30-40 cm high. The best earth to use is 50% well rotted compost and 50% top soil (humus-rich earth which has best yet not been agriculturally cultivated). The best place to cultivate seedlings is in half-shadow (e.g. a shadow canopy, palm leaves). When they have reached a height of around 50 cm and 8-10 mm diameter, the seedlings are then grafted or budded with the chosen scion.

In selecting parent trees for scions, choose those that have well-developed coronets, are the of right variety, and have plentiful blossoms and fruit over the years. You should therefore have been able to observe the trees over a number of years, or know someone else who has. To bud, choose scions from young woody twigs that are somewhat thinner than the seedling rootstocks in the tree nurseries. Remove the leaves from the twig one week before cutting away the scion, which is cut to a length of 10 cm.

After budding, the seedlings remain 4 weeks longer in the nursery before being planted out the fields. The hole should be at least 40 x 40 cm big and 50 cm deep, according to local conditions. Mix in 5 shovels of compost with the excavated earth. Part of this is then stamped into the hole in order to make contact with the earth. Then the seedling is planted with the rest of the soil, and again, pressed firmly down. In order to save on irrigation, it is best to plant out at the beginning of the rainy season, which means that the plant will be encouraged to grow during the dry period.

### Flower Formation

Young seedlings blossom in the first year. They should not be allowed to carry fruit though, as this would inhibit the growth of the tree. To encourage growth, the blossoms are therefore plucked away until the 4th year.

## 2.7.5. Planting Methods

The method chosen for planting is dependent upon the way they are being cultivated and the site conditions. On a mango plantation where mangoes are the main fruit sort, the following distances between plants must be upheld:

- On fertile ground with sufficient rainfall 10 x 10 m
- at semi-arid sites up to 15 x 15 m

Because mango trees grow rather slowly, it can take a relatively long time (up to 15 years) for the trees to occupy the room allotted to them. During this development phase, several possibilities exist to use the space available in a balanced way:

When the soil quality and rainfall are sufficient, plants that quickly produce fruit can be planted between the rows of mango trees, e.g. Papaya, Banana or pineapple.

Making use of the surfaces for sowing of green manure plants (compare chapter 2.7.4.).

## 2.7.6. Diversification Strategies

Quite often, mangoes are planted in the mixed crop systems of the house gardens in small farmholdings, or on extensively cultivated meadows and marginal ground, where relatively acceptable harvests can be achieved.

On organic farms, mango should also be integrated into a mixed crop systems. On the one hand, this will reduce the risk of pests through a large population of useful insects, and on the other, the risk to the harvest engendered by the natural alternation of mango can also be lessened.

Annual plants such as maize, hibiscus, beans, etc. can be planted during the early growth period, according to site conditions. If the soil and climatic conditions allow, more demanding crops such as papaya (a culture with a 3-5 year vegetation period), bananas (20 years and longer) as well as avocado, mangosteen (*Rheedia ssp.*, Achachairú), corossol (*Anona muricata*), coconut, lemons, nutmeg and many more can also be planted along with mango.

At sites with poor or dry soil, it is possible to cultivate a mixed-crop system with such low-demand crops as pineapple, guava, cashew, figs or other annona varieties.

Pasture land can slowly be transformed into better cultivating land by planting mangoes and guavas, if the grazing is controlled or cut as feed.

The following criteria should be heeded when choosing plants to include in a cultivation system with mango:

- Intercropping plants as well as green cover crops cannot be watered for a 2 month phase during the dry period or the mangoes will form an insufficient amount of blossoms.

- The bottom crops should not contain a high percentage of legumes, because the accumulation of nitrogen would otherwise inhibit the growth of the Mango tree, which then limits the production of fruit.

If the spaces between the fruit trees are to be used as crop acreage, it makes sense to establish a fruit rotation system. A phase with fruit, beans, vegetables, other fruits (e.g. pineapple) and animal feed is possible here. If the shade allows it, bell peppers, tomatoes and egg plants etc are also a possibility.

## 2.7.7. Nutrients and Organic Fertilization Management

### Nutrient Requirements

Mangoes require few nutrients. Nevertheless, it is advisable to supply a mango plantation with compost and green manure during the growth period. The fertilizer should be applied after the tree has blossomed, so that it has enough nutrients to produce fruit. A high level of production can be achieved in this way by supplying compost in the mixed system of domestic garden.

If the mangoes are on a plantation with other crops, then care must be taken not to supply fertilizer to the other crops during the time that the flower buds appear on the mangoes (e.g. that bottom crops are not irrigated during the first 2 months of the dry season), otherwise spoiling the production of buds.

**Table 22: Yields that can be achieved under good conditions (without taking alternation into account)**

| Variety (examples) | Yield per ha |
|---|---|
| Keitt, Tommy Atkins | 30 tons |
| Kent, Palmer, Irwin | 25 tons |
| Haden | 10 tons |

Special care should be taken that nitrogen is not made too readily available when beans are used as a bottom crops, because the vegetative growth of the fruit trees would then dominate.

Average harvests over several years under less than optimum conditions usually yield between 5 and 10 tons per ha and year. The yields per tree can vary, and can deliver between 100 and 500 kg, according to conditions. The yields in household garden systems can be significantly more in comparison to mango plantations.

## 2.7.8. Biological Methods of Plant Protection

### Diseases

The most common diseases with mango trees are **fungus** and **bacterial diseases.** The first important preventative measure is make sure that the propagation segments are healthy. The scions that were raised in tree nurseries and whose origins are perhaps unclear should be carefully examined. They shall not have been treated with any synthetic or chemical agents.

**Anthracnose,** caused by the fungus *Colletotrichum gloeosporioides,* is the most wide-spread disease among mangoes. The varieties vary in susceptibility. *Colletotrichum gloeosporioides* causes anthracnose on fruits, and drop of flowers on young branches. Anthracnose always appears as a result of scurvy (*Elsinoe mangiferae*). Fruits stricken with anthracnose can be plunged into a hot water bath (3-5 min./55°C), in order to kill off the fungus. Preventative measures are nevertheless preferable, to preclude injuries and an infection with scurvy, because anthracnose can usually only take hold on damaged fruits that are also affected by scurvy. A case of scurvy can usually be prevented by removing all dead plant material (branches, leaves and fruit). In exceptional cases, the fungus can be brought under control again with 1% Bordeaux Mixture[14].

While anthracnose generally attacks ripe fruits (only seldom the blossoms), a **bacterial infection** from *Erwinia sp.* can also affect young fruit. The symptoms are very similar to the flecks caused to the leaves and fruit by anthracnose. The bacteria usually survive in the ground – a heavy rainfall will then splash the spores against the lower leaves and fruits. Covering the ground can therefore help to protect against this. Active life in the soil will also help to prevent an explosive growth of bacteria. Sites where it can rain inside the blossoms can also be a problem.

Young fruit and also blossoms can be damaged by **powdery mildew** (*Oïdium mangiferae*). This fungus grows during warm and moist weather, during blossoming and when the fruit appears. A case of powdery mildew can dramatically affect the harvest. An open, well-ventilated population and regular cutting back of the coronets can best help to prevent mildew. In acute cases, mildew can also be brought under control with sulphur. When carrying this out, there should be no wind blowing, and the leaves should still be moist with dew.

**The leaf spot disease** (*Cercospora mangiferae*) on mangoes is visible as dented spots on leaves and fruit. The same applies for this fungus, an open and quick-drying population is the best protection against infection.

Fruit infected with Cercospora can no longer be sold; furthermore, both the leaf spot disease and scurvy prepare the way for a case of anthracnose. In exceptional cases, the leaf spot disease can be brought under control again with 1% Bordeaux Mixture[15].

[14] 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).

[15] Compare footnote No. 13

## Pests

The worst pests for mangoes are cotton scales, mealy bugs, cicadas and black flies (create honey dew). These are all **sucking insects** that live on the leaves, young buds and shoots. They can cause a lot of damage. Yet they all have natural enemies, such as e.g. ladybird larvae, wasps, spiders and other types, such as parasitic fungi e.g. with cicadas and black flies.

An ecological plantation with a variety of crops, enough plots under different crops e.g. forest and a sufficient amount of vegetation to cover the soil and enrich the variety of species (e.g. mulching only right after the plants have flowered) will provide enough enemies to combat the pests so that measures against them are usually unnecessary. Cicadas are averse to open, well ventilated soil; also, the soil must be drained well to avoid wet patches.

In emergencies, the following methods should help:

- **Scale insects** can be regulated with a “winter-spraying”, i.e. with paraffin oil (white oil) shortly before the larvae hatch from their eggs. The paraffin oil is sprayed on as a 3 % water emulsion.
- Plant spraying mixtures made of stinging nettles or Neem[16] can be used against **cicadas.** The worst damage occurs during blossoming, so the plantation should be checked regularly around this time in order to make up the brew and spray it early enough
- **Mealy bugs** lay their eggs on the ground next to the trunk. By wrapping smooth plastic bands around the trunk, the larvae can be prevented from infesting too large an area. Should they infest the tree, a solution of 1% soft soap (potassium soap) with 1 % pure alcohol is quite effective.

[16] According to the European Regulation for Organic Agriculture (EEC) 2092/91 the application of Neem preparations is restricted and only allowed for the production of seed and seedlings. This regulation is discussed controversial. An up-date information is available from your certification body.

- **Black fly** can be kept under control by useful insects. A variety of **prospatella** species can be of use here. This requires a good functioning control system because the useful larvae need to be made properly available for timely release. Where this is not possible, spraying white oil shortly before the pests hatch, in the case of scale insects, may be sufficient.

A Mango orchard.

## 2.7.9. Crop Cultivation and Maintenance

### Young Plants

In a newly set up plantation or when young mango plants are being planted in an existing plantation, the young trees can be planted together with the other crops. The other crops, that only have a short life-cycle, will not disrupt the mango's growth (as long as they are harvested afterwards). This also applies to crops with medium-long vegetation cycles, e.g. bananas or papaya. As soon as these enter their ripening phase and end their life-cycle (papaya after 4-5 years) they need to be removed. The resulting vegetative material is then hacked up and spread across the soil. This also applies with secondary forest systems that nevertheless need to be cut back regularly. As soon as the mango trees enter into their harvesting phase, the trees that belong to the species comprising the secondary forest system should be cut back far enough so that the mango trees' tips are at least on the same level as they are and are not covered by them. The area around the trunks must be kept covered with mulching material. This can either be gained from the mown natural vegetation or the cuttings that become available, as well as from palm leaves. The material should be spread carefully so that it does not touch the trunk, and thus give rise to fungus infections.

The soil between the trees can be used as crop acreage. Should this be impossible due to site conditions (e.g. too little rainfall), the naturally growing vegetation should be left to grow and then cut down before it blossoms in order to encourage the establishment of useful insects and to produce bio-mass. These are then mown down to provide a mulching layer that protects the soil, to aid the tilts of the soil and to positively influence the water-retaining capacity of the soil.

Mango trees react positively to being cut . It can become necessary in mixed cultivation systems to limit the height of growth and the crown diameter by pruning. Pruning stimulates the production of new shoots and thus provides more bio-mass. Using this method regularly, sites with only minimal organic material can help to raise the fertility of the soil.

### Crop Monitoring

In addition to measures such as pruning the trees, applying fertilizer, caring for the bottom crops, occasional crop protective measures and harvesting, it is also necessary to regularly check on the development of the fruits. If the crown is well formed during the early stages of the trees, and allows enough light to filter through and air to circulate, then only old, dead wood needs to be removed. The development of blossoms and fruit must be checked regularly. The alternating phases of mango yields also need to be taken into account. In addition to this alternation, poor blossoms and fruit development can have several causes. In the case of young trees, too much nitrogen (either through fertilizers or from a bottom culture with a high legume content) can prevent blossoming, as can watering the bottom crops during the blossoming period. In addition, an over-ageing of the crown in older trees can also lead to a lack of fruiting lateral. This can be alleviated with rejuvenation pruning.

The possible appearance of diseases and pests also needs to be monitored during the fruit development stage so that the necessary measures can be taken (compare chapter 2.7.6.). This is especially important when a heavy infestation of scales or black fly appears, as these need to be sprayed with white oil precisely before the larvae hatch.

As the harvesting period nears, regular checks need to be made to predict the correct time (compare chapter 2.7.8.). Fruit harvested too early or too late will suffer massive disadvantages in the market, as fruit harvested too early will not keep for very long.

## 2.7.10. Harvesting and Post-harvest Treatment

With hundreds of varieties, mangoes are differentiated by weight (250 g to 2 kg), shape (oval, pear or kidney-shaped), color of the skin (green, yellow, orange-yellow, orange-red) and taste (more or less aromatically sweet). The flesh is yellow to yellow-orange, juicy and has a varying fiber content according to variety, whereby fruits with a high fiber content are generally not sold as fresh fruit, but are processed to remove fibers. Mangoes have many different uses. Ripe fruits can be eaten fresh, or processed into juice, pulp, concentrate, candied fruits, jams, chutneys, canned fruits or dried.

If the mangoes are to be sold as fresh fruits, they must be treated with warm bath water to remove any dirt or funguses from the peel. It is recommendable to place them in a 55°C water bath for 5 minutes and then let them cool down slowly. Afterwards, they are dried, sorted, classified, packed and stored before shipment.

The EU quality standards are shown in the Annex

### Harvesting

A mango plantation will supply its first commercially marketable amount of fruit around 4-5 years after being planted.

At the end of the fruit's development period, the peel will turn leathery. The fruit is ripe for harvesting when the skin has turned from green to red or yellow. Some farmers wait to harvest until the first fruits have fallen to the ground of their own accord. Yet because the fruits fail to ripen at the same time, the color change must nevertheless be checked regularly.

The fruits are harvested by breaking them off or with a pair of scissors. A pair of steps or a cherry-picker will be needed for tall trees. With medium tall trees (up to ca. 4 m), the fruits can be picked individually with the help of a harvesting rod. Too many fruits should not be placed into one sack to avoid bruising them. Such fruits will not keep for long, and cannot be sold as fresh. Any damaged fruits should be separated during harvesting to prevent the spread of fungus infections.

### Post Harvest Treatment

Usually, post harvest handling is not required. For safety reasons, treatment with warm water is recommended (see below), and is absolutely necessary in cases of anthracnose infection.

The fruits are packed into sturdy cases. They are sorted visually, because machine sorting is expensive and complicated. For export to Europe, sizes from 270 g to 335 g. are preferable.

The fruits are generally packed in untreated wood wool, free from harmful substances, to prevent them lying too close to one another.

The cases must also be well aerated. Cartons which hold 5 kg of fruit have become standard for export to Europe, as this size is also easily managed in the retail business.

## Packaging and Storage

**Packaging**

The regulations concerning carton labeling were dealt with in section VI of the "UN/ECE standard FFV – 45 for mangoes".

**Storage**

- Mangoes that are not fully ripened and are to be shipped by sea should be stored at a relative humidity of 90% and not under 12°C.
- Fully ripened mangoes that are to be shipped by sea should be stored at a relative humidity of 90% and at a temperature of 10°C.

## 2.7.11. Product Specifications and Quality Standards

The **"UN/ECE standard FFV – 45"** defines the quality requirements for trading with fresh mangoes. These do not necessarily have to be adhered to, yet supply recommended guidelines. Mangoes intended for export are not included here. Different minimum and maximum values can be agreed upon between importers and exporters, providing they do not clash with official regulations.

**The following is an excerpt from "UN/ECE standard FFV – 45 for mangoes":**

(I) DEFINING TERMS

These standards apply to mangoes *Mangifera indica L.*, that are delivered fresh to consumers.

(II) QUALITY CHARACTERISTICS REGULATIONS

*a. Minimum Requirements*

- The mangoes must be as follows:
- Fresh and healthy
- Clean, practically free of visible foreign substances
- Practically free of pests and damage caused by them
- Free of fungus
- Free of bruising and frost-damage
- Free of strange taste of smell
- Well developed, ripe

*b. Classifications*

Mangoes are sold in three categories:

- Class Extra

  Mangoes in this class must be of the highest quality. They must possess the characteristics typical of their variety and/or trading type. The fruits must be unblemished, with the exception of very light surface flaws that do not detract from the fruit's general appearance, quality, the time it will keep.

- Class 1

  Mangoes in this class must be of good quality. They must possess the characteristics typical of their variety and/or trading type. The following blemishes are permissible, providing they do not detract from the fruit's general appearance, quality, the time it will keep and the presentation of the bunch or cluster in its packaging:
  - Slightly misshapen
  - Light flaws in the skin caused by friction or by other means, providing the area does not exceed 3, 4 or 5 cm² of the total surface area of the appropriate size class A, B, or C.

- Class 2

  This class is composed of those mangoes that cannot be placed in the upper classes, yet which fulfill the definitions of minimum requirements. The following faults are allowed, providing the mangoes retain their essential characteristics in terms of quality, preservation and presentation:

- Shape defects,
- Skin flaws, caused by scratches, friction or other means, providing the area does not exceed 5, 6 or 7 $cm^2$ of the total surface area of the appropriate size class A, B, or C.

(III) SIZE CLASSIFICATION REGULATIONS

**Table 23:**
**Mangoes are sorted according to their weight. The fruits must weigh at least 200 grams.**

| Size Classes | Weight | Maximum Differences in Weight within a Class |
|---|---|---|
| A | 200 - 350 g | 75 g |
| B | 351 - 550 g | 100 g |
| C | 551 - 800 g | 125 g |

(V) PRESENTATION REGULATIONS

*a. Uniformity*

- The contents of a carton must be uniform, and may only contain mangoes of identical origin, variety and/or trade type, and quality.
- The visible part of the carton must be representative of the entire contents.

*b. Packaging*

- The mangoes must be packed in a way that ensures they are sufficiently protected
- Packing material used inside the carton must be new, clean, and so shaped that it cannot cause any damage to either the inside or outside of the fruit. The usage of materials such as papers and stickers with company details on them is permitted providing the no toxic inks, dyes or glues have been used.
- The packaging must be free of all other materials.

(VI) REGULATIONS OF CARTON LABELING

Each carton must display the following details in unbroken, legible, permanent letters visible from the outside:

*a. Identification*

- Name and address of the exporter and packer

*b. Type of Product*

- "Mangoes", when the contents are not visible
- Name of the variety

*c. Origin of Product*

- Country of origin, and optionally, national, regional or local description

*d. Commercial Characteristics*

- Class
- Size (expressed in min. and max. weight)
- Size code (optional)
- Number of fruits

Although the following values are not laid down in the 'UN/ECE standard FFV – 45 for mangoes' they should nevertheless be adhered to:

**Table 24:**
**Commercial characteristics and values for Mangoes**

| Quality Characteristics | Minimum and Maximum Values |
|---|---|
| HEAVY METALS | |
| Lead (Pb) | max. 0.50 mg/kg |
| Cadmium (Cd) | max. 0.05 mg/kg |
| Mercury (Hg) | max. 0.03 mg/kg |
| RESIDUES | |
| Pesticides | not measurable |
| Sulphur oxide | not measurable |
| Bromide | not measurable |
| Ethylene oxide | not measurable |

## 2.8. Pineapple

### 2.8.1. Botany

Pineapples (*Ananas comosus L.*) originate from tropical South America. They are still cultivated there by the low-land population, who has integrated them into their agroforestry systems in a variety of ways. The varieties differ greatly in both taste and shape. Each variety also has local types. All pineapples are self-sterile and mostly free of seeds. The seeds are therefore only inseminated via external sources. The pineapple is a xerophyte, and can survive long dry periods. Rainwater, mist and dew are collected by the leaves and stored.

conventional production of pineapples.

### 2.8.2. Varieties and Countries of Origin

Organically grown pineapples are found in the following countries: Burundi, Cameroon, Columbia, Ghana, Guinea, Honduras, India, Sri Lanka, Togo, Uganda, USA.

No special varieties can be recommended for organic cultivation due to a lack of scientific research. One important aspect is its lack of spikes, as also occurs amongst certain cayenne varieties. Other differentiation characteristics are: size, shape, flesh color, taste and transportability. In addition, in many countries, local "varieties" are cultivated which are either suited for planting on conventional plantations or in agroforestry systems. In the latter case, a variety must be chosen which has a sufficient shade tolerance.

### 2.8.3. Uses and Contents

Pineapples are eaten fresh or processed into dried fruits, juice and as canned fruits

**Table 25: Contents and Weight in 100 g of the Edible Parts of Pineapples**

| Content | Weight |
|---|---|
| water | 86 g |
| Digestible carbohydrates | 13 g |
| Raw fat | 0,1 g |
| Raw fibers | 0,5 g |
| Vitamin A | 100 (20-200) I.E. |
| Vitamin C | 30 mg |
| Energy | 230 kJ |
| Waste before usage | 40% |

## 2.8.4. Aspects of Plant Cultivation

### Site Requirements

Pineapples as a plant of the first storey of a secondary forest eco-system prefer semi-shadowed conditions. Under the full strength of solar radiation, the fruits can develop sun-burn, especially when they stand out to one side and are no longer protected by the crown.

For good harvests, 1000–1500 mm of rainfall is necessary (600 mm and 2500 mm being the outer limits). Pineapples prefer stable temperatures. Temperatures under 20°C can lead to metabolic disturbances and chlorotic dis-coloring. For this reason, away from equatorial regions, pineapples are generally only planted up to heights below 700 m. In warmer, wetter regions (near to the equator) the growth period up to harvesting is 14-16 months, in cooler regions 18-20 months.

Pineapples react very sensitively to stagnant water, and sites must therefore be well drained. Planting in depressions where stagnant water can accumulate should be avoided, pineapples otherwise place relatively few demands on soil type and fertility. Irrigation is only necessary when long dry period occur, although basin irrigation should be avoided. Due to their relatively low requirements, pineapples can be planted in degraded soil when the appropriate measures are taken, and can help to gradually improve the soil to a normal state.

### Seeds and Seedlings

Pineapples vegetatively propagated by lateral shoots. The best ones to use are the suckers at the base of the trunk. The slips that form underneath the fruits are more numerous and can be used, yet these only begin to shoot during the second year. The lateral shoots can be stored in the shade for up to 3 months and then planted in absolutely dry soil. Only totally healthy and if possible large shoots should be chosen (ca. 400-500 g in weight are best) in order to ensure a uniform crop. The shoots growing underneath the fruits can also tolerate dryness, yet not as well as the suck-ers can because they are generally lighter in weight. All of the shoots should be cut with a sharp knife to ensure that the wounds are quickly sealed, or stored in a shady place to heal and dry the wounds more quickly. This will hinder an infection by dry-rot fungus. Care should be taken that no mealy bugs are present in the shoots or on the leaf blades. No soil should remain on the shoots to prevent an infection by soil-borne fungus such as e.g. *Phytophtora ssp.* and/or nematodes.

The fruit crowns can also be used for planting. The crop can also be increased by planting single leaves, which will then take up to 3 years before they produce any fruit.

Because the crops cannot be treated (dipping) with insecticides/ fungicides on organic pineapple plantations, the farmer is forced to pay particular attention to the quality and origin of the shoots (diseases that can be transmitted from crop to crop). This is especially the case for shoots that have been bought. In principle, it is recommendable to use shoots from the plantation itself and to work very carefully.

Small-holdings farmers are generally forced to use shoots from their own crops for economic reasons (small amounts, high costs). By utilizing slips, a relatively large number of plants can be produced in a short time, because depending on the variety, one tree will produce up to 7-8 suitable shoots. Far fewer suckers are produced, though. Due to their smaller size, the slips are first planted in a shady place for a year before being transplanted. This is especially recommended when the pineapples are to be integrated within an agroforestry system, because otherwise, the cultivation procedures will be hindered and the young plants may not develop dynamically enough dynamic to compete with the secondary crops.

## 2.8.5 Planting Methods and Cultivation Systems

In the majority of organic plantations, local varieties are planted together with other crops either in agroforestry or mixed crop systems. Examples exist where pineapples are planted as a rotation-fruit with green fallow land and other crops. The farming plan will depend upon which cultivation form is adopted (agroforestry system, mixed crops as a bottom culture, crop-rotation etc.).

**Table 26: Examples of Differing Organic Cultivation Systems**

| Country | Variety | System | Marketing type |
|---|---|---|---|
| Ghana | Smooth Cayenne | Crop rotation with different crops plus undersowing of legumes (green manure) | Export of fresh pineapples |
| India | Local varieties | Agroforestry system | Export of dried pineapples |
| Columbia | ditto. | Bottom crops in coffee plantation | Processing into jams, juices etc. |
| Uganda | ditto. | Agroforestry system | Export of fresh pineapples and dried pineapples |

### Example: Pineapples in a Crop Rotation System

**1. Planting Procedure**

A variety of planting methods exist (one, two or three rows) double rows prevail. The distances between the plants or rows depend; upon the variety used (tall or short plants) as well as the type of product desired (more plants per hectare for fresh fruits than for fruits being made into jams). Distances of 25-35 cm (using alternating planting holes) between the plants are sufficient in double-row systems, and 40-60 cm between the rows, with 75-90 cm between the double-rows. The distances should be greater for tall varieties (e.g. Cayenne: 90 x 90 cm planting distance, 120 cm between the double-rows). The soil should be neither water-logged nor completely dry. The shoots should be pressed into soil that has been lightly loosened and then filled in again. They should not be pressed in too deeply, and the vegetation point where the leaves will sprout must lie above the surface.

Non-climbing legumes (e.g. *Arachis pintoi*) can be sowed to cover the ground (protection against erosion) and to help suppress weeds before the pineapple shoots are planted.

**2. Crop Rotation**

A pineapple monoculture is not permitted in organic farming systems. The pineapples are integrated with the other crops in rotation (e.g. peanuts, beans, rice, vegetables); after the pineapples have been planted, a two up to three year break must follow. To prepare the land used for pineapple production green manuring plants like e.g. *Vigna unguiculata, Crotolaria juncea* or *Mucuna capitata* can be sowed prior to the pineapples.

**3. Flower Formation**

The flower formation is induced by ethylene. On conventional pineapple farms, special preparations can be used to induce flower formation to occur after only 10 months. These preparations are not permitted on organic plantations. This is also valid for carbide (CaC2). Neither in the European Regulation for Organic Agriculture nor in the IFOAM Basic Standards the use of carbide is permitted. Nevertheless some certification bodies approve the use of carbide in exceptional case by case decisions. Currently, the EU-Commission is evaluating whether carbide should be allowed in the future[17]. Should carbide be used , great care must be taken to prevent any explosions when manufacturing spraying mixtures (e.g. no copper containers!).

[17] An update information is available from your certification body.

**4. Protection Against "Sunburns"**
Depending on the region, very intensive solar radiation (and from a lack of shade on the plantation) can damage the fruit (sunburns). The only method of protection in these cases is the intensive-intensive method of binding the leaves around the fruits in order to cover them.


Pineapple intercropping with papaya.

### Example: Pineapples in Agroforestry Systems

**1. Planting Procedure**
Pineapples are an excellent choice to plant for a limited time on young agroforestry systems. Pineapples as well as papaya are well suited as so-called "nursery crops" to raise trees, as they are less demanding regarding the soil fertility. The way that pineapples are used on the plantation, and the types of other trees and bushes chosen depends on the site. In its early stages, a pineapple plant requires a lot of light, yet later on, it will be capable of growing even under a relatively thick roof of trees. Pineapples can only be added under limited conditions to systems that are already quite developed, or to older plantations.

The yields of pineapples in agroforestry systems are significantly lower than those of mono culture plantations. One of the main reasons for this is the relatively low density of trees in agroforestry systems. Instead of the 40,000 to 100,000 trees per hectare (according to whether they are being grown for fresh fruit or to be canned) on conventional mono-culture plantations, the density lies at around 5,000-25,000 trees. Yet in the long-term, these systems actually achieve greater stability with a higher level of total productivity (along with the pineapples, the other crops also turn in a harvest). In addition, agroforestry systems, especially those in regions near to the equator, adequately fulfill the demands made upon an ecologically tenable and long-lasting plantation system, which then also raises the soil fertility even in the long-term.

The following examples show a few of the possibilities available on organic pineapple plantations:

- A SITE WITH POOR SOIL AND HEAVY GROWTH OF GRAMINACEEN
  Sites that have already been degraded by the damage done by incorrect farming methods can reach a high level of yield again by utilizing the natural regeneration possibilities that eco-systems offer. The grass is mown down and spread over the surface as mulching material. Manioc and pineapples are planted in the prepared field. Seeds from the undemanding trees and bushes that naturally grow locally should be mixed with the pineapples. The pineapples will grow under the protection of the manioc. At the same time, the many varieties of trees and bushes that establish themselves should be left to their own accord. Only the weeds and grass that thrive should be cut down and spread over the surface. The tree vegetation should be regularly cut back. In the course of time, more and more demanding varieties can be planted where organic material is beginning to collect. The pineapple yield will not be very high early on. In addition to the use of the manioc and the improvement of the soil, the pineapples can be processed into dried fruits.

- A SITE WITH RELATIVELY GOOD SOIL – SYSTEM COMBINING LEMONS

  Young lemon plantations (up to 5 years old with diameters of 6 x 6 m) can be converted into agroforestry systems.

  A double row (0.5 x 1.0 m) of pineapple trees is sown between the rows of lemon trees. A mixture of tree seeds (*Erytrina ssp., Inga ssp.*, as well as primary forest varieties) is sown along with each pineapple, together with a handful of compost to activate the initial development. Additional bananas can be planted every 4 m. The pineapples will develop very well in this system. The advantage lies in that pineapples may be sold before the main harvesting phase of the lemon trees has been reached.

- A SIMPLE SYSTEM ON RELATIVELY GOOD SOIL

  Cuttings from 1.5-2 m tall *Gliricida sepium* and *Erytrina ssp* are planted at 2 x 3 m.. In between, a double row 1 x 1.5 m or 1 x 1 m of pineapples is planted, also with a mix of Inga ssp. as well as other species. In this relatively simple system, that is very similar to a young secondary forest with few varieties, flower formation can easily be influenced by altering the shade conditions. The entire plantation can be eroded after 7-9 years and will afterwards enjoy a greatly improved soil fertility.

- MIXED PLANTATION

  Pineapples are easy to combine with other crops as a bottom crop. In particular: coffee, cocoa, coconut, cashew nuts, coconut and date palms, hevea (rubber), avocado and also mangoes.

**2. Crop Rotation**

In diverse agroforestry systems, crop rotation is unnecessary. However, if the pineapples are planted as bottom crops in a mixed system, e.g. with oil or date palms, then the crop rotation methods mentioned above must be adhered to. This is the only way to avoid a heavy growth of pests and a decrease in soil fertility.

**3. Flower Formation**

The flower formation in agroforestry systems can be induced by selective tilling of the weeds and the cutting back of trees 2 months before blossoming is set to occur. The resulting sudden influx of light will have a similar effect to using carbide. This enables the harvesting time to be controlled in response to market demand (e.g. before or after the usual regional harvesting season to gain a price advantage).

**4. Protection Against "Sunburn"**

Not applicable.

## 2.8.6. Nutrients and Organic Fertilization Management

### Nutrient Requirements

The nutrient requirements for 1 ton of fruits are ca. 1 kg N; 0.2 kg P; 2.5 kg K; 0.3 kg Ca and 0.1 kg Mg.

A harvest of ca. 35 tons per year, would thus require 35 kg N, 7 kg P, 88 kg K, 11 kg Ca and 4 kg Mg. The amounts given refer to research carried out on conventional plantations, and are therefore only intended as orienting values.

The nutrient requirements of a crop rotation system is mainly provided by green manure (green fallow land as a first pre-crop, or sowing of non-climbing legumes). Deficits in the potassium supply can be balanced out by the use of wood ash (combined with compost). In exceptional cases, the certification bodies will allow the use of potassium magnesia. All of the remnants from the pineapples production should be spread over the soil (composting or mulching).

In calculating the amounts of compost required, it should be noted that the use of legumes as green cover plants can supply significant amounts of nitrogen to the soil. In this case, a compost with a rather high C/N ratio should be used. If possible, the compost should be spread in two separate lots. One half (ca. 2.5 tons) before planting, and ca. 2.5 tons to induce the flower formation. If the undergrowth is too dense, then either the entire compost can be spread in one go before planting, or the undergrowth can be mulched together with the second lot of compost.

Pineapples planted in diverse agroforestry system will usually have no need to be supplied with external, organic fertilizer. The fewer varieties an agroforestry systems contains (especially when leguminous trees are lacking), the more the soil will require fertilization with compost (or an undergrowth of soil-covering legumes).

## 2.8.7. Biological Methods of Plant Protection

Pineapples seldom suffer from pests and diseases when good growth conditions are prevalent. This requires, if possible, using plants from the plantation itself. The following pests and diseases occur especially in systems that lack diversification.

- **Rot root,** caused by *Phytophtora cinnamomi* and other fungi are only a problem in moist soils; pineapples cannot be planted in soils prone to waterlogging. Soil qualities can be improved by selective fruit rotations and application of organic compost material.
- **Thrips** (carrier of the viral disease "yellow spot") poses no serious problem in a well-balanced plantation system. In chronic cases, liquid herbal manure can be used, or in extreme situations, sulphur or pyrethrum[18] sprayed among the crops.
- **Mealy bugs** (*Dysmicoccus brevipes*) cause "wilt disease". Mealy bugs are transmitted by ants. Should the ant population gain the upper hand, due to a lack of natural enemies such as birds or small mammals, an infestation by lice can be significantly reduced by laying out sugar-water traps.
- **Nematodes** can appear in pineapple monoculture plantations. Problems with nematodes occur only on organic plantations, due to the normal practice of fruit rotation. Care should nevertheless be taken when buying shoots or young plants.

## 2.8.8. Crop Cultivation and Maintenance

### Crop Monitoring

The following points need to be heeded when cultivating pineapples:

- Choice of planting stock.
- Checking the site for water-logging. Should such areas exist on site, these cannot be used to grow pineapples, and soil improvement measures must be integrated into the planning of a crop rotation system.
- The plantation must be regularly checked to make sure that the pineapples are allowed uninhibited growth. An infestation of mealy bugs through ants must be stopped as soon as possible, providing shade for the fruits early enough might help.
- In agroforestry systems, any shading should be thinned out 6 months ahead of a planned harvest in order to induce flower formation.
- During harvesting, ripe fruits should be chosen according to their coloration.

As soon as the plantation begins to produce fruit, any harvested plants should be removed and cut up before being spread over the soil. The plantation will also need to be thinned out from time to time, because

[18] The European Regulation for Organic Agriculture 2092/91 as well as the IFOAM Basic Standards do only allow for the use of natural pyrethrins (extract from the flower heads of Chrysanthemum). Synthetical pyrethroids persist in the environment and are forbidden.

suckers which continually develop may limit the amount of room available for each individual plant.

### Weed Management

Tilling weeds is difficult to mechanize on pineapple plantations, and in its usual form, is neither possible nor desirable in agroforestry systems. When all possible niches are already occupied with plants, weeds will have little chance of gaining a foothold, and can also easily be uprooted by hand. Mature weeds can be cut down with a knife or pulled out and then cut up to be used for mulch material. One preventative measure is to sow non-climbing legumes before the pineapples are planted (e.g. *Pueraria ssp, Purearia phaseoloides* develops strong tendrils, and is not suitable for pineapples)., *Arachis pintoi,* some *Vigna ssp*. among others). Usually, this bottom culture will suppress the growth of weeds. Depending upon the amount of water available, when enough weeds have accumulated, these can be cut down and used as mulching material.

## 2.8.9. Harvesting and Post-harvest Treatment

### Harvesting

The average harvest for Cayenne on conventional plantations is around 35-40 tons/ha. The first year will usually yield ca. 38 tons, and the following seasons ca. 25 tons/ha. The fruits must be chopped down with a clean cut of a knife, for if the fruits are torn off, these wounds will leave behind ideal spots for fungus to develop.

The fruits should be harvested at the ideal time, and this time is dependent upon how the pineapples will be marketed. Fresh fruits destined for the local market are plucked when almost ripe. Fresh pineapples destined for export are harvested green-ripe or half-ripe (beginning to turn yellow-green at the base of the fruit), and can then be cool-stored for up to 4 weeks (storage temperature ca. 7°C). This enables the fruit to be transported by ship, instead of by an expensive and for ecological reasons difficult to justify air-route. Because of their low sugar-content, pineapples harvested too early are unpopular amongst consumers (pineapples do not ripen afterwards). This requires establishing a closed cycle of cooling facilities and dependable transport/logistic infrastructure.

Selection of pineapples for export and sales.

The color of the skin is an important criteria in determining the ripeness of the fruit. Fruits destined for the European market are often classified according to the extent to which an orange-yellow coloring has spread up from the base of the fruit:

- Ripeness-color 1: Only the base is orange-yellow.
- Ripeness-color 2: The orange- yellow color covers half of the fruit.
- Ripeness-color 3: The orange- yellow color reaches further up.
- Whole of the fruit.

In connection with the scale-scale of pineapple ripeness, it is worth noting that chemicals often used to promote the uniform coloring of the fruits are not permitted on organic plantations.

### Post-harvest Treatment

Post-harvest handling is usually limited to determining the classification of the fruits according to their size.

## 2.8.10. Product Specifications and Quality Standards

### Fresh Pineapples

Depending on the variety, pineapples weigh between 0.9-4 kg, Baby-pineapples are mostly less than 500 g. The white-yellow fruit is contained in a hard, scaly, skin similar in structure to pine-cones. Ripe fruits can be eaten fresh, or processed into juice, jams, candied fruits, stored in cans or dried.

Fruits intended for export should be harvested half-ripe, just when the color begins to change on their base. Juice squeezed out of the middle of the fruit should then have a "Brix"-value[19] of at least 13%. After harvesting, the fruits are then cleaned, the stalks cut to 2 cm, sorted, classified and packed.

- The EU Quality Standards are shown in the Annex!

[19] A Brix value is the measure of the concentration of sugars, acids, and other identifying compounds in a juice. Every fruit juice has a slightly different Brix value.

### Packaging and Storage

**Packaging**

The regulations concerning carton labeling were dealt with in section VI of the "Codex Alimentarius Standard for Pineapples".

**Storage**

- Unripe, hard fruits that are at present not saleable can be stored at 11-13°C and 90-95% relative humidity for up to 3 weeks.
- Ripe fruits can be stored at 6-7°C and 90-95% relative humidity for up to 2 weeks.

Caution: temperatures under 5°C cause black-brown spots to appear in the pulp.

### Annex: Quality Requirements

The **"Codex Alimentarius Standard for Pineapples"** (Codex Stan 182-1993) defines the quality requirements for trading with fresh pineapples. These do not necessarily have to be adhered to, yet they supply recommended guidelines. Pineapples intended for export are not included here. Different minimum and maximum values can be agreed between importers and exporters, providing they do not clash with official regulations.

The following is an excerpt from the "Codex Alimentarius Standard for Pineapples (Codex Stan 182-1993)":

(I) DEFINING TERMS

These standards apply to pineapples of Ananas comosus Merr., that are delivered fresh to consumers.

(II) QUALITY CHARACTERISTICS REGULATIONS

*a. Minimum Requirements*

The pineapples must be as follows:

- Fresh and healthy
- Clean, practically free of visible foreign substances
- Practically free of pests and damage caused by them
- Free of fungus
- Free of bruising and frost-damage
- Free of strange taste of smell
- Well developed, ripe

*b. Classifications*

Pineapples are sold in three categories:

- Class Extra

  Pineapples in this class must be of the highest quality. They must possess the characteristics typical of their variety and/or trading type. The fruits must be unblemished, with the exception of very light surface flaws that do not detract from the fruit's general appearance, quality, the time it will keep.

- Class 1

  Pineapples in this class must be of good quality. They must possess the characteristics typical of their variety and/or trading type. The following blemishes are permissible, providing they do not detract from the fruit's general appearance, quality, the time it will keep and the presentation of the bunch or cluster in their packaging:

  - Slightly misshapen and discolored
  - Light flaws in the skin caused by friction or by other means, providing the area does not exceed 4 % of the total surface area of the fruit.

- Class 2

  This class is composed of those pineapples that cannot be placed in the upper classes, yet fulfill the definitions of minimum requirements. The following faults are allowed, providing the pineapples retain their essential characteristics in terms of quality, conservation and presentation:

  - Shape and color defects,
  - Skin flaws, caused by scratches, friction or other means.

The flaws are not permitted to affect the fruit's pulp.

(III) SIZE CLASSIFICATION REGULATIONS

The pineapples are sorted according to weight. The fruits must weigh at least 700 grams, with the exception of baby pineapples, which must weigh a minimum of 400 grams.

**Table 27:**
**Pineapples sorted according to their weight**

| Reference letter | Weight |
|---|---|
| A | 700 - 1000 g |
| B | 1000 - 1200 g |
| C | 1200 - 1600 g |
| D | 1600 - 1800 g |
| E | more than 1800 g |

(V) PRESENTATION REGULATIONS

*a. Uniformity*

- The contents of a carton must be uniform, and may only contain pineapples of identical origin, variety and/or trade type, and quality.
- The visible part of the carton must be representative of the entire contents.

*b. Packaging*

- The pineapples must be packed in a way that ensures they are sufficiently protected
- Packing material used inside the carton must be new, clean, and so shaped that it cannot cause any damage to either the inside or outside of the fruit. The usage of materials such as papers and stickers with company details on them is permitted providing the no toxic inks, dyes or glues have been used.
- The packaging must be free of all other materials.

(VI) CARTON LABELING REGULATIONS

Each carton must display the following details in unbroken, legible, permanent letters visible from the outside:

*a. Identification*

- Name and address of the exporter and packer

*b. Type of Product*

- "Pineapples", when the contents are not visible
- Name of the variety

*c. Origin of Product*

- Country of origin, and optionally, national, regional or local description

*d. Commercial Characteristics*

- Class
- Size (reference letter or weight class)
- Number of fruits (optional)
- Net weight (optional)

Although the following values are not laid down in the "Codex Alimentarius Standard for Pineapples" they should nevertheless be adhered to:

**Table 28:**
**Quality Characteristics and Values or Pineapples**

| Quality Characteristics | Minimum and Maximum Values |
|---|---|
| HEAVY METALS | |
| lead (Pb) | max. 0.50 mg/kg |
| Cadmium (Cd) | max. 0.05 mg/kg |
| Mercury (Hg) | max. 0.03 mg/kg |
| RESIDUES | |
| Pesticides | not measurable |
| Sulphur oxide | not measurable |
| Bromide | not measurable |
| Ethylene oxide | not measurable |

## 2.9. Dates

The fruits of the date palm (*Phoenix dactylifera L.*) are sweet berries with a sugar content of more than 50%. The origin of the date palm (*Phoenix dactylifera L.*) is supposedly North Africa or Middle East. In North Africa and in the Middle East the date palm (*Phoenix dactylifera L.*) is a staple food that can be produced easily under unfavorable natural and economic conditions. Normally, this palm is cultivated for subsistence/local markets on small holder farms along with other crops. Because of its high nutritional value, great yields and its long life (yielding up to 100 years) the date palm was already mentioned as the "tree of life" in the Bible.

### 2.9.1. Botany

*Phoenix dactylifera L.* belongs to the Palmae (=Arecaceae) family. There are other species with eatable berries like *P. atlantica* A. Chev. And *P. sylvestris Roxb.*. But *Phoenix dactylifera L,* having more nutritious and tasty berries, is the only species with economic importance.

The date palm has a single stem of 15 to 30 m. Some 12 (0-25 range) flower buds develop during the winter in the axils of some of the leaves just below the growing point. The leaves ( 4 m long) can live up to 7 years, depending on site conditions. During youth stage of the palm, shoots develop from the buds in the leave axils. The shoots are used for vegetative propagation. The inflorescence, enveloped in a sheath or spate, pushes through the fiber on the leaf base it originated from to a length of 25 to 100 cm. There are 12 inflorescences every year.

The palm is dioeciously, which means there are male and female plants. The yellowish flowers are small, attached directly to the spike lets; male flowers are sweet-scented and have six stamens, female flowers consist of three carpel's with ovules, of which normally only one will develop into a fruit. For fruit setting, fertilization of the female flowers by male pollen is required, which in date palm cultivation is not left to the wind or insects but is done traditionally by hand. They insert a piece of spike let of male flower at the moment when the female flowers are opening. More modern methods will collect the pollen from the males and in combination with a carrier (such as flour) will be dusted on the female flowers with a mechanical device.

The development of the berries doesn't take more than five months. The color of the ripe berries is yellow and brown red depending on the variety. There can be more than 200 berries in one inflorescence.

The date palm may reach an age of over 100 years and reach up to 30 m in height. As the high yielding period is between 40 and 80 years, date palms are cut down earlier.

## 2.9.2. Varieties and Countries of Origin

At the end of the nineteenth century date palm were cultivated solely in the "old world". Nowadays, they cultivation takes place in many other regions of the world (e.g. United States: California, Arizona, Texas; Mexico; Brazil; Argentina; South Africa; Australia; Namibia). Nevertheless, the highest production is still in the Arabic area and in the Middle East.

**Table 29: World Date Production by Country in 1998**

| Country | Quantity in MT |
|---|---|
| Iran | 900.000 |
| Egypt | 750.000 |
| Iraq | 660.000 |
| Saudi Arabia | 600.000 |
| Pakistan | 535.000 |
| Algeria | 387.313 |
| United Arab Emirates | 250.000 |
| Sudan | 175.000 |
| Oman | 135.000 |
| Libya | 130.000 |
| USA | 019.050 |
| Israel | 009.760 |
| **Total** | **4.551.123** |

The following table gives an overview on different commercially important date varieties.

**Table 30: Overview of Different Commercially Important Date Varieties**

| Variety | Description of the Mature Fruit |
|---|---|
| Bahri | Fresh consumption: at Khalal stage; Sweet and juicy, yellow in color, available only during harvest season |
| Hayani | Fresh consumption: black and shiny in color, long fruit and not too sweet |
| Medhjoul | Dried date: large fruit, soft and sweet; light brown to dark brown in color |
| Amari | Dried date: soft, sweet and medium seized date |
| Deglet Nour | Dried date: semi-soft and famous flavor, light to dark brown in color, harvested semi-dry |
| Hadrawi | Dried date: sweet and fleshy date, dark brown (mahagony) in color) |
| Zahidi | Dried Date: round, medium seized and not too sweet date, golden in color |

Actually, three varieties are mostly required on the world market:

Medjhool: big seize and attractive appearance
Deglet Nour: unique taste and mostly know in the Middle Eastern
Barhi: preferred consumption at the Khalal stage (partially ripe)

Especially in the Republic of South Africa, Namibia, Zimbabwe and in the Sahel-region, new plantations mainly of Medjhool variety can be observed, whereas in the Arabic countries, Medjhool and Barhi are mainly used for new plantations.

In Egypt, Iran, Pakistan and Saudi Arabic the majority of production is aimed at subsistence and local markets.

On the contrary, countries like Iraq, Algeria, Marocco and Tunisia are focusing on exports mainly to Europe. All in all 250.000 tons (estimation) are traded on international markets, the majority is consumed locally.

Export orientation goes along with specialized farms, packing stations and warehouses in order to comply with international quality requirements. A negative impact of the export/market orientation is the reduced number of date varieties used for new plantations. The spread of only a few higher yielding varieties increases the risk of damage by pests and diseases. And, being the key species in very fragile micro-environments (e.g. oases) date palms ensure the biological diversity of oasis. Thus, by providing shade, keeping moisture and stabilizing/protecting soils. Without date palms, no other agricultural plants could be kept like olives, citrus, pomegranates, figs, almonds, grapes, alfalfa, beans and grains. A decrease in date varieties will have a negative impact in the long run.

Therefore it is recommended not only for organic date plantations but also for conventional ones to cultivate different date varieties (high yielding improved varieties for export and local varieties for domestic consumption and local markets).

Currently, most of the world's organic date cultivation takes place in Egypt, Tunisia, Marocco, Israel and United States.

## 2.9.3. Uses and Contents

Beside direct consumption of the whole dates, the fruits are traditionally used to prepare a wide range of products such as date juice concentrates (spread, syrup and liquid sugar), fermented date products (wine, alcohol, vinegar, organic acids) and date pastes for different uses (e.g. bakery and confectionary). Also, the by-products arising from date processing can be used for different purposes. Within agricultural systems date press cake (by-product of date juice production) as well as date pits can be used as animal feedstuff (also dates falling down from palms before maturity). In case no other uses are possible, all organic waste material arising from date processing shall be used in the very least as a component for compost preparation at least.

Furthermore, a wide range of other date palm products (beside the date fruit) exist because of the long tradition of date cultivation in the "old world". With respect to agriculture, shreddered leaves can be used as feedstuff for ruminants as well as a mulching material and/or a pooting medium for horticulture production (high cation exchange capability). All non-fruit components of the date palm (frond bases, midrib, leaflets, spikelets, fruit stalks, spathes) have a certain but limited value for ruminant feeding (in natural environments with no or limited alternatives it should be used). Leaves are very often used to construct fences providing wind protection and creating favorable micro-climates for horticulture and/or in nurseries. Also, date palms provide construction material for different purposes (roofs, fences, baskets, cranes, textiles etc.).

The nutritional value of dates is a high sugar content (around 50-60%), potassium (2.5 more than bananas), calcium, magnesium and iron as well as vitamins (B1,B2) and Niacin. People eat fresh and/or dried dates. Dried dates can easily be stored and preserved because of the naturally high sugar content.

## 2.9.4. Aspects of Plant Cultivation

### Site Requirements

**Temperature**

Date palms require an arid climate (hot and dry) with a temperature between 25° C to 32° C and a sufficient water supply. Daily maximum temperature below 9° C and a minimum temperature below 0°C are growth-inhibiting and temperatures around -7°C cause damage. As a precondition for flowering date palms need temperatures over 18°C (in the shade) and for fruit setting temperatures above 25°C.

**Water**

The daily water uptake of an adult date palm is estimated with 150 to 200 l. Rain fed date palm cultivation is not possible. To ensure growth and development of the berries irrigation is needed. Rainfall and humidity leads to fungus diseases and pollination is inhibited. Rainfall during final maturation of the fruits can cause damage in many date growing areas.

**Soil**

Date palms grow on different types of soils, but the best yields can be reached with sandy loams. Soils should be permeable with a good drainage and a deep ground as roots grow deep (6 meters) into the soil for water uptake. The date palm is considered to have the highest salt tolerance compared of all fruit crops. Also, alkaline soil conditions with a pH up to 8 are tolerable.

**Table 31: Overview of Different Commercially Important Date Varieties**

| High salt tolerance (ECe x 10_ = 18*) | Medium salt tolerance (ECe x 10_ = 10) | Low salt tolerance (ECe x 10_ = 5) |
|---|---|---|
| Date Palm | Pomegranate | Pear Almond |
| | Fig | Apple, Apricot |
| | Olive | Orange, Peach |
| | Grape | Grapefruit, Strawberry |

*The numbers following ECe x 103 are the electrical conductivity values of the saturation extracts in millimhos per cm at 25° C associated with a 50% decrease in yield.

## Site Requirements of Different Varieties

The following table from DOWSON and PANSIOT shows the site requirements of different varieties:

**Table 32: Site requirements of different varieties of dates**

| Country | Varieties | Site Requirements |
|---|---|---|
| Tunisia, Algeria | Bouhatem, Bouzeroua Kenta, Aguewa | suitable for early rain in autumn |
| Irak, California, Arizona | Dayri, Halawy, Kustawy | small rain sensitivity |
| Algeria | Iteema, Deglet Noor | high rain sensitivity |
| Irak, Egypt | Zahidi, Hayany | low sensitivity against cold |
| Algeria | Azerza, Taddala | resistant against |
| Algeria | Deglet Noor | drought sensitive |
| Irak, Tunisia | Sayer, Lemsi | high salt resistance |

## Seeds and Seedlings

Propagation of date palms can be done by using the seeds (sexually) and by using the offshoots (asexually). Using seeds, 50% will develop to male date palms that do not bear fruits. For this reason, the use of offshoots (vegetative propagation) is the most common method. Offshoots are cut with a chisel and/or machete from proven female cultivars and transplanted into a nursery with good growing conditions (wind protection, shade trees, soil etc.) in order to support the development of the roots.

After one year, (or earlier) young date palms are transplanted to their permanent place. The right time for transplantation depends on the development of the root system as well as on the number of palm leaves (10 to 12 are recommended). Sometimes offshoots already have developed roots at the mother plant. In this cases offshoots can be planted directly.

In more intensive and specialized date palm plantations seedlings are gained by tissue culture, to avoid the propagation of pest and diseases.

Date Plantation in Jordania.

## 2.9.5. Methods of Planting

In the traditional date orchards, and especially in the oasis, the density of palms is very high with the intention to form an almost closed canopy. The high density provides shade and protection from wind, thus creating a micro-climate in which the harsh conditions of a hot and dry climate are tempered to make living conditions somewhat more sustainable. However, the high density diminishes the opportunities for growing secondary crops and the introduction of mechanization in date palm cultivation.

In specialized plantations the most common planting system is in a grid of 9mx9m (or 10mx10m) providing space for the use of machines as well as for secondary crops. In case an old plantation needs rejuvenation, young date palms are planted very close to the old palms, to be removed them when the young palm starts to bear fruits. Sometimes date palms are planted around a field for arable cropping and or horticulture production in combination with other fruit trees.

The young date palms are planted in a hole (90cm deep x 90cm wide) in order to put the roots closer to the water table. In traditional cultivation systems, the alkaline earth is removed and replaced by a mixture of organic manure, sand and ash. In organic cultivation systems, it is recommendable to add also composted organic material.

It is recommendable to prepare the wholes two to three months before planting. After planting the young date palms are watered daily for at least one or two weeks. With the objective of protecting the date palm and to improving growing conditions, young plants should be surrounded by fences (e.g. with cut date palm leaves). In addition a coat out of straw and palm leaves is put around the shoot to reduce water losses.

Normally, farmers choose the season with moderate temperatures for planting. However, date palms can be planted throughout the year provided sufficient water availability is given. In order to provide natural pollination, two to three male shoots are planted with approximately 100 female shoots to gain pollens.

Before planting new date plantation land has to be prepared by building a drainage and irrigation system. Old stems should be removed but old palm leaves should be reduced to small pieces and brought into the soil by plowing (provided the material is not infested with pests and diseases). In some areas it is recommendable to establish shelter belts of Tamarisk trees (*Tamarix aphylla*) and Ironwood (*Casuarina equisetifolia*) before planting the date palms.

## 2.9.6. Diversification Strategies

Traditionally, intercropping with other fruit trees (citrus, pomegranates, olives, grapes, guava) or arable crops (alfalfa, barley, beans etc.) is practiced in many of the main production areas. Without the shade provided by the date palms other crops very often cannot grow. Organic cultivation does not allow for monoculture systems. In particular, intercropping with alfalfa and other legumes provides an enrichment of the soils with nitrogen as well as fodder for livestock production. In addition to a site-appropriate mixed system of date palms, arable crops and fruit trees date plantations should be sheltered/surrounded by green fences (e.g. with Polynesian Ironwood (Casuarina ssp.) or by stripes of Spanish Reed (*Arundo donax*) within the plantation. Both are multiple use plants in arid climates.

## 2.9.7. Nutrients and Organic Fertilization Management

### Nutrient Requirements

The following average amounts of nutrients are citied in the literature looking on conventional date palm plantations: 500 g N (nitrogen), 300 g P (phosphorous) and 250 g K (potassium).

It has been shown that there is a stronger effect of nitrogen in terms of yield and quality than Phosphorous and Potassium. The effect of Phosphorous and Potassium on yield and quality is not proven.

### Organic Fertilization Strategies

In organic cultivation fertilization strategies are based on green manure and compost. This strategy doesn't differ much from the traditional way of fertilizing date palms. Animal manure was applied by digging a trench around the tree in order to bury the animal manure. Nitrogen was provided by intercropping of alfalfa (and other appropriate leguminous plants). Organic cultivation systems requires for a sufficient supply with composted organic materials (animal manure with other organic materials like straw and other organic waste material) on a regular basis. At least every 4 years compost should be added to the date palm. For this reason, the compost must be brought into the soil around the stem. Regular application of organic materials improves the water holding capacity and therefore the efficiency of irrigation.

## 2.9.8. Biological Methods of Plant Protection

Most of the problems concerning disease and pests have the following causes:

- Monoculture cultivation and use of non-resistant and/or of few varieties
- Insufficient distance between species that grow to the same height; failure to trim agro forestry systems.
- Unfavorable soil conditions like degenerated or poor soil, soil not deep enough for roots, lack of organic material, high salinity etc.
- Unsuitable site conditions (deep water table, insufficient irrigation, drought, temperature, high rainfall level etc.)

In the case that diseases and/or pests occur in a date plantation, the overall situation of a date plantation has to be analyzed in order to identify the reasons. In this way, it will be possible to develop site appropriate strategies to prevent the outbreak of diseases/pests in the long run.

In general, two major threats exist in conventional date palm plantations, namely Red Palm Weevil (*Rhyncophorus ferrugineus*) and Bayoud (*Fusarium oxysporium*). The outbreak of both can be prevented by the strict use of non-infested seedlings and strong hygienic precautions. Tissue culture propagation of seedlings is the most successful way to achieve this aim, but requires appropriate techniques and facilities. The health status of date offshoots and seedlings from nurseries needs to be clarified in order to avoid any infestation of the plantation. In this context, it is of utmost importance to implement regular disinfections of the working tools, removal of infected palms, leaves or inflorescences.

## Diseases

Most occurring fungal diseases:

- **Omphalia root rot:** Triggered by *Omphalia pigmentata* or *O. tralucida.* This fungus doesn't exist in the stem, only in the roots.
- **Inflorescence rot (and/or Bayoud):** Triggered by *Fusarium oxysporum* f. sp. *Albedinis*. This fungus exists in the soil. Symptoms: white chlorite color and fade of the palm leaves. Bad cultivation conditions and an intensive cultivation of alfalfa and vegetables in rotation supports an infection. The following varieties have lower fruit quality but are supposed to be resistant to inflorescence rot: Takerboucht, Bou Jigou, Taadmant und Bou Stammi.
- **Diplodia disease:** Triggered by *Diplodia* spp. Can occur in young cultivations.
- **Terminal bud rot:** Triggered by *Ceratocystis paradoxa.* Rot of the terminal buds in older palms.
- **Khamedj:** Triggered by *Mauginiella scaettae.* Rot of the flowers can lead to a total destruction of the inflorescence.
- **Fruit roots:** Triggered by *Aspergillus niger, Rhizopus nigricans, Alternaria citri.*

## Pests

- **Cottony cushion scale:** *Parlatoria blanchardii* and *Phoenicoccus marlatti* are wide spread. Sucking on the leaves leads to early death of the leaves. Cottony cushion scales need humidity and wind free areas therefore they exist inside of the plantation. Biological control is done with natural predators like bugs of the species *Pharascymnus, Cybocephalus* and *Chilocorus bipustulatus* but also by appropriate methods of cultivation.
- **Bryobia:** *Oligonychus afrasiaticus* and *Paratetranychus simplex* are wide spread in North Africa and in the Middle East and *O. pratensis* in California. Bryobias infest the leaves and unripe fruits. They need dry and windy conditions. The use of *Arundo donax* in mixed cultivation supports their speading, therefore it is recommendable to use other crops for mixed cultivation.
- **Caterpillars:** Most common are the caterpillars of the butterfly *Ephestia cautella* and *Batrachedra amydraula,* which eat the leaves and penetrate into the fruits. Bacillus Thuringiensis is used for biological control.
- **Bugs:** Rhinoceros bug of the species *Oryctes spp.* They eat tissue of the young leaves and destroy the area of vegetation. There are different biological control possibilities: Removal of their hotbeds like rotten plant material and green manure. Artificial preparation of hotbeds for catching, biological control by the fungus *Metarrhizium anisopliae* and the virus *Rhabdionvirus oryctes.*
- **Fruit bugs** of the species *Cotinis texana, Carpophilus hemipterus, Coccotrypes dactyliperda.* They destroy ripe fruits and inflorescences. Inflorescences are wrapped with bags as a rescue measure.

Plantation of Dates in Jordania.

### Rodents

As in other palm crops rats, mice and other rodents may cause damage on the trunk as well as on the fruits. For this reason it is recommendable to support predators like owls with the objective as controlling the rodent population in the date plantation. Another mechanical way of reducing fruit damages is to place a mechanical device around the stem in order to make it impossible for rodents to climb up the tree.

## 2.9.9. Crop Monitoring and Maintenance

Regular activities during a growing season are:
In intensive date plantations machines (cranes) are used to lift the workers for artificial pollination, maintenance work and harvesting.

- Artificial pollination
- Protection of inflorescences by bags
- Bunch management

In this case, it is important to remove some elements to avoid nutritional competition, at the growing point. Normally, the age limit is less (between 40 and 80 years is the high yielding period), consequently the height will not be more than 15-25 m maximum before it is cut down because of declining yield and increasing difficulty (and danger) in reaching the crown during pollination, bunch management and harvesting.

## 2.9.10. Harvesting and Post-harvest Treatment

### Harvesting

The color of the dates indicates the right harvesting time. At the “Khalal” stage dates are partially-ripe showing a yellow or red color (depends on the variety). At this stage some dates are already harvested in spite of the fact that the moisture and tannin content is still very high. Most of the dates are harvested at the fully-ripe stage showing a color. Furthermore, the sugar content is higher and/or moisture and tannin content is lower.

Harvesting is labor intensive as dates are hand picked. In intensive date plantations cranes are used to lift up the workers. However, in most of the cases, workers have to climb up the date palm in order to reach the fruit brunches.

Overall country averages in the main production regions do not go much higher than 20-30 kg/palm/year, though the production inputs are also less (fertilizers, pesticides) and generally the palms are very closely spaced. Even so, in well organized date plantations, yields may reach over 100 kg/palm/year under favorable environmental conditions. At the age of 30 years date palms reach the high-yielding period.

### Preparation, Transport and Storage

After harvesting dates are sorted, washed in drinking water, air dried (45°C), resorted and packed. Sorting of dates is done manually. While sorting workers can remove dates with any indication of infestation as well as other particles and damaged dates.

Fruit Harvesting

Sorting

Washing

Drying

Sorting

Packing

Storage

Air-drying should result with a moisture content of 20% or below in order to prevent incidence of molds and yeasts. Storage of dates depends on anticipated duration of storage as well as on the variety of dates. The optimum storage temperature is 0° C which allows for a storage period of up to 6 - 12 months. Semi-soft dates like Deglet Noor and Halawy have a longer storage life than soft dates like Medjool and Barhi. For longer storage durations it is possible to freeze the dates (-18°C). In case dates are stored for a short time; temperature shall be below 13°C (prevent insects to cause feeding damages and reproduction) and/or below 5°C (control of new insect infestation). The humidity in storage rooms shall range between 70% and 75%. High moisture in combination with higher temperature levels increases enzymatic as well as non-enzymatic browning of dates.

Dates with insect infestation have to be treated in order to maintain export quality. Unlike conventional dates the use of methyl bromide and other chemical storage pesticides is not allowed within management system for organic food. Alternatively, disinfestations with 100% carbon dioxide for 1-2 days is recommended.

Other measurements to ensure product quality are:

- Avoidance of temperature fluctuations; otherwise, moisture condensation on dates will support growth of unwanted micro-organisms
- Clean and hygienic conditions in packing houses, storage rooms etc.
- Separated storage of dates as ripe dates absorb the aroma of other products (e.g. garlic, onions, herbs, spices)
- Packaging of dates in nitrogen reduces enzymatic browning (darkening) of dates (exclusion of oxygen).

## 2.9.11. Product Specifications and Quality Standards

There is a wide range of date products offered in the market like syrup, juice, jams, preserves and condiments. Dates are often used as a component of food preparations like sweets, confectionary, breakfast foods, desserts, baking products and dried fruit and nut mixtures as well. The main share of the organic date production is sold as fresh or dried fruit.

### CODEX ALIMENTARIUS STANDARD FOR DATES

(World-wide Standard)

**A. SCOPE**

This standard applies to commercially prepared whole dates in pitted or un-pitted styles packed ready for direct consumption. It does not apply to other forms such as pieces or mashed dates or dates intended for industrial purposes.

**B. DESCRIPTION**

*Product Definition*

Dates are the product prepared from sound fruit of the date tree (Phoenix dactylifera L.) whose fruit:

(a) is harvested at the appropriate stage of maturity;
(b) is sorted and cleaned to remove defective fruit and extraneous material;
(c) may be pitted and capped;
(d) may be dried or hydrated to adjust moisture content;
(e) may be washed and/or pasteurized; and
(f) is packaged in suitable containers to assure preservation and protection of the product.

*Varietal Types*

Varietal types are classified as:

(a) Cane sugar varieties (containing mainly sucrose) such as Daglat Nuur (Deglet Noor) and Daglat Beidha (Deglet Beidha).
(b) Invert sugar varieties (containing mainly invert sugar - glucose, and fructose) such as Barhi (Barhee), Saiidi (Saidy),
(c) Khadraawi (Khadrawy), Hallaawi (Halawy), Zahdi (Zahidi), and Sayir (Sayer)

*Styles*

Styles may be classified as:

(a) unpitted; and
(b) **pitted.**

*Sub-styles*

Sub-styles are as follows:

(a) Pressed - dates which are compressed into layers using mechanical force.
(b) Unpressed or Loose - dates which are free-flowing or packaged without mechanical force or compression.
(c) Clusters - dates with the main bunch stem attached.

*Size Classification (Optional)*

Dates may be designated as to size names in accordance with the following charts:

**(a)** Unpitted dates **(b)** Pitted dates

Size No. of dates in 500g
Unpitted Dates
Small . . . . . . . .more than 100
Medium . . . . . . . . . .80 to 100
Large . . . . . . . . . .less than 80

Pitted Dates
Small . . . . . . . .more than 110
Medium . . . . . . . . . .90 to 110
Large . . . . . . . . . .less than 90

**C. ESSENTIAL COMPOSITION AND QUALITY FACTORS**

*Optional Ingredients*

Dates from organic agriculture shall be kept as natural as possible. Use of glucose syrup, sugars, flour, vegetable oils as allowed according to the Codex Alimentarius for Dates is not usual for organic qualities.

*Quality Factors*
*General Requirements*

Dates shall be prepared from such fruit and under such practices so as to ensure that the finished product possess a characteristic color and flavor for the variety and type, be of proper stage of ripeness, free of live insects and insect eggs and mites and meet the following additional requirements:

**(a) Moisture Content** (Maximum)
- Cane sugar varieties 26%
- Invert sugar varieties 30%

**(b) Size (minimum)**
- Unpitted Dates: 4.75 gram
- Pitted Dates: 4.0 gram

**(c) Pits (Stones)**
- Not more than two pits or (in Pitted Style) 4 pieces of pit per 100 dates
- (d) Mineral impurities

Not more than 1 g/kg

*Definition of Defects*

(a) Blemishes
- Scars, discoloration, sunburn, dark spots, black nose or similar abnormalities in surface appearance affecting an aggregate area greater than that of a circle 7 mm in diameter.

(b) Damaged

- (Unpitted dates only) - dates affected by mashing and/or tearing of the flesh exposing the pit or to such an extent that it significantly detracts from the visual appearance of the date.

(c) Unripe Dates

- Dates which may be light in weight, light in color, have shriveled or little flesh or a decidedly rubbery texture.

(d) Unpollinated Dates

- Dates not pollinated as evidenced by thin flesh, immature characteristics and no pit in unpitted dates.

(e) Dirt

- Dates having embedded organic or inorganic material similar to dirt or sand in character and affecting an aggregate area greater than that of a circle 3 mm in diameter.

(f) Insects and mites damage and contamination

- Dates damaged by insects or mites or contaminated by the presence of dead insects or mites, fragments of insects or mites or their excreta.

(g) Scouring

- Breakdown of the sugars into alcohol and acetic acid by yeasts and bacteria.

(h) Mould

- Presence of mould filaments visible to the naked eye.

(i) Decay

- Dates that area in a state of decomposition and very objectionable in appearance.

*Allowance for Defects*

The maximum allowances for the defects shall be:

A total of 7% by count of dates with defects (a)
A total of 6% by count of dates with defects (b), (c) and (d)
A total of 6% by count of dates with defects (e) and (f)
A total of 1% by count of dates with defects (g), (h) and (i)

**D. WEIGHTS AND MEASURES**

Containers shall be as full as practical without impairing quality and shall be consistent with a proper declaration of contents for the product.

**E. LABELLING**

In addition to sections 1, 2, 4 and 6 of the General Standard for the Labeling of Pre-packaged Foods (Ref. CODEX STAN. 1-1981), the following specific provisions apply:

- The Name style and variety of the Food
- List of Ingredients
- Net Contents
- Name and Address of the manufacturer, packer, distributor, importer, exporter or vendor
- Country of Origin
- **Lot Identification**
- Expiring date

**F. METHODS OF SAMPLING AND ANALYSIS**

*Method of Sampling*

Gross Sample

Select at random not less than 2 individual packages per each 1,000 kg portion of the lot. From each individual package draw a sample of 300 g, and a gross sample of not less than 3,000 g. is sufficient. Use the gross sample to

Carefully check for live infestation and general cleanliness of the product prior to its examination for compliance with other provisions of the standard.

Sub-samples for Examination and Testing

Mix the gross sample well and take small quantities at random from many different places as follows:

- For moisture test - 500 gram
- For pits (in pitted style) - 100 dates
- For specified defects and size requirements - 100 dates

**F. METHOD OF EXAMINATION**

Using a strong light, examine each date carefully for internal defects. If the dates are pitted, open up the flesh so that the internal cavity can be viewed. If the dates are unpitted, slit the date open so as to expose the pit, remove the pit and examine the pit cavity.

Fresh and dried dates

## 2.10. Pepper

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 in Oriental countries as early as 2000 years ago. The most popular variety was the long pepper (*Piper longum L.*) from Bengal. Pepper was used in Europe as a spice as early as the Middle Ages. During the 16th century, the Portuguese empire secured a monopoly in trading the spice that was later broken up by the English and Dutch imperial powers. At present, only black pepper (*Piper nigrium*) plays an important role in global trading.

### 2.10.1. 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 that 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 is distinguished by the main shoots that grow upwards, and the lateral, fruit-bearing shoots that grow horizontally. The main shoots form numerous nodes on which adventitious roots grow for climbing, as well as lateral shoots and the stemmed, heart-shaped leaves and blossom ears.

The different varieties range from single-sexed to hermaphrodite and are self-pollinating. Their syncarpy, which is up to 15 cm long produces berry-like fruits (bot. drupes). These take around 6-8 months to develop from blossom to ripe fruit.

### 2.10.2. 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 that 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 comes mostly from India, Madagascar, Tanzania and Sri Lanka.

## 2.10.3. 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).

Pepper 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.

## 2.10.4. 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. At first, pepper grew relatively well. However, 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 utilization of fungicides and mineral fertilizers. On many plantations, though, these measures proved to be economically unprofitable, and the sites were abandoned.

### 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 frequently in young secondary forests (where new trees grow in clearings and on the forest's edge), where they grow 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.

### Seeds

The following methods of producing seeds should be considered:

**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 apart. 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.

**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.

**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 as 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 approximately 2 months, the shoot is cut away and allowed to acclimatize 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.

## 2.10.5. 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 have already been described for, e.g. cacao, bananas, papaya and vanilla.

## 2.10.6. 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.

The tutors are planted on small earth mounds 15 cm high with a diameter of 50 cm that 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.

## 2.10.7. Nutrients and Organic Fertilization 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. However, 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 economical.

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 fertilizer. They can easily be raised from seedlings, and also be planted quite close together (1 x 0.5 m).

## 2.10.8. Biological Methods of Plant Protection

In the cases of demanding cultures such as pepper, a production system 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. In 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. 2.10.7.)
- Lignin-rich mulch material will stimulate the actinomycetes in the soil, which in turn are antagonists of fusarium

### Diseases

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

**Table 33: The Most Important Diseases in Pepper Cultivation**

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

### Pests

Nematode infestation by *Meloidogyne spp.* causes the main problem on conventional pepper cultivations. Greater damage, especially in Indonesia, is caused by various bugs; scales and green flies, beetles, as well as butterfly caterpillars.

If the plantations are situated near houses, then free-roaming pigs and chickens will often cause considerable damage to the plants. These animals must be kept off of the plantations.

## 2.10.9. Crop Monitoring and Maintenance

This sensitive crop requires special care of the soil as 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.

### New Plantations

Young pepper plantations form blossoms within the first year. However, it is recommendable to remove these during the first two years in order to avoid inhibiting vegetative growth. The main shoots must be attached to the tutor.

To stimulate growth of the main shoot and lateral shoots, shoots 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.

### 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 that 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.

## 2.10.10. 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 color.

### 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 is separated from the syncarpy, washed and conserved in brine (salt water, vinegar[20], citric acid).

[20] Vinegar from certified organic production.

## 2.10.11. Product Specifications and Quality Standards

### White and Black Pepper

**Preparation**

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

The following is a systematic description of the steps necessary to manufacture white and black pepper.

FLOW-CHART OF THE MANUFACTURE OF WHITE AND BLACK PEPPER

| White pepper | Black pepper |
|---|---|
| Harvest (ripe, red berries) | Harvest (half-ripe, green berries) |
| Separation of berries and sorting | Soaking in boiling water |
| Water roasting (covered with water) | Drying |
| Separation of meat | Removal of stems |
| Washing | Sorting and packing |
| Drying | |
| Sorting and packing | |

**Manufacturing White Pepper**

In order to manufacture white pepper, the berries are picked when fully ripened, when they take on a yellow-red color. 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 remain there until the fruit meat can be removed from the seeds, which usually takes between a week and ten days. Sacks are removed from the water, and the meat separated by treading on the sacks or rubbing them. Then, the corns are washed carefully again in water to remove residues of meat, dirt and slime. The remaining gray 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.

**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 shriveled and dark brown, with a diameter of 3-6 mm. The process causes weight loss, meaning that only a yield of 32 % can be expected when processing fresh berries into black pepper.

**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 coloring, 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 may not be treated with methyl bromide or ethylene oxide, or irradiated with ionizing rays.

**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 upon between importers and exporters, providing these do not clash with official regulations.

**Table 34: Quality Characteristics with Minimum and Maximum Values for White and Black Pepper Corns**

| 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 be able to wash themselves, or at least their hands (washrooms, toilets), and wear clean, washable garments.
- Water used for cleansing purposes must be free from feces and other contaminants.
- Animals or animal feces must not come into contact with the product.

**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.

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

**Table 35: Numbers Describing the Weight of the Contents Must be of the Following Sizes**

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

*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.

## 2.11. Different Possible Processing Methods for Fruits

### 2.11.1 Dried Fruits

Drying is the oldest method of making food storable for longer periods. It is based on the fact that micro-organisms tend to cease growing below a certain level of water content. During drying, it is important to extract the water from the fruit as carefully as possible. The most important features are good air circulation and not too high temperatures

Preparation of mangos for the drying process.
(Picture: Claro AG)

FLOW-CHART FOR THE PREPARATION OF DRIED FRUIT FROM FRESH FRUITS

Fruit

Sorting

Washing

Peeling

Pulping

Drying

Sorting and packaging

Labeling and storing

*Sorting*
After harvesting, the fruits are sorted as only fresh, unripe and not fermented fruits can be used for drying.

*Washing and Peeling*
The fruits must be washed very carefully in order not to damage them. Afterwards, inedible parts such as leaves, seeds, pips, heartwood and skins are removed.

*Pulping and Drying the Fruits*
The fruits are now cut into same-sized pieces, and laid out to dry in the air and sun in thin layers on racks, in solar dryers (drying tunnels) or drying ovens (artificial drying at 70°C).

*Sorting and Packaging*
Before they are packed, the fruits are inspected and sorted again to rid them of discolored, skin remnants and seeds etc...

*Labeling and Storage*
The packaged fruits can now be labeled and stored prior to being shipped.

During and after drying, the dried fruits may not be treated with methyl bromide, ethylene oxide, sulphur oxides or ionizing radiation.

## Quality Requirements

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

**Table 36: Quality Characteristics with Minimum and Maximum Values for Dried Fruits**

| Quality Characteristics | Minimum and Maximum Values |
|---|---|
| Taste and smell | Variety-specific, aromatic, fresh, not moldy |
| Cleanliness | Free from foreign particles, such as insects, sand, small stones etc. |
| Water content | max. 18 % |
| aw-value | 0.55 to 0.65 (at 20 °C) |
| RESIDUES | |
| Pesticides | Not measurable |
| Sulphur oxide | Not measurable |
| Bromide and ethylene oxide | Not measurable |
| MICRO-ORGANISMS | |
| Total number of parts | max. 10,000/g |
| Yeasts | max. 10/g |
| Mould fungus | max. 10/g |
| Staphylococcus aureus | max. 10/g |
| Coliforms | max. 1/g |
| Escherichia coli | Not measurable in 0.01 g |
| Enterococci | Not measurable in 1 g |
| Salmonella | Not measurable in 20 g |
| MYCOTOXINS | |
| Staphylococcus enterotoxin | Not measurable |
| Aflatoxin B1 | max. 2 µg/kg |
| Total aflatoxins B1, B2, G1, G2 | max. 4 µg/kg |
| Patulin | max. 50 µg/kg |
| HEAVY METALS | |
| Lead (Pb) | max. 1.25 mg/kg |
| Cadmium (Cd) | max. 0.125 mg/kg |
| Mercury (Hg) | max. 0.10 mg/kg |

In order that the quality requirements are upheld, and no contamination of the fruits 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 be able to wash themselves, or at least their hands (washrooms, toilets) and wear clean, washable garments.
- Water used for cleansing purposes must be free from feces and other contaminants.
- Animals or animal feces 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.

Preparation of mangos for further processing.
(Picture: Claro AG)

## Packaging and Storage

### Details Given on Packaging

The label on the jar must display the following:

- Packaging types and material
  In order to be exported to Europe, the dried fruits can be packed in consumer packs, or wholesaler packs (bulk)

in bags made of foils, impermeable to steam (e.g. polyethylene or polypropylene). Before sealing, a gas (e.g. nitrogen) may be added (nitrogen flushing).

- Details given on packaging
  If the dried fruits are packed directly for consumers, then the following details must be included on the outside of the packets:
- Product name ("trade name")
  The name of the product, e.g. organically grown dried banana slices[21]
- Manufacturer
  Name and address of the manufacturer, importer, exporter or trader within the country of origin, and which country.
- List of contents
  A list of ingredients and additions, beginning with the heaviest proportion of total weight at the time of packaging.
- Weight

DETAILS OF THE TOTAL PACKED WEIGHT IN GRAM

**Table 37: Numbers Describing the Weight of the Contents Must be of the following Sizes**

| 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

[21] 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 plantation must be recognisably declared as such.

### Function of the Product Packaging

The product packaging should fulfill the following functions:

- Protect it from loss of aroma and against undesirable smells and tastes from its surroundings (aroma protection).
- Offer sufficient conservation properties, especially against loss or gain of moisture.
- Protect the contents against damaging.
- Provide a surface area for advertising and product information.

## 2.11.2 Fruit Marmalades

### Processing

Jams are basically preparations made of fruit (jams) and various sugars that are made conservable mainly by heat treatment (boil down). The half-set yet spreadable consistency of these products is achieved by releasing the pectin found in the fruit pulp during the boiling process, and using this together with further pectin added to form a jelly-like mass.

FLOW-CHART FOR THE PREPARATION OF JAM FROM FRESH FRUITS

Fruit

Sorting

Washing

Peeling and sorting

Pulping

Addition of sugar

Heating and boiling down

possible addition of pectin, citric acid and spices, then renewed heating

filling into jars

vacuum sealing

Pasteurizing

Cooling

Labeling and storing

*Sorting*
After harvesting, the fruits are sorted because only those that are fresh, ripe and not rotten can be used to make jams. Jams can also be made from previously prepared frozen fruits and pulp.

*Washing*
The fruit should be washed very carefully as it can easily be damaged.

*Peeling and Sorting*
This follows the procedure of removing leaves, wooden pieces, pips or seeds and peel. Peeling is often done manually, or with knives, yet sometimes the skin is loosened with steam and then subsequently rubbed away mechanically. Finally, the fruits are sorted again to remove any blackened pieces, bits of peeling seeds etc.

*Pulping and Adding Sugar*
The peeled fruits are then pulped, and sugar added. They might also be mixed with water or fruit juice. To make jam, at least 350g fruit per 1000g finished product must be used; to make jam extra, at least 450g fruit per 1000g finished product must be used. The sugar must be ecologically grown.

**Table 38: Minimum Fruit Content for the Manufacture of Jam**

| Description | Fruit Content During Manufacture |
|---|---|
| Jam, extra | 450 g fruit per 1000 g product |
| Jam | 350 g fruit per 1000 g product |

*Heating and Boiling*
The mixture is now heated to 70-80°C and boiled down, while constantly being stirred, at 65°C until shortly before it reaches the desired consistency.

*Adding Citric Acid, Pectin and Spices (Optional)*
If necessary or desired, citric acid, pectin and spices (from certified organic production) can be added, and the mixture again briefly heated to 80°C.
Filling into jars, vacuum-sealing and Pasteurizing
The liquid mass is now poured into jars, vacuum-sealed and pasteurized.

*Cooling, Labeling and Storage*
After the heating process, the jams are first cooled to 40°C, and then subsequently down to storage temperature, are labeled and finally, stored.

Preparation of mangos for further processing. (Picture: Claro AG)

## Quality Requirements

In addition to the previously mentioned quality requirements, such as clearly defined fruit content, the jams must also conform to the following specifications. These quality requirements, with their minimum and maximum values, are generally issued by the authorities or importers. Yet agreements may be reached between individual manufacturers and importers upon different values, providing they still conform to official requirements.

**Table 39: Quality Characteristics with Minimum and Maximum Values for Jam**

| Quality Characteristics | Minimum and Maximum Values |
|---|---|
| Smell and taste | Variety-specific, aromatic |
| Cleanliness | Free of foreign substances such as peel, stalks etc. |
| Contents of jam extra | Min. 450 g per 1000 g product |
| Contents of jam | min. 350 g per 1000 g product |
| Soluble dry mass in percent (measured refractometrically) | min. 60 % |
| MYCOTOXINS | |
| Aflatoxin B1 | max. 2 µg/kg |
| Total aflatoxins B1, B2, G1, G2 | max. 4 µg/kg |
| Patulin | max. 50 µg/kg |
| RESIDUES | |
| Pesticides | Not measurable |
| Sulphur oxide | Not measurable |
| Bromide | Not measurable |
| Ethylene oxide | Not measurable |

In order to conform to the quality requirements, and to prevent the fruit from becoming contaminated, all preparations must be carried out under clean, hygienic and acceptable conditions. The following aspects must be heeded:

- Equipment (tubs, knives etc.), as well as working surfaces (tables etc.) and preparing and storage rooms, should be cleaned regularly.
- Personnel should be healthy, be able to wash themselves, or at least their hands (washrooms, toilets) and wear clean, washable over garments.
- Water used for cleansing purposes must be free from feces and other contaminants.
- Animals or animal feces must not come into contact with the processed fruits.

## Packaging and Storage

### Packaging Types and Material

In order to be exported to Europe, the jams are usually filled into consumer-size jars with twist-off lids.

### Details Given on Packaging

The label on the jar must display the following:

- Product name ('Trade name')
  The name of the product, consisting of: Name of the fruit with or without the extra description – according to fruit content; e.g.: Banana jam extra, organically grown[22]
- Manufacturer
  Name and address of the manufacturer, importer, exporter or product trader, plus country of origin.
- List of contents
  A list of ingredients and additives in the jam, beginning with the heaviest proportion of total weight at the time of packaging
- Details of the total sugar content
  Total sugar content per 100 g product (measured refract metrically at 20 °C) must be represented with the words "Total sugar content ....g per 100 g".
  e.g.: Total sugar content 55 g per 100 g.
- Details of fruit content
  The fruit content per 100 g product must be given with the words "manufactured from....g fruit per 100 g".
  e.g.: manufactured from 45 g fruit per 100 g.
- Notice about cooling
  The notice about storing the product in a cool place must be given with the words:
  "After opening, store in a cool place".
- Weight
  Details of the total weight in grams
- Best before date
  The 'Best before ...' details must include day, month and year; e.g.. best before 30.11.2001
- Batch number

[22] Compare footnote No. 5

## 2.11.3. Canned Fruits

### Processing

Canned foods are products that can be stored over a long period in airtight containers (metal or glass jars). They are preserved mainly by heat treatment, during which the micro-organisms present in the fruit are significantly reduced in number, or their development so restricted, that they are prevented from spoiling the product.

CHART: FLOW-CHART FOR THE PREPARATION OF CANNED PRODUCTS FROM FRESH FRUITS

Fruit

Sorting

Washing

Peeling and sorting

Pulping

Filling into jars or cans with syrup

Vacuum sealing

Pasteurizing or sterilizing

Cooling

Labeling and storage

*Sorting*

After harvesting, the fruits are sorted, because only those that are fresh, ripe and not rotten can be used to make jams. Jams can also be made from previously prepared, frozen fruits and pulp.

*Washing*

The fruit should be washed very carefully as it can easily be damaged.

*Peeling and Sorting*

This follows the procedure of removing leaves, wooden pieces, pips or seeds and peel. Peeling is often done manually, or with knives, yet sometimes the skin is loosened with steam and then subsequently rubbed away mechanically. Finally, the fruits are sorted again to remove any blackened pieces, bits of peeling seeds etc.

*Pulping*

The peeled fruit can be cut into a variety of shapes, according to type (indicated by the crosses table 40). The shape of the cut fruit must be given on the can (slices, diced, pieces etc.).

**Table 40: Different Possible Cut Shapes for Different Fruits**

| Description | Cut shape | Pine-apple | Mango | Papaya | Banana |
|---|---|---|---|---|---|
| Whole fruit | Peeled | | | | X |
| Slices | Slices of fruit cut into approximately the same size | X | X | X | X |
| Half slices | Uniformly cut, semi-circle shaped slices. | X | | | |
| Diced | Fruit cut into dice shapes of roughly the same size. | X | X | X | |
| Balls | Fruit pulp pieces cut into roughly ball shapes | | X | | |
| Pieces | Pieces of fruit cut into irregular shapes | X | | | |
| Grated | Irregular thin strips and pieces of fruit | X | | | |
| Chunks | Large regularly cut pieces of pineapple | X | | | |
| Titbits | Trapeze-shaped segments of pineapple | X | | | |

*Filling in Jars or Cans*

The cut pieces are now filled into jars or cans and covered with syrup. Additional information must be given on the can according to the sugar content of the syrup.

**Table 41: Sugar Concentration of the Syrup Used for Canned Fruits**

| Sugar Concentration* of the Syrup | Description on the Can |
|---|---|
| 9-14 % | Very lightly sugared |
| 14-17 % | Lightly sugared |
| 17-20 % | Sugared |
| over 20 % | Strongly sugared |

* The sugar must be organically grown.

If the appropriate fruit juice has been used as syrup then ... "in natural juice" must be included on the label, e.g.: Organically grown bananas in natural juice.

*Vacuum Sealing, Pasteurizing or Sterilizing*

After the jars or cans have been vacuum sealed, they are either pasteurized (temperatures above 80°C) or sterilized (temperatures above 100°C).

*Cooling*

After the heating process, the canned fruits are first cooled to 40°C, and then brought subsequently down to storage temperature.

*Labeling and Storage*

After they have been cooled, the canned fruits are labeled and stored.

## Quality Requirements

In addition to the previously listed quality requirements, such as clearly defined sugar concentrations of the syrup and shapes specific to certain fruits, the contents should also conform to the following characteristics. These quality requirements, with their minimum and maximum values, are generally issued by the authorities or importers. Yet agreements may be reached between individual manufacturers and importers upon different values, providing they still conform to official requirements.

**Table 42: Quality Characteristics with Minimum and Maximum Values for Jam**

| Quality Characteristics | Minimum and Maximum Values |
|---|---|
| Taste and smell | Variety-specific, aromatic, not moldy |
| Cleanliness | Free of foreign substances such as peel, stalks etc. |
| MYCOTOXINS | |
| Aflatoxins B1 | max. 2 µg/kg |
| Total aflatoxines B1, B2, G1, G2 | max. 4 µg/kg |
| Patulin | max. 50 µg/kg |
| RESIDUE | |
| Pesticide | Not measurable |
| Sulphur oxide | Not measurable |
| Bromide | Not measurable |
| Ethylene oxide | Not measurable |

In order to conform to the quality requirements, and to prevent the fruit becoming contaminated, all preparations must be carried out under clean, hygienic and acceptable conditions. The following aspects must be heeded:

- Equipment (tubs, knives etc.), as well as working surfaces (tables etc.) and preparing and storage rooms should be cleaned regularly.
- Personnel should be healthy, be able to wash themselves, or at least their hands (washrooms, toilets) and wear clean, washable garments.
- Water used for cleansing purposes must be free from feces and other contaminants.
- Animals or animal feces must not come into contact with the processed fruits.

## Packaging and Storage

### Packaging Type and Material

For export to Europe, the fruits can be packed into single or wholesale packages (bulk) made of glass, aluminum or tin cans.

### Details Given on Packaging

The label on the jar must display the following:

- Product name ('Trade name')
  The name of the product, consisting of: Name of the fruit with or without the description extra – according to fruit content; e.g.: Mangos in slices, lightly sugared, organically grown[23]
- Manufacturer
  Name and address of the manufacturer, importer, exporter or product trader, plus country of origin.
- List of contents
  A list of ingredients and additives in the jam, beginning with the heaviest proportion of total weight at the time of packaging
- Weight
  Total and dry weight of the fruit

**Table 43: Numbers Describing the Weight of the Contents Must be of the following Sizes**

| 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
- Batch number

[23] 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

## 2.11.4. Fruit Pulp

### Processing

Canned foods are products that can be stored over a long period in airtight containers (metal or glass jars). They are preserved mainly by heat treatment, during which the micro-organisms present in the fruit are significantly reduced in number, or their development so restricted, that they are prevented from spoiling the product.

FLOW-CHART FOR THE PREPARATION OF FRUIT PULP FROM FRESH FRUITS

Fruit

Sorting

Washing

Peeling and sorting

Pulping and straining

De-aeration (partially)

Pasteurizing or sterilizing

Filling

Cooling, labeling and storage

**Manufacturing Fruit Pulp**

In producing pulp, only fresh, ripe fruit should be used that has not yet turned moldy. The skin of fully ripened fruits is entirely yellow, and easy to peel from the fruit. After harvesting, the fruit are first sorted and washed, before being peeled by hand and placed directly in a solution of 4% citric acid and 1% ascorbic acid, to prevent discoloring.

Afterwards, the fruits are placed in a heat exchanger, where they are heated to a temperature of 93° C in order to deactivate any enzymes, and to break down the fruit pulp. The pulp then passes through a two-stage sieve equipped with a 0.8 mm and a 0.5 mm screen. After de-aeration, the pulp is homogenized at a pressure of 100-300 bar and sterilized for 40-45 seconds at 100°C.

The fruit pulp can now be filled into tin cans whilst still hot, whereby the cans are sealed while being steamed, the temperature maintained for 5 min., and then rapidly cooled down. At temperatures of around 15°C, the pulp can be stored for up to 1 year. After pasteurizing, the pulp can also be cooled down and filled into polyethylene bags placed in 50-200 kg barrels. It is then rapidly frozen, and can be stored at -18°C for 18 months. Pulp which has been filled under antiseptic conditions (bag-in-box) can be stored for up to 1 year at room temperature.

Preparation of mangos for further processing. (Picture: Claro AG)

### Quality Requirements

These quality requirements, with their minimum and maximum values, are generally issued by the authorities or importers. Yet agreements may be reached between individual manufacturers and importers upon different values, providing they still conform to official requirements.

**Table 44: Quality Characteristics with Minimum and Maximum Values for Fruit Pulp**

| Quality Requirements | Minimum and Maximum Values |
|---|---|
| Smell and taste | Variety-specific, aromatic |
| Cleanliness | Free of foreign substances such as peel, stalks etc. |
| Relative density (20/20) for pineapple juice | min 1.045 |
| Brix value[24] for pineapple juice | min 11.2 % |
| Relative density (20/20) for Banana pulp | min 1.083 |
| Brix value for Banana pulp | min 20.0 % |
| Relative density (20/20) for Mango pulp | min 1.057 |
| Brix value for Mango pulp | min 14.0 % |
| Ethanol | max 3.0 g/kg |
| Volatile acids, evaluated as acetic acid | max 0.4 g/kg |
| Lactic acid | max 0.5 g/kg |
| D-Malic acid | Not measurable |
| Sulphuric acid | Not measurable |
| Hydroxymethylfurfural (HMF) | max 20 mg/kg |
| HEAVY METALS | |
| Arsenic (As) | max 0.1 mg/kg |
| Lead (Pb) | max 0.2 mg/kg |
| Copper (Cu) | max 5.0 mg/kg |
| Zinc (Zn) | max 5.0 mg/kg |
| Iron (Fe) | max 5.0 mg/kg |
| Tin (Sn) | max 1.0 mg/kg |
| Mercury (Hg) | max 0.01 mg/kg |
| Cadmium (Cd) | max 0.02 mg/kg |
| RESIDUES | |
| Pesticide | Not measurable |
| Sulphur oxide | Not measurable |
| Bromide | Not measurable |
| Ethylene oxide | Not measurable |
| MYCOTOXINS | |
| Aflatoxin B1 | max 2 μg/kg |
| Total aflatoxins B1, B2, G1, G2 | max 4 μg/kg |
| Patulin | max 50 μg/kg |

24 A Brix value is the measure of the concentration of sugars, acids, and other identifying compounds in a juice. Every fruit juice has a slightly different Brix value.

In order to conform to the quality requirements, and to prevent the fruit from becoming contaminated, all preparations must be carried out under clean, hygienic and acceptable conditions. The following aspects must be heeded:

- Equipment (tubs, knives etc.), as well as working surfaces (tables 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 (wash-rooms, toilets) and wear clean, washable over garments.
- Water used for cleansing purposes must be free from faces and other contaminants.
- Animals or animal faces must not come into contact with the processed fruits.

### Packaging and Storage

#### Packaging Type and Material

In order to be exported to Europe, the pulp/juices can be packed into single or wholesale packages (bulk) consisting of glass jars, tin cans or polyethylene or polypropylene bags, and also filled antiseptically into 'bag-in-boxes'.

#### Storage

Pasteurized pineapple juice, as well as pasteurized banana, mango and papaya pulp can be stored as follows:

**Table 45: Storage Conditions and Packing Material for Fruit Pulp**

| Packaging material/ storage temperature | Pineapple-juice | Banana-pulp | Mango-pulp | Papaya-pulp |
|---|---|---|---|---|
| Tin cans/glass jars storage temperature below 15°C | 1 year | 1 year | 1 year | 9-12 months |
| Polyethylene bags/ Deep frozen at -18°C | – | 18 months | 18 months | 12 months |
| Filled antiseptically, bag-in-box/ Room temperature | 1 year | 1 year | 1 year | 6-9 months |

## 2.11.5. Transport Packaging

A form of transport packaging is required to ship the sales packages, the bulk or singly packed fruits. In choosing them, the following aspects should be heeded:

- Transport packaging made, for example, out of card-board, 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 notice of the organic nature of the product[25]

[25] When products from organic plantations are being labelled 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 is applicable to organic products being imported into Europe.

Details given on packaging; The label on the jar must display the following:

- Product name ('Trade name')
- The name of the product, e.g.: Organic banana pulp[26]
- Manufacturer
- Name and address of the manufacturer, importer, exporter or product trader, plus country of origin.
- List of contents
- A list of ingredients and additives, beginning with the heaviest proportion of total weight at the time of packaging, e.g.: bananas, citric acid…
- Weight
- Total weight
- Best before date
  The 'Best before ...' details must include day, month and year; e.g.. best before 30.11.2001
- Batch number

**Table 43: Numbers Describing the Weight of the Contents Must be of the following Sizes**

| 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 |

## Storage

- The dried fruits 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 fruits 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.)
- Color 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.


Processed Fruits

[26] 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

# 3

# Organic Vegetables

In the tropics and subtropics conventional intensive vegetable production is characterized by extremely high input of pesticides and fertilizers. Some of these pesticides, even if they are no longer allowed because of high health risk and environmental damage, are still sold to the producers. Intensive vegetable production in the tropics and subtropics in many cases does not apply wide crop rotations and large regions are specialized only in a few vegetables.

Intensive conventional vegetable production is also characterized for the extensive use of labor. In many countries, whole families are involved in this work; in some cases, even children have to work (e.g. production of tomatoes, chili, aubergines or egg plants etc. in Mexico). Families offering their labor power also migrate across the country.

### What are the Consequences of Intensive Conventional Vegetable Production?

Single-crop production leads to an over-exploitation of the land and increasing pest and disease pressure. Intensive use of pesticides and fertilizers contaminates water, air and soil. After cultivating the same crop year after year on the same land, the insects and diseases become resistant to the common pesticides; therefore, farmers become dependent on costly external inputs, and even then farmers suffer yield depressions due to loss of soil-fertility. This mechanism has caused farmers from an entire region to shift to different crops or give up their production. Furthermore, growers have suffered health problems due to contamination by agro-chemicals.

### What Alternatives Offers Organic Vegetable Production?

Organic vegetable production has gained major importance in many countries, because in vegetables pesticide application is much more “visible” and closer to the final consumer than, for example, cereals or any other agricultural product that receives important post-harvest treatments and further processing. This is the reason why organic vegetables in many countries are the first products demanded by the consumers. Producers, processors and traders recognized this opportunity and started programs of fresh and processed organic vegetables. Today, organic vegetables are the most important items in the organic food assortment. In some European countries, organic vegetables have a market share of more than 20% of total vegetable sales.

In tropical and subtropical countries, national markets for organic vegetables products have been developed very slowly or do not exist at the moment. Therefore, organic vegetable production is still mainly destined for the export. However, in countries like Brazil, Argentina and China, many consumers are more and more interested in healthy food and local retailers are starting to sell organic vegetables.

NGO's, governmental institutions and traders initially started to promote the conventional production of vegetables for self consumption by small farmers in tropical and subtropical areas. This promotion was aimed at resolving the lack of vitamins and minerals in the rural population. Since the 90s, an increasing demand for off-season organic vegetables has led to export programs of organic vegetables from the tropics and subtropics. The sale of organic vegetable products has offered farmers additional income and higher prices. Currently, the producer prices for organic vegetables are 10 to 100% higher compared to prices for conventional vegetables. However, it is important to recall that for organic vegetables in particular, additional labor, often hand-work, is required. This considerably increases production costs.

Nowadays, many small farmer organizations commercialize their surplus of organic products in the national and particularly on the export markets. Step by step, large farmers in the tropics and subtropics have also started to produce organic vegetables in order to provide fresh and processed organic vegetables to the export markets.

## General Aspects of Organic Vegetable Production in the Tropics and Subtropics

Organic vegetable production in the tropics and subtropics requires flexibility and the application of new technologies from the producers. In addition to the general challenges related to vegetable production, farmers in tropical and subtropical regions are confronted with the following production constrains:

- Poor soils with low content of organic matter;
- Climatic stress (floods, cyclones, drought);
- Lack of locally adapted production technologies and slow technology transfer;
- Lack of locally adapted varieties and good quality of seeds;
- Fast development of pest and disease infestations;
- High post harvest losses;
- Lack of adequate logistic and marketing facilities;

Organic agriculture is a great alternative for vegetable growers in the tropics and subtropics. However, organic vegetable production is differentiated from conventional vegetable production through a higher production risk, possible lower yields, introduction of new management strategies and higher labor cost. The following aspects have to be considered before starting organic vegetable production:

**a) Seed and Seedlings**

Whether seeds or seedlings are bought or produced by the grower, organic seed/seedlings must be of high quality because poor quality material (infested seed and plants with disease, weak growing plants, etc.) in the initial stages of organic production reduces the success of the whole operation. The seed and seedlings must be from organic origins. If there is no seed of organic quality, producers may use conventional seeds, but only if they are not treated with fungicides or insecticides. In this case, the farmer has to prove that in his region no organic seed and plant material is available. Furthermore, the conventional seed and all plant material should not be of genetically modified origin.

If the producer decides to produce its own seeds/seedlings, he first has to select the healthiest plants and vegetable fruit. From fruit vegetables and seed vegetables early plants must be selected, and from leaf vegetables late plants. Leaf vegetables are plants that produce many leaves before flowering.

1. Fruit vegetables (legumes, maize, zucchini, and most leaf vegetables) should be harvest when fully ripened. The pods or ears can be dried directly in the sun. The seeds have to removed by hand or by threshing.
2. Vegetables with fruits not rich in water (chili, melon, eggplant etc.) should be harvested when the fruits are very ripe. Cut the fruit in half, wash the seeds in water and then put them in the sun to dry.
3. Vegetables with fruits rich in water (tomato, cucumber) should be treated as follows: the mashed fruits should

put in a pot or container with water for a few hours. The pulp will float to the top and the seed will sink to the bottom. The seeds must be put in the sun to dry.

It is important that seed be well dried for storage in a cool, dark and dry place.

For the own growth of seeds it is recommendable to use own substrate material (compost and soil mixture). This measure avoids the introduction of contaminated material into the farm (e.g. pesticides residues, diseases, pest and weeds). The compost covers the need of nutrients as potassium, phosphorus, magnesia, calcium and trace elements. For vegetables with a long seedling period or high nitrogen demand (as celery, leek, cauliflower, broccoli) organic nitrogen fertilization with e.g. corn powder, liquid manure or vinasse is needed.

**b) Organic Vegetable Production Systems**

In the tropics and subtropics, different vegetable cropping systems with different needs of nutrients and diverse soil-plant-relationships are applied. Some examples are the following:

- Crop rotation system;
- Intercropping system;
- Agroforestry system.

**The crop rotation** system includes different crops that are grown at the same time but on different plots (planed sequences of crops for each season). In a rotational cropping system, the incorporation of different crops is possible (legumes crops; groundnuts, grassland or legumes cover crops; as Crotolaria) for improving soil fertility, accumulating nitrogen, reducing weeds, pest and diseases. An example of a crop rotation in the tropics: crotolaria, sorghum, groundnuts, vegetables, maize interplanted with cowpeas. The overall goal of this crop rotation is to build up soil.

Objectives of crop rotations in organic vegetable production:

1. Maintain and enhance soil fertility and structure through use of different soil zones by different plant roots;
2. Import of nutrients through green manuering;
3. Set up a logical sequence of crops: 1. green manure; 2. heavy feeders; 3. medium feeders; 4. low feeders;
4. 3-5 year breaks between two crops in order to prevent pests and diseases.

**Intercropping system** involves growing different crops on the same piece of land at the same time. The intercropping systems allows a more efficient use of the agroecological system: crops use the water, light and soil nutrients at different levels under and above the ground. Furthermore, the diversity of crops reduces the risk of a mass infection by pests or diseases. A typical example in the subtropics is the intercropping of maize, beans and zucchini. Important is the combination of varieties that fit together and occupy different ecological niches.

*Agroforestry system*

Vegetables in agroforestry systems are mixed mostly with fruit trees, leguminous trees, banana, palm trees, and other species covering the soil. The agroforestry systems may reach a high degree of diversity where there are fewer risks of pest and diseases, However, these systems need continuous organic productions in order to maintain the productivity at acceptable levels. An example of agroforestry in the tropics is the combination of palm trees, papaya, bananas and vegetables.

**c) Organic Plant Nutrition and Fertilization**

In conventional intensive vegetable production, mineral fertilizers have been the most commonly used source to supply nutrients to the crops. Fertilizers are applied in granular or/and liquid form (fertigation). The efficient use of the farm nutrients sources has an important role in organic vegetable production. The interaction of soil, climate, plants, nutrients and farmer is a complex relationship that must be understood by the producer in order to implement the ideal organic fertilizer strategies. It starts with the establishment of a locally adapted production system.

The organic fertilization in the tropics has to be adapted to the cropping system that is used and depends on the growing conditions and cropping combinations. The following sources of nutrients are at the organic vegetable grower's disposal:

- Cover crop (green manure) with leguminous;
- Mulching (plant residues etc.);
- Animal manure (dung and slurry);
- Compost;
- Commercial organic fertilizers.

*Cover crops*

Besides the beneficial proprieties of a cover crop (competition to weeds, reduce soil erosion, avoid the nutrient loss, improve the natural crop protection, build active soils, supply nutrients to the following crop, etc.), it is important to take into account the good establishment of said crop in order to improve the positive effects of using it in the crop rotation. Successfully establishing green manures in organic vegetable production requires:

- Sufficient water supply;
- High seed density;
- Good soil structure;
- Avoid exhausted soils or improve nutrient content by adding manure or compost;
- Use native leguminous cover plants; together with local inoculants (Rhizobium).

The advantage of a leguminous cover crop is the nitrogen fixation, which can be available to the following main crop. There are the following leguminous cover crops that can be applied in the tropics and subtropics: alfalfa (*Medicago sativa*), desmodium (*Desmodium intortum* (Mill). Urb), indigofera (*Indigofera tinctoria*), soybeans (*Glycine max* (L.) Merr), broad beans (*Vicia fava* var. major), hairy vetch (*Vicia ssp*) etc. In addition to leguminous crops, other crops may be used as cover plants, for example sunflower: it has a deep root system and helps to improve the aeration of the soil. Cover crops should also be selected according to the following crop. For example, hary vetch or *Vicia fava* or crottolaria can be used as cover crop before planting tomatoes; in the case of asparagus, a cover crop (e.g. *Vicia fava*) can be planted directly in the crop and during the shoot development of green asparagus. The cover crop can be mulched in order to mobilize the nutrients bound in the organic matter.

*Mulching and using crop residues*

The crop residues are also an important source of nutrients for the following vegetable crop. One possibility to obtain a faster residue effect is to chop up the residues and incorporate them superficially 15 cm into the soil. About 80% of the bound nitrogen in the organic material of the crop residues can be mineralized within 6 to 8 weeks after soil incorporation. Crop residues contain 40 to 100 kg nitrogen per ha, according to the green mass remaining on the field. Generally, young plant material brings a lot of nitrogen into the soil; older material binds soil nitrogen.

*Animal manure*

The animal manure it is an important source of organic matter for the soil and nutrients for the crops. Adequate management of the manure is essential in order to obtain good quality organic fertilizer and to avoid nutrient losses. In the tropics and subtropics, the environmental conditions can cause problems if the manure is not stored correctly. High precipitation can wash out essential nutrients and direct sun and high temperatures volatilize the N of the organic matter – covering the manure with leaves is therefore a must.

The following animal manure can be use in organic vegetable production:

- **Liquid Manure** (slurry): liquid cattle manure; offers good quantities of nitrogen, phosphorous and particularly potassium. It is optimal to apply in vegetable production. Liquid pork manure; it is ideal for soil with poor phosphor content. Both can be used after the incorporation of a cover crop into the soil in order to avoid the nitrogen fixation during the decomposition of the organic matter. In using liquid manures on vegetables, it is important to respect the minimal hygienic requirements of not contaminating the crop with slurry. In leaf vegetables (spinach, lettuce, etc.), liquid manure can only be applied before planting or sowing. The effect of the liquid manure to the crops is generally quick. Liquid manure can be applied directly to vegetables crops that remain for longer periods in the field. However, for crops such as carrots and onions, it is not suitable. Depending on the type of liquid manure, it has to be diluted with water (for example 1 part slurry: 1 part water). Do not apply slurry during sunshine.

- **Dung:** cattle dung; the principal effect is the incorporation of organic matter, cattle dung is relatively low in nitrogen content and high in potassium. Poultry dung; it has a high content of P for the requirements of the vegetable crops but too low in potassium content per unit of nitrogen. Should the applications of dung (cattle or poultry) not cover the supply of nitrogen, liquid manure or other commercial organic fertilizers must be applied. The mineralization of dung is quite slow, therefore, it is applied as a source of phosphor and potassium. When dung is applied to vegetables, it is preferable to apply it directly to the field before sowing or planting. For root vegetable as carrots, only very good decomposed dung should be applied.

*Compost*

The compost can be applied as base fertilizer for organic vegetables. The applied quantity of compost should not pass the limit of phosphor requirement for the following three years. About 50 tons per ha of compost may improve the soil activity and enhance the mobilization of the soil nutrients from the reserve of the soil. The amount of compost necessary for vegetables is about 20 to 25 $m^3$ (details referring to compost production: see chapter 1.2).

*Commercial fertilizers*

Commercial fertilizer can be used if all other strategies do not work due to special soil conditions (phosphor fixation in high aluminum content soils, high deficiencies of macronutrients as potassium or micronutrients as Fe) or a lack of available organic material or the farm during the conversion period. It is important that before starting with the conversion to organic production, that care and planning be based on the constraints on plant nutrition that could appear during the planning period and when reaching a more stable soil system (close nutrient cycle). For example, if the compost does not solve the problem, applications of rock phosphate can help to reduce such deficiencies. If potassium shows some deficiencies in a soil test, materials with high K-content should be used in compost production (e.g. wood-ashes, potassium sulphate or stone powder). However, commercial organic fertilizers are of additional help only when used in limited quantities. (organic standards). For fertilizers rich in nitrogen, please check local availability of organic wastes like hornmeal.

**d) Weed Management**

Weed regulation is an important issue in organic vegetable production. The application of preventive and direct measures has great influence in the manual work and the economic results of the whole operation. Therefore, all preventive and direct measures have to be carefully planned and coordinated in order to reduce manual labor to the maximum. With specific implementation of preventive measures, the weed pressure and the damage to the vegetable crop can be limited:

*Direct measures*

In organic vegetable production, the use of any chemical herbicide applications is not allowed. As an alternative, organic producers rely on mechanical and thermal methods. Mechanical weed regulation is closely related to soil tillage and soil management (see above). Weed management, improvement of soil fertility and plant nutrition are planned together in organic vegetable production.

**Table 47: Preventive measures for weed regulation**

| Measure | Observation |
|---|---|
| Locally adapted crops; | Select appropriate varieties for the local conditions; for example, strong growing varieties for high rainy areas or drought resistant varieties for areas with dry periods; |
| Competitive varieties | Must select the most competitive varieties that have a faster seedling development and good soil cover, meaning those with wide and dense leaf structure; |
| Use crop rotations; | The weed pressure in a parcel depends on the climatic conditions, the weed seed reserve in the soil and the crop rotation. Therefore, crop rotation and production methods can be applied to regulate weeds. Incorporation of a faster, strong growing green manure plant (*Cajanus cajan and Canavalis ssp*); |
| Select the vegetable crop according the weed pressure on the parcel; | Annual crops and perennial crops when possible in parcels with low levels of weed pressure; |
| Ideal preparation for the seed/planting bed (row, etc.); | Implement measures to control weeds before the crop is planted. E.g. letting the weeds grow and regulating them before planting, if necessary several times (=false seed bed). In arid regions: if necessary and possible, irrigate weeds in order to make then grow before seeding/planting vegetables; |
| Plant instead of sowing; | Seedlings have more field advantages than a direct seeding because the plants have already passed different development stages and can compete faster than non germinated weeds; |
| Use strong young plants; | Young plants with a good development and high quality are more competitive to weeds; |
| Balanced plant fertilization; | Only a good supply of plant nutrients allows for a vigorous growing. Fertilization on the plant line improves the growth of the vegetable crop but not that of the weeds; |
| Avoid the disseminations of weeds; | A well directed fermentation (enough moisture, ideal turning frequencies) of the compost produces heat to enable seeds and vegetative weed plant material to decompose; |
| Avoid seed formation of weeds; | Weeds with seeds: remove as soon as possible from the fields and compost them; |
| Reach during the entire cropping period a high cover of the soil; | Keeping the soil cover with adequate underseeding, for example, a non climbing, dwarf, and dense cover plant (white clover). Covering the soil with mulch systems; for example mulch produce from a preceding crop, or during the mowing of the underseeding plant and physical mulches of plastic and new paper. |

In organic vegetable production, it is important to have a weed free period according to the developmental need stages of the crop. This does not mean the complete eradication of weeds during the cropping period, but rather having a period free of weeds during the sensible earlier stages of the crop. After this stage, some weeds can be left to grow again in order to protect the soil (soil erosion), absorbing soil nutrients and enhancing the beneficial organism (insects, spiders etc.). However, it is important to avoid that the weeds produce seeds for further propagation. Weed management has to be adapted to the local conditions (precipitation, competition etc.), the species of weeds and the crop.

Different strategies may be implemented depending mainly on the vegetable crop, variety, soil type, kind of equipment or equipment combination (expanding harrow, spring harrow, orbital harrow, finger hoe, star hoe etc.). Mechanical weeding is possible if the adequate machinery already exists on the farm. In the case that no infrastructure is available, manual weeding is an alternative but may increase labor cost considerably. Thermal weed regulation (flame weeder) might be an alternative. However, high costs and external energy inputs limit the implementation of this method in the tropics and subtropics. Generally, weed and soil management requires considerable changes in the farm infrastructure and organization and therefore needs to be carefully prepared and planned before starting a conversion.

**e) Pest and Disease Management**

*Prevention measures*

Pest and disease management is in many cases a big challenge for organic vegetable producers in the tropics and subtropics. However, if preventive and direct measures are combined in an optimal way, the risk of an infection by pests and diseases can be reduced to a level that does not cause economically harmful yield reductions.

The aim of organic vegetable production is the application of, to the greatest extent, preventive measures geared towards maintaining and improving the health of the plant. Today, a great number of factors and possibilities are known that directly or indirectly influence the natural power resistance of the plants.

In poorly aerated soil, the biological activity, the root growth and the nutrient uptake is reduced. The resistant power of the plants will be weak. Therefore, it is important to utilize soil preparation gently, avoiding soil compacting with heavy machinery when the soil is too wet. Wide and diverse crop rotations diminish the problem with soil diseases and pests (e.g. fusarium, sclerotinia, nematodes, etc.). A wide distance between the plant set may avoid the rapid dissemination of insect pests. Against some diseases and pests, the selection of resistant varieties is one of the best prevention strategies that can be applied to protect vegetable crops. An equilibrated nutrient supply to the plants and regular irrigation offer vegetables optimal development possibilities. An excessive nutrient supply can affect the health of plants adversely. High contents of nitrogen foster infection through fungi and infestations of different insects. The organic production of vegetables in green houses must be carried out under ideal temperature conditions; good management of the irrigation and the air humidity is necessary in order to avoid the development of diseases. In addition to these strategies, there are many measures that can be used. For example, the improvement of beneficial organisms in the field through the incorporation of ecological compensation areas, semi-natural habitats and intercropping methods.

Including special crops in the rotation like Tagetes helps to control nematodes efficiently. Because almost all foliar diseases (with exception of powdery mildew) need wet leafs to infect a plant, the organic grower must keep his crop dry:

5. Irrigate in the morning;
6. Use drip irrigation were appropriate (tomatoes, cucumbers, eggplant and melon);
7. Wide plant distance.

*Direct plant protection in organic vegetable production*

Organic vegetable growers combine a number of direct management methods, such as:

- biological control (release of natural predators, entomopathogenous fungi, and antagonists);
- mechanical methods, such as protective nets;
- natural based fungicides, such as sulphur, copper, oils and plant extracts.

All these methods are generally less effective compared to chemical pesticides; therefore a combination of preventive and direct measures is most successful in organic vegetable production. Please check with your local organic certifier whether a specific organic insecticide or fungicide is allowed; neem, for example, is not allowed under all standards.

*Diseases*

Almost all substances allowed in organic vegetable production have a preventive effect; therefore, at the first symptoms of diseases, they should be applied. For this reason, regular monitoring is very important. Young plants and diverse vegetables crops are also sensitive to some substances. It is important to note that copper and sulphur at higher concentrations can cause injures to the plants. The following products are available for the direct control of diseases in organic vegetable crops:

1. Products that can improve the natural resistance of the plant (plant extracts, stone powder, etc).
2. Substances with fungicidal effect (e.g. plant oils, copper and sulphur).

*Pests*

The direct pest management methods are applied and based only on the monitoring of traps and on an excess of possible damage limits. The risk of damage by insects can be calculated on aregular basis through visual monitoring. Traps are used to control the dissemination and infestation pressure from the different pests. The following types of products and measures are available for the direct control of pest insects in organic vegetable crops:

1. Products that can improve the natural resistance of the plant (plants extracts, rock powder, etc).
2. Mechanical and bio-control measures (crop protections nets, bacterial substances etc.)
3. Beneficial insects in green houses (wasps).
4. Preparations with insecticides effects (e.g. soap, plant extracts).

Banana in intercropping with beans.

## 3.1. Beans

Beans (*Phaseolus vulgaris*) are originally from the central and South America. Through the increment of processing vegetable, beans obtain their importance as fresh vegetable world wide. The category *Phaseolus L.* comprises more than 200 species however, the most commercially used are the *P. vulgaris L. ssp. vulgaris var. nanus* (bush bean) and *P. vulgaris L. ssp. vulgaris var. vulgaris* (runner beans).

There are different colors (yellow, blue, violet and green) and sizes (5 to 25 cm) of pods. Also, there are different seed colors; white, light brown, brown and white-red. Beans have a weak main root with many secondary roots. On the lateral roots, the root-tubers are formed with the nitrogen fixing bacteria *Rhyzobium leguminosarum,* which lives in symbiosis with the bean plant.

### 3.1.1. Ecological Requirements

**Soil**

Beans can growth in many different soils; however, the less ideal soils for beans are those with high content of sand or clay and with very low pH. The optimal pH lies between 6 and 7.5.

**Temperature Requirements**

Beans require soil temperatures of at least 8-10 °C for germination and at least 12°C air temperature. Furthermore, strong winds can damage leaves and flowers resulting with yield reduction.

### 3.1.2. Planting Systems and Soil Management

**Suitable Cultivars**

The amount of varieties of beans (both, bush and runner beans) is very diverse. A selection of the beans can be carried out according to the end purpose. (green and yellow for the fresh market and processing industry.) The selections of the varieties can be classified from the development period (to plan for the processing industry), pod size, type of production and resistance to diseases. Varieties for the processing industry should be specially selected for the harvest with machines, considering resistance and the ability of said varieties to ripen homogeneously while demonstrating good sensorial characteristics and global characteristics of consistency and flavor.

Bean plant *(P. Vulgaris)*

## Propagation and Field Preparation

Organic beans are propagated by seeds sown directly into the fields.

The seed bed should be middle fine, and demonstrate few crop residues on the soil surface. A good seed bed is an important condition for an homogeneous emergence that improves after the mechanical weed control.

## Design of Plantation

In organic systems in the tropics and subtropics, beans can be found in two different cropping systems, the rotational cropping and intercropping system. Depending on the cropping system, there are different cultural practices:

## Organic Beans under Rotational Cropping System

### Plant Density

There is a close relationship between the plant density and yield. In the tropics and subtropics, there is a high variation of plant density, distance between the rows etc. depending on the tools and machinery that are available in each region. Generally, beans will be seeded with 40-50 cm distance of row and 4-5 cm depth. Depending of the end use, variety and local conditions, optimal plant density is 25 to 50 plants per $m^2$. Beans for the processing industry may be sown between 30 to 40 plants per $m^2$ for the fresh market and those harvested by hand several times may be sown with 25 to 32 plants per $m^2$.

The start of the crop is important for the success of bean production. Beans need the best possible seeding and emergence conditions. Seeding by wet soils, for example, can cause the growth of beans to completely fail.

### Crop Rotation

The productions of beans should have an interval period of 3 to 4 years if they are grown by themselves. Cereals as oat, wheat and maize, are convenience preceding crops for beans. However, crop harvesting with heavy machines must be avoided, especially during soil wet conditions. Crops that are not convenient for beans are potatoes, and cruciferae.

Beans leave light – available nitrogen in the soil. Therefore, it is important to seed a cover crop (grass mixture) or a crop after the harvest in order to fix the nitrogen in the vegetative parts of the plants (especially in high rainy areas). It is also recommendable to use minimum tillage to avoid high mineralization of the organic matter. As following crops, species with a high nitrogen demand such as lettuce, fennel, broccoli, spinach or cauliflower are recommendable. Cereals and arable crops can be also used as following crops to beans.

**Fertilization**

A general nutrient requirements for beans is 30 kg of nitrogen per ha, 20 kg of phosphor per ha and 70 kg of potassium per ha.

In normal active and organically managed soils, the requirements of the beans may be covered without additional organic fertilizers, especially if green manure (grass mixture) was incorporated before bean seeding. If the soils have low nutrient content, compost or animal manure (up to 15 t/ha) should be applied 2 weeks before seeding. It is important to avoid utilizing too much organic fertilizer (animal manure, compost etc.), as a high supply of nutrients makes beans more susceptible to disease.

**Organic Beans under Intercropping System**

One of the most traditional methods to grow beans (runner beans) in an intercropping system is the maize-beans-zucchini cropping method. However, in this traditional system, crop rotation is not implemented and generally a repetition of the intercropping is carried out year after year. However, in some regions a one year fallow is utilized. One of the bases of organic agriculture is balanced crop rotation. Therefore, adequate crop rotation has to be planned. For example; Maize-beans-zucchini // vegetables // leguminous as crop // cereals // green manure.

Maize and beans are mostly sown together during the main rainy period. Because in a maize-beans-zucchini intercropping the harvest of the product occurs separately and the agricultural implementations are carried out with animals, the row distance is of about 80 cm for beans. The plant density may be of 50 plants of maize per $m^2$, and 30 plants per $m^2$. Zucchini is mostly planted by distributing some seeds over the entire field according the needs of the farmer. It is important to mention that sowing is done manually, and the depositions of the seed into the soil occurs in the following traditional way: 3 seeds of maize and two of beans are seeded in every 50 cm hole. After emergence, one maize plant is removed from the each hole, and one or two bean plants are left. The fertilization in the maize-beans-intercropping can be directed from the maize plant requirements. However, little experience with organic fertilizers exists. A possible recommendation for such intercropping systems can be the following: a base organic fertilization some weeks before sowing with 15 tons of cattle dung and applications of compost to the maize plants in the following maize stages: between 4 to 6 leaf stage of the maize, a hand full of compost; at the beginning of silk emergence of maize and at full flowering, also a hand full compost. One possible improvement of this method is using bush beans and planting the maize from beans separately, but in the same line.

**Irrigation**

In areas with warm and dry periods, it is recommendable to irrigate the beans during and after the flowering.

Different types of beans: Vicia faba, Phaseolus vulgaris, Vigna angularis.

## 3.1.3 Pest and Disease Management

### Diseases

Through appropriate crop management, especially crop rotation and organic fertilizations, diseases are generally not a problem. However, a number of diseases can appear:

**Table 48:**
**Disease of Beans and organic control Managment**

| Disease | Important to Know | Preventive Measures | Direct Measures |
|---|---|---|---|
| Halo blight (*Pseudomonas syringae pv. phaseolicola*) | It is one of the most important bacterial bean diseases. Wet and warm periods increase the infestation possibilities. This disease is propagated mostly by the infected seed. | Use of healthy seeds and resistant varieties. The first infection herd must be removed from the field. | In the case of a high potential for infection, it is feasible to spray low dosages of cupper (be care full, leaves can be burn). |
| Antracnose (*Colletotrichum lindemuthianum*) | This fungi cause one of the most important mycosis infections. Cool and wet temperatures foster the propagation of the fungi. | Preventive measures: use of healthy seeds and resistant varieties. Apply in four year intervals in the crop rotation as the disease appears. | |
| Sclerotina and Botrytis | | Avoid wet soils, high plant densities, and over fertilization with nitrogen. If there is a problem with Sclerotina, a three year interval with cereals and Liliaceae must be implemented. | |
| Mosaic virus | This virus causes changes in the bean leaves with mosaic forms, eventually, the infected part of the plant dies. This can cause high yield losses. The dissemination of the virus is via aphids, mechanically, and through the seed. | tolerant varieties, virus free seeds, living barriers such as maize and oat to reduce the dissemination of aphids. | |

### Pest Management for Beans

**Table 49:**
**Pests of Beans and Organic Control Managment**

| Pests | Important to know | Preventive measures | Direct measures |
|---|---|---|---|
| Black Aphids (*Aphis fabae*) | | Due to dangers psed by infestation, field monitoring must be carried out and remove the infestations nest from the crop. Natural enemies must be promoted by leaving a high diversity of vegetation at the edges of the fields. Direct measures: eventually an application with lube soap, or pyrethrum and rotenone. | |
| Bean fly (*Phorbia platura*, syn. *Delia platura* and *D. florigale*) | | Do Not use the following crops as preceding crop; namely, cruciferae, spinach and potatoes. No applications of fresh cattle manure to the crops. | Until now do not exit a direct control. |

### 3.1.4 Weed Management

Adequate weed regulation is an important base upon which to build good yields. Early and extended weed competition during bean development can dramatically reduce the pod yield, while late competition with a middle weed density may influence the yield. Therefore, it is important to have a weed free period, between the first 4 to 6 weeks.

A Pre-weed regulation before bean sowing of can save much work during the growing season. Pre-weed regulations consist on tillage the soil (minimum tillage or plough) just before the sowing of the following crop. Weeds that have emerged are then incorporated into the soil. Therefore, it is important to wait at least two weeks after the cover crop for the seedbed preparation.

Fields of beans in Peru.

Weeds on crop beans can be blind controlled between the seeding and the emergence stage, with a light pressure on the soil of a comb-harrow. The comb-harrow work can only be successful until the 2nd and 3rd leaf stage of the weeds; therefore, such implements must be employed as early as possible.

One or two passes with the comb-harrow by the first 5 to 6 weeks of bean development can regulate weeds. The advantage of the comb-harrow is that it covers the surface widely.

In the case that the comb-harrow can not be used, because of wet soils or possible damage to the bean plants, a hoeing implement can be applied. The hoe weeding implement can control larger weeds, and generally two or three passes are more than sufficient. Weeds that are between the plants can be controlled manually.

Weeds that can produce seeds during the bean cropping period can affect the harvest through to seed weed contamination, e.g. amaranth.

### 3.1.5 Harvesting and Post Harvest Handling

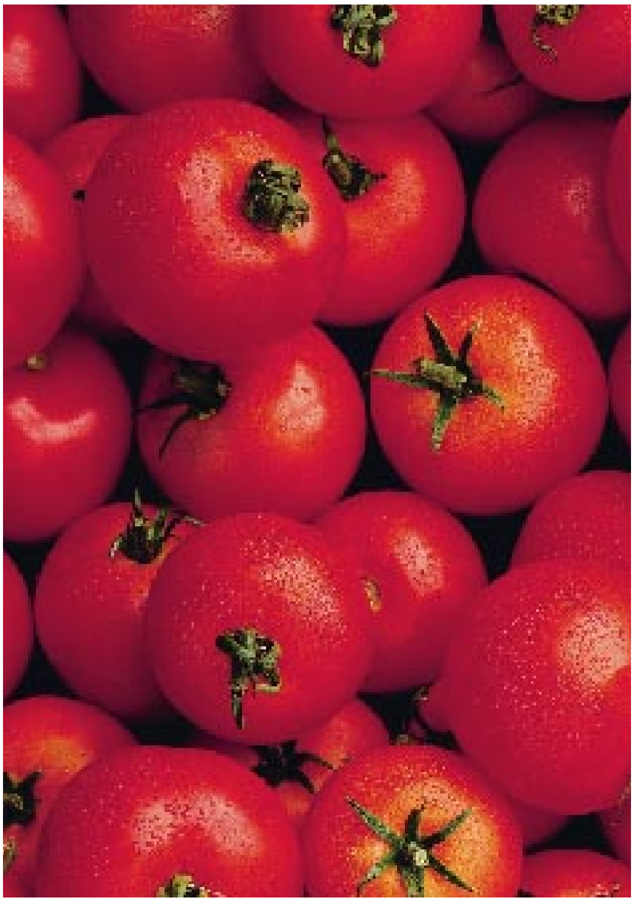
The harvest period can be determined through the dry matter content of the pod. (at the beginning of the harvest, 7-8%, and by the end 9-10%. As a rule the brake method can also be used, which consists in breaking the pods (cracks when is broken); the broken points should be green and juicy, and the seeds (depend the variety) no longer than 8-10 mm.

For the fresh market, the pods can be washed and assorted. Beans can be packaged in bags or cartons and stored at 5 to 7 °C, maintaining a shelf life of 6 to 10 days. The pods should be ties inside of the bag.

## 3.2 Tomato

The tomato is one of the most popular vegetables in conventional and in organic agriculture. It is important for the fresh market and for processing, and is produced all over the world. Efficient harvesting, handling, and marketing techniques are especially important in the production of organic tomato, as it is a highly perishable crop.

Tomatoes (*Lycopersicon esculentum Mill.*) belong to the Solanaceae family and are related to egg plants, paprika, and potatoes. There are different forms and colors of tomatoes: small, medium size and long. The colors vary from red to yellow and orange to green.



### 3.2.1. Ecological Requirements

Tomatoes are found in wild form in the tropical Andes. All similar climates and soil conditions are favorable to tomatoes. However, tomato grows on a wide range of climates and soil.

**Soil**

Tomatoes do not have high requirements regarding the soil type where they will be grown. However, heavy soils and high clay soils can favor the development of diseases. Loamy sandy soils with a good depth of drainage and a high content of nutrients are ideal for tomato production. Tomatoes grow well in alkaline soils, but the tomatoes prefer neutral to light acid soils (pH 5.5 to 7). Tomatoes build an extensive root system that can reach very deep zones in the soil. Tomatoes are adventitious and propagate in large quantities; the rooting of the soil on the first top layers is strong, therefore care should be taken in weeding with a hoe.

**Temperature**

Tomatoes like warm temperatures and plenty of sunlight. They are sensitive to low temperatures and highly sensitive to frost. Therefore, production areas and types of green houses have to be selected carefully.

**Table 50:**
**Optimal Temperature Requirements for Tomatoes**

| Development stage | Day temperature °C | Night temperature °C |
|---|---|---|
| Germination (W1) | 23-25 | 23-25 |
| Until to transplant (W2-W3) | 20-22 | 18-20 |
| Seedling (W2-W8) | 18-20 | 16-18 |
| Planting (W8-W10) | 20 | 16-18 |
| Final transplanting | 18-20 | |

By temperatures over 32°C and under 15°C the tomato-fruits do not grow uniformly. Tomatoes are self-pollinizers. For good fecundation, tomatoes require a relative humidity level of 60 to 80%, and a temperature around 23°C. At temperature less than 13°C or more than 27°C, fecundation is poor.

## 3.2.2 Organic Tomato Production Systems

### Suitable varieties

Most traders, retailers and supermarkets actually prefer specially firm durable varieties in order to minimize losses due to all the handling along the logistic chain from the field to the shop. Traditional types of tomatoes have a durability of approximately of one week; there are new varieties for which traditional breeding (semi-longlife or longlife) and genetic engineering ("flavor savor") have increased durability be four weeks. In organic agriculture, genetically manipulated tomatoes are not allowed. For organic growers, disease-resistance or tolerance is in many cases more important than other factors, such as durability. For example, "Peretti" tomatoes are more susceptible to flowering rotten than round tomatoes. Furthermore, local markets decide which varieties are in demand. Market demands, disease resistance, suitability to cropping systems and life storage period are factors that influence the selection of varieties in organic tomato production.

Two different growth forms of tomatoes can be found: plants with determinate growth (bush) and tomatoes with an indeterminate growth (vining). Tomatoes with determinate growth are still found in bush tomatoes and in the early varieties used for short period growing.

Support system for tomatoes.

### Propagation and Nursery Management

Tomatoes can be sown directly in wooding cartons or special seeding trays. Tomatoes seeded in wooding cartons must be transplanted into pots or special trays after two weeks (at least after the first real leaf appears). Those seeded in special trays can be left to grow (depending of the size of the individual pot), until they are ready for transplanting in the fields or into bigger pots.

If direct seeding in big pots is carried out, some extra seeds have to be sown to replace not germinated seeds. The ideal time for transplanting in the field is the beginning of flowering in the first grape. It is important that seedlings are maintained under ideal conditions in order to obtain strong and young plants.

Young plants of tomatoes require a balanced nutrient supply. The growing medium for seedling during germination time has to be low in salt content. A substrate with peat, lime and some inert part (like perlite or pumice) fulfilled this requirement. After transplanting, the mixture can contain up to 50% peat, 30 % high quality compost and 20% light soil. The use of 20-50% coir is also possible, but the salt content has to be low (coconuts not "stored" in the sea).

### Design of the Rotation

Organic tomatoes are planted in a rotational system. Continuous production of tomatoes can be changed in the same year by producing lettuce, cucumber, leek, cauliflower, paprika or incorporating a cover crop. For farmers that dispose of only small vegetable plots, long rotations may be impractical. In such cases, soil building practices (green manure, compost) that improve soil microflora are important to promote natural disease suppressing conditions. Pastures and small grain crops that are grown in rotations to increase soil structure and organic matter should be ploughed down several months in advance of planting (problems of cutworm and wireworm).

Organic growers have had very good experiences with planting leguminous cover crops before the tomatoes, e.g. hairy vetch (*Vicia villosa*) and fields beans (*Vicia faba*).

Tomatoes are planted in the field when the first flowers open. Different plant densities are used; for strong growing varieties, a plant density of 2-2.2 plants per $m^2$, for slow growing varieties, plant to a density of 2.7-3 plants per $m^2$. Organic growers prefer a lower density in order to guarantee good ventilation and reduce disease infections.

**Table 51: Mulch Management for Tomatoes**

| Type | support system | Mulch | Distance in the row | Distance between the rows |
|---|---|---|---|---|
| Bush tomatoes | unsupported | No mulch / plastic or organic mulch | 0.4 – 0.5 m | 0.6 – 0.8 m |
| Stick tomatoes | supported | No mulch / organic mulch | 0.3 – 0.4 m | 0.8 – 1 m |
| Greenhouse | cord | plastic or organic mulch | 0.4 m | Double rows: 0.8 and 1.2 m |

There are different training systems used in tomato culture. These can be unsupported on bare ground; unsupported on plastic or organic mulch and supported (staked) by wire cages, stake and weave, or trellises, either on bare ground or plastic mulch. The two systems in widespread commercial use are: stake and weave, and cage culture. Each training system requires its specific management methods on the field. By the end of the crop, the plant can be pruned on its top in order to avoid fruit cracking.

## 3.2.3 Soil Nutrition and Organic Fertilization

### Fertilization

Organic fertilization decisions are influenced by different factors, such as soil and climate, crop rotation, manure sources, availability of compost turners, manure spreaders, fertilizer drills and availability of commercial organic fertilizer. Beans need the following nutrients per ha and year with a yield of 10-12 kg per $m^2$: 170 kg nitrogen, 80 kg of phosphorous, 340 kg of potassium and 60 kg of magnesium. Enough phosphorus and potassium are available for tomatoes in most soils. Soils managed organically for several years may allow acceptable tomato-yields based on green manure with legumes and compost applications. However, in most cases, organic growers also apply nitrogen to the soil in the form of compost, manure and other organic nitrogen sources.

At the beginning of tomato development, nutrient needs are relatively small and increase with flowering and fruit setting. An average application before planting of 30 t/ha compost, based on animal manure and plant materials, covers the needs of the main nutrients for organic tomato production. The organic fertilizer can be incorporated into the soil during the field preparation and bedding operations, or banded to the side of the plants. The incorporation of a leguminous cover crop before the planting of tomatoes improves the nitrogen supply significantly.

Additional foliar applications with substances such as fish emulsion, seaweed, biostimulants, and compost or weed teas may be applied in organic tomato production. However, results of foliar fertilizations are not consistent. Fertigation and the injection of soluble fertilizer through drip lines are feasible with specifically formulated organic fertilizers.

Poor and deteriorated soils with low organic matter content will probably need additional organic fertilization, such as horn meal, rock phosphate and micronutrients (based on soil analysis). The application of magnesium and micronutrient-fertilizers require prior permission through certification based on soil analysis that proves soil deficiency.

### Conditions for the Nutrient Availability

Organic tomato production is based mainly on compost applications. Nitrogen in compost is organically fixed and has to be transformed in a soluble form (mineralized) by microorganisms. Soil-temperatures of 12-14°C, a good aeration and enough soil-moisture support mineralization. Phosphorous is not available for the tomatoes subjected to temperatures under 14°C. A phosphorous-deficiency in tomatoes is shown by a purple color on the under side of the leaves.

## 3.2.4 Irrigation

Tomatoes in full productions evaporate about 4-6 l of water per $m^2$ day. At the beginning and the end of the crop, 2 l per $m^2$ day is more than enough. To improve root development, it is recommendable to limit irrigation for some weeks after planting. Regular irrigation is very important for the nutrient supply, plant health and fruit quality. Irrigation can be done by drop irrigation (most commonly used) and flood irrigation. Advantages and disadvantages of the different irrigation systems have to be evaluated carefully before investing in organic tomato production; for example: flood irrigation may increase soil borne diseases; drip irrigation may increase salt concentrations in the top soil.

Support system for tomatoes.

## 3.2.5 Pest and Disease Management

Tomatoes are susceptible to physiological disturbances, diseases and pests. Priorities in organic tomato production have all the management methods to prevent such pests and diseases:

- Optimal site selection;
- Selection of pest and disease resistant varieties;
- Wide rotation (in case of soil borne diseases at least four years should be free of tomato-production);
- Creation of semi-natural habitats and ecological compensation areas;
- Improvement of soil fertility and activation of soil microbial life;
- Balanced nutrient supply;

With such measures, non parasitic damages and physiological disturbances (such as green collar, blossom end rot and cracking of fruits), as well as nutrient deficiencies can be reduced. In addition, organic preparations are applied (see positive lists); however, they often are less effective than synthetic products and therefore only a combination of preventive and curative methods leads to successful organic tomato production.

**Disease**

Preventive measures: to avoid dew formation with appropriate irrigation period (fungi spores, with exception of the powdery mildew, needs free water to germinate and in the leaf to penetrate) and the optimal row orientations to improve air circulation, suspending field activities when vegetation is wet, to select the optimal variety according the local conditions. Drip irrigation promotes dry leaves. Prevention and sanitation measures are important. These include post-season destruction of vines by hot composting, removal of diseased tomato plants and solanaceous weeds, sterilization of plant stakes prior to reuse, prohibiting tobacco use in the field, and frequent cleaning of tools and implements to prevent carrying problems between fields. A minimal four week solarization with clear plastic before planting can suppress diseases, nematodes, and other pests – attention: weeds also grow under the plastic.

**Table 52:**
**Examples of Tomato Diseases and Ways to Manage them Organically**

| Disease | Important to Know | Preventive Measures | Direct Measures |
|---|---|---|---|
| Early blight (*Alternaria solani*) | On leaves (oldest) dry and brown spots with concentric circle and bright edges; this symptom appears before phytophtora | Infection sources are in the soil, (attention with the crop rotation), the seeds should be put in hot water treatment by 50 °C during 50 min, avoid near infestation sources such as infected potatoes crops, harvest residues very carefully to compost. | Repeated copper applications, especially before rainy wet periods, treatment with substances that enhance plant resistance. |
| Late blight (*Phytophtora infestans*) | Fungal diseases with wet green-green and later brown colored spots, high air humidity causes the appearance of white mycelium on the under leaf side, the fruits stay hard, with big spots that later become rugose. | For spore germination, at least 4 h of dew on the leaf is necessary, high humidity increases dissemination: plants (esp. leafs) should be maintained as dry as possible (controlled irrigation, drip irrigation), selections of part resistant varieties, no overdosing with organic fertilizer, avoid proximate infestation sources as potatoes crops. | Repeatedly copper applications, especially before rainy wet periods, treatment with substances that enhance plant resistance. |
| Gray mould (*Botrytis cinerea*) | The gray-green infected parts of plant show a gray mycelium; infection of the fruits is observable through bright circles with round, darker spots. | The pruning of leaves should be carried out early in the morning and during dry days, the big shoots should not break, but rather cut off to 1 cm; select varieties with loose structures. | Infected plants are removed from the field. |
| Leaf spot, *septoria* leaf spot | Numerous small browns spots with gray or black centers; leaves turn yellow and drop. | Sanitation measure in the production operations, crop rotation, avoid water in leaves | Application of copper |
| Antracnose | Fruit has small, slightly sunken circular spots that spread and crack open. | Use of resistant cultivars, optimal sanitation, crop rotation, and physical support of plants. | Applications of copper, removal of severely infected plants. |
| Powdery mildew (*Oidium lycopersicum*) | Powder white spots on the upper side of the leaf, the leaves become yellow and die. | The irrigation should be optimally managed; high air humidity promotes dissemination after the primary infection. Use tolerant varieties. | Treatment with untreated milk has given good results, also with soy lecithin and fennel oil and sulphur. |
| Viruses and bacterias | Virus and bacteria are often transmitted through contaminated clothes or tools. Therefore, maximum farm sanitation is necessary. | Infected plants must be removed as soon as possible from the fields. | Copper is applied against bacteria on young plants in stages of development. The substances must also reach the under part of the leaves (especially in late blight disease). |

### Pest insects

The management of tomato insect pests requires monitoring and the integration of all possible cultural practices (preventive measures). In addition, direct control measures may be applied, such as: release of beneficial organisms (biological control) and organic pest control substances (see positive list).

## Pest Management

**Table 53:**
**Examples of Tomato Pests and Ways to Manage them Organically**

| Pest | Damage | Control |
|---|---|---|
| Aphids | Suck sap; it is a vector of diseases; creates honey dew; misshapen foliage, flowers and fruits. | Insecticidal soap; release of beneficial insects if they are available (lady beetle, lacewings etc.); applications of *beauvaria bassiana*, pyrethrum, rotenone. |
| Army worm | Feeds on foliage and fruit | Release of beneficial insects if they are available; applications of Bt on larvae, superior oil. |
| Blister beetle | Feeds on foliage and fruit | For severe infestations, applications of pyrethrum, rotenone, or sabadilla. |
| Colorado potato beetle | Feeds on foliage | Application of Bt on larvae; encourage beneficial insects through the incorporation of ecological structures; applications of neem, pyrethrum, and rotenone. |
| Cutworm | Cut plants stem | Use of parasitic nematodes to soil, spreading wood ashes around the stem, moist bran mixed with Bt scattered on soil. |
| Flea beetle | Many small holes in foliage | Row covers; sanitation; applications of parasitic nematodes to soil; applications of neem, pyrethrum, rotenone, sabadilla. |
| Fruit worm | Feeds on foliage, flower, fruit | Destroy infested fruits; applications of Bt on larvae; use of row covers; applications of neem. |
| Hornworm | Feeds on foliage and fruit | Applications of Bt on larvae, pyrethrum if the infestation is severe. |
| Pinworm | Fruit has narrow black tunnels | Destroy infested fruits; application of sabadilla |
| Stink bug | Deformed fruits with whitish-yellow spots | Control weeds near plants; use trap crops; attract beneficial insects by planting small-flowered plants; applications of sabadilla. |
| Whitefly | Distorted, yellow leaves, creates honey dew that attracts sooty mold. | Applications of insecticidal soap; use of yellow sticky traps; release beneficial insects; applications of garlic oil; neem, pyrethrum, rotenone, and Beauveria bassiana. |

**Table 54:**
**Direct Measures for Weed-regulation in Organic Tomato Production**

| Measure | Advantages | Disadvantages |
|---|---|---|
| Open soil | Permits hoeing mechanically or manually, regulating weeds that grow between crop rows and within tomatoes rows (manually); Mineralization of the organic matter can be influenced; Makes able fertilizations with solid organic products. | It is dependent of the soil and weather conditions (wet or dry); Manual regulation of weeds needs time and may be costly. |
| Soil Vaporization | Control weeds and soil borne diseases; Mechanical and manual hoeing are also possible, as well as the use of organic fertilization. | Harms soil structure and microorganisms; Nutrient loss by vaporization; High energy-consuming; Suitable for small plots; |
| Dead mulch | Improves the soil structure, preserves the water in the soil, enhances the microbial activity and fauna, adds nutrients and feeds soil organism as they decompose; Regulates weeds that grow within the tomatoes rows, especially if there is low weed pressure. | Weed growth through the mulch; Problem with the germination of mulch seeds; Makes mechanical weeding more difficult; Possible pesticide residue. |
| Plastic mulch | Improves the soil structure; Regulates weeds growing within crop rows; A high content of seeds of weeds is recommended; Reduces water loss. | Makes irrigation more difficult, but feasible; Organic fertilizations with solid materials are not possible; Higher cost; Some organic certifications restrict the use of plastic mulches |
| Living mulches (cover plants) | Improves the soil structure; Compete with weeds; After mulching, provides nutrients through its decomposition (legumes living mulches, hairy vetch, alfalfa). | Compete for water and nutrients, therefore living mulches require some suppression either with partial tillage or mowing. |

### 3.2.6 Weed Management

Successful weed regulation in organic tomato production is based on a combination of different strategies. The planning of a diverse crop rotation – especially those including cover crops that compete with weeds – is the first and most important step in organic tomato production. Organic growers also pay a great deal of attention to sanitation measures that avoid the introduction of weeds (seeds and propagules). Tomatoes have a critical period of about 4-5 weeks after transplanting where they need weed-free conditions.

### 3.2.7 Harvesting and Post-Harvest Handling

Harvesting tomatoes is labor intensive. For storage and shipping, the tomatoes can be picked at the initial stage of maturity- when the blossom end turns pink. Tomatoes can be harvested 2-3 times per week, preferably in the morning. Temperature-management is critical to maintain quality. The tomatoes should be stored at 10-13°C. The flavor will be reduced if tomatoes are stored at low temperatures; high temperatures accelerate fruit ripening.

In comparison to conventional production of tomatoes, the yield of organic grown tomatoes is comparable if all measures were managed correctly during the growing period .

## 3.3. Cabbage

Cabbage is the oldest and most widely grown vegetable of the Brassica group, belonging to the mustard family. It is a biennial plant, producing its large, waxy leaves surrounding smaller compacted head leaves in the first year, and a flower stalk bearing yellow flowers in the second year.

It takes 90 to 120 days from seed to harvest, often being transplanted as a seedling from a nursery at a young age.

Cabbage (*Brassica oleracea L. convar. capitata var. capitata*) is one of the world's most important vegetables, especially in the temperate zone. Most processed cabbage goes for the production of sauerkraut.

### 3.3.1. Ecological Requirements

**Temperature**
As a cool season crop, cabbage grows at a temperatures ranging from 0 to 25°C, with an optimum temperature range of 15 to 20°C.

**Soil**
Cabbage may be grown on a variety of soils but it does best on a well- drained, loam soil well supplied with organic matter. Sandy loams are preferred for early crops. As cabbage is sensitive to soil acidity soil pH should be between 6.5 and 7.

**Irrigation**
Cabbage crops require a constant amount of water supply throughout the whole season in order to prevent the cracking of heads. Depending on the production site, an irrigation system should be in place. Soil type does not affect the amount of total water needed, but does dictate frequency of water application. Lighter soils need more frequent water applications, but less water is applied per application.

## 3.3.2. Organic Cabbage Production Systems

### Suitable Varieties

Hybrid varieties dominate. White and red cabbage exist, but the white variety dominates the market. Various varieties are available that are resistant to heat, cold and a number of important diseases and physiological disorders. Choose varieties available on the local market carefully. Growth period differs from approximately 75 days for early varieties, 90 days for mid-season, to over 120 days for late large-headed varieties (from seed to maturity).

### Important Considerations for Field Selection

With respect to the selection of an appropriate field before planting cabbage (and all other crucifer plants too), consider the following important factors which affect a number of diseases such as club root and *Sclerotinia*:

- No crucifer crop, or related weed has been in the field for at least 2 years, 4 years preferable. Crucifer crops include cabbage, cauliflower, broccoli, kale, kohlrabi, Chinese cabbage, mustards, turnips, rutabagas, radishes etc. Cruciferous weeds include wild radish, shepherdspurse, wild mustards etc. Also, crucifer plant waste should not be dumped on these fields.

- Fields with club root in the past needs strict control of soil pH, which should be over 6.5. Application of lime could some weeks before planting the cabbage seedlings is reported to reduce further infection.

### Seed, Transplant Production and Field Seeding

Cabbage is both direct seeded and transplanted. Hot water seed treatment is used under certain conditions (especially for transplant production) to reduce the infection with seed borne diseases (50° C for 25 to 30 minutes; after, the wet seed must be quickly cooled and dried). Hot water seed treatment requires extensive experience and should be performed by knowledgeable experts.

For seedings in seedbeds for transplant production, choose a site where crucifer crops have not been grown before. Fresh market cabbage and may be field seeded or transplanted. Cabbage for processing is generally field seeded. Direct seeding might be more problematic poor germination sometimes occurs and weed management at this development stage is more difficult.

Preparation for direct seeding requires the same attention given a seed bed area. A fine textured soil, free of rocks, clods and trash, firm and very level, is required for mechanical seeding. After the first true leaves have formed, growers have to strive for the right plant density. Thinning out to leave 38 to 45 cm between them. Spacing between rows should also be 38 to 45 cm. In the case that tractors are used, 4 rows should be planted as one set, leaving the necessary distance between sets to accommodate tractor tire width.

## 3.3.3. Soil Nutrition and Organic Fertilization

### Fertilization

If a mineral soil is below pH 6.3 or an organic soil is below 5.5 and/or the calcium (Ca) level is below 8 meq/100g soil lime should be applied. Compared to other vegetables, cabbage has a fairly high lime requirement. Lime should be mixed into the seedbed at least several weeks before seeding and preferably the preceding year. A lime application is effective over several years.

Cabbage up-take of nitrogen and potassium is high in comparison to other vegetables. On the one hand, application of a well balanced compost (enriched with rock-phosphates, wood ash/potassium) when preparing the seedbed for cabbage is recommended. Furthermore, a leguminous plant like pea, beans and/or alfalfa should be planted the year/season before cabbage to enrich the soil with nitrogen rich organic materials.

## 3.3.4. Pest and Disease Management

**Table 55:**
**Examples of Cabbage Diseases and Ways to Manage them Organically**

| Disease | Symptoms | Preventive Measures |
|---|---|---|
| Black Blight<br>*Mycosphaerella brassicicola* | Aboveground portions show symptoms. Dark concentric rings with definite edges surrounded by a yellowish zone. Dark lesions may develop on stored cabbage and may penetrate deeply. | 1. Locate plant beds 1 mile or more from diseased fields.<br>2. Burn straw stacks, and plow under diseased refuse of cabbage, turnip, and rutabaga seed fields immediately after harvest and before transplanting the new crop<br>Hot water seed treatment at 122°F for 30 min eliminates seedborne inoculum. Treat a small quantity of each seed lot, and test the germination before treating all the seed |
| Downy Mildew (Staghead)<br>*Peronospora parasitica* | Starting with small, light green-yellow lesions on the upper leaf surface (later showing on the undersurface and spots turning to yellow. At a later stage leaf may become papery and die. Cabbage heads develop sunken black spots. | • Eradicate cruciferous weeds (fungus hosts)<br>• Manage irrigation to reduce periods of high humidity |
| Sclerotinia Stem<br>(*Sclerotinia sclerotiorum*) | Cottony white mold on aboveground parts (sclerotina changing from white to black) | • Rotate using nonsusceptible crops such as grass or grains.<br>• Encourage maximum air movement between rows. |
| Black Spot (Leaf, Stem, or Pod Spots) *Alternaria brassicae* and *A. brassiciola.* | Yellow spots develop, enlarging to circular areas with concentric rings and possibly surrounded by yellow halos. Centers may be coated with black spore masses. | • Wide rotation<br>• Use clean seed. Seed not known to be clean may be treated in water at 50°C for 25 to 30 min.<br>• Bury or remove crucifer residues. |
| Bacterial Soft Rot (*Erwinia carotovora* subsp. *carotovora*) | Small, water-soaked areas appear and rapidly enlarge. Tissue becomes soft and mushy, and within a few days the affected plant part may collapse. An offensive odor usually is present | • Set out plants in rows to allow good air drainage.<br>• Cultivate carefully to minimize injuring plants.<br>• Control frequency and source of irrigation water.<br>• Avoid frequent irrigation during head development.<br>• Time irrigation to allow the head to dry rapidly.<br>• Avoid stagnant water sources.<br>• In storage, use a buffering material such as straw or paper to prevent injury to the heads.<br>• Keep storage house humidity between 90 and 95% and the temperature between 0-4°C |
| Clubroot The disease is caused by *Plasmodiophora brassicae*, can survive in soil 18 years or more after an infected crop. | The distinctive symptom is abnormally large roots–fine roots, secondary roots, the taproot, or even on the underground stem. Roots develop clubs (swellings). | • Care for uninfected seedbeds, seeds, transplants, drainage water, irrigation water and equipment<br>• Long rotations (6 years or longer) help prevent a pathogen buildup and reduce disease.<br>• Control wild mustards if they are a weed problem. |
| Black Leg and Phoma Root Rot *Phoma lingam* (sexual stage: *Leptosphaeria maculans*) | Pale, irregular spots on leaves later become ashy gray with scattered black dots (pycnidia) on the surface. Stem lesions are elongated with purple borders near the soil line and extend below the soil surface, causing a black rot of lower stem and roots. | • Plant only stock seed free of the fungal pathogen.<br>• Treat infested seed 25 to 30 min in water at 50° C.<br>• Seedbeds should not have crucifer crops on or near them for at least 5 years.<br>• Inspect seedbeds for obvious foliar infections.<br>• Transplants, if lifted, should not be dipped in water before transplanting. |
| Phytophthora Root<br>(*Phytophthora megasperma* ) | Leaf margins discolor, turn brown, and eventually die. Aboveground portions of the plant wilt, and plants may die. Lateral roots are absent or entirely decayed. Symptomatic plants are found in wet areas of the field. | • Plant only on well-drained soil that has a minimum of low areas where water can accumulate.<br>• Avoid excessive irrigation.<br>• Practice a 3-year rotation with nonsusceptible crops. |
| Damping-off (Wirestem)<br>*Pythium* spp., *Fusarium* spp. and *Rhizoctonia solani* | Damping-off kills seedlings before or soon after they emerge. | • In the greenhouse or seedbed, pasteurize the soil with solar radiation<br>• Make seedbeds on well-drained soil; avoid excessive irrigation.<br>• Space rows and/or seedlings in the seedbed to maximize air movement.<br>• Carefully examine seedlings when transplanting; discard any with signs of wirestem.<br>• If damping-off occurs, stop watering for a while. Allow soil to dry somewhat around the plants. If the seedlings are in flats or in cold frames, give them as much air and light as possible.<br>• Rotation with cereals may reduce pathogen populations in soil.<br>• Remove or encourage decomposition of plant debris. |

## Disease

Cabbage plants are susceptible to physiological disturbances, diseases and pests. Preventive measures against such pests and diseases have priority in organic cabbage production:

- Optimal site selection
- Selection of pest and disease resistant varieties
- Wide rotation
- Creation of semi-natural habitats and ecological compensation areas
- Improve soil fertility and activate soil microbial life
- Balanced nutrient supply

With these preventive measures, most pest and disease problems can be avoided or reduced. In addition, organic preparations can be applied (see positive lists); however, they often are less effective than synthetic products. Therefore, only a combination of preventive and curative methods lead to a successful organic cabbage production. Attention must be given to the legal requirements for organic agriculture (e.g. EU-regulation only allows for a restrictive use of means like copper, natural insecticides etc.). In case new preparations should be applied, final approval granted by the responsible certification body is necessary.

## Pest Insects

**Table 56:**
**Examples of Cabbage Pests and Ways to Manage them Organically**

| Pest | Damage | Control |
|---|---|---|
| Aphids, including Cabbage aphid *Brevicoryne brassicae* Turnip aphid *Hyadaphis erysimi* Green peach aphid *Myzus persicae* | Cabbage and turnip aphids are gray mealy plant lice forming colonies on foliage or in heads or in buds. Weaken plants and constitute an adulterant in processed foods. | Lady bird beetles |
| Cabbage maggot *Delia brassicae* | White maggots that feed on roots and underground stems and weaken, lodge, and kill plants. | |
| Cabbage Head Caterpillar *Crocidolomia binotalis* | Destruction of the growing point by extremely mobile larvae | Strategies must be include diamondback moth: Cabbage planting during rainy season; Hand removal of eggs and early larvaetwice per week; Trapping plants like Indian mustard have shown good results; Neem kernel extract |
| Diamondback moth *Plutella xylostella* | Small, pale yellowish-green larvae with erect black hairs. Eats holes in foliage. Adults are small gray or brown moths with white marks on forewings that form a diamond when wings are folded. | Planting of trap crops (collards) between cabbage rows and/or around the cabbage field; Sexual pheromones; Spraying of B. thuringiensis; Larval parasitoid *Diadegma semiclausum*; |
| Flea beetles including cabbage flea beetle *Phyllotreta cruciferae* | Small, shiny, steel-blue, jumping beetle. Eats round holes in leaves of wild and cultivated crucifers. Particularly serious on seedlings. | Intercropping with garlic; Early season trap crop along the field; garlic mixture with water; Neem and Derris; |
| Imported cabbage worm *Pieris rapae* | Large holes in leaves, attacks the head near maturity, leaving damage similar to that of diamondback moth | Sabadilla (*Schoenocaulon officinale*) powder in combination with Derris dust (be careful as sabadilla is toxic to honey bees); |
| Loopers, including Cabbage looper *Trichoplusia ni Alfalfa* looper *Autographa californica* | Larvae damage plants by chewing holes in leaves | Bacillus thuringiensis; Mass release of Trichogramma spp; Sabadilla (*Schoenocaulon officinale*) powder in combination with Derris dust (be careful as sabadilla is toxic to honey bees); |

## 3.3.5. Harvesting and Post Harvest Handling

Cabbage for processing should be delivered to the processor as soon after harvest as possible. Heads should be harvested when firm and before they split or burst. In harvesting for fresh market, leave 4-6 wrapper leaves attached to the head. The wrapper leaves are usually removed when harvesting for kraut.

**Storage**

Store cabbage at 0° C and a relative humidity of 98 to 100%. If stored under proper conditions late cabbage should keep for 5 to 6 months. The longest keeping cultivars belong to the Danish class. Early-crop cabbage, especially southern grown, has a storage life of 3 to 6 weeks. Cabbage is successfully held in common storage, where a fairly uniform inside air temperature of 0 to 1.6°C can be maintained.

Cabbage wilts quickly if held under too dry storage conditions; hence, the humidity should be high enough to keep the leaves fresh and turgid. Use of polyethylene liners or pallet covers to prevent desiccation can prove desirable under some storage conditions. The storage life of late cabbage can be extended for several months if it is held in an atmosphere with 2.5 to 5 % oxygen and 2.5 to 5 % carbon dioxide.

Cabbage should be handled carefully from field to storage, and only solid heads with no yellowing, decay, or mechanical injuries should be stored. Before the heads are stored, all loose leaves should be trimmed away; only three to six tight wrapper leaves should be left on the head. Loose leaves interfere with ventilation between heads, and ventilation is essential for successful storage. Upon removal from storage, the heads should be trimmed again to remove loose and damaged leaves. Cabbage should not be stored with fruits emitting ethylene.

## 3.4. Asparagus

Asparagus *(Asparagus officinalis L.)* belongs to the family of Liliaceae. It grows very well in warm countries with much sunshine. The only condition is a cool period of at least 2 months as a resting time for the plants.

Asparagus is one of the most valuable perennial vegetable crops. Plants are not difficult to grow and will thrive under a variety of conditions. They tolerate drought, though the yield and quality are greatly reduced. A good supply of water will help to produce a large yield of juicy, crisp shoots for immediate use, quick-freezing or canning. With proper care, an asparagus bed should produce for 20 years or more.

The production potential is high due to the long vegetation period. The harvesting period can last up to 3 months.

Field of Asparagus in Jordania.

### 3.4.1. Ecological Requirements

Asparagus should not be planted in any field in which asparagus had been planted in the past in order to reduce the incidence of Fusarium wilt and several root rots.

Deep soil is necessary because asparagus is a deep-rooted plant. Good drainage is essential, and while flooding for a short time in the spring may be permitted, the surface water must be removed quickly during the growing season. Perennial weeds must be eliminated the year prior to planting. The ideal site should have full sun exposure.

Asparagus is a heavy feeder and requires rich soil that is well prepared before planting. Poorly drained soils, too deep planting and too much organic fertilizer reduce the lifespan of the plants due to fungae attacks on the roots. In selecting sites, consider risk from soil insects. Check for wireworms if old pastures or alfalfa fields are to be used.

**Soil**

Asparagus can be grown on many types of soil, but good drainage is imperative.

The best type of soil for asparagus is a deep, rich, well-drained, sandy loam. Asparagus roots may reach a depth of 3 meter and the soil should allow full development of the storage roots.

Heavy (clay) soils are reasonably satisfactory if the top layer is of good depth (15 to 20 cm.) and an abundance of organic matter has been incorporated into the soil.

Soils ranging from slightly acid to slightly alkaline (pH. 6.0-7.5) are best. Asparagus will tolerate soils too acidic or too alkaline for many other crops, but yields on such soils may be lower.

Field of Asparagus with irrigation system.

**Temperature**

Asparagus germinates well at temperatures ranging between 15 and 30 °C. It does not grow at temperatures bellow 5°C and above 40°C.

## 3.4.2. Organic Asparagus Production Systems

**Suitable Varieties**

American varieties like "Mary Washington" and "California 500" which are resistant against rust, are very popular.

**Propagation and nursery management**

**Seedling Preparation**

Seeds are sown in the spring, at 3-4 cm of depth, 4-5 cm of distance in the row and 0.6 m between rows. Distances should be adapted in accordance to the percentage of germination of the seed, which has to be tested before plantation. After sowing, irrigate the seeds until germination and cover the soil with dead mulch to protect against weed. One year old seedlings are best to use for transplantation. Because of their fine and sensitive roots, they should be carefully managed.

**Transplantation of Seedlings**

Place the plants in a trench 0.30-0.45 m wide and 0.30 m deep. The crowns should be spaced 0.25-0.40 m apart. Spread the roots out uniformly, with the crown bud side up, in an upright, centered position, slightly higher than the roots.

Cover the crown with two inches of soil. Gradually fill the remaining portion of the trench during the first summer as the plants grow taller. Asparagus has a tendency to "rise" as the plants mature, the crowns gradually growing closer to the soil surface. Apply an additional 3-5 cm of soil between the rows in later years.

**Design of the rotation**
One year before final transplant in the field it is useful to sow a legume as green manure to increase organic matter and nitrogen content of the soil.

## 3.4.3. Soil Nutrition and Organic Fertilization

**Fertilization**
Fertilize trenches with organic compost or manure and lime, 10-15 days before transplanting seedlings. To improve soil conditions, sow Lathyrus sativus as a green manure during the winter, when the asparagus becomes dormant.

## 3.4.4. Irrigation

Irrigate as needed and to keep ferns growing vigorously. Six to 8 irrigations may be needed during the first and second year. During the cutting season 1-2 irrigations should be adequate. Refill the soil profile after harvest through several irrigations to promote good fern growth.

Irrigate as necessary to promote and sustain good fern growth after harvest well into the fall. Asparagus water use during fern growth is reported to be 6.8 inches in July, 7.6 in August and 4.6 in September (in Brazil). Fall irrigation is reported to increase yields the following spring and to reduce winter freeze damage.

Soil type does not affect the amount of total water needed, but does dictate frequency of water application. Lighter soils need more frequent water applications, but less water applied per application. Asparagus is often grown with furrow irrigation.

Organic Asparagus

## 3.4.5. Pest and Disease Management

Preventive measure against such pests and diseases have priority in organic eggplant production:

- Optimal site selection
- Selection of pest and disease resistant varieties
- Wide rotation (to avoid soil borne diseases)
- Creation of semi-natural habitats and ecological compensation areas
- Improve soil fertility and activate soil microbial life
- Balanced nutrient supply

With these preventive measures most pest and disease problems can be avoided or reduced. In addition, organic preparations can be applied (see positive lists); however, they often are less effective than synthetic products. Therefore, only a combination of preventive and curative methods leads to a successful organic asparagus production. Attention must be given to the legal requirements for organic agriculture (e.g. EU-regulation for organic agriculture only allows for a restrictive use of means like copper, natural insecticides etc.). In case new preparations should be applied, approval granted by the responsible certification body is necessary.

#### Disease

**Table 57: Examples of Asparagus Diseases and Ways to Manage them Organically**

| Disease | Symptoms | Preventive measures | Direct measures |
|---|---|---|---|
| Puccinia asparagi | | Resistant varieties | Copper applications |

#### Pest Insects

**Table 58: Examples of Asparagus Pests and Ways to Manage them Organically**

| Pest | Damage | Control |
|---|---|---|
| Spotted asparagus beetle *Crioceris duodecimpunctata* | Brick-red, black-spotted adult appears late in spring. Adults attack both spears and ferns. Larvae feed on berries. | Rotenone, handpicking |
| Cutworms and Armyworms | Tend to climb and feed on growing spears | Cultural Methods: Plowing one month before planting to turn caterpillars/larvae to the surface; hand-picking at night for removal of larvae; Natural insecticides: Derris, Rotenon |
| Wireworms *Ctenicera* and *Limonius* spp. | Kill and weaken young plants and eat holes in spears | Intercropping of garlic |

### 3.4.6. Weed Management

Weeds and grasses are the worst problems for asparagus. They compete with the developing spears, make an unsightly area in the field and significantly decrease yield and quality.

**Table 59: Direct Measures for Weed-regulation in Organic Cabbage Production**

| Measure | Advantages | Disadvantages |
|---|---|---|
| Soil cover with dry material | High efficacy against weeds | High labor |
| Soil cover with living plants | High efficacy agaisnt weeds | Eventually, they will compete for water and nutrients |
| Hoeing | | High costs |

### 3.4.7. Harvesting and Post Harvest Handling

Asparagus is not harvested the first year (the year of crown establishment). Second year harvest is usually limited to 4-6 weeks depending on crop vigor. Full-season harvest is conducted the third year but full production usually occurs about the 4th year. Asparagus fields last about 12 to 15 years although some fields may remain productive for over 20 years.

The harvested asparagus is very sensitive to high temperature. The shoot continues to grow even after cutting and become hard through sclerenchymisation. There should be no more than 3 hours between cutting and the delivery to a cooling room or in the factory.

Due to the fast growing shoots, it may be necessary to harvest twice per day.

After harvest, several factors contribute to fiber formation. Most post-harvest fiber development occurs within

24 hours. This can be slowed dramatically by cooling promptly to 2° C. There is an increase in fiber with storage, especially at higher than optimum temperatures, but the increase is low under proper storage. Fiber content (or at least its integrity) can even be reduced under CA (controlled atmosphere) storage with low oxygen and high carbon dioxide levels. Water-loss after harvest also increases fiber development, making humidity in storage an important consideration. Film wraps or placing butt ends on water pads also helps reduce fiber development.

The recommended holding and shipping temperature is 0°C, with a relative humidity of 95%. Keep asparagus upright in containers with moisture pads whenever possible.

Fresh asparagus is highly perishable and deteriorates rapidly at temperatures above 4°C. Thus, the spears should be cooled immediately after cutting, preferably by hydro-cooling. In addition to general deterioration, spear growth, loss of tenderness, loss of flavor, loss of vitamin C, and development of decay take place at moderately high temperatures. Asparagus can be kept successfully for about 3 weeks at 1°C and 4-5 weeks in controlled atmosphere storage (see below). It can be held for about 10 days at 0°C, but it is subject to chilling injury when held longer at this temperature.

High relative humidity is essential to prevent desiccation, particularly at the butt ends. Commonly, the desired relative humidity is obtained by placing the butts of asparagus on wet pads. A high relative humidity can also be obtained by prepackaging spears in perforated film. Non-perforated film is not acceptable because the extent of increases in carbon dioxide and decreases in oxygen may be injurious and because enough ethylene may accumulate to toughen the spears.

Asparagus with white butts is less perishable than all-green asparagus. Bacterial soft rot, which can occur at either the tip or butt of the asparagus, is the principal decay.

Asparagus may be damaged by exposure to ethylene, and should not be stored with apples, or other ethylene generating material. Adverse exposure may result in undesirable elongation, curving, and toughening.

Controlled-atmosphere storage is beneficial to asparagus, even for a short periods because it delays decay and toughening, which occur rapidly after harvest. Gas concentrations should be 2-3% oxygen and 5-10% carbon dioxide at 1-2°C. If temperature control is uncertain and might exceed 7°C, the carbon dioxide concentration should not exceed 7 %; but if the temperature is maintained at 0°C, a 12 percent concentration is suggested. Brief exposure to 20 % carbon dioxide will reduce soft rot at the butt end.

## 3.5. Carrots

Carrots (*Daucus carota L.* ssp. *sativus*) belong to the Apiaceae family and is a hardy, cool-season biennial that is grown for the thickened root it produces in its first growing season.

Although carrots can endure summer heat in many areas, they grow best when planted in the cool season. Carrots are eaten both raw and cooked and they can be stored for winter use. They are rich in carotene (the source of vitamin A) and high in fiber and sugar content.

### 3.5.1. Ecological Requirements

The carrot is a plant that grows in mediterranian climates. Maximum growth is reached at a medium temperature of 18° C and a well balanced water supply. It withstands low temperatures, even light freeze, but suffers under heat and drought. However, adapted varieties make growing of carrots at temperatures around 25° C possible.

A soil temperature in the range of 15 to 20° C produces the sweetest, most tender and brightly colored roots. Higher soil temperatures lead to stubbier roots with a woody texture and strong flavor. While the total percentage of sugar in a carrot root does not increase with age, there is a shift from glucose (simple sugar) to sucrose (table sugar). This causes a gradual increase in sweetness.

**Soil**

Deep, well-drained, sandy loam and muck soils of pH 5.5 to 7.0 are desirable. A chisel plow is recommended to work these soils to a depth of 12 to 15 inches for good root penetration. Soils should be bedded to obtain optimum drainage and maximum root length and smoothness.

Organic Carrots

### 3.5.2. Organic Carrot Production Systems

**Suitable Varieties**

It is important that season specific varieties for summer or winter are used.

**Propagation**

Carrots are sown directly on the field. In order to archive a high percentage of germinating seeds, the soil structure should be well prepared (without excessive tillage). Seeds need to be planted near to the surface and to be covered lightly with 0.3-0.6 cm of soil. Germination is slow and irregular.

**Table 60: The following Planting Scheme is Reported**

| Type | Distance in the row | Distance between the row |
|---|---|---|
| Daucus carota | 0,2 m | 0,3 – 0,4 m |

Carrot cultivation for seed production of different varieties must be widely separated for purity reasons. This includes wild carrots from adjacnet areas, as they are able to cross with cultivars.

#### Design of the Rotation

Carrots may be rotated with alfalfa or other leguminous cover crops, small grains, onions, spinach. In order to reduce soil borne disease problems rotation with crops like celery, parsley, beets and sesbania shall be avoided.

## 3.5.3. Soil Nutrition and Irrigation

#### Fertilization

Levels of phosphorus and potassium should be higher if compared to other crops. Also, boron deficiency can lead to carrot cracking.

#### Irrigation

Moisture management in carrots is especially important during stand establishment and during root expansion. Since small carrot seeds are unable to emerge when surface crusting occurs and can be burnt off if surface temperatures are too high, irrigation during the pre-emergence period revolves around maintaining a moist, cool, loose soil surface. This often requires frequent, light irrigation.

Conversely, deep, excessive irrigation during this period promotes problems with damping off of emerging seedlings. In the remainder of the season, available soil moisture should be depleted by no more than 50 percent. However, maintenance of excessively moist soil may cause anaerobic soil conditions that can kill the root growing point, resulting in misshapen carrots at harvest.

As carrot roots develop most of their size in the last half of their growth period, irrigation is especially critical during this time. Water deficit during this period will have the greatest negative impact on yields. A balance must be struck, however, between maintaining adequate moisture while minimizing wetness in the canopy that promotes common fungal diseases such as alternaria and cercospora.

During the last half of the growing period, irrigate only early in the day to allow for rapid canopy drying whenever possible. Soils should also be allowed to dry to 50 percent of available soil moisture during harvest to prevent excessive cracking and damage to roots during harvest.

On most soils, weekly irrigation during the peak is adequate, however with sandy and sandy loam soils, irrigation may be required as frequently as every three to four days.

If irrigation is used, plant seed on raised beds, as 2-3 acre-feet of water is needed to grow a crop.

## 3.5.5. Pest and Disease Management

Preventive measure against such pests and diseases have priority in organic carrot production:

- Optimal site selection
- Selection of pest and disease resistant varieties
- Wide rotation (to avoid soil borne diseases)
- Creation of semi-natural habitats and ecological compensation areas
- Improve soil fertility and activate soil microbial life
- Balanced nutrient supply
- Intercropping of different vegetables

With these preventive measures most pest and disease problems can be avoided or reduced. In addition, organic preparations can be applied (see positive lists); however, they often are less effective than synthetic products. Therefore only a combination of preventive and curative methods lead to successful organic carrot production. Attention must be paid to the legal requirements for organic agriculture (e.g. EU-regulation for organic agriculture only allows for a restrictive use of means like copper, natural insecticides etc.). In case new preparations should be applied, approval granted by the responsible certification body is necessary.

## Disease

**Table 61:**
**Examples of Carrot Diseases and Ways to Manage them Organically**

| Disease | Symptoms | Preventive measures | Direct measures |
|---|---|---|---|
| Black leaf spot (*Macrosporium carotas*) | Small dark spots with yellow centers on leaves | Good quality seeds; crop rotation | Copper applications |
| *Sclerotium rolfsii* | Stem attack ( sometimes roots) with dark brown lesions symptoms | Soil solarization/Solar heating; Organic material even straw added to the soil increase growth of antagonistic soil organisms; Onion as a pre-crop may reduce disease incidence; | Anatagonistic fungi like Trichoderma harzianum and Bacillus subtilis; |

## Pest Insects

**Table 62:**
**Examples of Carrot Pests and Ways to Manage them Organically**

| Pest | Damage | Control |
|---|---|---|
| Aphids, including the "Carrot aphid" *Cavariella aegopodii* | Considered a vector of certain virus diseases | Support of natural enemies like lady beetles and parasitic wasps; In urgent cases applications of B. bassiana and/or rotenone; nicotine, tobacco extracts |
| Carrot rust fly (*Psila rosae* ) | Worms burrow into and through roots. Burrows are often filled rust-red frass with | |
| Cutworms (many species) | Small to large larvae that feed on roots and foliage. | Support of natural enemies; Cultural Methods: Plowing one month before planting to turn caterpillars/larvae to the surface; Hand-picking at night for removal of larvae; Natural insecticides like Derris, Rotenon; Depending on the site and crop flooding of the field is reported to help; |
| Vegetable Weevil (Listroderes Dificilis) | Tunnels being eaten into the roots | Support of natural enemies of adults and larvae (e.g. birds, ants, wasps, parasitic nematodes, tachnid flies); Cultural control: wide crop rotation (including other hosts plants); Wild hosts like chickweed should be removed adjacent to the carrot field; |
| Slugs | | Beer traps |
| Wireworms | | Intercropping of garlic |
| Nematoids (Meloidogyne spp) | Produce warts on the carrots surface, as well as splitting into two | Crop rotation, especially with certain legumes as green manure |

## 3.5.6. Weed Management

Weed management is important mostly during the first stages, when the carrot plants are still very small and weak. Soil should be covered with dry matter of any kind.

## 3.5.7. Harvesting and Post Harvest Handling

Carrots harvested and handled in hot weather are more likely to decay, and care should be exercised in handling to prevent wilting.

Mature carrots are well adapted for storage and are stored in large quantities during the fall and winter for both the fresh market and processing. Careful handling during and after harvest to avoid bruising, cutting and breakage will help ensure successful storage.

Mature topped carrots can be stored 7 to 9 months at 0° to 1°C with a very high relative humidity, 98 to 100 %. However, even under these optimum conditions 10 to 20 % of the carrots may show some decay after 7 months. Under commonly found commercial conditions (0° to 4°C) with 90 to 95 % relative humidity, 5 to 6 months storage is a more realistic expectation. Prompt cooling to 4°C or below after harvest is essential for extended storage. Poorly pre-cooled roots decay more rapidly.

Carrots lose moisture readily and wilting results. Humidity should be kept high. Carrots stored at 98 to 100% relative humidity develop less decay, lose less moisture, and remain crisper than those stored at 90 to 95 % relative humidity. A temperature of –1°C to 1°C is essential if decay and sprouting are to be minimized. With storage at 4 to 10°C, considerable decay and sprouting may develop within 1 to 3 months.

Pre-storage washing of carrots may be desirable if they are harvested under wet conditions. Many potential decay-causing organisms are removed by washing. Also, clean, washed carrots allow freer air circulation. Air circulation between crates of pallet boxes in which carrots are stored is desirable to remove respiratory heat, maintain uniform temperatures, and help prevent condensation. An air velocity of about 14 to 20 ft/min is adequate at low storage temperatures.

Bitterness in carrots, which may develop in storage, is due to abnormal metabolism caused by ethylene. This gas is given off by apples, pears, and certain other fruits and vegetables and from decaying tissues. Bitterness can be prevented by storing carrots away from such products. Also, development of bitterness can largely be avoided by low-temperature storage, as it minimizes ethylene production. Some surface browning or oxidative discoloration often develops in stored carrots.

## 3.6. Cucumber

Cucumbers (*Cucumis sativus L.*) are grown for eating fresh or preserving as pickles. Cucumbers have two different flowers, male and female. Male flowers open first and always drop off. Female flowers form the cucumber should not drop off. Therefore it is important to have honey bees or bumblebees near the field that pollinate the flowers and improve fruit formation. Cucumbers are vining plants, members of the Cucurbita family that includes pumpkins, squash, and gourds. They grow best when allowed to sprawl along the ground on the seeding bed. This is because secondary roots will develop along the vine at the junction between the vine and the leaf. Secondary roots are a source of additional nutrients for plants and fruits.

Selection of cucumbers for sales and transportation.

### 3.6.1. Ecological Requirements

Cucumbers must be grown in warm temperatures and full sunlight; avoid planting cucumbers in the rainy seasons and on very windy areas. They mature quickly and are well suited to field growth. Cucumbers do best in loose, sandy loam soil but can be grown in any well drained soil with a pH 6.0 to 7.3.

### 3.6.2. Organic Cucumber Production

Before preparing the soil, all big rocks and large sticks have to be removed from the soil. Residues of plant materials have to be incorporated into the soil at least 4 weeks before planting or seeding. Weeds have to be regulated before planting cucumbers with a superficial soil tillage (harrow). Good preparation of the seed bed is important because cucumbers root in very shallow soil. The soil has to be worked into beds 10 to 15 cm high and at least 1.50 to 3.0 m apart. Ridges are especially important in heavy soils and poorly drained areas because cucumbers must have good drainage.

#### Suitable Varieties

There is a vast diversity of cucumber varieties that can be used for growing. Organic growers select the most disease resistant varieties (e.g. powdery mildew) and those varieties with good yield and good quality properties. Generally, two types of cucumbers are grown. Slicing types get 15 to 20 cm long and 3 cm or more in diameter when mature. Pickling types are 8 to 10 cm long and up to 2.5 cm in diameter at maturity. Both types can be used for pickling if picked when small.

#### Design of Plantation

Since cucumber is a vine crop, it requires a lot of space. Vines can reach 2 to 3 m or more. Field cucumbers can spread out on the ground. Three seeds of cucumber can be deposited on the fields manually in each hole at the edge of the ridge. The final plant distance should be about 40 cm apart. After germination, extra plants should be removed to improve better growth. The advantages of direct seeding cucumbers are that plants develop a better root system, and it is a less expensive method in comparison to planting. Water the first day and if there is no rain, every two to three days until they germinate. Stop vine growth when cucumbers reach the top of the bed by picking off the fuzzy end of the vine. This will leave more energy for fruit development.

Cucumber requires high levels of nutrients. This must be taken into account in crop rotation. Preceding crops should leave enough soil nutrients for cucumber. Organic growers therefore select leguminous crops (e.g. pigeon pea), beans, or other vegetables as leek that have been grown after a green manure. The break between two cucumber crops within the crop rotation is at least 3 years.

## 3.6.3. Soil Nutrition and Irrigation

### Organic Fertilization

The nutrient requirements of cucumber are about 140 kg nitrogen, 30 kg phosphorous and 170 kg potassium per ha. Organic growers "fertilize" the soil, where nutrients are transformed and made available for uptake by the plants through microorganisms. This may be obtained through a high percentage of leguminous crops (beans) or cover crops (e.g. hairy vetch) in the soil and through the application of well fermented compost or animal manure. Additionally, commercial organic fertilizers may be used (e.g. compost, horn powder) that are available in the growing region. For example, in a crop rotation after green manure (e.g. hairy vetch) and during the soil preparations 30 t/ha of compost or animal manure can be applied. In cucumber planting, a half hand full of compost for each spot of plants can be added.

Support system for cucumber plantation.

### Irrigation

Cucumber needs enough water for adequate yields. A suitable system is drop irrigation. Water the plants weekly if it does not rain.

## 3.6.4. Pest and Disease Management

### Diseases

Several different diseases attack cucumbers. Most show up as spots on the upper or lower sides of leaves or on fruit. A wide crop rotation discourages diseases.

Wherever downy mildew appears, a copper spray should be considered every 14 days. Copper is considered as one of the least desirable of organic fungicides because of its soil toxicity. Therefore, annual application is limited to 4-8 kg/ha (depending on the organic standard applied). Never spray in full sun (it will burn the plants).

Downy Mildew needs wet leaves for propagation. Preventive measures include the selection of tolerant varieties, irrigation early in the morning, and improvement of an early harvest. Use drop irrigation.

Powdery Mildew: preventive measures, selection of tolerant varieties. This fungus prefers dry conditions. Direct measures include the application of substances as fennel oil, soy lecithin, and sulphur sprays (spray only when cloudy with low concentrations).

Cucumber wilt is spread by cucumber beetles. Remove and destroy affected plants. Prevent by controlling cucumber beetles.

### Pests

Organic growers check for Insects as often as possible. Plant protection nets are used in order to prevent high infestations. Different insects attack the cucumbers including aphids, Mexican bean beetles or cucumber beetles.

Mexican bean beetles look like a large, orange ladybug except that they lack the distinctive black and white ladybug "face". Their larva are yellow and fuzzy. Damage to foliage makes it look somewhat like lace. Both adults and larva are easy to catch as they drop straight down when disturbed. Cucumber beetles (stripped and spotted) are yellow, with the appropriate markings. They fly away if disturbed, and so are harder to catch. For a large infestation, different products are available, such as: rotenone, pyrethrum, fatty acids and quassia.

## 3.6.5. Weed Management

Before seeding cucumber weed curing can be performed. During the cucumber growth period, the following strategies are applied on an organic farm:

- Organic mulch is a good possibility if available on the farm or in the region.
- Plastic mulch is an alternative but rather expensive.
- Manual hoeing is labor intensive but it is a very effective and secure method to regulate weeds. In manual hoeing, be careful with the superficial roots of the cucumber.
- The use of a cover crop (e.g. hairy vetch) that competes strongly with weeds is an optimal preventive measure to avoid weed infection before cucumber harvest.

## 3.6.6. Harvesting and Post Harvest Handling

The harvest area can be divided, for example, in two sub-areas that are harvested alternately; this allows smaller picker-teams and consequently a reduction in production costs. The following aspects have to be taken into consideration during harvesting:

- Harvest frequently, even when the first harvest does not cover the cost. Pick cucumbers while they are still small; this will force the vines to produce more allowing a cucumber to reach full maturity, thus producing full size mature seeds without halting plant production.
- In harvest cucumbers that are not well formed when they reach the desired size, do not wait until they turn yellow. Yellow cucumbers are over mature and will be strong flavored and of poor quality.
- Avoid standing on the plants.

Organic Vegetables

## 3.7. Aubergine - Eggplant

Eggplants belong to the family of Solanaceae and originate in tropical east India. They are grown as annual or pluriannual plants. They have a dense branching habit, the branches being erect or prostrate. As a rule, the annual plant is not more than one meter high, but in favorable climatic conditions pluriannual plants also grow up to 3 m high.

The leaves are whole, often slightly lobed, but rarely serrate. They are of varying sizes ranging from 10 to 30 centimeters in length. Some varieties have thorny stems.

There are at least three widely cultivated species of eggplant that are easily recognized by their characteristic flowers and fruits. They are:

- eggplant (*Solanum melongena L.*)
- bitter tomato with oblong fruits (*Solanum esculentum L.*)
- bitter tomato with globular fruits (*Solanum incanum L.*)

Eggplant is a cold-sensitive vegetable that requires a long warm season for best yields. The eggplant culture is similar to that of bell pepper, with transplants being set in the garden after all danger of frost is past. Eggplants are slightly larger plants than peppers and are spaced slightly farther apart. Eggplant requires careful attention for a good harvest.

### 3.7.1. Ecological Requirements

Eggplants grow in full sunlight, but they tolerate some shade. They withstand drought quite well, but yields are low when water is scarce.

A well-drained sandy loam of pH 5.5 to 6.5 with high organic matter content is ideal for growing eggplant. Fertility requirements are similar to those of tomato and pepper.

To reduce risk from verticillium wilt and other diseases avoid using fields in which tomato, pepper, potato, strawberry or caneberries must be planted.

#### Temperature

Eggplants grow best at temperatures ranging between 18 and 25°C.

**Table 63: Optimal Temperature Requirements for Eggplants**

| Development stage | Day temperature °C | Night temperature °C |
|---|---|---|
| Germination | 23-25 | 23-25 |
| Until to transplant | 20-25 | 18-20 |
| Seedling | 18-20 | 18-20 |
| Planting | 20-25 | 18-20 |
| Final transplanting | 18-25 | |

### 3.7.2. Organic Aubergine Production Systems

Eggplant requires a long growing season, so transplants are most commonly used. They are usually started in the greenhouse or hotbeds. Sow seeds in shallow flats of soil mix 9 to 10 weeks before transplanting to the field. Constant temperatures must be maintained as young plants are easily checked by cool temperatures or droughts.

Although eggplants have perfect flowers and, self-pollination would not appear to be a problem, bees are required for good pollination. Usually, wild bees are adequate, but if they are not present, bees should be provided.

#### Suitable varieties

The consumers' preferences are varieties of long egg-plants, but there are also short and round eggplant varieties available.

### Propagation and Nursery Management

Seeds should be sown in plastic bags, seeding trays or on the field, in a rather protected place, chosen for the purpose of growing young plants. Eggplant seeds take between 10 and 25 days to germinate.

Transplanting of the young plants is made as they reach around 15 cm or the stage of 5-6 leaves. Careful watering-in is necessary at the time of transplanting because transplants are very sensitive to water stress.

Once in the field, the distance in rows for eggplants is of 0.8 – 1.0 m and between rows it is of 1.2 –1.5 m. If the chosen planting distances are greater, lifetime and productivity of each plant is increased.

### Design of the Rotation

Due to certain diseases, correct rotation is of great importance for the eggplant. It should never be planted before or after the cultivation of other Solanaceae such as tomato or potato. Eggplants grow well after legumes like green beans or peas.

Organic eggplants are planted in rotational systems. Pastures and small grain crops that are grown in rotations to increase soil structure and organic matter should be ploughed down several months in advance of planting in order to avoid problems with cutworm and wireworm. Organic growers have had very good experiences planting leguminous cover crops before the eggplants, e.g. hairy vetch (*Vicia villosa*).

## 3.7.3. Soil Nutrition and Irrigation

As a general rule, a regular supply with organic material is of utmost importance. Green manure is applied to protect the upper soil layer and to offer nutrients for microorganisms/ plants. On the other hand, compost is applied in order to maintain and improve long-term fertility of the soil.

Correct fertilization is made in accordance with different factors such as soil type, growth stage and fertilizer availability.

Well nourished eggplants will produce more fruits over a longer period of time, especially in cases were fertilization was made during flowering of the plant. Eggplants require higher amounts of phosphorus and of boron (application of rock phosphate to the compost applied to the eggplant production site might be appropriate).

### Irrigation

Shortly after transplantation of the young plants into the field, eggplants should be irrigated daily. Later, irrigation is made every 2 to 4 days, depending on the soil type and climate.

Soil type does not affect the total amount water needed, but does dictate frequency of water application. Lighter soils need more frequent irrigation, but less water applied per irrigation.

To improve the root development, it is recommendable to limit irrigation for some weeks after planting if conditions allow. Regular humidity is needed for the nutrient supply; plant health and fruit quality are very important. The irrigation can be done by drop irrigation (most commonly used) and flood irrigation. Advantages and disadvantages of the different irrigation systems have to be evaluated carefully before investing in organic eggplant production; for example: flood irrigation may increase soil borne diseases, drip irrigation may increase salt concentrations in the top soil.

Depending from the production site and climatic conditions, coverage with organic materials (e.g. from weeding) might help to keep soil moisture.

## 3.7.4. Pest and Disease Management

Eggplants are susceptible to physiological disturbances, diseases and pests. Preventive measure against such pests and diseases have priority in organic eggplant production:

- Optimal site selection
- Selection of pest and disease resistant varieties
- Wide rotation (in case of soil borne diseases at least a four period should be free of eggplant-production)
- Creation of semi-natural habitats and ecological compensation areas
- Improve soil fertility and activate soil microbial life
- Balanced nutrient supply

With these preventive measures, most pest and disease problems can be avoided or reduced. In addition, organic preparations can be applied (see positive lists); however, they often are less effective than synthetic products. Therefore only a combination of preventive and curative methods lead to a successful organic eggplant production. Attention must be given to the legal requirements for organic agriculture (e.g. EU-regulation only allows for a restrictive use of means like copper, natural insecticides etc.). In the case that new preparations should be applied, final approval granted by the responsible certification body is necessary.

### Diseases

Diseases of eggplants include verticillium wilt, phomopsis rot, rizoctonia. Seed treatment can reduce seed rot and damping-off.

**Table 64: Examples of Eggplants Diseases and Ways to Manage them Organically**

| Disease | Symptoms | Preventive measures | Direct measures |
|---|---|---|---|
| Verticillium wilt (fungus – *Verticillium albo-atrum*) | Young plants appear normal, but become stunted as they develop. Severely affected plants turn yellow. The lower foliage wilts and defoliation occurs. Symptoms continue to progress until death occurs. | long term rotations with non-related crops that are not susceptible to wilt, and by planting in well-drained soil. Cotton gin trash should be avoided or be well composted if used. | Application of copper |
| seed rot and damping-off | | proper growing conditions | |
| Leaf Spot and Fruit Rot (fungus – *Phomopsis vexans*) | circular brownish spots on fruit and leaves. On the fruit, soft, sunken spots become rotted and shriveled. | Use a three year crop rotation. | Application of copper |
| Early Blight (fungus – *Alternaria solani*) | seedling dieback known as collar rot. Later infection is on the foliage beginning on the lower part of the plant and developing upward. Spots are characterized by concentric rings that give a target appearance. | Plants that are well fertilized and irrigated are not as susceptible. Long rotations, weed control, adequate fertilizer, and irrigation (furrow) will help reduce losses. | |
| Colletotrichum Fruit Rot (fungus – *Colletotrichum melongenae*) | Lesions on the fruit vary from small spots to one-half inch in diameter. The tissue is sunken, with an area filled with a flesh-colored ooze of fungal spores | Rainfall and overhead irrigation favor disease development. | |
| Yellows (Tobacco Ring Spot Virus) | Yellowing and whitening of upper leaves. Later, entire plant becomes yellow and may die | Avoid planting in fields where yellowing has occurred and, if warranted, control nematodes. The dagger nematode is a known vector of the virus. | |

### Pest Insects

Proper rotations and field selection can minimize problems with insects.

**Table 65: Examples of Eggplants Pests and Ways to Manage them Organically**

| Pest | Damage | Control |
|---|---|---|
| Aphids Different species | Suck plant juices; a vector of diseases; creates honey dew; misshapen foliage, flowers and fruits. | Insecticidal soap; release of beneficial insects if they are available (lady beetle, lacewings etc.); applications of beauvaria bassiana, pyrethrum, rotenone |
| Colorado potato beetle *Leptinotarsa decemlineata* | Feeds on foliage | Application of Bacillus thuringiensis, neem, pyrethrum, and rotenone on larvae |
| Spider mites *Tetranychus* spp. | Feed on plant juices and cause yellowing and browning of leaves | Promote natural enemies like ladybird beetles, green lacewings, predatory mites Application of Tephrosia, garlic, neem, pyrethrum, turmeric |
| Western potato flea beetle *Epitrix subcrinita* | Feeds on foliage, cause tiny holes in the leaves. Damage can be severe, especially on young plants | applications of neem, pyrethrum, rotenone, sabadilla |
| Wireworms *Limonius* spp. Brown, jointed larvae of click beetles | Kill young plants, weaken older ones. | Tobacco, neem |
| Cutworm | Cut plants stem | Use of parasitic nematodes to soil, spreading wood ashes around the stem, moist bran mixed with Bt scattered on soil. |

## 3.7.6. Weed Management

Weed control is important during the first growth stages. After that the plant achieves enough height and strength to compete for water and sunlight.

Successful weed regulation in organic eggplant production is based on a combination of different strategies. Planning for a diverse crop rotation – especially when involving cover crops that compete with weeds – is the first and most important step in organic eggplant production. Organic growers also pay much attention to sanitation measures that avoid the introduction of weeds (seeds and propagules).

## 3.7.7. Harvesting and Post Harvest Handling

Harvest eggplant fruit when they have developed full bright color for the variety, but while they are still firm to touch. At this stage, the seeds will be young, white, and tender and the flesh firm and white. As the fruit passes the prime stage for eating and becomes over-mature, the fruit surface becomes dull, the seeds harden and darken, and the flesh becomes spongy. Prompt picking increases fruit set and yields.

Fruit are cut from the vine about 3 cm above the calyx or fruit attachment, using a sharp knife or clippers. Fruits are wiped clean or washed after harvest to enhance their glossy appearance. Fruits must be handled carefully so that the spines on the calyx (or other sharp objects) do not pierce their delicate skin.

### Storage

Eggplants should be stored between 7 and 13°C with a recommended humidity level of 90-95%. Eggplant fruit are chilling sensitive at 10°C and below and deteriorate rapidly at warm temperatures, so they are not adapted to long storage. Pitting, surface bronzing, and browning of seeds and pulp are symptoms of chilling injury, and loss of sheen and wilting are symptoms of normal deterioration. Sensitivity of eggplants to chilling differs with cultivar, maturity, size of fruit, and season of harvest. Fruit harvested at optimum maturity or in midsummer are more sensitive than those harvested at an over-mature stage or in the fall, when the growing temperature is cool. Thus, eggplants harvested in midsummer can be held approximately a week at 13°C, whereas those harvested in fall can be held about 10 days at 9°C.

## 3.8. Lettuce

Lettuce (*Lactuca sativa L.*) is a seasonal herb of the family Compositae. Some varieties form heads and are called cabbage or head lettuce. The leaves are large, more or less crinkled, sometimes lobate and varying in color from pale green to purple. The rosettes of cabbage lettuce are sometimes very compact.

There are five distinct types of lettuce: **leaf** (also called loose-leaf lettuce), **Cos** (or **romaine**), **crisphead** (or **Iceberg**), **butterhead** and **stem** (also called asparagus lettuce).

Leaf lettuce, the most widely adapted type, produces crisp leaves loosely arranged on the stalk. It is the most widely planted and consumed salad vegetable. Cos or romaine forms an upright, elongated head; crisphead varieties, the iceberg types, are adapted to northern conditions and require the most care. The butterhead varieties are generally small, loose-heading types that have tender, soft leaves with a delicate sweet flavor and stem lettuce forms an enlarged seeds stalk.

### 3.8.1. Ecological Requirements

Lettuce responds well to a moist, rich soil, full exposure to sun and cool weather conditions. It is a typical plant of the temperate climate.

**Temperature**

It is grown everywhere where the average temperature remains between 10°C and 20°C. In a hot climate, head building can be disturbed. Generally, lettuces would benefit from cool nights, which tend to enhance its mild sweet flavor; whereas high temperatures in general (above 25° C) tend to produce strong flavors (bitterness). Certain semi-head and leaf lettuce are more tolerant of high temperatures and do not develop strong flavors.

### Soil

Sandy peat and mucks, deep black sandy loams and loams are the most suitable types of soil. Lettuce is slightly tolerant to acidic soils, but ideal pH ranges between 6.0 and 6.8. Good moisture holding capacity with good drainage is important, especially for heading types. Soils that compact easily or are compacted can adversely affect head lettuce growth. For successful head lettuce production, soils should be managed to reduce compaction as much as possible. In the case of direct seeding, a fine soil texture support a good germination.

## 3.8.2. Organic Lettuce Production Systems

### Suitable Varieties

Although mostly adapted to colder climates, there are summer and winter varieties which can be used in each of the seasons.

### Propagation and Nursery Management

Lettuce should be sown into seeding trays so that young plants may grow strong enough for the field. Transplanting occurs when plants have 4-6 leaves, usually after 25 – 30 days. To get stronger and bigger lettuce, seedlings can be covered with a fine layer of substrate during its growth on the trays. Because of the danger of soaking small plants, it is not advisable to irrigate the trays one day before transplanting occurs.

Raised beds are ideal for lettuce production. They help prevent damage from soil compaction and flooding. They also improve air flow around the plants resulting in reduced disease incidence.

### Seeding

Seeding depths is about ? to ? inch. In case of heavier soils, less depth is recommended. Germination will take place 3-5 days under good conditions. Direct seeding needs some thinning 10 to 14 days after the seeding day.

### Transplanting

Normally, transplanting is done manually or semi-manually with planters who ride on platforms close to the ground setting seedling blocks in the prepared furrows.

Depending on the type of lettuce, seedlings are planted in smaller or larger distances in and between the row.

**Table 66: Distance between and in the Row for Plantation of Lettuce**

| | Distance in the row | Distance between the rows |
|---|---|---|
| Lettuce | 0,25 m | 0,25 – 0,30 m |

## 3.8.3. Soil Nutrition and Irrigation

### Fertilization

Liming is made necessary where soils have a low pH. Previous fertilization with manure or organic compost and phosphorus, 8-10 days before transplanting young plants, will also aid in a better development.

### Conditions for the Nutrient Availability

Because of its small roots, nutrient availability for lettuce is more difficult than for other species. About 80% of the growth occurs 3-4 weeks before harvest. This is the most critical period. During the same period, a physiological disorder called tipburn occurs most often. Tipburn is said to be linked to an undersupply of Calcium. Fertile and well balanced soil is the best precondition to ensure a satisfactory nutrient supply.

### Irrigation

Lettuce requires a constant supply of moisture for the whole growing period. In the later stages of crop development, a good supply is of particular importance. However, conditions that are too dry or too wet lead to heads of less quality.

As many as 8-10 irrigations and 10-12 inches of water per acre may be necessary depending on seasonal variation, variety and planting date. Soil type does not affect the amount of total water needed, but does dictate frequency of water application. Lighter soils need more frequent water applications, but less water applied per application. Sprinkler irrigation in lettuce is widespread.

## 3.8.4. Pest and Disease Management

Preventive measure against such pests and diseases have priority in organic lettuce production:

- Optimal site selection
- Selection of pest and disease resistant varieties
- Wide rotation (to avoid soil borne diseases)
- Creation of semi-natural habitats and ecological compensation areas
- Improve soil fertility and activate soil microbial life
- Balanced nutrient supply
- Intercropping of different vegetables (e.g. Basil as repellent against Aphids)

With these preventive measures most pest and disease problems can be avoided or reduced. In addition, organic preparations can be applied (see positive lists); however, they often are less effective than synthetic products. Therefore only a combination of preventive and curative methods lead to a successful organic lettuce production. Attention must be given to the legal requirements for organic agriculture (e.g. EU-regulation for organic agriculture only allows for a restrictive use of means like copper, natural insecticides etc.). In the case that new preparations should be applied, approval granted by the responsible certification body is necessary.

### Disease

**Table 67:**
**Examples of Lettuce Diseases and Ways to Manage them Organically**

| Disease | Symptoms | Preventive measures | Direct measures |
|---|---|---|---|
| Viruses (mosaic and others) | Rottening of leaves; bad formation of leaves; small plants | Control insects that act as vectors to these diseases | Remove infected plants |
| S. minor (lettuce drop); S. sclerotiorum | Leaves wilt and fall from the head in succession. The heart may remain erect, but becomes a wet, slimy mass | Reduce humidity beneath and between the foliage (wider rows, pruning of old leaves); | *Coniothyrium minitans* and *Trichoderma spp.* Only parasites that have shown good effects against *S. Sclerotium* |
| Botrytis | Tip-end rot | Proper aeration (field/storage room) | Remove infected plants (field and storage room); application of antagonistic fungus *Trichoderma harzianum* seems to be effective (not applied in practise until now) |
| Septoria | | | Copper applications |

## Pest Insects

**Table 68: Examples of Lettuce Pests and Ways to Manage them Organically**

| Pest | Damage | Control |
|---|---|---|
| Aphids, primarily Green peach aphid Myzus persicae | | Natural enemies, some of which are specific and others that are general to all aphids. Most effective e.g. in Hawaii are the predatory syphid maggots, Allograpta sp., lady beetles and parasitic wasps. Other effective parasite is Diaretus chenopodiaphidis Ashmead; In urgent cases tobacco applications; |
| Cucumber beetles including Western spotted cucumber beetle Diabrotica undecimpunctata | Attack seedlings and feed on foliage | Use of White Tephrosia (Tephrosia candida) in form of mulch and/or aqueous extract (20g of leaves in 100 ml of water); Tephrosia plants contains strong fish poisons which may also affect human health. |
| Cutworms and Armyworms | Feed on stems and leaves. Usually in soil during the day | Cultural Methods: Plowing one month before planting to turn caterpillars/larvae to the surface; hand-picking at night |
| Loopers, including Alfalfa looper Autographa californica | | Bacillus thuringiensis |
| Slugs, Several species | | Hot chili preparations (aqueous extract) |
| Land mollusks | feed on foliage and leave slime trails | Sweet Basil leaf extract |
| Wireworms Limonius spp. | | Intercropping of garlic |

## 3.8.5. Harvesting and Post Harvest Handling

Because lettuce is so fragile, it is handled as little as possible. Most fresh market lettuce is hand cut and trimmed, and placed in cardboard cartons in the field. It is then trucked to a central area for vacuum cooling. In a few areas it is not vacuum cooled, but placed in a cooler for temporary holding until trucked to market. No lettuce is washed before it gets to the store, but some may be hydro cooled or hydro-vacuum cooled.

Lettuce and other leafy items must be kept clean, and free of soil and mud. A stronger bitter taste and toughness develops if harvest is delayed or if crop is over- mature, and then the product becomes unmarketable.

Lettuce is extremely perishable and needs to be handled delicately, and marketed rapidly. Lettuce may be held temporarily at 0°C and 90-95% relative humidity for several days.

Head lettuce is harvested when the heads are of good size (about 2 lbs), well formed and solid. If the plants are wet with rain or dew the leaves are more brittle and break more easily. Leave three undamaged wrapper leaves on each head. Put 24 heads in rigid cardboard containers in the field and avoid bruising. Grade heads according to size, pack in cartons (vacuum cooling is mandatory) for long shipments. Leaf, butterhead and cos types are cut, trimmed and tied into compact bundles before placing in cartons.

## 3.9. Onions

Onions (*Allium cepa L. var cepa*) are originally from the middle Asia. They are related to garlic, asparagus and other crops of the Liliaceae family. Onions, with their different possibilities of utilization (fresh, dry, and processed etc.) are one of the most important vegetables worldwide.

There are two basic types of onions; bulb-forming onions produce a single bulb in a season. Bulb-forming onions include storage onions and "sweet" onions. The difference between storage and fresh onions is that storage onions keep for a longer period of time.

Organic Onions

Onions for storage generally have a darker color, thicker skins, and a more pungent flavor than fresh onions. Storage onions can be grown from seed, onion sets, or transplants.

Perennial onions produce clusters of small onions. Perennial onions include potato onions, bunching onions, Egyptian onions, and shallots. Fresh onions don't keep well and are best eaten soon after they are harvested. They are commonly referred to as sweet onions.

### 3.9.1. Ecological Requirements

Optimal soils are middle heavy soils, with a neutral pH and good infiltration that permits the percolation of the water. Onions like warm temperatures and less than 750 mm precipitation. They grow well in different temperature ranges and are suitable in northern, subtropical and tropical climates. Typical productions regions are dry areas, with warm temperature and high sunlight.

### 3.9.2. Organic Onion Production Systems

**Suitable Varieties**

It is recommendable to use fast growing varieties that will shorten the susceptible period for diseases.

**Propagations and Nursery Management**

Onions can be grown from seeds, small dormant onions called "sets", or onion transplants:

- Set onion: seeds 90 kg per ha, row distance 20 cm, 2 - 3 cm deep. Harvesting when the set onions have a size of 15-20 mm diameter. Store them dry until planting
- Plantlets: 4-5 seeds per pot in 4cm cubes or tray with 20-50 $cm^3$ pots; ready to plant with 3 leaves.

**Sawing or planting in the field:**
The size of the onion mainly depends on the sawing/planting distance:
With low sawing or planting density, you will harvest big onions.

- Direct sawing: 4-6 kg seeds per ha;
- Planting set onions: 800 - 1000 kg per ha, with 5 to 7 cm distance in the row.

Onions intercropping with papaya.

### Crop Rotation

Organic onions are planted in a crop rotation schedule. It is not recommendable to plant onions in the same soil for more than one season. Onions can be planted only one time within five years in the crop rotation. This is important in order to avoid diseases. Previous crops can be potatoes, crucifers, field beans, but not carrots or celery. Onions have a good effect as a preceding crop. Onion organic matter residue is about 1 ton per ha, which contains approximately 25 kg of nitrogen, 10 kg of phosphor, 35 kg of potassium. Crops that can be cultivated after onions in the same year include, for example, spinach.

## 3.9.3. Soil Nutrition and Irrigation

### Fertilization

Onions don't require high nutrient supply. A good potassium-nitrogen relationship is important in order to avoid diseases and guarantee good storage-quality. Planting cover crops (e.g. hairy vetch) before onion crops in many cases provides enough nutrients for onions. Suitable organic fertilizers are well fermented compost (15 to 20 ton per ha). Fresh animal manures are not suitable because they increase infestations with pest insects (onion fly).

### Irrigation

Sufficient water supply is important for the development of onions. Water slowly and deeply to produce healthy onions.

## 3.9.4. Pest and Disease Management

### Disease

Diseases caused by fungi are common in onion production. Frequent diseases are downy mildew (*Peronospera destructor*), different Botrytis diseases (*Botrytis aclada, B. cinerea*) and white rot of onion (*Sclerotium cepivorum*).

Growing onions in good aerated soil and within an optimal crop rotation are ideal preventive measures to reduce the possibility of infestations. Organic growers mainly plant onions at the end of the crop rotation because they have low nutrient requirements. Before the next onion crop, a 4-5 year period free of Liliaceae are necessary.

Additional preventive applications of substances that make plants resistant to diseases and improve protection against diseases (e.g. extracts of herbs).

### Pests

Trips can cause problems to organic onions. Cultural measures are: crop rotation; deep plowing (20 cm) after the harvest to destroy the larvae living in the soil; trips do not like wet plants, so irrigation can also slow down trips. In case of high infestation pressure rotenone and pyrethrum may be applied (see positive lists of organic standards). Control in these plant extracts is often poor, and as a draw-back, the beneficial organisms will be harmed.

Organic growers protect their onions from onion fly (*Della antiqua*) and leek moth (*Acrolepia assectella*) with a plant protection net. For large plots, this method may be too expensive; therefore it is mostly used for small plots and mainly for fresh onions. If the pressure of leek moth is high, neem spraying will have an effect.

## 3.9.5. Weed Management

Onions are not very competitive due to the long period of germination and the poor cover of the soil. Therefore, organic onions should be grown in areas with low weed-pressure and in the rotation after a cover crop. Furthermore, onions are shallow rooted and any cultivation should be cautious to avoid damage to the bulbs or roots. Cultivation should be shallow, without bringing excessive soil to the plants. Due to these conditions, other recommendable steps in organic onion production include:

Onion fields.

- Starting with bulb-onions (dormant onions);
- Weeds should be controlled before planting the onions;
- Mechanical weed regulation (hoeing) should start at the early development of the weeds;
- Take special care of weeds that germinate in latest stages of the crop. This can cause problems during the harvesting;
- Mulching can also help control weeds.

## 3.9.6. Harvesting and Post Harvest Handling

**Fresh Onions**

Fresh sweet onions can be stored for several weeks in a cool, dark place. They can be stored in the refrigerator, but not in plastic bags. This will inhibit air circulation and promote rotting of onions.

**Storage**

The ripe period for storage onions is reached when at least 75% of the crop populations has been laid down. Too early a clearing can cause problems during storage. Too late a clearing can cause the shell to drop away and induce sprout out. After the harvest, the onions will store better if they are dried for a week outdoors. Leave tops on bulbs during drying. After drying, cut tops within 3 cm of bulb. The onions can be picked up manually or with a full harvester. Onions are stored in dry and good ventilated stores. Storage temperatures should be below 30°C.

## 3.10. Radish

Radish (*Raphanus sativus L.*) belongs to the Brassicaceae or mustard family. It is a very old crop plant cultivated in Egypt at the time of the Pharaohs, as well as in ancient Roman and Greece.

Numerous varieties are grown, classified according to the shape and color of the root or the growing season. The ancient black radish is seldom cultivated nowadays. The most widely used varieties are the white and/or red radish; rapidly maturing plants are always eaten young and raw. In Chinese and Japanese cooking radishes are generally cooked, eaten in soups, pickled (Kimchi) and dried. Here oriental types, such as the elongated and round daikon radishes (or Long White Radish) are important staple foods. In India, mourgi radish (rat-tailed radish), grown for its seed pods, is very common (seeds of radish are sprouted). Specific varieties of oil-seed radish also exist.

### 3.10.1 Ecological Requirements

Given their short biological cycle (25 to 90 days depends on the variety) and the selection of an appropriate planting period, radishes may be grown in a wide range of environments.

#### Temperature

Radish prefers cool and not too sunny days, and grows best in spring and autumn. Even light frosts will be tolerated. The optimum temperature is between 10-20 ° C. Radish seed will not start to germinate with soil temperatures above 35° C.

Therefore, in (sub-) tropical areas, the rainy/winter season seems to be the preferred cultivation time. High temperatures lead to the development of small tops and roots will become pithy after reaching maturity rapidly, and a strong flavor will be produced.

#### Soil

Radishes need light, well-drained and highly fertile soils for easy root expansion. If the soil is crusty, roots become misshapen. Light mineral soils or muck soils are preferred but radishes may be grown on a wide range on other soils too (like their ancestor, the wild radish, which is grown in nearly all types of soil). Daikon radish requires deep, friable soil for best quality roots. Commercial cultivation must take into consideration roots that need to be washed, which will be more difficult in heavier soils.

Due to the fact that the crop develops very rapidly and the root system is not very extensive, the most favorable conditions for root activity should be attained by thorough seed-bed preparation and shallow cultivation.

Soil pH should be maintained about 6.5 or higher by adding lime (dolomitic lime). In spite of the fact that radish will tolerate slightly acidic soils, pH should not go below 5.5.

### 3.10.2 Organic Radish Production Systems

#### Design of the Rotation

As for all members of the mustard family, the selection of the correct production site is of utmost importance:

No crucifer crop, or related weed, should have been present in the field for at least 3-4 years (members of the mustard family include cabbage, cauliflower, broccoli, kale, kohlrabi, Brussels sprouts, Chinese cabbage, all mustards, turnips, rutabagas, radishes etc.; Cruciferous weeds include wild radish, wild mustards etc.). Also, crucifer plant waste should not have been dumped on these fields.

It is well known that radishes will thrive under close planting or as an intercrop between rows of later-maturing plants. In some cases, radish can be used as a companion crop (e.g. intercropping is recommended with cucumbers against cucumber beetle).

### Direct Seeding

Radish is sown directly in rows. Seeding depth is 10-20 mm, whereas a distance between the rows of 20 cm. 40 to 60 plants per meter is desirable. Depending on the percentage of germinated seeds, thinning out may be required in order to avoid high plant densities (which will lead to less quality roots). Germination will start 4-8 days after seeding. Sow every seven to 10 days in order to ensure a continuous supply of radishes. Of course, bigger varieties like Daikoon need another row spacing.

## 3.10.3 Soil Nutrition and Irrigation

### Fertilization

The application of animal manure (and compost) some weeks before sowing helps to build up the water holding capacity and balance the nutrient supply. In the same context, correct positioning in the crop rotation is important in order to ensure a good nutrient supply from the early beginnings of the growth period. About 15t/ha organic manure can be applied, attention has to be given to an oversupply of nitrogen (e.g. with poultry manure) as this could lead to excessive top growth and bad qualities.

### Irrigation

Keeping the short production period in mind, continuous growth and subsequently continuous water supply is needed. Quick growing can be ensured by irrigation for optimum growth and tenderness. For best root quality, irrigate to maintain uniform and vigorous growth. In addition to irrigation, a well prepared soil enriched with organic material is important to guarantee satisfactory water holding capacity.

Of course, the long white radish (Daikoon) needs more water because of the longer growth period (60-70 days) in comparison to the bunching types (with 25-35 days).

Soil type does not affect the amount of total water needed, but does dictate frequency of water application. Lighter soils need more frequent water applications, but less water applied per application.

## 3.10.4 Pest and Disease Management

Preventive measure against such pests and diseases have priority in organic radish production:

- Optimal site selection
- Selection of pest and disease resistant varieties
- Wide rotation (to avoid soil borne diseases)
- Creation of semi-natural habitats and ecological compensation areas
- Improve soil fertility and activate soil microbial life
- Balanced nutrient supply

With these preventive measures, most pest and disease problems can be avoided or reduced. In addition, organic preparations can be applied (see positive lists); however, they often are less effective than synthetic products. Therefore, only a combination of preventive and curative methods leads to successful organic radish production. Attention must be given to the legal requirements for organic agriculture (e.g. EU-regulation for organic agriculture only allows for a restrictive use of means like copper, natural insecticides etc.). In the case that new preparations should be applied, approval granted by the responsible certification body is necessary.

### Disease

Due to the short cultivation period only a few diseases cause economic losses. One of them is black rot, a fungus disease.

**Table 69: Examples of Radish Diseases and Ways to Manage them Organically**

| Disease | Symptoms | Preventive Measures |
|---|---|---|
| Black Rot | Dark irregular patches on the root | Good soil drainage as well as crop rotation (3-4 years) |
| White Rust | White pustules on the leaves, stems | Crop Rotation (3-4 years); Separation |
| | and flowers | of young and old crops; Destruction |
| | | of infested crop residues; |

### Pest Insects

The most important pests are cabbage white butterfly, aphids and diamondback moth, which also attack cauliflower and cabbage (or other crucifers).

**Table 70: Examples of Radish Pests and Ways to Manage them Organically**

| Pest | Damage | Control |
|---|---|---|
| Aphids, including Cabbage aphid *Brevicoryne brassicae* Turnip aphid *Hyadaphis erysimi* Green peach aphid *Myzus persicae* | Cabbage and turnip aphids are gray mealy plant lice forming colonies on foliage or in heads or in buds | Support of natural enemies like Lady Bird Beetles |
| Cutworms and Armyworms including Black cutworm (*Agrotis ipsilon*) | | Cultural Methods: Plowing one month before planting to turn caterpillars/larvae to the surface; hand-picking at night for removal of larvae; Natural insecticides: Derris, Rotenon; Bacillus thuringiensis |
| Diamondback moth (*Plutella xylostella*) | Small, pale yellowish-green larvae with erect black hairs. Eats holes in foliage. | Planting of trap crops (collards) between cabbage rows and/or around the cabbage field; Sexual pheromones; Spraying of B. thuringiensis; Larval parasitoid Diadegma semiclausum; |
| Flea beetles including cabbage flea beetle *Phyllotreta cruciferae* | Frequent attacks and destroys seedling plants. | Intercropping with garlic; Early season trap crop along the field; garlic mixture with water; Neem and Derris; |
| Wireworms Ctenicera and Limonius spp. | | Intercropping of garlic |

## 3.10.5 Weed Management

Because of the short growing period and the fact that radishes are grown in smaller areas, weed control is not a severe problem. Good land preparation before seeding (encourage the weeds to germinate before sowing) is the best way to avoid problems. Furthermore, inter-row cultivation of other crops (green manure) can be done to suppress weed growth as well as mulch with organic materials. However, in case of severe problems, manual weeding is necessary to avoid any damage to the radish crop.

## 3.10.6 Harvesting and Post Harvest Handling

All harvesting is done by hand. Red radishes are pulled and tied in bunches. The bunches are washed and should be cooled immediately after harvest for best shelf life. Radishes should be kept moist and cool at all times to prevent dehydration. Daikon radish may be mechanically undercut before harvest and can be processed (for dried and pickled radish).

Radishes tend to wilt. Therefore, harvest them in the cold and keep them cool and moist. In the storage room temperature should be around 0°C and a the relative humidity around 90%.

## 3.11. Spinach

Spinach (*Spinacia oleracea L.*) is of little importance in the tropics and subtropics because it grows well only under cool weather conditions. Better adapted to warm weather conditions are vine spinach (*Basella sp.*) and New Zealand spinach (*Tetragonia expansa*).

Malabar spinach, also known as Vine spinach, Indian spinach, Malabar Nightshade, Pasali and Pu-tin-choi, is a regular food item in tropical Africa and southeast Asia, where it originated. It is a low growing plant that sends out runners, with thick, dark green leaves.

New Zealand spinach is a seasonal herb of the family Tetragoniaceae, native to Asia and commonly used in South America. It is a prostrate, creeping vegetable and looks like a many-branched trailing plant. It has typical pale green leaves, fleshy, oval to lanceolate in shape.

All the foliage is edible and is consumed as a leafy vegetable, in sauces or as a side dish.

The plant grows from seed. It thrives in full sunlight, and is very productive in well-watered soils rich in organic manure.

### 3.11.1. Ecological Requirements

#### Soil

Muck soils provide needed organic matter and high, uniform, moisture content. Sandy soils or sandy loam soils may be used, especially in the case of New Zealand spinach. A pH of 6.2 to 6.9 is optimum with a pH between 6.5 and 7.0 being ideal for good growth. In general, all types of spinach grow very poorly at pH levels below 6.0.

#### Temperature

Recent research indicates that a temperature of 15-20°C is ideal for optimal growth.

### 3.11.2. Organic Spinach Production Systems

#### Suitable Varieties

The use of proper varieties is very important. For spinach (*Spinacia oleracea L.*), slow-growing, slow-bolting (slow seed-stalk development as day length increases) varieties are used for late spring and summer harvest, while fast-growing (these tend to be fast bolting), vigorous varieties should be used for fall, winter, and early spring harvest. Although long days and increasing temperature predispose spinach to bolting, bolting is increased by exposure of young plants to low temperatures.

Disease resistance in spinach varieties is developed for the season to which the variety is adapted. With proper varieties, spinach production for the fresh market is possible almost year-round.

Flat, semisavoy, and savoy leaf varieties are used for different markets. The flat and some of the semisavoy varieties are used for processing. All three types are used for fresh market with semisavoy and savoy types predominating.

Spinach varieties may also be classified as prostrate, semi-erect, and upright. The savoy types are not suitable in organic farming for processing. In conventional farming, plant growth regulators may sometimes be applied before harvest to cause a more upright leaf growth and reduce the risk of soil contamination. This is important due to difficulties in removing soil from savoy leaves during washing and processing.

Malabar spinach (*Basella spp.*) has three species which are common: *B. rubra, B. alba,* and *B. cordifolia,* which are red stem, green stem, and heart-shaped leaf forms, respectively. This is a warm-season crop that produces aggressive vines that may reach 3 to 4.5 m in length. The succulent leaves and tender shoots are marketed and used in the same way as spinach.

New Zealand spinach (*Tetragonia expansa*) is a tender annual with fleshy stems and leaves, resembling spinach. It has very limited commercial demand, but because of its adaptability to hot summer temperatures and drought, it is popular in warmer climates. In Brazil there is one adapted variety that is sold, called New Zealand (same name).

#### Propagation and Nursery Management

All types of spinach (*Spinacia oleraceae L., Basella spp.* and *Tetragonia expansa*) can be sown directly into the field, although soil moisture and temperature should be ideal. It is also of great importance that the right spacing in and between rows is followed (see table 71). Because of their toughness, seeds should be soaked in warm water for 24 hours before being planted. In cases where seeding trays are used, seedlings should be transplanted as soon as they reach the 3-5 leaf stage.

In the tropics and sub-tropics spinach (*Spinacia oleraceae*) can be planted in autumn; in colder regions at higher altitudes, above 800 m, spinach thrives all year long. Because of the heat, bolting before the leaves are large enough to consume is a very common problem.

New Zealand spinach (*Tetragonia expansa*) may germinate slowly and irregularly, but once the plants are established, they drop seeds and start new ones.

**Table 71: Distance between and in the Row for the Planting of Spinach**

| Type | Distance in the Row | Distance between the Rows |
|---|---|---|
| Spinacia oleraceae | 0.3 m | |
| Tetragonia expansa | 0.4 – 0.5 m | 0.3 – 0.4 m |
| Basella spp. | 0.2 – 0.4 m | |

## 3.11.3. Soil Nutrition and Irrigation

#### Fertilization

In general, decisions on the level and type of fertilization needed should be based on the results of soil analysis and field history. Soil nutrition has to be regarded as a long term investment. Tropical soils are known as rather acidic soils, with low pH and high aluminum content. In these cases, spinach growth requires correction with calcium.

Fertilization after each harvest is useful for a better re-growth of the leaves.

#### Irrigation

Spinach is a quick-growing, shallow-rooted crop that is not tolerant to water stress. Maintain adequate moisture by frequent irrigation when necessary but avoid irrigation practices that splash soil onto the leaves or damage them.

New Zealand spinach is very resistant to heat and dry soil, but achieves best results when irrigated.

## 3.11.4. Pest and Disease Management

Preventive measure against such pests and diseases have priority in organic spinach production:

- Optimal site selection
- Selection of pest and disease resistant varieties
- Wide rotation (to avoid soil borne diseases)
- Creation of semi-natural habitats and ecological compensation areas
- Improve soil fertility and activate soil microbial life
- Balanced nutrient supply
- Intercropping of different vegetables

With these preventive measures, most pest and disease problems can be avoided or reduced. In addition, organic preparations can be applied (see positive lists); however, they often are less effective than synthetic products. Therefore only a combination of preventive and curative methods lead to a successful organic spinach production. Attention must be given to the legal requirements for organic agriculture (e.g. EU-regulation for organic agriculture only allows for a restrictive use of means like copper, natural insecticides etc.). In the case that new preparations should be applied, approval granted by the responsible certification body is necessary.

### Disease

**Table 72: Examples of Spinach Diseases and Ways to Manage them Organically**

| Disease | Symptoms | Preventive measures | Direct measures |
|---|---|---|---|
| Cercospora leaf spot *Cercospora beticola* | Fungal disease which causes small gray spots with red or brownish-red edges on leaves. The infected tissue drops, leaving a perforated surface | Ideal management of irrigation; respect sowing season; Crop rotation | Application of fungicides based on copper |
| Mildew (Oidium) | White spots on the upper side of the leaf lead to its death in later stages | Ideal management of irrigation; high air humidity promotes dissemination after the primary infection | Application of fungicides based on copper |
| Alternaria | Dry and brown spots with concentric circles and bright edges appear on older leaves | | Application of fungicides based on copper |

### Pest Insects

Proper rotations and field selection can minimize problems with insects.

**Table 73: Examples of Spinach Pests and Ways to Manage them Organically**

| Pest | Damage | Control |
|---|---|---|
| Aphids, including Bean aphid *Aphis fabae* | Suck sap | Insecticidal soap; garlic extract; milk with ashes; applications of B. bassiana; rotenone; nicotine. |
| Black plant louse | colonizes foliage | Applications of nicotine |
| Green peach aphid *Myzus persicae* | Suck sap of leaves | Insecticidal soap; milk with ashes; nicotine |
| Melon aphid *Aphis gossypii* | Suck sap of roots; death of young plants | Applications of nicotine |
| Cucumber beetles including Western spotted cucumber beetle *Diabrotica undecimpunctata* | Feeds on foliage | Application of rotenone |
| Cutworms Agrotis sp. | feed on the leaves for the first 1 or 2 weeks then on the roots and at night they emerge and feed on the upper parts | young caterpillars feeding on leaves can be controlled with preparations of derris, pyrethrum or tobacco. The moths can be caught with light traps. A mixture of wood ash and chalk on the soil reduces the activity of the older caterpillars. |
| Armyworms (caterpillars of various moths, most of them belonging to the genera *Spodoptera* | can completely destroy young plants, feed on leaves | Release of beneficial insects if they are available; applications of Bt on larvae, superior oil. Spraying of insect-controlling plant preparations like neem, tobacco, garlic-pepper extract. |
| Lygus bugs *Lygus spp.* | sucking plant juices of young seedlings | spray pyrethrum preparations |
| Wireworms Limonius spp. | | Intercropping of garlic |
| Loopers, including Alfalfa looper *Autographa californica* | | Intercropping of onions, radish; Bacillus thuringiensis |

## 3.11.5. Weed Management

**Table 74: Direct Measures for Weed-regulation in Organic Spinach Production**

| Measure | Advantages | Disadvantages |
|---|---|---|
| Manual hoeing | Reduces cutworms | More work (high costs) |
| Dead mulch | No need of hoeing | Costs a lot of time to prepare the mulch if cutting machines are not available (most cases) |

## 3.11.6. Harvesting and Post Harvest Handling

Spinach for processing yields are approximately 8 to 10 tons per acre.

For processing - harvest before plants are too large or begin to bolt (usually when about 40 cm tall). Sometimes a second cut is made for a chopped pack after suitable re-growth has developed.

At harvest, the first cut is made 14 - 18 cm above the ground in order to eliminate as much stem and petiole as possible from the whole leaf pack. This also is done to avoid as many of the yellow or old leaves as possible. At the second cutting, small disks are used to cut away these yellow or old leaves and to remove some soil away from the crown to facilitate harvest. Depending on temperature, and plant density, 3-4 weeks are needed between the first and second cutting to obtain adequate re-growth.

A number of mechanical harvesters are available for processing spinach.

**For fresh market -** plants should be dry and slightly wilted to prevent petiole breakage. When harvesting by hand, cut above the crown or soil line and bunch. Care should be taken to exclude leaves that are dirty with soil or are yellow. Bunched spinach must be handled extremely carefully to reduce breakage of plants or bunches during bunching, washing and packaging.

Specialty leaf lettuces and spinach for bag mixes have usually been hand harvested, but mechanical harvesters for this purpose are now available.

Freshly cut spinach is highly perishable. Care is needed in keeping loads from overheating. Loads must be cooled if they are to be transported long distances to the processing or packing plant.

Keep spinach at 0°C and 95 to 100% relative humidity. Spinach is very perishable; hence, it can be stored for only 10 to 14 days. The temperature should be as close to 0°C as possible because spinach deteriorates rapidly at higher temperatures. Crushed ice should be placed in each package for rapid cooling and for removing the heat of respiration. Top ice is also beneficial. Hydro-cooling and vacuum cooling are other satisfactory cooling methods for spinach.

Most spinach for fresh market is prepackaged in perforated plastic bags to reduce moisture loss and physical injury. Controlled atmospheres with 10 to 40 percent carbon dioxide and 10% oxygen have been found to be beneficial in retarding yellowing and maintaining quality.

### Packing

Spinach is commonly packaged in 20 to 22-lb cartons packed 2 dozen each; or 7.5 to 8-lb cartons of 12 film bags, each 10 oz; or 20 to 25-lb bushel crates.

## 3.12. Sweet Corn

Sweet corn (*Zea mays var. rugosa*) has specific environmental and cultural needs that must be met for the plant to produce marketable yields. Corn is a warm-season crop that requires high temperatures for optimum germination and rapid growth. Climatic conditions, such as drought or flooding, can reduce yields and cause small, deformed ears.

Corn is wind-pollinated and should be planted in blocks of at least 4 rows for good pollination to occur. Sweet corn can also cross-pollinate with other types of corn. If sweet corn is planted downwind of popcorn or field corn, kernels will be starchy instead of sweet. Cross-pollination between white and yellow cultivars will change the colors of the kernels. Extra-sweet and standard cultivars also should not be planted near each other or at the same time. To prevent cross-pollination, sweet corn should be separated from different types of corn by at least 300 m; different types or cultivars of corn should be planted at least 1 month apart, or cultivars with different maturity dates should be planted.

### 3.12.1. Ecological Requirements

#### Soil and Climatic Requirements

Sweet corn grows best in a well-drained soil with a pH of 5.5 to 7.0. In choosing a site for corn production, heavy clay soils with poor drainage and areas subject to flooding should be avoided. Dry, sandy sites should only be used if irrigation is available. Soil pH can be raised by incorporating ground limestone. Because soil reaction with lime is slow, limestone should be incorporated early, preferably before corn sowing.

### 3.12.2. Organic Sweet Corn Production System

#### Suitable Varieties

Variety selection is an important consideration in sweet corn production and includes factors such as sweetness, days to maturity, seed color, size, yield potential, and tolerance to pests.

Three types of sweet corn are available: standard (su), sugary-enhanced (se), and super-sweet (sh2). The su type is the old-fashioned sweet corn with which we are all familiar. It must be consumed quickly after harvest, or the sugars rapidly turn to starch. The se types contain more sugar than the su type and, if cooled, will remain sweet for several days after harvest. The sh2 type also contains more sugar than the su type but converts very little sugar to starch. If properly cooled, a sh2 variety will remain sweet for 7 to 10 days after harvest. Appropriate selection from available varieties suitable to local conditions has to be strongly taken into account.

#### Design of Plantation

Fresh corn seed should always be used, especially for super-sweet cultivars. Standard and sugary-enhanced corn seeds should be planted about 3 cm deep in moist, heavy soil; 3 to 6 m deep in very light, sandy soils. Super-sweets need to be planted shallow -only about 1 inch deep.

If large field of sweet corn are being planted, especially se and sh2 varieties, purchase of a precision seeder might be cost worthy to reduce seed costs and labor costs for thinning. Depending on the cultivation equipment available, seeds are usually planted 13 to 16 cm apart in rows 75 to 100 cm apart. Once the plants are well established, they should be thinned to stand 20 to 30 cm apart in the row. Sweet corn may be planted in a 3-year rotation with pumpkins and beans.

Organic sweet corn growers use cover crops to increase organic matter, improve soil tilt, and reduce erosion. Some cover crop possibilities are the hairy vetch, clover and alfalfa. To ensure the nitrogen-fixing capabilities of the legume, a grower should inoculate the legumes with the proper bacteria before seeding.

To conserve space, sweet corn is often intercropped with vine crops, such as cucumbers, pumpkins, and muskmelons. The vines can be trained to grow between the corn plants. An alternative to intercropping within the same field is strip-cropping. In this system, two or three different crops are grown in strips, commonly 2 to 6 rows wide.

An ideal rotation plan for organic sweet corn might look like this:

- year 1: legume cover crop, or a legume-grass pasture;
- year 2: sweet corn;
- years 3 and 4: other vegetables.

Long rotations like the above example are desirable because grass and legume sod crops are "soil builders", whereas row crops are soil depleters. A cover crop system for organic sweet corn involves the establishment of an annual legume, or cereal grain and legume mix. Pure stands of vetch or combinations of cereal grain and hairy vetch are suitable.

## 3.12.3. Soil Nutrition and Irrigation

### Organic Fertilization

Sweet corn is a fairly heavy feeder, and proper soil fertility is critical for high yields and good growth. Once stunted by lack of nutrients, sweet corn may never fully recover. Over the growing season, sweet corn needs approximately 140 kg of nitrogen per ha. After a successful cover crop with legumes the organic growers, apply 30 tons of manure per ha 2-3 weeks before planting. Nitrogen deficiency is fairly common in sweet corn, particularly wet soils; flooded soils; or dry, sandy soils. Nitrogen deficiency in young plants causes the whole plant to be pale comprised of spindly stalks and yellow leaf tips. In older plants, nitrogen stress is often expressed kernel tip shriveling.

Phosphorus-deficient plants are usually dark green with reddish-purple leaf tips and margins. At low pH levels or in sandy soils, magnesium deficiency may occur. Magnesium deficiency in corn appears as yellow to white striping between veins of leaves. Older leaves become reddish-purple and leaf tips may die.

Commonly used commercial organic fertilizers for sweet corn are bone meal (4% nitrogen and 21% phosphor) or cottonseed meal (7% nitrogen, 2.5% phosphor, and 1.5% potassium). Adding organic matter such as animal manure and compost to the soil increases the level of nutrients, improves soil microbial activity, and increases water-holding and nutrient-holding capacity. Sweet corn does best with a pH of 6.0 to 6.5 and needs moderate to high levels of phosphorus and potassium. Rates of application should be determined by soil testing. Rock phosphate, potassium sulfate (mined, untreated source), sulfate of potash-magnesia, and a limited number of other rock powders may also be used for organic production.

Rock mineral fertilizers, manures, and bulk composts can be applied and incorporated during field preparation and bedding operations; often, application is made in the Fall previous to the preceding cover crop. Banding to the side of the row at planting is another option-primarily in combination with organic fertilizers or palletized and fortified composts.

### Irrigation

Sweet corn needs a continuous supply of moisture to ensure pollination and growth of kernels in the ear. After the tassels are produced, sweet corn requires 1 to 2.5 l of water each week. A grower should never allow the soil to dry.

## 3.12.4. Pest and Disease Management

### Disease

Although there are several corn diseases, there now are many sweet-corn cultivars with resistance to the major diseases.

Whenever possible, organic growers select marketable cultivars with disease resistance to fit specific needs and conditions.

Corn smut, which appears particularly on white cultivars, is characterized by large, fleshy, gray-black galls on the stalks, tassels, or ears. It is important to remove and destroy the first galls before they open. To control smut, avoid injuring plantings and avoid areas where smut occurred before.

Rust and leaf blights can be a problem in extended periods of warm, moist weather or areas of heavy dew. Rust blown from field corn planted upwind nearby can threaten sweet-corn crops. Cultivars resistant to rust are recommended in threatening conditions.

Mosaic is a viral disease. It is best controlled by resistant varieties. If susceptible varieties are planted, it's important to remove Johnson grass, an alternate host, from adjacent areas, and keep aphids-the vectoring agent-in check.

**Pests**

Insects that attack sweet corn during its early growth include corn rootworm, cutworm, white grub, wireworm, and flea beetle.

**Wireworms** and **white** grubs can be regulated by delaying planting and to let exposed worms and grubs starve or be eaten by birds.

**Corn earworms:** The night-flying, light brown- or buff-colored moth lays eggs on the corn silks. Low infestations can be handled by simply removing the damaged ear tip from the corn after harvest. Earworm adult moths should be monitored by pheromone traps placed near the corn field.

**European corn borer** larvae live over the winter in stalks and ears left in the field. European corn borers usually have two generations per year. Corn is vulnerable to corn borers when tassels, silk, and pollen are present; preventative action is required or damage will occur. Field corn planted nearby is the source of most European corn borer problems for sweet corn. In most cases, a grower should plow under corn debris to help destroy over wintering stages of some pests. Trichogramma wasps provide control against European corn borers, beneficial nematodes sprayed on the corn plant and silk may reduce earworm damage, and ladybugs will help control aphid populations.

## 3.12.5. Weed Management

Weed control in organic sweet corn production is based on good rotation and timely mechanical cultivation. Before planting, weed populations can be reduced through use of crop rotations and cover crops. Try to rotate crops with different growth habits, warm season crops, and crops grown in wide and narrow rows. On small plantings, organic mulches, such as straw, can help shade out weeds between the rows. Prior to planting, till the soil several times to expose weed seeds and stimulate their germination. Conduct the last tillage just before sowing the crop. After the crop has emerged, cultivate frequently, getting as close to the corn plants as possible without damaging the roots. Spring-tooth harrows and finger weeders work especially well for this purpose. When the corn is 25 to 30 cm tall, till for the last time, throwing soil against the base of the plant (ridging). Equipment commonly used to cultivate between rows includes multi-row rototillers, coil-tine harrows and rolling cultivators. For small-scale production, a grower may walk the field frequently with a hand-held hoe.

## 3.12.6. Harvesting and Post Harvest Handling

Each sweet-corn plant should produce at least one large ear that should be harvested at prime maturity. Sweet corn should be harvested when the silks are dry and brown and the ear has enlarged to the point that the husks are tight. Under warm day and night conditions, this stage is usually 17 to 18 days after silking.

Corn should be cooled at least 4 °C. The longer the delay between harvest and cooling, the greater the conversion of sugar to starch and subsequent quality loss.

## 3.13. Water Melon

Watermelon, Citrullus lanatis, originated in South and East Africa.

Large (20-to-40-pound), red-fleshed, seeded watermelons make up the bulk of those sold commercially, but smaller (10 pound) icebox types are also grown on significant acreages. Yellow-fleshed and seedless types are also grown, but for the cultivars available now, seed is much more expensive. Production may be more difficult and yield lower than for standard cultivars.

Melon fields.

### 3.13.1. Ecological Requirements

Watermelons are also warm-season crops, requiring a 4-month frost-free period, minimal soil temperatures of 21°C for germination and soil temperatures of 24 to 27°C for optimal germination.

Watermelons are not as likely as muskmelons to produce bland-tasting (low sugar) fruit when over-irrigated. They can tolerate higher water levels and will, in fact, develop blossom end rot, a calcium deficiency present when either moisture or Ca is lacking. There are reports, however, that excess nitrogen can reduce sugar content.

#### Soil

Watermelons grow best on a sandy loam soil, with a pH between 5.5 and 6.8. If planted on clay soils, yields may be very low. In all cases, watermelons need soils with a high level of organic matter.

Watermelon is known to be sensitive to manganese toxicity, a common problem in low pH soils. Seedling watermelons react to manganese toxicity with stunted growth and yellowish crinkled leaves. Older plants generally exhibit brown spots on older leaves that may be mistaken for symptoms of gummy stem blight. Manganese toxicity is usually associated with soils having a pH below 5.5.

However, in wet seasons the condition may occur at higher pH levels when the soil has been saturated for a period of several days. This condition has been noted in several watermelon fields with pH ranges at 5.8 or slightly higher when the crop was planted flat. Planting watermelons and other cucurbits on a bed is a good insurance against manganese toxicity during a wet season. The best solution to manganese toxicity is to apply lime in the fall at rates based on the results of a soil test. A pH of 6.0 should be maintained for maximum yields.

#### Temperature

The minimum soil temperature required for germination of these crops is 16 °C, with the optimum range between 21 to 32°C.

#### Wind Breaks

In windy areas it is recommendable to plant wind breaks between watermelon plants rows (e.g. grains) in order to protect the young plants against any damage (allow enough space to avoid windbreak contact with watermelons).

## 3.13.2. Organic Melon Production Systems

### Suitable Varieties

Best market varieties fulfill characteristics such as strong rind for better transportation, small mesocarp (the white part between the rind and the fruit flesh) and sweet and juicy flesh. Seedless varieties also exist, but cause higher seed costs (and needs to be explained to the consumer as fruits are not 100% free of seeds). In general, the selection of the right variety depends on different factors such as site conditions, local availability, market demands and resistances (in case of water melons some varieties are resistant against Fusarium, Anthracnose etc.).

### Propagation and Nursery Management

Direct sowing is possible but not recommendable when dealing with seedless varieties or less than ideal site conditions. The latter would increase the germination time and delayed development in the plant.

Watermelon vines require considerable space. Plant seed 3 cm deep in hills spaced 2 m apart. Allow 2-3 m between rows. After the seedlings are established, thin to the best three plants per hill. Plant single transplants 60-90 cm apart in the rows.

To replace failures, it is best to prepare seedlings inside. Start the seeds 3 weeks before they are to be set out in the field. Plant 2 or 3 seeds in pellets, pots or cell packs and thin to the best one or two plants.

For expensive seedless types, plant one seed to a pot or cell and discard those that do not germinate. Do not start too early - large watermelon seedlings transplant poorly. If you grow seedless melons, you must plant a standard seeded variety alongside. The seedless melon varieties do not have the fertile pollen necessary to pollinate and set the fruit.

### Design of the Rotation

Due to the considerable impact of insects and diseases, watermelons should not be replanted in the same place for a period of as long as 4 years

Cultivation of other curcubits like cucumbers, melons, squash in the neighborhood of watermelons does not cause problems with product quality. Only when producing seeds for further propagation, is isolation needed to maintain crop purity.

## 3.13.3. Irrigation

Watermelons are deep rooted in sandy soils when growth is vigorous. They require uniform irrigation for optimum growth and yield. Reduce irrigations as fruit reach harvest stage.

Research has shown that the use of drip irrigation is superior to sprinkler irrigation. Drip irrigation under plastic mulch is an effective way of applying water efficiently and may reduce total water requirements by as much as 30%.

Soil type does not affect the amount of total water needed, but does dictate frequency of water application. Lighter soils need more frequent water applications, but less water applied per application. Watermelon is often grown with furrow irrigation.

## 3.13.4 Pest and Disease Management

Water melons are susceptible to physiological disturbances, diseases and pests. Preventive measures against such pests and diseases have priority in organic melon production:

- Optimal site selection
- Selection of pest and disease resistant varieties
- Wide rotation (in case of soil borne diseases)

- Creation of semi-natural habitats and ecological compensation areas
- Improve soil fertility and activate soil microbial life
- Balanced nutrient supply

With these preventive measures most pest and disease problems can be avoided or reduced. In addition, organic preparations can be applied (see positive lists); however, they often are less effective than synthetic products. Therefore, only a combination of preventive and curative methods leads to successful organic melon production. Attention must be given to the legal requirements for organic agriculture (e.g. EU-regulation only allows for a restrictive use of means like copper, natural insecticides etc.). In the case that new preparations should be applied, final approval granted by the responsible certification body is necessary.

### Disease

**Table 75: Examples of Melon Diseases and Ways to Manage them Organically**

| Disease | Symptoms | Preventive measures | Direct measures |
|---|---|---|---|
| Antracnose (Colletotrichum lagenarium) | Circular spots that spread | Crop rotation, cupper applications, every 10 days | Once infected, there are no effective measures |

### Pest Insects

**Table 76: Examples of Melon Pests and Ways to Manage them Organically**

| Pest | Damage | Control |
|---|---|---|
| Aphids: Bean aphid *Aphis fabae* Melon aphid *Aphis gossypii* Potato aphid *Macrosiphum euphorbiae* | Suck leaves | Encourage natural predators like ladybirds, spiders and lacewings; Intercropping of onions; Botanicals like Neem, Garlic/Chilli extracts, Derris etc. |
| Cucumber beetles, including Striped cucumber beetle *Acalymma vittatum* Small, slender, greenish-yellow beetles with three prominent stripes on back Western spotted cucumber beetle *Diabrotica* and *ecimpunctata* | | Use of White Tephrosia (*Tephrosia candida*) in form of mulch and/or aqueous extract (20g of leaves in 100 ml of water); Tephrosia plants contains strong fish poisons which may also affect human health. |
| Cutworms and Armyworms Several species Red, brown, green worms | Feed on roots, stems, leaves, buds. Usually in soil by day | Cultural Methods: Plowing one month before planting to turn caterpillars/larvae to the surface; hand-picking at night for removal of larvae; Natural insecticides: Derris, Rotenon |
| Grasshoppers Different species | Feed on foliage, buds, and blooms | White Tephrosia (see above) |
| Loopers, including Cabbage looper *Trichoplusia ni* | | Bacillus thuringiensis |
| Spider mites *Tetranychus spp.* | Feed on plant juices. | Support of predators e.g. ladybird beetle; Insect- controlling plants like Neem, Pyrethrum and Turmeric; Low nitrogen level in the soil; |
| Wireworms Limonius spp. | | Intercropping of garlic |

## 3.13.5. Weed Management

As for all crops; good crop rotation is the pre-condition to avoiding greater damage due to weeds. In the commercial production of water melons, the use of ground plastic mulches is widespread. However, in organic farming systems, bio-degradable mulches are preferable if available.

**Table 77: Direct Measures for Weed-regulation in Organic Melon Production**

| Measure | Advantages | Disadvantages |
|---|---|---|
| Bio-degradable ground mulches | Keeps the soil warm (increase earliness), protects against weed and certain pests | Expensive |

## 3.13.6. Harvesting and Post Harvest Handling

Harvests generally begin about 30 days after full bloom and continue for several weeks with 3 to 4 cuttings at 3-to-5-day intervals. Ripeness in watermelon is difficult to determine because the fruit remains attached to the vine, rather than “slipping” off. The flesh of a typical red-fleshed watermelon changes from immature pink to red-ripe, and then to over-ripe within a 10-to-14 day harvest window. Overripe fruits have a watery, mushy texture and lower sugars. Rind color changes indicating maturity, if any, are specific to cultivars. “Golden Midget” turns yellow as it ripens, and “Sugar Baby” becomes dark green and loses its stripes. Generally, however, the only indication of ripeness is that the tendrils of the leaf closest to the fruit attachment become dry. Additional ripeness indicators include a change in ground spot color from greenish-white to pale yellow. The rind becomes hard to pierce with the fingernail and the blossom end “fills out”. When ripe, there is also a “bloom” or powdery coating giving the fruit a duller appearance and a rough feel. Although researchers are experimenting with various nondestructive gauges of fruit soluble sugars, at this point the usual method for timing the start of watermelon harvest is to cut open a few representative melons in the field.

In addition to the difficulties of harvest timing, there are a number of other problems associated with watermelon harvest. If the field has received abundant water, the watermelons may crack open, especially if harvested in the morning when full of water (turgid). The risk of cracking can be reduced by harvesting in the afternoon and by cutting the stem rather than pulling the fruit off. Stacking watermelons on the side, rather than on end, also reduces the risk of cracking.

Cut watermelons must be shaded to minimize additional heat buildup and because direct sunlight after harvest (especially on the ground-spot) reduces watermelon quality. If plants are not too turgid, field heat can also be minimized by harvesting in the morning. Watermelons should be dry when loaded, however, rather than dew-covered. They are either bulk loaded into straw-padded trucks, or placed in multi-walled corrugated fiberboard bins holding 60 to 80 melons and weighing 1,100 to 1,200 pounds fully loaded. Transit temperatures should be 7 to 10°C.

Watermelons are stored at higher temperatures and lower humidity than muskmelons (10° to 13°C, 90 percent relative humidity). Storage for prolonged periods below 10°C can lead to chilling injury; e.g., one week at 0°C can cause pitting, color loss and off flavors. At 10° to 13°C, they can be kept 2 to 3 weeks after harvest. Even within this range, however, the red color is gradually lost. Although watermelons do not ripen off the vine, flavor and color in seeded (but not seedless) watermelons will improve over a 7 day holding period at room temperature.

P A R T

C

# Global Market Perspectives for Developing Countries

The major organic markets are expected to grow between 10 to 30% in the next 5 to 10 years. In all mayor organic markets, the product group fruit and vegetables plays an important role. Accordingly, organically grown fruits (fresh and processed including nuts) and vegetables (mainly processed vegetables) from subtropical and tropical areas are facing good marketing perspectives. At the export level, organic price premiums of about 10 to 50% are reported (of course, depending on different factors like product, quality and season). But organic premiums are expected to decrease in the coming years.

Exportation under own brands is extremely difficult because of the fact that processors, wholesalers and retailers have introduced own brands to the market. Therefore, companies interested in being listed by wholesalers/retailers have to elaborate market specific concepts utilizing a sufficient marketing budget. In fact, most of the products from developing countries are either raw materials or semi-processed products.

Normally, importers are interested in the development of strategic and/or long-term partnerships with suppliers. This is also true for the organic fruit and vegetable market. Nevertheless, the highly competitive market requires a reasonable price/quality ratio, continuity of supply and additional services. In many cases, producers/exporters in developing countries start conversion to organic agriculture after concluding a co-operation contract with a buyer.

European importers of organic fruit and vegetables see mayor constraints in the trade with developing countries regarding product quality, lack of reliability of exporters, communication problems, logistic problems and organic certification issues. The latter is of increasing importance. Even in the European Union, with the EEC-regulation for organic agriculture, (EEC 2092/91) the implementation of the regulation differs from country to country. Furthermore, private organic labeling organizations dominating the organic market in some European countries have specific requirements. The recent introduction of national organic regulations in Japan and the United States made the international trade with organic food products a bit more complicated. Sometimes, organic regulations are seen as a trade barrier. In this context, the International Federation of Organic Agriculture Movements (IFOAM) is promoting an international harmonization process in order to overcome the mentioned constraints.

Exporters in developing countries are required to carefully investigate the particularities in their target markets:

**Standard Requirements**

Since 2001, the use of ethylene in organic pineapple production (flowering induction) is banned by the EU-regulation for organic agriculture. As a consequence most of the larger organic pineapple suppliers (in Ghana, Cameroon and Ivory Coast) have lost their businesses. Organic production systems relying on the use of copper preparations will also be banned in the future.

**Prices, Market Trends and Consumer Patterns**

In order to adjust production and export strategies, it is of utmost importance to investigate the market situation in the target countries on a regular basis. Every single market has its own characteristics, such as preferences for specific products, new product trends or changing consumer behavior.

**Domestic Production and Supply Structure**

Because of the strong preference for domestically produced organic food the availability of the various fruit and vegetable products and/or periods of short supply have to be analyzed carefully. For example, imported products like apples, pears, onion and garlic are accepted only in the off-season period.

Non-harmonized international regulations for organic food, the lack of market transparency, and insufficient up-to-date information on prices must be seen as a major problems for exporters in developing countries. Only in very exceptional cases neutral information on pricing is given. For example, the German semi-governmental organization ZMP (www.zmp.de) offers a weekly price information service for organic fresh produce as well as background market reports.

The ability to offer high-quality fresh produce depends, to a large extent, on the professional post-harvest treatments of the products. In this context, adequate infrastructure and logistic systems (including cold storage and disinfestations facilities approved for organic food) are the pre-conditions for market success.

Inappropriate packaging and labeling of organic fruit and vegetables is also frequent between exporters and importers. Concerning packaging materials, more and more biodegradable materials are being used.

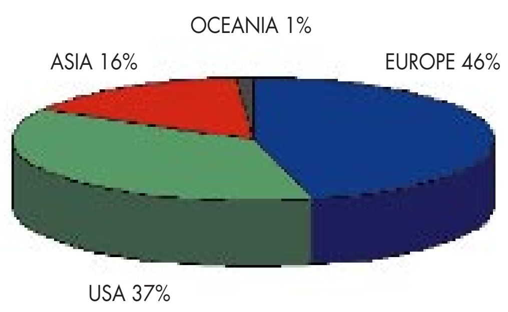
With a few exceptions, world-wide consumers prefer domestically produced organic fruits and vegetables for different reasons (support of domestic farmers, reliability of certification, food miles discussion etc.). Organic imports from countries with a “green image” (like New Zealand in Japan) are far more accepted by the consumers. Keeping this in mind, the market success of single exporters can be supported by export promotion activities aiming at improving/developing a green image for a export country in a target market.

# 4

# Organic Markets by Regions

The graphic below shows that the major markets for organic products are in North America and in Europe. However, emerging organic markets also exist in different Asian and Latin American countries. In this chapter, the organic markets of a selected group of countries is presented; here, is special interest is paid to the fruit and vegetable sector.

**Figure 3:
Breakdown of Global Sales Revenues by Region in 2001 (estimated)**




(Source: Organic Monitor)

All figures mentioned in the subsequent chapters are found in the literature and should be used carefully. Nevertheless, the figures presented give a rough idea of organic market reality and future developments within.

## 4.1. North-America

The North American region is not only one of the largest production areas of organic food, but is also the largest organic market. The leading position is held by the United States followed by Canada. Despite the fact that Mexico is exporting increasing quantities of different organic products like coffee, sesame, honey, citrus, apples, avocados and bananas, no domestic organic market has yet been developed.

### 4.1.1. United States

#### Organic Market in Figures and Distribution Channels

With an estimated value of 9.3 billion US-$ at retail price level, the United States is the largest single market for organic food products (2001). The market has shown growth rates of 24% in the last 3 years. The organic share of total food sales is estimated with 2%.

**Table 78:
Distribution Channels for Organic Food and Beverages in the United States**

| Distribution Channel | Percentage |
|---|---|
| Conventional Supermarkets | 43% |
| Specialty Stores | 50% |
| Others | 7% |

Nearly all mainstream retailers have introduced a range of organic food products within the last years. However, with more than 12.000 natural food stores, a good part of all organic sales are realized in the specialty retail sector. Currently, two natural food store chains, WILD OATS and WHOLE FOODS MARKET, are operating throughout the United States. Most of the natural food stores are concentrated in 10 states.

## The Organic Fruit and Vegetable Market

The United States has the ability to produce a wide range of organic fruit and vegetables in the different climatic regions of the country. According to US official statistics from 1997, about 41.000 ha of fruits (incl. nuts) and vegetables were cultivated organically. Principal domestically produced organic vegetables are mixed vegetables, lettuce, potatoes, tomatoes and carrots. Principal domestically produced fruits are grapes, apples, citrus, dates and tree nuts.

A substantial part of all organic sales is realized by the product segment of fruit and vegetables. Figures of 1999 show that a turnover of 1.45 billion US-$ were realized in both natural food stores and conventional supermarkets. The organic premium seems to be a bit higher in natural food shops. All in all premiums are ranging between 11% and 167 %.

**Table 79:**
**US Fruit and Vegetable Imports – Theoretical Organic Potential (1999/2000)**

| Product | Quantity (US$ 1000) | Product | Quantity (US$ 1000) |
|---|---|---|---|
| VEGETABLES | | FRUIT | |
| Tomatoes | 12.806 | Nuts and preps | 15.428 |
| Peppers | 9.114 | Grapes, fresh | 11.041 |
| Potatoes, fresh or frozen | 8.717 | Cashew nuts | 9.135 |
| Other vegs, fresh or frozen | 6.115 | Melons | 5.220 |
| Cucumbers | 3.544 | Citrus, fresh | 4.483 |
| Cauliflower and broccoli , fresh or frozen | 3.234 | Mangoes | 2.899 |
| Onions | 2.749 | Pineapples, fresh or frozen | 2.680 |
| Asparagus, fresh or frozen | 2.400 | Berries, excl strawberries | 2.665 |
| Squash | 2.248 | Other fruit, fresh or frozen | 2.433 |
| Beans, fresh or frozen | 860 | Avocados | 2.158 |
| Peas incl. chickpeas | 746 | Apples, fresh | 1.846 |
| Garlic | 549 | Strawberries, fresh or frozen | 1.678 |
| Eggplant | 482 | Pears | 1.613 |
| Carrots, fresh or frozen | 463 | Pecans | 1.574 |
| Lettuce | 405 | Other nuts | 1.455 |
| Water chestnuts | 404 | Peaches | 794 |
| Filberts | 378 | Kiwi, fresh | 723 |
| Mustard | 324 | Macademia nuts | 727 |
| Radishes, fresh | 298 | Brazil nuts | 550 |
| Okra, fresh or frozen | 245 | Plums | 471 |
| Cabbage | 210 | Chestnuts | 199 |
| Celery, fresh | 209 | Pistachio nuts | 41 |
| Endive, fresh | 83 | | |
| TOTAL vegetables | 56.583 | TOTAL fruits | 69.813 |

No figures are available with respect to the import value. The total value of fruit and vegetable is estimated at 6 billion US-$ a year. 2% of all fresh produce sales are said to be organic. This would equal about 120 Mio US-$. However, this is only a rough calculation as the food service sector is not included.

Exporters have to analyze the organic market by states, as considerable regional differences with respect to the retail, the import and distribution sectors exist. Some of the important market players at the import and distribution levels are ALBERT's ORGANICS (importer and wholesale distributor), BETA PURE FOODS (ingredient supplier), MADE IN NATURE FRESH (importer and distributor) JONATHAN'S ORGANICS (importer and distributor) and VALLEY CENTER PACKING (importer of organic citrus, avocados and exotic fruits).

## 4.1.2. Canada

### Organic Market in Figures and Distribution Channels

The organic retail market volume is estimated at approximately 1 billion US-$ in 2000, which comprises 1% of the total food sales. The organic market is expected to reach 3.1 billion US-$ in 2005 with annual market growth rates of 20%.

**Table 80: Distribution Channels for Organic Food and Beverages in Canada**

| Distribution Channel | Percentage |
|---|---|
| Conventional Supermarkets | 49% |
| Specialty Stores | 48% |
| Others (e.g. Online-Groceries, Direct Sales) | 3% |

All mainstream retailers like SOBEYS, A&P, SAFEWAY and LOBLAWS are in the process of extending the organic offer. The largest supermarket chain LOBLAWS has recently introduced an own organic brand ("Presidents Choice Organics"). Health stores were the first retailers offering organic food in Canada. These specialty stores still play an important role. In particular, bigger stores like ALTERNATIVES, THE BIG CARROT and TAU reach annual sales volumes of more than 1 million US-$ each. In Canada, the organic food manufacturing industry is very small. As a consequence, more than 80% of all packed and final food products are imported from the United States.

### The Organic Fruit and Vegetable Market

In 2000 about 365 fruit growers and 415 vegetable growers cultivated about 3400 ha organically. The most important domestically produced organic fruits and vegetables are carrots, broccoli, lettuce, shallots, squash and/or apples, pears, peaches, raspberries and strawberries. Some of the most popular items are reported to be bagged organic salads and greens, cherry tomatoes, apples, bananas, oranges, broccoli and romain lettuce. Because of the climatic situation, special interest is also given to exotic fruits. Most of the fresh produce is from Canada and the United States; a smaller part is imported from Mexico and some South-American countries. According to company statements, PROORGANICS is the leading organic fresh food importer/distributor in Canada.

## 4.2. Europe

Organic agriculture has a long tradition in Europe. The European market for organic food represents the second largest market after the USA. Organic retail sales increased to 9 billion US-$ in 2000. In the last two years, the organic market has shown significant growth in most of the European Union member states with annual growth rates ranging between 20-30 %.

The most important driving factor of market growth is an increased health awareness of consumers. In combination with the outbreak of severe food scares such as Mad Cow Disease and Foot and Mouth Disease, safe and healthy food is a top issue in all European countries. Other important reasons to buy organic food are: better taste, non-genetically modified food, environmentally friendly production and well-being of animals.

In all European countries, the leading supermarket chains have entered the organic business in the last years. In a very short time span core lines of organic food products were developed that have led to growth rates in some product categories of more than 50%. Distribution channels other than supermarkets include specialty retail stores (Whole Food Stores, Health Stores etc.), direct sales of farmers (farm shops, farmers markets), home delivery services and Internet online-shops. Currently, so-called "organic supermarkets" with sales areas greater than 200sqm are shooting up like mushrooms in the bigger cities of some European countries. Another trend towards organic food can be seen in the catering industry serving either in canteens of social, health and municipal institutions or in the restaurant sector.

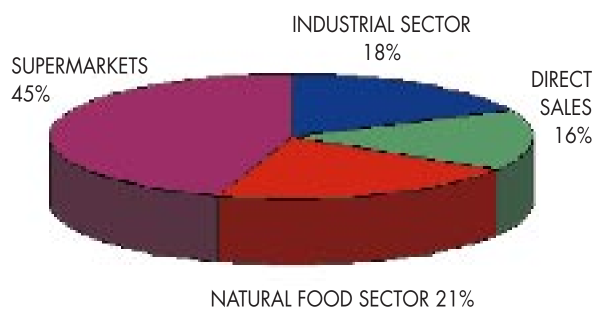
With the growing market large multinational food manufacturers have entered the organic market step by step (Heinz UK, Nestle, Kraft Group etc.). Furthermore, TV advertisements for organic food took place in different European countries for the first time (Italy, Germany, United Kingdom). All estimates with respect to the further market growth came to the conclusion that the current driving factors will push the market further on, but growth rates will be not as high as in past. In single countries with a high per capita consumption of organic food, first indications are present that the market is becoming saturated.

In retail strategies either at supermarkets or organic specialty stores, an attractive and diverse offer in fresh organic fruits and vegetables plays an essential role. Mainly the specialty retail sector (including the organic supermarkets) tries to offer a larger and much fresher assortment of organic fruit and vegetables in order to compete with the mainstream retailers. In this context, specialty retailers give regional fruit and vegetables a prominent place. In many cases, farmer groups deliver directly to the outlets with the effect of a high degree of freshness that the logistic system of mainstream retailers cannot achieve.

As food consumption patterns are changing towards more convenient foods products like pre-packed salads, frozen vegetables etc. are increasing, but not only convenient food is required. More and more consumers prefer to buy ready to serve meals and/or eat outside home. In general fruit and vegetable consumption is increasing in European countries (a tendency that is backed up by a growing number of vegetarians and campaigns like "5 a day").

With respect to organic food manufacturing, the organic baby food sector took a lead in the last years. In the UK the organic share of total baby food sales have reached 30%, in Germany with the early engagement of HIPP the organic share is above 60% of total baby food sales. Baby food manufacturers like HIPP, HEINZ (UK), NESTLE are in need of substantial quantities of tropical fruit pulps (banana, mango, papaya). The market for dried fruits (and nuts) is also growing as both product segments are needed for specific compound food products (müesli, bakeries, snack food etc.). Another important organic food processing sector with an increasing demand is the fruit and vegetable juice sector. In addition, citrus fruits, banana, guava, mango, pineapple and papaya juice concentrates are required.

**Figure 4: European Market for Imported Organic Fruit and Vegetables: Sales Breakdown by Marketing Channels, 2000**




(Source: Organic Monitor 2000)

## 4.2.1. Austria

### Organic Market in Figures and Distribution Channels

The organic retail market volume is estimated with about 320 Mio EURO in 2000 (+ 11% in comparison to 1999) which is 1.8%-2.0% of the total food market. Per capita consumption of organic food reaches a value of 40 EURO per year.

**Table 81: Distribution channels for organic food and beverages in Austria**

| Distribution Channel | Percentage |
|---|---|
| Conventional Supermarkets | 75% |
| Specialty Stores | 10% |
| Direct Sales | 10% |
| Others | 05% |

Supermarket chains with a high profile in the area of organic food marketing are Billa-Merkur (belonging to REWE Group) and SPAR Group. Billa has realized an organic share of the total turnover of about 4.2% (180 Mio EURO) in 2000 and SPAR Group of about 1.17% (42 Mio EURO). It is expected that supermarket chains will increase their share of the total organic food market up to 78%-80% until 2005. The specialty retail sector plays a minor role but may increase in the future. At the moment, only 160 so-called natural food shops exist, most of them with sales areas less than 100 sqm. Great potential is seen in the gastronomy and catering sector.

The most known organic labels in the year 2000 were the own brands of SPAR (Natur Pur known by 86% of the Austrian consumers) and Billa (ja!Natürlich known by 84%) as well as the label of the biggest Austrian certification body Ernte für das Leben (known by 35%; www.ernte.at).

### The Organic Fruit and Vegetable Market

The premium for organic fruit and vegetables range from 20% to30% at supermarket level. Traditionally, organic food from regional production plays a specific role in Austria. Main organic vegetables are potatoes, carrots, onions and to a minor extent zucchini, tomatoes, lettuce, cucumber and green pepper.

The main supermarket chains are still committed to the policy of preferring local production, which may change in the future. In this context it is important to know that more than 50% of all organic fruit and vegetables sold by Austrian organic farmers directly. 23% by the supermarkets and 19% by specialty stores. In most of the imports, either fruits or vegetables originate from Italy, Spain, France and Germany:

The organic industry shows less interest in perishable products due to the higher economic risk. In addition, Austrian consumers do not demonstrate trust in organic

| Table 82: The Main Imported Organic Vegetables and Fruit | | | |
|---|---|---|---|
| **Vegetables** | **Quantity (in tons)** | **Fruits** | **Quantity (in tons)** |
| Zucchini | 2.700 | Oranges | 4.000 |
| Kohlrabi | 2.500 | Lemon | 3.400 |
| Broccoli | 1.000 | Kiwi | 1.000 |
| Potatoes | 900 | Apple | 400 |
| Onions | 700 | | |
| Carrots | 1.200 | | |
| Fennel | 300 | | |
| Tomatoes | 100 | | |
| **TOTAL** | **9.400** | **TOTAL** | **8.800** |

products from outside of the European Union. This two factors result in a small and slowly growing market for tropical fruits and vegetables. Imported bananas, pears, mangos and avocado failed to exceed a value of 1 Mio EURO in 2000.

The majority of imported organic fruits and vegetables is handled directly by the supermarket chains and/or specialized importers. A portion of the import products is supplied by South German companies.

## 4.2.2. France

### Organic Market in Figures and Distribution Channels

The organic retail market volume is estimated with about 1.150 Mio EURO in 2000, which is 1.0% of the total food market. Per capita consumption of organic food reaches a value of 19.6 EURO per year.

| Table 83: Distribution Channels for Organic Food and Beverages in France | |
|---|---|
| **Distribution Channel** | **Percentage** |
| Conventional Supermarkets | 47% |
| Specialty Stores | 43% |
| Direct Sales | 10% |

Nearly all supermarket chains like Carrefour, Casino Group, Monoprix etc. are engaged in marketing of organic food. The first supermarket offering organic food was Monoprix. Carrefour introduced an own organic brand (Carrefour Bio) in 1997. It is expected that supermarket chains will increase their share of the total organic food market in future.

However, the French specialty retail sector also has a strong market position, with more than 3.500 outlets. Unlike other European countries, the specialty retail sector is far more organized. The leading position is held by Biocoop with more than 200 specialized shops. But franchise systems like La Vie Claire (100 outlets) or Rayons Verts (>40 outlets) are also playing an important role. The most known organic label in France is by far the national logo Agriculture Biologique (AB; www.agriculture.gouv.fr).

The overall organic market growth is estimated by 20% to 30% over the next years due to an ongoing extension of outlets and assortments.

### The Organic Fruit and Vegetable Market

The French organic fruit and vegetable market has shown a high growth rate of more than 30% (2000/2001). Due to the slow increase of the domestic production, lucrative market opportunities exist for exporters. Almost one third of organic fruit and vegetable products were imported in the year 2000. The most important domestically produced vegetables in the year 1999 were potatoes (789 ha), cabbage (685 ha), pumpkin (276 ha), artichokes (170 ha), lettuce (160 ha) and green beans (105 ha). Regarding fruit and tree nuts, the picture is as follows: plums (567 ha), apples (591 ha), walnuts (712 ha), chestnuts (1119 ha), apricots (405 ha), kiwifruit (223 ha), almonds (218 ha), pears (180 ha), peaches (157 ha) and cherries (225 ha).

The mayor distribution channels for organic fruits and vegetables in 1999 were Direct sales (48%), mainstream retailers (20%) and specialty stores (32%). One of the most important companies in the French organic fruit and vegetable market is BIOPRIM, based at the wholesale and distribution center in Perpignan. A part from France and import products from Spain, Italian products play an important role. However, Morocco, Egypt and countries in Latin-American have reached growing importance as suppliers. BIOPRIM also bought farms in Morocco. BIOPRIM PRONATURA and BIODYNAMIS are important market players, and are also engaged in re-exports to North-European countries.

**Table 84:**
**Imports of Organic Fruits and Vegetables into France – 1999**

| Vegetables | Quantity (in tons) | Fruits | Quantity (in tons) |
|---|---|---|---|
| Artichoke | 48 | Apple | 1.814 |
| Broccoli | 1.550 | Apricot | 155 |
| Cabbage | 81 | Avocado | 380 |
| Carrot | 1.710 | Banana | 914 |
| Celery | 32 | Citrus | 400 |
| Cherry tomato | 60 | Orange | 3.873 |
| Courgette | 675 | Lemon | 1.405 |
| Cucumber | 16 | Tangerine | 774 |
| Endives | 17 | Pomelo | 570 |
| Fennel | 131 | Coconut | 3 |
| Fresh ginger | 5 | Date | 18 |
| Garlic | 43 | Grape | 272 |
| Green beans | 11 | Guava | 2 |
| Lettuce | 60 | Kiwi | 145 |
| Onion | 467 | Mango | 156 |
| Pepper | 413 | Melon | 10 |
| Potato | 383 | Nectarine | 7 |
| Pumpkins | 113 | Papaya | 6 |
| Sweet potato | 22 | Passion fruit | 1 |
| Tomato | 2.707 | Peach, Nectarine | 431 |
| Other vegetables | 1.156 | Pear | 287 |
| | | Pineapple | 386 |
| | | Strawberry | 67 |
| | | Watermelon | 18 |
| | | Other fruits | 9 |
| **TOTAL** | **9.700** | **TOTAL** | **12.100** |

From all tropical fruit imports, pineapple, banana, mango, avocado, passion fruit, papaya and lychee count for about 15% of the market.

## 4.2.3. Germany

### Organic Market in Figures and Distribution Channels

The organic retail market volume is estimated with about 2.06 billion EURO in 2000, (+ 14% in comparison to 1999) which is 1.6% of the total food market. Per capita consumption of organic food reaches a value of 31 EURO per year.

**Table 85:**
**Distribution Channels for Organic Food and Beverages in Germany**

| Distribution Channel | Percentage |
|---|---|
| Conventional Supermarkets | 33% |
| Specialty Stores | 38% |
| Direct Sales | 17% |
| Bakeries, Butchers | 07% |
| Others | 05% |

Supermarket chains with a high profile in marketing of organic food are REWE, EDEKA and tegut. Own organic brands of German supermarket chains (REWE with Füllhorn; EDEKA with Bio-Wertkost, TENGELMANN with Naturkind etc.) count for less than 50% of the total organic sales of the multipliers. Most of the larger supermarket chains still fail to present an attractive range of organic fruit and vegetables in their outlets, whereas some regional supermarket chains like TEGUT and BREMKE&HÖRSTER have developed attractive organic ranges of fruit and vegetables.

It is expected that supermarket chains will increase their share of the total organic food market in the future, but the German specialty retail sector has a strong market position. About 4.000 natural food shops and health shops offer organic products, most of them with at least a small range of fruit and vegetables. In order to increase competitiveness, specialty stores have extended the sales' areas over the years. More than 100 organic supermarkets with sales areas of more than 200sqm were founded in the last 3 years. Most of the newly founded organic supermarkets intend to attract customers with a wide range of fresh organic fruit and vegetables. Freshness and diversity of products (including) are of utmost importance in the competition process with the supermarket chains.

The most recognizable organic labels in the year 2000 were the labels of three important organic farmers and certification organizations BIOLAND (known by 46%; www.bioland.de), NATURLAND (known by 31%; www.naturland.de) and DEMETER (known by 31%; www.demeter.de). At the end of the year 2001, the German Government launched a national organic logo (www.bio-siegel.de) that will be promoted through a strong publicity campaign.

### The Organic Fruit and Vegetable Market

According to a GfK consumer poll recently published, 30% of German households bought once organic vegetables at least in the last 9 months of 2001. Mainly, households with children and those with housewives between 35 and 49 years buy fresh organic vegetables. Organic vegetables are sold in the specialty retails stores (19.2%), weekly farmers markets (15.7%), direct sales (19.8%) and the different conventional retailers like supermarkets, hypermarkets, discounters (31.7%).

Almost half (45% ) of all organic fruits and vegetables sold in Germany are imported. The major part of importations originate from EU countries like Italy, Spain, France and The Netherlands. In addition, exotic fruits as well as off-season vegetables are imported from Non-EU countries. Main supplying countries are Argentina (apples and pears), Brazil (mangos), Dominican Republic (banana, mango, coconuts), Egypt (potatoes, onions and garlic), Israel (avocado, citrus-fruits, spring vegetables), New Zealand (kiwi fruits and apples), South Africa (table grapes) and Uganda (mango, banana and pineapples).

Some of the major market players are LEHMANN NATUR (leading importer and distributor of organic fruit and vegetables), NATURKOST WEBER (importer and wholesaler of both fresh and frozen/processed produce), BIOTROPIC (subsidiary of LEHMANN NATUR and specialized in tropical fruits like banana, mango), NATURKOST SCHRAMM (importer and wholesaler focusing on the specialty retail sector), DENREE (Germany's largest wholesaler for organic food with a complete range of fruits and vegetables) and SAVID EUROPE (largest European importer of organic bananas from Dominican Republic, co-operation partner of DENREE). However, conventional fruit traders (importers and wholesalers) such ATLANTA GROUP (Germany's biggest fruit trading company) have also started to work in the organic market. In the organic dried fruit (nut) sector companies like RAPUNZEL NATURKOST AG, DAVERT MÜHLE, CARE NATURKOST and DE VAU GE GESUNDKOSTWERK are important importers and processors. In the fruit juices sector VOELKEL AG and BEUTELSBACHER GmbH are major importers. Last but not least, HIPP (babyfood manufacturer) is one of the world's largest organic food manufacturer.

## 4.2.4. Italy

### Organic Market in Figures and Distribution Channels

The organic retail market volume is estimated at about 1.45 billion EURO in 2001 (with growth rates of 20% in the last 4 years), which is 1.5% of the total food market.

**Table 86: Distribution Channels for Organic Food and Beverages in Italy**

| Distribution Channel | Percentage |
|---|---|
| Conventional Supermarkets | 50% |
| Specialty Stores | 40% |
| Others | 10% |

COOP, the first supermarket chain offering organic food in 1996, and ESSELUNGA has the strongest profiles with respect to sales of organic food. Both run own organic brands, and have increased the number of outlets offering organic food systematically. All in all, 1500 supermarket outlets offer organic food all over Italy. The specialty retail sector counts with about 1100 natural food shops that offer fresh produce. Recently, the franchise companies NATURASI and BOTTEGAENATURA have founded about 40 organic supermarkets with a huge range of organic fruit and vegetable products.

### The Organic Fruit and Vegetable Market

The share of organic fruit and vegetables from total organic sales is estimated at almost 30%. The important distribution channels for fruit and vegetables are supermarket chains (45%), specialty retail shops (45%) and direct sales (15%).

**Table 87: Imports of the Most Relevant Organic Vegetables and Fruit into Italy – 2000**

| Product | Quantity (in tons) |
|---|---|
| VEGETABLES | |
| Garlic | 120 |
| Carrots | 1.840 |
| Onions | 1.360 |
| Peppers | 120 |
| Potatoes | 800 |
| Other vegetables | 40 |
| **TOTAL vegetables** | **4.280** |
| FRUIT | |
| Oranges | 60 |
| Apricots (incl. dried) | 28 |
| Plums (incl. dried) | 20 |
| Apples | 495 |
| Pears | 1.350 |
| Kiwis | 950 |
| Bananas | 9.235 |
| Almonds | 72 |
| Hazelnuts | 66 |
| Other dried fruit | 148 |
| Other fruit | 60 |
| **TOTAL fruits** | **12.484** |

As the Italian government follows a bureaucratic procedure for import authorizations from organic products from Third Countries, most of the organic imports from Non-EU countries are realized by trade partners in other EU countries. Only a small number of Italian companies holds a direct import license in the organic fruit and vegetable sector (e.g. ORGANICSUR).

Main Non-EU suppliers of organic fruits and vegetables are located in Angola, Argentina (apples and pears), Cameroon (pineapples), Colombia (bananas), Dominican Republic (bananas), Egypt (carrots, garlic, potatoes) and Israel.

Some of the important market players in the organic fruit and vegetable segment are APOFRUIT, BRIO and ECOR (all distributors of fresh organic produce focusing on the supply of supermarket chains). Others are BAULE VAULANTE (distributor and processor focusing on nuts and dried fruits), KI GROUP (nuts, dried fruits and processed goods) and ABAFOODS (concentrated juices).

## 4.2.5. Switzerland

### Organic Market in Figures and Distribution Channels

The organic retail market volume is estimated with about 490 Mio EURO in 2000 (+ 20% in comparison to 1999) which is 2,1% of the total food market. Per capita consumption of organic food reaches a value of 68 EURO per year.

**Table 88: Distribution Channels for Organic Food and Beverages in Switzerland**

| Distribution Channel | Percentage |
|---|---|
| Conventional Supermarkets | 69% |
| Specialty Stores | 19% |
| Direct Sales | 7% |
| Others | 5% |

Supermarket chains with a high profile in marketing of organic food are COOP, MIGROS and SPAR Group. In the year 2000, the following organic shares of the total turnover with food products were realized: COOP 5.3% (225 Mio EURO), MIGROS 2.2% (112 Mio EURO) and SPAR Group < 0.5% (0.8 Mio EURO).

The most known organic labels in the year 2000 were the own brands of COOP ("NaturaPlan" known by 81% of the Swiss consumers), MIGROS ("MigrosBio" known by 70% and the label of the leading organic labeling organization Bio Suisse ("Knospe" known by 58%; www.bio-suisse.ch).

### The Organic Fruit and Vegetable Market

With a 5% organic share from the total fruit market and a 10% organic share from the total vegetable market, Switzerland shows the highest consumption in comparison to other European countries for the year 2000. The organic premium for fruit and vegetable is about 40-60% at retail price level. The strongest products are apples, pears, potatoes, carrots, cabbage and celery. Most of the organic fruit and vegetable products are sold in supermarket chains.

A strong preference for domestically produced organic food is given. However, the import share of total organic fruit sales (including nuts) counts 60%, the import share of total organic vegetables only 10%.

**Table 89: Growth Perspectives for Different Fruit and Vegetable Products**

| Products | 2000 | 2003 |
|---|---|---|
| Fresh Vegetables | Good | Good |
| Stored Vegetables | Average | Average |
| Processed Vegetables | Good | Good |
| Fresh Fruit | Good | Good |
| Fruit Juice | Good | Very Good |
| Dried Fruits (nuts) | Good | Good |

All in all the organic import quantities are reported as 2.500 t for vegetables, 3.000 t for fresh fruits, 485 t for dried fruits and nuts as well as 260 t for fruit juices. The most important Non-EU supplier countries are for

| | |
|---|---|
| Fresh vegetables: | Egypt, Israel, Canada |
| Processed vegetables: | Hungary |
| Fresh Fruits: | Argentina, Chile, Dominican Republic, Israel, Mexico, Uganda, |
| Fruit Juices: | Brazil, Israel, Honduras, Mexico, Uruguay |
| Dried Fruits (Nuts): | California, Costa Rica, Morocco, Tunisia |

The breakdown by products gives the following picture:

**Table 90: Imports into Switzerland of Organic Fruit and Vegetables (in Tons) – 2000**

| Product | Quantity | Product | Quantity |
|---|---|---|---|
| FRUITS | | VEGETABLES | |
| Citrus fruit | 2054 | Cauliflower | 494 |
| Figs | 335 | Potatoes | 456 |
| Banana | 217 | Tomatoes (and products) | 378 |
| Strawberries (incl. frozen) | 137 | Onions | 264 |
| Peaches (incl. frozen) | 125 | Beetroot | 167 |
| Grapes | 100 | Fennel | 129 |
| Apricots | 98 | Cucumber | 87 |
| Apples | 92 | Broccoli | 114 |
| Plums | 71 | Diverse vegetables | 186 |
| Nectarines | 68 | Carrots | 53 |
| Dried apricots | 40 | | |
| **Total** | **3337** | **Total** | **2328** |

Important market players in the organic fruit and vegetable market in Switzerland are VIA VERDE AG and BIOPARTNER (beside fresh products also engaged with frozen vegetables, nuts and juices). Both companies are importers and distributors delivering to the conventional and/or specialty retail sector. Last but not least, is should be mentioned that the most known organic labeling organization, BIO SUISSE, prohibits air-transportation of organic food.

## 4.2.6. The Netherlands

### Organic Market in Figures and Distribution Channels

The organic retail market volume is estimated with about 331 Mio EURO in 2001 (+22% in comparison to previous year) which is 1.2% of the total food market. According to conservative estimations, the Dutch organic market will reach about 3.5% by 2005. Per capita consumption of organic food reaches a value of 17.33 EURO in the year 2000.

**Table 91: Distribution Channels for Organic Food and Beverages in the Netherlands**

| Distribution Channel | Percentage |
|---|---|
| Conventional Supermarkets | 45% |
| Specialty Stores | 42% |
| Others (Direct Sales etc.) | 13% |

The only multiplier with a high profile in marketing of organic food is ALBERT HEIJN (Ahold-Group). In the year 2000, 80% of all organic sales of the mainstream retailers (or 36% of total organic sales) were realized by Albert Heijn. The specialty retail sector offers products in about 250 outlets organic food. About 50% of the specialty stores are affiliated to the marketing and franchise organization NWO (Hoofdkantoor Natuurvoedings Winkel Organisatie B.V.).

The most known organic label in the Netherlands is by far the EKO-Label, granted by the private certification organization SKAL (www.skal.com).

### The Organic Fruit and Vegetable Market

The domestic area under organic horticultural production was estimated with 2100 ha in the year 1999 (1800ha vegetables, 260ha fruits and 40ha greenhouses). According to the Productboard for Horticulture, about 65% of the domestic organic fruit and vegetable production is exported to other European countries (2000). As Dutch consumers are not willingly to pay a high organic premium, organic farmers/companies prefer to export organic horticultural production.

A good portion of the Dutch imports of organic fruits and vegetables are re-exported to other European countries (especially UK, Germany, Scandinavia). EOSTA B.V. is not only a major distributor of organic fruit and vegetables in The Netherlands, but also throughout Europe. Other mayor players are TRADIN (dried goods, bananas), NATUDIS (dried goods), ZANN (fresh fruit and vegetables), ODIN (wholesaler of fresh fruit and vegetable), ORLEMANNS (one of the largest European processor of frozen organic potatoes and vegetables) and HAK

**Table 92: Net Imports of Certified Organic Fruit and Vegetables (in Tons)– 2000**

| Product | Quantity (in Tons) | Countries of origin |
|---|---|---|
| VEGETABLES | | |
| Asparagus | Less than 100 | Argentina |
| Garlic | Less than 300 | Argentina |
| Ginger | Less than 100 | Brazil, Honduras, Dominican Republic |
| Onions | 500-1.000 | Argentina |
| Tomatoes | 750-1.000 | Spain, Israel |
| FRUIT | | |
| Apples | 2.500-3.500 | Chile, Argentina, Brazil |
| Avocados | Less than 500 | Mexico, Spain, Israel, South Africa |
| Bananas | 750-1.000 | Dominican Republic, Colombia, Ecuador, Peru |
| Citrus fruit | 5.500-7.500 | Italy, Spain, South Africa, Argentina, Israel, Australia |
| Grapes | Less than 100 | Argentina, Chile |
| Kiwi | 2.500-3.500 | New Zealand, Italy |
| Mango | Less than 500 | Burkina Faso, Guinea, Dominican Republic, Mexico, Israel, Brazil |
| Pears | 1.500-2.500 | USA, Argentina |

(preserved fruits and vegetables). Furthermore, a subsidiary of THE GREENERY the DISSELKOEN ORGANICS BV plays an increasing role in the Dutch organic fruit and vegetable market.

The traditional position of The Netherlands as a gateway to Europe (with its strong port Rotterdam) is relevant for the organic sector to the same extent.

## 4.2.7. United Kingdom

### Organic Market in Figures and Distribution Channels

The organic retail market volume is estimated with about 1.300 Mio EURO 2000 (+ 20% in comparison to 1999) which is 1% of the total food market.

**Table 93: Distribution Channels for Organic Food and Beverages in the Netherlands**

| Distribution Channel | Percentage |
|---|---|
| Conventional Supermarkets | 80% |
| Specialty Stores | 11% |
| Direct Sales | 09% |

Supermarket chains with a high profile in marketing of organic food are SAINSBURY, TESCO and WAITROSE. It is expected that the supermarket chains will increase their share of the total organic food market. However, in absolute figures, the specialty retail sector has also shown growth in turnover. The foundation of organic supermarket chains in London like PLANET ORGANIC, FRESH&WILD and HERE STORES as well as the enlargement of existing Whole Food Stores/ Health Stores (about 1900 stores throughout the UK) make specialty retail an important market sector. The most recognizable organic label in the UK is by far the label of the leading organic labelling/certification organization SOIL ASSOCIATION (www.soilassociation.org).

### The Organic Fruit and Vegetable Market

The total acreage for horticulture has counted 4922 ha (2001) with 602 ha for organic fruits (apple>pears>strawberries) and 4318 ha for organic vegetables (potatoes>root crops>green vegetable). Despite the fact that the organic horticulture area in the UK has increased by 40% in the last year, most of the organic produce has to be imported (85% of all fruit and vegetables).

Fresh fruits and vegetables represent by far the most important product category in the UK market. From the total turnover of the organic market (2001) 33% (or 432 Mio Euro) are generated by organic fruit and vegetables. However, with an increase of 15%, (2000/2001) the growth rate is moderate in comparison to other categories like baby food (65%), dairy products (40%) or meat and sausages (65%).

More than 85% of all organic fruit and vegetable sales take place in supermarket chains. All outlets of UK multipliers already offer at least a core assortment of organic fruit and vegetable. Multipliers are still in the process of extending the number of organic fruit and vegetable products in their outlets, which is the most important driving factor for further growth in this category. SAINSBURY, TESCO and WAITROSE are seen as the most pro-active multipliers regarding the organic fruit and vegetable sector. The leading market position in the organic fruit and vegetable sector is held by ORGANIC FARM FOOD (UK). Over the last years, the market has become more fragmented (e.g. 30 companies mainly pre-packers for the multipliers are engaged in the organic fruit sector).

Traditionally, organic apples and pears play an important role in UK supermarkets. The organic share of all pipe fruits sold in the UK has already been reached. However, subtropical and tropical fruits are also gaining more and more importance. Above all kiwi fruit (20% organic share) and banana are very popular. With respect to organic vegetables, the import share is expected to drop in the coming years as the domestic production increases. Between 1998 and 2000, the market volumes almost doubled.

In both segments, saturation effects are expected in the coming years with the consequence of higher competition on retail and supplier levels. Market growth is forecasted at 10-15% over the next years.

**Table 94: UK (selected) Organic Fresh Fruit and Vegetable Imports – 2000**

| Product | Quantity (in tons) | Product | Quantity (in tons) |
|---|---|---|---|
| VEGETABLES | | FRUIT | |
| Potatoes | 30.000-40.000 | Bananas | 20.000 |
| Carrots | 5.000-6.000 | Pineapple (incl. dried) | 1.000-1.200 |
| Onions | 6.000-7.000 | Guavas & Mangoes | 800-1.000 |
| Legumes | 1.800-2.000 | Oranges | 13.000-13.500 |
| Beans | 1.400-1.500 | Clementines | 3.500-3.800 |
| Asparagus | 80-100 | Satsumas | 1.500-2.000 |
| Courgettes | 920-1.000 | Mandarins | 500-550 |
| Cassava | 40-45 | Tangerines | 100-120 |
| Sweet potatoes | 300-320 | Lemons | 2.800-2.900 |
| | | Limes | 450-470 |
| | | Paw paw/papayas | 150-200 |
| | | Strawberries | 860-900 |
| | | Raspberries, blackberries, blueberries | 50-60 |
| **TOTAL vegetables** | 45.540-57.965 | **TOTAL fruit** | 44.710-46.700 |

## 4.3. Asia

Japan – by far the largest market for organic products in Asia and the second largest in the world – is of particular interest for the global organic export industry. However, in an increasing number of other Asian countries like China, India, Malaysia, Philippines, Singapore, Taiwan and Thailand domestic markets for organic products are emerging. In some of the countries mentioned, national organic schemes are in preparation in order to develop a legal framework for further development of the sector and/or have already been introduced, such as in Thailand (August 2001). The aforementioned does not allow genetically modified organisms, and has developed a national logo for organic agriculture as well as a national certification scheme for organic products.

### 4.3.1. Japan

#### Organic Market in Figures and Distribution Channels

The organic retail market volume is estimated, according to different sources, to be around 2.5 billion US-$ (2001). This figure also includes sales of so-called green products that do not fulfill international norms for organic agriculture. The real organic share is unclear, but has been reported at 1% (350 US-$). The main distribution channels for organic food and beverages are:

**Teikei System/Consumer Cooperatives:**

Traditionally, organic food was sold from the farmer to the consumer directly. This system focuses on domestically produced goods. In some areas, professional distributors are charged with organizing the deliveries. More than 18 million consumers are organized in consumer co-operatives, organizing product procurement for its membership.

**Supermarkets:**

Supermarket chains are starting to extend their "pure" organic lines. Currently, a number of so-called green products dominates the product offering on the shelves.

**Home Delivery:**
About 2400 Internet sites offer organic and green products in Japan.

The newly introduced national logo for organic food is the JAS-Organic Logo (further details www.maff.go.jp).

In 1992 the Japanese Ministry of Agriculture, Forestry and Fisheries (MAFF) defined voluntary guidelines for sustainable agriculture requiring third-party certification:

**"Organic":** No chemicals have been used for more than 3 years.
**"Organic in transition":** No chemicals have been used between 6 months and 3 years.
**"No pesticides":** No chemical pesticides have been used.
**"Reduced pesticides":** Less than 50% pesticide input than usual.
**"No chemical fertilizer grown":** No chemical fertilizer have been used.
**"Reduced fertilizer grown":** Less than 50% fertilizer input than usually.

This regulation has led not only to confusion in the food industry but also on the part of the consumer. The high number of so-called "pseudo-bio" products caused consumer irritation and of course was a barrier for further market growth. In April 2001, a new Japanese regulation for organic agriculture was set in motion. The future will show to what extent the organic industry and the Japanese consumer will accept the new regulation, which still contemplates other "green categories".

The new Japanese Agriculture Standard (JAS) for organic food also defines procedures for the importation of organic products (further details see www.organicstandard.com).

## The Organic Fruit and Vegetable Market

With a population of about 126,7 Mio people, a good number of urban areas (e.g. Tokyo 8,0 Mio; Yokohama 3,4 Mio; Osaka 2,5 Mio) and a food importation rate of about 80%, Japan has become a prime target market for organic exporters. But import requirements, in particular for fresh fruits and vegetables, make the entrance into the Japanese market difficult. In combination with the high quality and/or phytosanitary requirements[27] for fresh fruits and vegetables, legal requirements for market access have also been seen as a major issue for exporters.

The self-sufficiency rate for fresh vegetables is 84%, whereas fresh fruits reach only 49%. Prices for organic products are up to two-three times higher than conventional ones, which underlines the immaturity of the Japanese market. The import share of organic fruit and vegetables is reported to be below 5%. The main reason is the fact that almost 70% of all deliveries of fresh fruit and vegetables to Japan are fumigated. According to the new national organic regulation. (since the 1st of April) fumigated deliveries lose their organic status, which was not the case before.

**Table 95: Forecast of Certified Organic Fresh Fruit and Vegetable – Imports 2001**

| Fruits | Quantity (in tons) | Vegetables | Quantity (in tons) |
|---|---|---|---|
| Mango | 10 | Asparagus | 100 |
| Avocado | 50 | Onion | 200 |
| Orange | 135 | Pumpkin | 2.000 |
| Grapefruit | 300 | Carrot | 400 |
| Kiwi | 2.300 | Ginger | 50 |
| Banana | 11.000 | | |
| **TOTAL** | **13.795** | **TOTAL** | **2.750** |

[27] Exporters are running the risk to loose the organic status for their products because imported fresh products must be fumigated at random according to the Japanese law.

Consumer interviews have shown the following preferences for organic fruit and vegetables:

| | |
|---|---|
| Fresh vegetables: | onions, carrots, sweet potatoes |
| Fresh fruits: | apples, mandarins, strawberries |
| Frozen vegetables: | french fried, asparagus, mixed vegetables, pumpkin |
| Canned products: | corn, mandarins, asparagus |
| Juices: | apple, vegetables, tomato, orange |

The value of all imported organic products is reported at 90 Mio US-$ (1999).

Most important supplying countries for fruit and vegetables are New Zealand, Australia and USA. A good portion of the total organic export of New Zealand is sold on the Japanese market, above all kiwi-fruit, squash and onions. Analysis of organic fruit and vegetable products from the United States gives the following picture:

**Fresh Vegetables (and Herbs):**
carrots, peppers, broccoli, basil, oregano, rosemary, thyme
**Fresh Fruits:**
apple, grapes, oranges, lemons, blueberries, grapefruits
**Dried Fruits**:
Raisins

Furthermore, the Japanese organic food industry developed strong relationships to organic producers in neighboring countries such as China and Korea. It is expected that an increasing part of the organic imports (including fruit and vegetable) will originate from these countries in the future. However, main sourcing areas for exotic fruits such as bananas are the Philippines, Dominican Republic, Colombia and Ecuador. Other organic fruits and vegetables are imported from South-American countries such as Chile and Argentina.

With respect to the high risk (legal fumigation procedure) of importing organic fresh produce, it might be wise to concentrate on the processed organic food. In this context, the Japanese market offers good perspectives regarding convenience food (bagged salads), frozen vegetables (french fries, mixed vegetables), fruit pulps (banana, mango) and fruit juices (guava, oranges).

## 4.3.2. Singapore

The organic market is estimated with 3.5 Mio US-$ at retail price level. All organic food has to be imported.

**Table 96: Organic Food Market Structure in 2000 (Estimated)**

| Food Items | % Share of Market |
|---|---|
| Fresh fruits and vegetables | 10% |
| Non-alcoholic beverages, e.g. juices and cider vinegar | 15% |
| Flours, pulses and lentils etc. | 20% |
| Confectionery items, including spreads | 5% |
| Breakfast cereals, cereal bars and snack foods | 5% |
| Chilled and frozen products, including meat | 5% |
| Other items, e.g. coffee, tea, sugar, edible oils, canned foods, specialty foods and wines | 25% |
| **Total** | **100%** |

Source: FAS-Report Organic Products in Singapore (2001)

The major distribution channel is the mainstream retailer NTUC FAIRPRICE. This retail chain with about 41 outlets gave a sales area for organic food to the major importer of organic food in Singapore, ORIGINS HEALTH FOOD Ltd., on a concessional basis. Other conventional supermarket chains such as COLD STORAGE and SHOP & SAVE offer only a very limited range of organic food. Beside the conventional supermarkets, more and more organic food is sold in specialty retail stores like NATURES FARM, FAMILY HEALTH FOODS, ORGANIC PARADIESE, ORGANIC NETWORK and others. Currently, most of the fresh organic fruit and vegetable products are supplied by Australian growers.

## 4.4. Organic Markets in Developing Countries

The last chapter is aimed at highlighting that markets for organic food and in particular organic fresh fruit and vegetables also exist in developing countries. The exploration of the domestic market offer export-oriented companies an additional business, reducing the risks of international commodity trading and allowing domestic companies (with less and/or no experience in the export business) to enter the organic business.

In addition to the aforementioned emerging organic markets in different Asian countries, successful examples are also present in other regions of the world. In many South American countries (Argentina, Brazil, Uruguay), the conventional supermarket chains have started to develop organic product lines. In spite of the fact that the overall number of organic items is still very small, the offering of fresh organic fruit and vegetables is quite impressive. In Argentina supermarket chains like JUMBO and DISCO (Ahold-Group), in Brazil PAO DE AZUCAR, CARREFOUR and others are already offering organic fruit and vegetables.

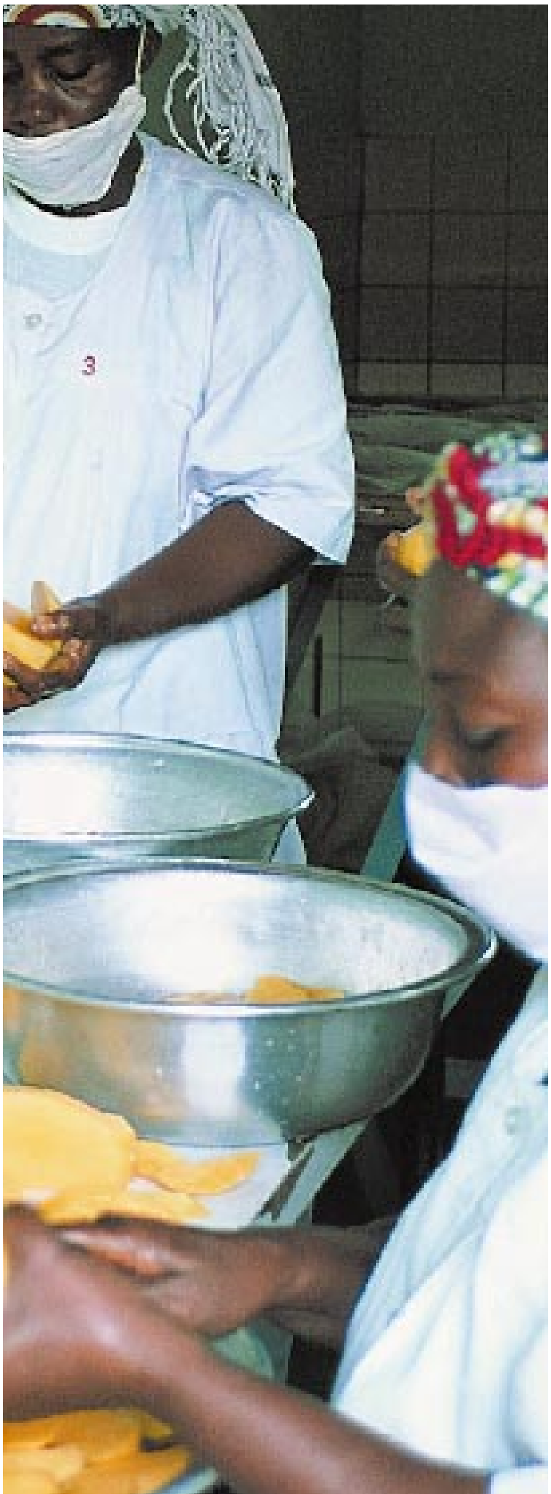
Another example is the SEKEM-Group in Egypt. This group represents more than 1000 biodynamic farmers producing, in addition to fruit and vegetables, a wide range of dried goods (like grains, pulses, groundnuts etc.). SEKEM is exporting mainly to European markets. Additionally, a domestic marketing concept was carried out over the last few years. Today, SEKEM is selling a whole range of organic products not only in own shops in Cairo but also in different supermarket chains all over the country.

The organic markets in East European countries like Poland, Hungary or Czech Republic are also at a very early stage of development. However, more and more supermarket chains have started to offer at least a small range of organic food items. In the mid-term these markets will offer additional export perspectives.

PART

D

# Standard and Regulations



5

# Requirements and Conditions Relating to Organic Trade

Standards relating to organic food products are production and processing standards that describe, prescribe, allow or prohibit procedures and materials. Standards for certification and labeling are also involved.

Characteristics of organic food standards:

- Standards are defining production methods; their main focus is not the product quality;
- Organic food standards regulate minimum requirements for organic food production, not best practice;
- International standards or guidelines, national regulations and regional standards exist.
- A large number of private standards currently exist. They are continuously developed by producer organizations. In 1980, the International Federation of Organic Agriculture Movements (IFOAM) finalized the first International Basic Standards for Organic Agriculture, which were further developed at a later date (see below).
- The first national regulations were developed in France and in Denmark in the late 80´s. In 1991, the EU introduced the EU Regulation 2092/91 for organic food. This regulation has been further developed and amended several times by the authorities in Brussels.
- In 1999 the Codex Alimentarius Program, a joint governmental WHO/FAO Program finalized International Guidelines for organically produced food; this program is also in the process of further development.

## 5.1 General Trade Constraints, Customs and Tax Regulations

The European Union (EU) has a Common Agricultural Policy (CAP), a common commercial policy and common import and customs regulations for imports from outside the EU. Organic products are subject to the same customs tariffs as conventional products.

The ACP-EU Partnership Agreement (Cotonou 2000) forms the basis for developing long-term cooperation between the EU countries and the 69 African-Caribbean-Pacific countries (ACP countries). The Agreement provides for preferential tariffs for the ACP countries. It also provides for "general preferential tariffs for developing countries". Products from the Least Developed Countries are duty free. In order to take advantage of preferential tariffs, imported goods must be accompanied by a certificate of origin.

The Common Agricultural Policy applies quantitative restrictions and special charges for agricultural imports (depending on the product, the season and country of origin). These also apply to organic products. Importers must apply for an import license.

The current World Trade Organization (WTO) reform negotiations are pushing forward towards liberalization of trade in agricultural products based on the resolutions of the GATT Uruguay Round. A key element in this is the commitment on the part of the industrialized countries to reduce customs tariffs and export subsidies by a further 13–24% by the year 2004. The aim of the WTO is to facilitate access for emerging economies and economies in transition to industrialized countries markets.

## 5.2. Importing Goods into the EU, USA and Switzerland

The regulations on imports in the EU Regulation on organic production are of great significance for the international market for organic products. Article 11 of the EU Regulation governs market access for organic food products in the countries of the EU. It requires that organic foods imported into the EU from third party countries must have been produced, processed and certified in accordance with equivalent standards. The exporting country must give details of the standards and inspection procedures implemented for evaluation by the EU. In this respect, the requirements and conditions relating to access for organic products are comparable to those laid down in the Swiss Organic Farming Ordinance[28]. Enforcement is the responsibility of the EU Member States, although in Germany it is in fact carried out at the level of the German federal states (*Länder*). Further details may be found in the EU Regulation on organic production[29].

At the present time there are two ways of authorizing imports into the EU:

- **Access via the List of Third Countries** in accordance with Art. 11, paragraphs 1–5: A country or certification body may apply to be added to the list of third countries (EU Third Countries List) via its diplomatic representatives in Brussels. In order to be added to this list, the country making the application must already have enacted organic farming legislation and a fully functional system of inspection and monitoring must be in place. In addition, it must provide an confirmation of equivalence and other information on organic farming methods applied in the country. The application is then assessed and decided upon by the European Commission. To date only 5 countries have been included on the list: Argentina, Australia, Hungary, Israel and Switzerland. Goods imported from these countries need only be accompanied by a consignment-specific certificate of inspection.
- **Access via Import Permit** in accordance with Art. 11, paragraph 6, for all countries not included on the list of third countries (i.e. the vast majority of imports into the EU). As a rule, certification bodies operating at the international level will assist exporters and importers in putting together all the information and evidence needed to accompany the application for an import permit. Requirements vary from one EU country to another, but the following are those that generally apply: the exporter applies for inspection by one of the European certification bodies that is approved and accredited in the EU (where possible with local inspectors). Inspection contracts set out the schedule for annual inspections. National certification bodies are subject to annual assessments by an EU-accredited certification body specially assigned to this task. In some EU countries, national certification bodies may be exempted from this annual assessment if they participate in the accreditation program of IFOAM. After the import permit has been issued by the designated inspection body, then either the exporter must ensure that the organic goods from the third country are accompanied by a certificate of inspection, or the importer must be able to produce a certificate of inspection for each consignment imported from the third country.

Within the EU all organic products may be freely traded. However, procedures relating to the issue of import permits are not the same in all EU countries. It is advisable to seek advice from the relevant authorities before trading commences.

28 See website information in the annex.

29 for details please consult the handbook “The Market for Organic Food and Beverages”; see chapter 4.6

### Some Points Relevant for US Importers

The new National Organic Program regulations require businesses selling food labeled as "organic" in the US to follow the new US standards for the production and handling of organic foods. This includes organic food imported into the US. The National Organic Standards require all agricultural products sold, labeled or represented as organic in the United States be certified by a U.S. Department of Agriculture (USDA) accredited certifying agent. However, in lieu of organic certification by a USDA accredited certifying agent, imported organic agricultural product may be sold in the United States if they have been certified and recognized through:

1) a USDA recognition of conformity assessment or
2) an equivalency determination.

Under the recognition of conformity assessment option, imported organic agricultural product may be sold, labeled, or represented as organically produced if the product is produced and handled to the National Organic Standards and certified by an accredited certifying agent recognized by USDA. Recognition of certifying agents will be determined by the USDA, based upon the request of a foreign government, certifying that the foreign certifying agent's government is able to assess and accredit certifying agents as meeting the requirements of the USDA National Organic Program.

Imported organic agricultural product may also be sold, labeled or represented as organic when USDA has determined a foreign government's organic certification program to be equivalent to that of the NOP. Equivalent means that USDA has determined that a foreign government's technical requirements and conformity assessment system adequately fulfil the objectives of the Organic Food Production Act and its implementing regulations. Determinations of equivalency are the most complex and time-consuming types of import arrangements to establish. Outside the US, certification agencies based in Canada, Europe, Latin American, and Oceania, are either applying for USDA accreditation, or waiting for their governments to negotiate equivalency of their national organic programs with the US program. Although the USDA will accept foreign accreditation applicants, it has announced that it will also accept organic products certified in countries with which the US has an equivalency or an acceptance agreement. To date, there are no such agreements, and only informal, preliminary communication with other countries has occurred. For example, USDA is currently working with India to determine whether their organic certification programs are equivalent to the technical requirements and conformity assessment system of the NOP.

**The US Organic Foods Production Act**

The US Organic Foods Production Act (OFPA) was signed into law October 1990, the final rule was published in December 2000. Purposes:

- To establish national standards governing the marketing of certain agricultural products as organically produced products;
- To assure consumers that organically produced products meet a consistent standard; and
- To facilitate interstate commerce in fresh and processed food that is organically produced (however, states can have more strict standards).

*Not covered in OFPA:*

Private requirements in addition to NOP Standards
Equivalent standards from Trading Partners.

### Some Points Relevant for Swiss Importers

- The exporter in the EU must apply for a Swiss import certificate from his inspection body and ensure that the product bears the code number and name of the inspection body and that it is labeled "bio" (organic).
- If a product has been approved in accordance with EU Regulation No. 2092/91 on Organic Food Production, then it can be approved automatically as organic in Switzerland too, and vice versa. An exception is made

in the case of products from farms in the process of conversion. When a conversion product from the EU, or another country, is imported into Switzerland, this must be specifically declared.

- In order to comply with the requirements of private labeling schemes, conditions such as whole-farm conversion and other additional conditions may be imposed on imports from abroad, i.e. also on those from the EU.
- Import requirements from countries outside the EU and from countries on the Country List are similar to those found in EU-regulation. Analogously to the EU, Switzerland also operates a system of **"individual authorization"**. For direct imports from countries that are not included on the list of third countries, the importer in Switzerland must submit an application for individual authorization to the Federal Office for Agriculture (FOAG) together with an **attestation of equivalence** for the relevant product and its producer.

# 6

# Principles of Inspection and Certification of Organic Products

## 6.1. Requirements Relating to Inspection Bodies

Since January 1988, all inspection bodies accredited in the EU must satisfy the requirements of the EN 45011 standards (these are identical to ISO Guide 65; both set out general standards for certification bodies) in order to be deemed as suitable imports of organic goods to be approved by the European authorities. Because of equivalency requirement, this also applies to all inspection bodies in third countries from which certified products are imported into Europe. In other words, it also applies to local inspection bodies in emerging markets and markets in transition. There are three options for going about this:

1. The inspection body is accredited by an accreditation body in accordance with EN 45011 standards.
   The accreditation body must be a member of the EA-MLA (European co-operation for Accreditation) or the IAF-MLA (International Accreditation Forum).
2. The inspection body has been approved by a competent authority in the third country in accordance with EN 45011 or ISO Guide 65.
3. The inspection body has been assessed by a qualified expert in accordance with EN 45011 or ISO Guide 65. The assessment has been confirmed by a supervisory authority in the EU.

All three options are valid in all of the countries of the EU. At the present time, confirmation of assessments carried out by experts under option 3 is only undertaken by German authorities. Confirmation by a German authority is, however, recognized in all of the EU countries. In Germany, the primary view is that in many third countries option 2 does not exist and secondly, there are only very few accreditation organizations corresponding to option 1. A checklist is obtainable from the German interstate working group of organic control authorities[30] giving details of how an expert assessment in accordance with options 1, 2 and 3 should be carried out.

The EU countries have not reached any agreement as to whether they should recognize IFOAM as an accreditation organization under option 1 or 3. The IFOAM accreditation program, and International Organic Accreditation Service (IOAS), have been recognized thus far primarily in some Scandinavian countries. IOAS accreditation is not recognized by the EU authorities because IOAS is not a member of any of the organizations mentioned above (EA-MLA, IAF-MLA).

Surveillance of a local inspection body by a certification body accredited in the EU is no longer carried out the way it used to be; this now comes under options 1 to 3.

This however is NOT relevant for countries outside Europe

[30] Länderarbeitsgemeinschaft zur Verordnung EWG 2092/01, LÖK.

## 6.2. Certification of Organic Production

### 6.2.1. Frequently Asked Questions (FQA)

**Can all naturally produced produce be sold as organic?**

No, most organic import markets, such as e.g. the European Union or the United States have set up a legal framework, e.g. a regulation, to define the requirements for products to be labeled and marketed as "organic products". These regulations always include the requirement that all steps of production be certified by an accredited certification agency. Furthermore, organic requirements comprise far more aspects than merely the lack of chemical inputs. All requirements are outlined in more detail in the chapter "Requirements for certification".

**What is organic certification?**

Certification is a procedure for verifying that products conform to certain standards. In the case of organic products, it is primarily the acknowledgement that such products have been produced according to the applicable organic production standards.

**How to become certified?**

In order to apply for certification, operators need to contact one or several accredited organic certification agencies and describe their present operation and plan for organic production. The certification agency will prepare an offer with cost estimation and a description of services. As soon as the operator has chosen the certification agency and signed an inspection contract with them, he is officially in the certification process. Then the first inspection will be conducted to verify whether or not the operation is in compliance with the organic standard for which certification is sought. As a result of the certifier's evaluation and certification process, the operation will receive a certificate and/or certification notification in which certain corrective measures might be required. In the certification decision, the operator will be informed on his organic status (i.e. as which quality he can label his produce, e.g. organic in conversion) and can sell his produce accordingly.

**Is the same certification valid world-wide?**

There are different organic markets with their own individual certification requirements, i.e. their own regulations and standards. Therefore, produce that is e.g. exported to Europe must be certified according to a regulation equivalent to the EU-Regulation for organic farming; produce exported to the US must, from this year onwards, be certified according to the USDA National Organic Program, etc. However, most major certification agencies offer certification according to the most common organic markets. Applicants therefore might need to inform said entities as to which import market they are targeting.

**Are the same organic labels used world-wide?**

In addition to official legislation defining which requirements products must fulfill in order to be labeled as "organic produce", there is presently a vast number of organic labels that can be both private or governmental. Nowadays, many of these labels serve marketing purposes, i.e. in different countries where consumers traditionally trust certain organic labels. All private labels must have at least the same minimum requirements as the underlying organic regulation (e.g. Regulation (EEC) N° 2092/91 for all organic labels in Europe), but often they have additional requirements or emphasis on certain aspects more than others. Examples for popular organic labels in the EU and Switzerland are: Demeter (world-wide standard for bio-dynamic farming), Soil Association (UK), Bio Suisse (Switzerland), Naturland (Germany), KRAV (Sweden), EKO (Holland), AB (France).

Which organic label might be most useful for your marketing efforts, in addition to the compulsory organic certification according to the organic regulation, is best decided while defining future customers and major export markets. For more information, please refer to the chapter organic standards/private labels.

**How soon can produce be exported as organic?**

The requirements concerning the so-called conversion period for organic produce, i.e. the time for which a farm has to be cultivated organically before the crops can be sold as organic, differs slightly between organic standards. For products with Europe as a destination, the required conversion period is defined as 36 months before harvest for per-annual crops (e.g. fruit trees) or 24 months before sowing for annual crops (e.g. vegetables). For detailed comments regarding the conversion period, please refer to the chapter certification requirements.

**Can a farm produce both organic and conventional crops?**

According to most organic regulations, but not necessarily according to private standards, a farm may cultivate two different units. This means that part of the fields can be cultivated organically, i.e. according to the organic production rules, and other fields are cultivated with conventional farming methods, i.e.. using synthetic pesticides or fertilizers. However, the same crop variety may not be produced organically and conventionally (with some exceptions) and many additional separation requirements need to be fulfilled. Please refer to the chapter certification requirements for more details.

**Is organic production equivalent to natural or sustainable production?**

No, one of the most significant factors distinguishing organic farming from other concepts of sustainable farming is the existence of binding production standards and certification procedures[31]. This means that only produce that is produced and certified according to the relevant standard can be currently sold and labeled as organic produce. These organic standards comprise a couple of requirements that would not intuitively be seen as requirements for sustainable farming.

[31] International Trade Center (ITC), 1999, Organic Food and Beverages: World Supply and Major European Markets, UNCTAD/WTO.

**Why do processors and traders also need to be certified?**

Manufacturers and traders of organic produce also need to be covered in the organic certification procedures. This requirement can basically be explained with the necessity to supervise the whole chain of custody in order to ensure that what arrives to the consumer is actually the same organic product originally cultivated, and that only permitted ingredients and auxiliaries have been used it its production.

**Can products be sold as organic on the local market?**

Principally the term “organic” is not protected unless it is defined in a legal act. Many countries world-wide are presently establishing their own organic standards, defining which requirements products need to fulfill in order to be sold as organic. If there is no such regulation or standard in place in your country, you are of course free to label and sell your natural produce as organic. This may, however, require a lot of marketing effort, since people may not be familiar with the organic production concept and may not trust in your claim that the produce is “organic”. However, more and more local markets for organic produce have developed over the past years. Local certification schemes have also developed, and it may be very interesting to explore this marketing option.

**What is the advantage of organic certification if being already an organic farmer**

Basically your only advantage is that you can then market and label your produce as organic, which might be particularly interesting for export. Of course there is also the advantage that you will receive professional support in setting up an appropriate quality management, perhaps even improving your production quality and methods while simultaneously seeking organic consultancy. However, if you only intend to produce crops in your home garden for home consumption and local sales (and no local demand for certified organic produce), then is most probably advantageous to manage your fields organically, but without having this production certified as organic.

**How does the Export of Organic Products Differ from the Export of Conventional Produce?**

***Broader company objectives:*** In addition to pure economic objectives, ecological and social aspects must also be considered. The latter form the basis of a firm's credibility with its customers, and this in turn is the foundation for a long-term business relationship.

***Quality:*** Most of the consumers of organic food have high expectations in terms of product quality. Organic products must usually meet the same quality standards as conventionally produced goods. Only slight allowances are made in the case of fruit. The requirements also relate to food packaging. It is common practice to provide the importer or potential customer a representative sample of the organically produced products. On this basis, an agreement can be reached with the trading partner as to whether the quality standards are sufficient to satisfy market requirements.

***Logistics:*** Some private certification standards for organic food do not allow import by air. In addition, during transportation organic food products may only be sprayed with pesticides or cleaning agents that are specially permitted for use in organic agriculture.

***Packaging and labeling:*** Packaging must be free from pesticides, colorings, solvents or cleaning agents that could contaminate organic food. Organic food products must be labeled in accordance with the regulations laid down by national/supranational organic regulations.

***Certification:*** To have an imported product passed as "organic" in EU, USA, Japan, Switzerland etc., the producers, processors, exporters and importers must undergo inspection and certification at least once a year by an accredited organic inspection and certification body.

***Access to the market:*** products from emerging markets and markets in transition are regulated by means of regulations on equivalence. The production, processing, inspection, certification and labeling of organic products in emerging markets and markets in transition must take place according to the requirements that are equivalent to those of the national/supranational organic food regulations. This is not to say that identical procedures are imposed. In fact, it is desirable to adapt organic farming standards to local conditions and make use of certification bodies in the emerging markets and markets in transition.

## 6.2.2. Organic Standards: Types of Organic Standards

There is at present no regulation on organic products applicable world-wide and a confusing number of organic standards make orientation of organic operators, especially in developing countries, quite difficult. The main organic standard types can be summarized as follows:

A) International private or intergovernmental framework standards, such as IFOAM International Basic Standard or the Codex Alimentarius.
B) Baseline Regulatory Standards and Regulations such as the EU Regulation (EEC) N° 2092/91 or the American USDA National Organic Program
C) Private Organic Label Standards

International framework standards (A), such as in particular the IFOAM Basic Standard, aim to harmonize different certification programs by providing a uniform framework for organic standards world-wide. They cannot be used directly as a basis for certification, and as such are not directly applicable to organic operators in tropical countries. However, it may be helpful to understand the underlying principles and issues in all organic certification programs world-wide.

Baseline regulatory standards (B) regulate certain organic markets, i.e. contribute a legal basis for the minimum requirements that a product and its production process have to fulfill in order to label and market it as "organic". Most organic regulatory standards define the requirements for organic production and labeling within the applicable market but also define certain import requirements.

The most important regulated organic markets are

- The European Union with its regulation on organic Production Regulation (EEC) N° 2092/91
- The US organic market with its National Organic Program that will come into force in October 21, 2002.
- The Japanese organic market with its JAS Standard
- Switzerland, Israel, Argentina, Czech Republic, Hungary, Australia have set up organic regulations that are considered equivalent to the Regulation (EEC) N° 2092/91.
- Many other importing and exporting countries world-wide are presently developing their own organic regulatory standards

These regulations have in common that they all regulate market access for imports of organic food. The EU regulation 2092/91 serves as a model for other national and supranational regulations for two reasons:

- The EU-regulation was the first regulation that laid down minimum requirements and is therefore a pioneer in this subject.
- EU is the most important import market for organic food products. Most producers and exporters from developing countries and markets in transition therefore must comply with the EU-regulation.

In addition to these compulsory minimum standards for organic produce, there is a large number of private organic standards (C) that generally existed before the regulatory framework standards came into force. These private standards currently principally serve marketing purposes, i.e. according to the country of sale different standards may further facilitate the marketing of the organic produce given that consumers associate organic quality with this particular label. These private standards include all requirements of the underlying regulatory standard and sometimes exceed these regulations in certain aspects. Examples for private label standards of importance for international producers are: Demeter (world-wide) Naturland (Germany), Soil Association (UK), KRAV (Sweden), Bio Suisse (Switzerland). The major private labels are described below in more detail.

## 6.2.3. International Regulations (IFOAM, Codex Alimentarius)

### IFOAM Basic Standards

The extent and progress of organic agriculture in many countries have been enhanced substantially by the development of a set of principles, requirements, and guidelines for organic farming and processing commonly referred to as Basic Standards. This evolved into the International Federation of Organic Agriculture Movements (IFOAM) Basic Standards which have been agreed by the IFOAM General Assembly for the first time in 1980. It reflects the collective knowledge and practices of IFOAM members who, in 1972, came from five countries of Europe and now from 115 countries representing over 700 member organizations.

The IFOAM Basic standards are recognized worldwide and, as a "living" document, it is continuously evaluated and constantly improved through a democratic process every two years when IFOAM holds its General Assembly.

The IFOAM Basic Standards seeks to clarify the practices and procedures approved in organic agriculture; those that may be accepted, and those that are to be prohibited. In each area they clearly describe the underlying guiding principles, give recommendations for the direction to go and clearly indicate the relevant requirements

The IFOAM Basic Standards cannot be used for certification on their own. They are standards for standards, providing a framework for certification programs world wide to develop their own national or regional standards. These will take into account local conditions and may well be stricter than the IFOAM Basic Standards. The IFOAM Basic Standards also forms the basis from which the IFOAM Accreditation program operates. More than 20 certification programs worldwide are accredited by IFOAM.

### Codex Alimentarius Guidelines

The Codex Alimentarius Commission was established in 1962 as a joint intergovernmental body of the UN Organizations FAO/WHO, with the objectives of protecting the consumer's health and facilitating international trade in food through the harmonization of food standards on a world-wide basis. Codex standards, codes and related texts have received wider acknowledgement following the conclusion of the WTO (World Trade Organization) "Agreement on the Application of Sanitary and Phytosanitary Measures" (SPS) and Technical Barriers to Trade (TBT), as Codex was specifically mentioned under SPS, while the reference to international standards in the framework of TBT applies to Codex. Codex standards and related texts also play an important role in providing guidance to member countries when they develop or update their national regulations. Codex recommendations cover all aspects of food safety and quality, including labeling, and inspection and certification systems. The Codex Committee on Food Labeling is responsible for all food-labeling matters, such as the definitions of certain claims commonly found in the market, in order to provide clear information to the consumer.

The Codex Alimentarius began in 1991 with the elaboration of Guidelines for the production, processing, labeling and marketing of organically produced food. In June 1999, the plant production began and in July 2001, animal production was approved by the Codex Commission. The requirements in these Codex Guidelines are in line with IFOAM Basic Standards and the EU-Regulation for organic food

**Table 97:**
**Main Differences Among the IFOAM Basic Standards, the Codex Guidelines, and the EU-Regulation 2092/91**

| **Items** | *IFOAM Basic Standards 2002* | *Codex Alimenta-rius Organic Guidelines 1999/2001* | *EU-Regulation 2092/91 (incl. Amendments) for organically produced food* |
|---|---|---|---|
| **Scope** | food and non-food, including fish, textiles (new draft) etc. | mainly food | food and non-food |
| **Conversion** | farm or farm unit, minimum 1 years before harvest, perennials 2 years | farm or farm unit, minimum 2 years before harvest, perennials 3 years | farm or farm unit, minimum 2 years before harvest, perennials 3 years |
| **Landscape/ Biodiversity** | only a recommendation to national bodies | only a recommendation | only a recommendation |
| **Fertilization** | comparable list, clear criteria list for new inputs | comparable lists, exclusion of manure from factory farming, | comparable lists, only manure from extensive farming |
| **Pest and disease control** | comparable list | comparable list | comparable list |
| **GMO products** | excluded | excluded | excluded |
| **Animal husbandry** | rather detailed, developed as a framework for national organizations | developed more as a framework for national bodies | very detailed regulation, especially for poultry |
| **Processing** | elaborated criteria list for new additives and processing aids, detailed list | criteria list in further elaboration, for animal products very restrictive list | Little developed criteria, no developed list for animal products yet |
| **Labeling** | conversion label after 2nd year allowed. Mixed products with >95% organic: full labeling; 70% products: emphasis labeling; products with <70% only on the ingredients list | Conversion label after 2nd year allowed. Mixed products with >95% organic: full labeling; 70% products: labeling on the ingredients list, only allowed on a national level | conversion label after 2nd year allowed. Mixed products with >95% organic: full labeling; 70% products: labeling on the ingredients list |

Source: Otto Schmid, FiBL

(2092/91, 1804/99). These Codex guidelines clearly define the nature of organic food production and prevent claims that could mislead consumers about the quality of the product or the way it was produced. There are differences with regard to the details and the areas that are covered by the different standards (see table 97).

The Codex Alimentarius Guidelines are important for the harmonization of international rules geared towards building up consumer trust. They will be important for equivalence judgments under the rules of WTO. In order to develop the market for organically produced food, the Codex Guidelines also give guidance to governments in developing national regulations for Organic Food. These Codex Guidelines for organically produced food will be regularly reviewed at least every four years based on given Codex procedures. The final adoption is done by the Codex Alimentarius Commission. The Codex-Alimentarius-Guidelines on undertaken agriculture can be downloaded from the web (see Annex 1-B).

## 6.2.4. The European Regulation on Organic Production

In the Member States of the EU, plant products are governed by Regulation No. 2092/91, in effect since 1993, while products from organically managed livestock are governed by EU Regulation No. 1804/99, enacted in August 2000. The EU Regulation applies to non-processed crop and animal products (incl. honey, but no fishery products), processed agricultural products intended for human consumption and to animal feed.

The regulation also defines two different possibilities for import of organic food produce originating from non-EU member countries.

These regulations constitute an important step towards consumer protection. They protect producers from unfair competition and protect consumers from pseudo-organic products. Plant and animal products, and processed agricultural goods imported into the EU, may only be labeled using terms such as "organic" in English and "biologisch" or "ökologisch" in German, etc., if they conform to the provisions of the EU Regulation.

The EU Regulation on organic production lays down minimum rules regulating the production, processing and import of organic products, including inspection procedures, labeling and marketing, for the whole of Europe. In other words, the Regulation defines what constitutes an authentic, certified organic product. Each European country is responsible for enforcement and for its own monitoring and inspection system. Applications, supervision and sanctions are dealt with at regional level. At the same time, each country has a certain degree of freedom with regards to how it interprets the Regulation on organic production and how it implements the Regulation in its national context.

**The EU-Regulation**

- Council Regulation EEC No. 2092/91 and more than 20 amendments
- Set in force 1991 by European parliament
- Protecting consumers, preventing fraud, creating transparency
- Regulating labeling, certification and international trade
- Harmonization within the EU

**Content:**

| | |
|---|---|
| ***Article 5:*** | Labeling may refer only to organic production if produced according to these rules |
| ***Article 6:*** | rules of production |
| ***Annex I:*** the | Principles of organic farming at farm level |
| ***Annex II:*** | lists of permitted products |
| ***Article 8 and 9:*** | requirements for inspection systems and certification programs. |

## Labeling Requirements

The rules for labeling of organic produce (Art. 5) clearly define that products may only refer to organic production methods if they are produced in accordance with the production rules and certified according to the inspection rules as laid down in this Regulation. All usual common terms for organic in the different member states are equally protected in their use (e.g. "biologisch" in German, "écologico" in Spanish, "biologique" in French). Also included in the labeling rules are all requirements concerning the composition of a processed organic product. Briefly summarized, processed organic produce must contain at least 95% organic ingredients to be labeled as organic produce (with various restrictions concerning all other ingredients or auxiliaries/additives) or at least 70% organic ingredients in order to indicate the organic quality of certain ingredients on the ingredient statement. Products containing less than 70% organic ingredients may not write any indication or reference to organic production on their label. The rules for processing organic products are outlined in more detail in the chapter certification requirements.

## Organic Crop Production Requirements

The organic plant production standards as defined in Article 6 and the Annex I and II (and Annex III regarding conventional production) include the following requirements:

- fertilization and plant protection by natural methods using if necessary certain products that are listed as permitted inputs in the related Annexes of the Regulation: plant-protection (Annex II, part B), fertilizers and soil conditioners (Annex II, part A)
- only organically produced seeds or propagation material may be used (certain exceptions defined)
- genetically modified organisms or their derivates must not be used
- the same crop variety may not be produced in the organic and the conventional unit of a farm.
- Definition of the minimum conversion period, i.e. the period that the organic production rules must have been fulfilled until a product can be certified as organic. The minimum conversion period is 36 months before harvest for perennial crops and 24 months prior to sowing for annual crops.

  For information on livestock production see chapter 6.5.

## Inspection Requirements

The inspection rules as defined by Art. 8 & Art. 9 as well as Annex III (Minimum control requirements) outline the following requirements:

- All operators that handle (produce, process, re-pack, label, import, store, export) organic produce are subject to inspection and certification by an approved certification body
- There has to be at least one physical inspection a year, covering all production and preparation units or other premises. In addition the inspection body shall conduct random inspection visits, announced or not.
- Documentary accounts: the operator has to keep detailed documentation on all production measures, agricultural inputs used, harvested quantities, incoming as well as outgoing products, all purchased goods used as ingredients/auxiliaries in processing of organic goods.
- Organic products need to be continuously physically labeled with their origin, organic quality and the responsible certification agency. This also applies to all relevant documentation.
- Detailed description of all necessary inspection measures to be applied by the certification agencies; standards regarding the obligations and requirements for organic certification agencies.

## Import Provisions

Organic food products originating from a non-EU member country may be imported and marketed as organic in the EU, if it is accepted that the products are produced and certified according to procedures equivalent to those of the EU.

There are two ways of meeting the requirements for equivalence:

- The country of the exporter has been accepted by the EU as having equivalent standards and inspection measures and has therefore been added to the so-called Art.11-list of third countries ("third country list"). Exports from such countries is much facilitated and no individual authorizations are necessary. Currently the following countries are listed on the Art.11 list: Switzerland, Israel, Argentina, Australia, Hungary, Czech Republic.
- An individual EU member country can authorize individual importers to market produce from a certain exporter as organic within the member state. In order to gain this permission, importers apply for import authorizations (also called individual authorizations) to their competent authority and support the application by appropriate documentation (usually issued by the certification body of the exporter) to confirm that the products are produced and certified according to rules equivalent to those of the EU. Since presently the bulk of products entering the EU is covered by individual import permits[32] and procedures vary between different countries of import, import procedures with import authorizations are explained in more detail in the chapter import procedures.

As soon as organic products have been imported (custom cleared) with a valid import authorization and the required certificate of inspection (import certificate, transaction certificate) has been issued, they can circulate freely within all countries of the European Union from one certified operator to another.

[32] International Trade Center (ITC), 1999, Organic Food and Beverages: World Supply and Major European Markets, UNCTAD/WTO.

## 6.2.5. The Swiss Regulation on Organic Production

The Swiss Organic Farming Ordinance is stricter than the EU Regulation on Organic Production in requiring conversion of the whole farm to organic management (see Table 98 and, for more detail, Annex III). Its requirements relating to the conversion process, on the other hand, are less strict than the EU Regulation: in Switzerland there is no "year zero". As a result, conversion normally takes two years rather than three as in the EU.

**Table 98: Organic Farming Regulations: Differences between EU and Swiss Regulation**

| Criteria | EU Regulation No. 2092/91 | Swiss Organic Farming Ordinance (BV) |
|---|---|---|
| Whole-farm conversion to organic management | not obligatory | mandatory; however, vineyards and orchards are partly exempted |
| Step by step conversion | Step by step conversion | up to max. 5 years possible in the case of special crops |
| In-conversion label | from 2nd year on | from 1st year on |
| Documentation of ecological services | no regulation | required for direct payments |
| Compensatory habitat areas | no regulation | required for direct payments; 7% of land farmed |
| Nutrient level | max. 170 kg/ha (for animal husbandry) | max. 2.5 LU equiv.[(1)]/ha in valleys; balanced nutrient input/output |
| Limits on copper use | no regulation, permitted until 2002 | max. 4 kg/ha |
| Slug pellets and pyrethroid insecticides | permitted in traps till 2002 | Prohibited |
| Animal husbandry | detailed regulation from January 2001 | detailed regulation from January 2001 |
| Processing | no irradiation | no irradiation |
| Genetically modified organisms and products derived from them | prohibited | Prohibited |
| Packaging | no regulation | no regulation |

[(1)] LU equiv.: Livestock unit equivalent (DGVE, Düngergrossvieheinheit)

### 6.2.6. The US National Organic Program (NOP)

With its National Organic Program (NOP Final Rule), the United States has finally regulated its organic market. The regulation has taken effect October 21, 2002. Since then all produce marketed in the US as "organic", "100% organic" or "made with organic..." needs to be certified according to the rule by a certification agency accredited by USDA, the US Department of Agriculture.

Although the structure of the NOP differs quite considerably from the structure and major focus of the EU Regulation (EEC) N° 2092/91, the regulation covers basically the same issues: Applicability (what has to be certified), Organic Production and Handling, Labeling, Certification requirements, Accreditation of certification bodies, Administrative (National List of allowed and Prohibited Substances).

Compared to the EU-Regulation, the final NOP rule emphasizes certain aspects more than the EU-Regulation e.g. It puts great emphasis on the organic production and handling system plan, in which the operator himself declares all his planned activity for the next year and outlines in detail measures that will be taken to ensure compliance with the Act. The plan is approved by the certification agency and then is binding for the operator. Certain major requirements of the EU-Regulation do not apply, e.g. producing the same crop variety in organic and conventional quality. The list of allowed inputs, the necessary conversion period for crop production, the animal husbandry requirements and the labeling requirements for processed products are defined differently. Some important differences for organic operators are outlined in chapter 6.7.

### 6.2.7. The Japanese Agricultural Standards for Organic Products (JAS)

In line with a revision to the Law Concerning Standardization and Proper Labeling of Agricultural and Forestry Products (the JAS Law), the Japanese Ministry for Agriculture, Forestry and Fishery (MAFF) has in 2000 established the Japan Agricultural Standards (JAS) for organic agricultural products and processed foods made from organic agricultural products. Under this system, products that do not meet the appropriate JAS requirements may neither bear the Organic JAS mark nor be labeled as organic products in Japan[33]. The Japanese Agricultural Standard of Organic Agricultural Products[34] and the Japanese Agricultural Standard of Organic Agricultural Product Processed Food[35] define the necessary requirements for products in order to be labeled as organic. In addition there are several supplementary regulations that define inspection procedures and technical certification criteria for manufacturers, importers, sub-dividers and production process management directors.

Products that are to be labeled as JAS organic in Japan or to be used as ingredients in JAS certified organic food, need to be JAS certified, which implies certification by a JAS accredited certification agency. At the time of print only very few foreign certification bodies were accredited by MAFF. However, years of diplomatic efforts and attempts from certification bodies as well as government to obtain mutual acceptance of standards and registered certification agencies seem to show some result. So far, all the National Organic Program and all USDA accredited certifiers in the US have been accredited by MAFF and European regulation and accredited certifiers can be expected to be accepted soon. The only option for organic operators that are not

[33] MAFF Update Number 353 March 31, 2000

[34] Notification No. 59 of MAFF on Jan 20, 2000

[35] Notification No. 60 of MAFF on Jan 20, 2000

certified by one of these accredited certifiers according to JAS at present is re-certification by a Japanese certification body. This is costly and requires a couple of additional efforts from the operator in particular with regard to written organic quality management procedures and a manager trained specifically as JAS production and process manager.

Some important differences of the JAS organic standard compared to other standards are described in chapter 6.8.

## 6.2.8. Private Label Standards

For many years, large number private label standards have existed. Some countries in Europe and elsewhere had already formulated their own legislation on organic production or private standards and labeling schemes before the applicable organic baseline regulation came into force, in some cases many years earlier. These quality marks for example in Germany, Denmark, Austria or Switzerland, are well trusted by the consumers and are one of the reasons for the current boom in these market for organic products in these countries[36]. Private organic standards are continuously developed by producer organizations. For farmers, the standards of the label they use for marketing their products are most relevant. Private labels allow regional identification and are therefore an important tool of the organic movement of a country. IFOAM therefore recommends that countries of the south, that do not yet have a local market for organic products, also create their own private organic label standards.

Some of these "private labels" have been developed by governments (e.g. AB Label in France) but most commonly by farmers associations (e.g. Naturland or Bioland in Germany; Bio Suisse in Switzerland, KRAV in Sweden or Soil Association in the UK). Some label organizations have established associated independent certification agencies with the same name (e.g. Soil Cert, KRAV Kontrol), others have contracts with certification agencies to conduct the inspection of the specific label requirements on their behalf. Obviously all private labels in Europe have incorporated the minimum requirements of Regulation (EEC) N° 2092/91 and organic operators certified according to a private label scheme are always certified both to the applicable baseline regulation (e.g. Regulation (EEC) N° 2092/91 in Europe) and the private standard (e.g. KRAV). Some labels are only regulating the last processing steps while others also include the farm production. These latter standards are more important for international operators since their operation might need to be certified by a private label organization already in the country of origin. E.g. roasted coffee to be labeled with the NATURLAND quality mark need to be originating from coffee producers that are themselves NATURLAND certified.

Most private labels are of marketing importance in only certain countries or areas. Only Demeter is known as a private label/quality mark for bio-dynamic agriculture and is trusted world-wide.

The following table highlights some important European private labels with their respective markets of importance for international projects.

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36 SIPPO Swiss Import Promotion & FibL research Institute of Organic Agriculture, 2001, The Organic Market in Switzerland and the European Union.

**Table 99:**
**Important European private labels with their respective markets**

| Label (main market) | Introduction |
|---|---|
| Demeter (international)<br>www.demeter.net | Demeter is a world-wide certification system for bio-dynamic agriculture, used to verify to consumers in over 60 countries where food or products have been produced according to the Demeter Standards. Demeter-International e. V. and if there are any member organizations in the producing country, certify projects/operations in countries according the International Demeter standards. Inspection and certification agencies as well as single inspectors need to be approved by Demeter International |
| Naturland (Germany, US, Europe)<br>www.naturland.de | • In order to obtain Naturland certification and the right to use the popular Naturland label, operations need to become member of the farmer association Naturland e.V.<br>• Most important label for organic coffee on the European market |
| AB (Agriculture Biologique)<br>(France) | • No requirements exceed the EU-regulation, except the standards for livestock production. All European organic goods imported into the EU with a valid import authorization can be labeled as AB.<br>• Organic goods coming from non European countries, must be listed on the Annex (so called "Addenda I") of the AB regulation, as either not being available or not cultivated within the EU Listed products include e.g. coffee, cacao, bananas, pineapples, tea, spices, etc.<br>• The product must be labeled by a French importer/packer |
| Soil Association (UK)<br>www.soilassociation.org | - the Soil Association is the UK most important certification body and its label is widely recognized and very popular on the UK market<br>- The Soil Association is presently evaluating several international certifier to ensure equivalence with their certification. For such certifiers no re-certification processes are necessary<br>- On the contrary the importer has to apply for Soil Association re-certification upon the basis of a detailed inspection report and related documents. Oversea operators can have their own direct contract with Soil Association to directly label products with the Soil Association label. |
| Bio Suisse (Switzerland)<br>www.bio-suisse.ch/uploads/e_bibliothek_9-1.pdf | - Bio Suisse is the Swiss organic farming association and its label the "bud" is basically the only recognized organic label on the Swiss market, although products can also be marketed as organic (without bud) if they comply with the Swiss Organic Farming Ordinance or the EU-Regulation on organic farming.<br>- Application for Bio Suisse certification can only be submitted by the Swiss importer (license holder) on the basis of a detailed inspection report covering all aspects that are important for Bio Suisse certification (not all certification agency necessarily describe all aspects). |

Other private European labels without crop production rules substantially exceeding the EU-Regulation in producer-relevant aspects and therefore without direct importance for international producers are e.g. biogarantie (Belgium), EKO (Holland), Statskontrolleret okologisk (Denmark), BIO-Austria-Kontrollzeichen (Austria), KRAV (Sweden), Ökoprüfzeichen (Germany), garanzia AIAB (Italy).

Most of the private label organizations mentioned are IFOAM accredited, which can also be of certain marketing importance.

The re-certification process for above named private labels usually includes a re-evaluation of the inspection and certification documents by the private standard certification body, the issue of a private label certification decision (sometimes with additional conditions to the operator) and some kind of contractual obligation concerning the use of the organic private label (e.g. Naturland: membership and label licenses fee of producer required; Bio Suisse: license contract with the Swiss handler that uses the Bio Suisse logo).

## 6.2.9. Relationship to Fair Trade

Smallholders and cooperatives producing cash crops have always been vulnerable to falling world market prices. A number of organizations worldwide try to reduce these risks by ensuring that producers are rewarded fairly for their products. The organizations guarantee the small farmers and producer associations in the South a fair price for their produce and act as intermediaries in marketing the products, that then bear the label of the organization. Fair trade organizations have separate programs for different crops, of which the labels for coffee and cocoa are the best known.

In Europe, the most frequently seen fair trade labels are those of Max Havelaar, Transfair and World Shops. Further information can be found on the website of Labeling Organizations International (FLO), Max Havelaar and Transfair. Fair trade labels also appear in the United States and elsewhere, though to a lesser extent than in Europe.

Having a Fair Trade label does not necessarily mean, however, that the products can also be sold as "organic". In order to be designated organic, the project must be subject to accredited organic inspection procedures.

Several private organic labeling and certification schemes maintain close contacts with Max Havelaar or Transfair, since some projects conform to the standards of both organizations. The combination of "organic" and "fair trade" labeling can enhance a product's market prospects and is used successfully with organic products from developing countries, such as banana, coffee, cocoa, tee, citrus and flowers.

## 6.3. Certification Requirements EU-Regulation and other standards

The following certification requirements are based on Regulation (EEC) N° 2092/91 since presently the European market is still the major organic import market and the EU-Regulation exceeds most other baseline regulations in some regard. Differences or additional requirements of other regulations such as the USDA National Organic Program, the Japanese JAS standards or important private organic labels are outlined in specific chapters. However, the texts have been written to address the main requirements of all organic standards, as also defined by the IFOAM Basic Standards.

### Pre-requirements for certification

**Inspection along the Chain of Custody**

According to Regulation (EEC) N° 2092/91 all operators that handle (produce, process, re-pack, import, export) organic produce are subject to inspection and certification by an approved certification body. Therefore all steps in the organic chain of custody need to be properly supervised and inspected/certified:

- Farms: all units managed by the organic operator need to be subject to inspection, thus also including conventional units managed by the same operator. Only products originating from certified organic production units can be sold as organic.
- All processing activities (including simple processing such as cleaning, drying, re-packing)
- Storage facilities, Cool warehousing
- All trade activities: thus both exporters and importers. Currently brokers (never own the goods) do not need to be certified, the physical flow of goods is decisive. The certification agency of the exporter is crucial for all import procedures into the EU and is in charge of verifying that all previous production steps have been duly inspected and certified by an approved certification agency

- All transport activities between organic units need to fulfill certain requirements as outlined in the organic regulation, and thus are implicitly verified during the inspection of the related organic units of origin/destination.
- According to the last amendment of Annex III, of the EU regulation those units involved in the production, preparation and import of organic products who have contracted out a part or a the total of the concerned operations to third parties are also subject to inspection and certification.

**Agreement with Certification Body**

All operators to be certified need to have signed an inspection contract with an approved certification agency before any organic activity. The contract can be either direct or else involving a third party as the mandator of the inspection. In this case this third party "owns" the certification and usually organic exports will only be granted with the mandator's consent. This is also the case for subcontracting, i.e. an certified operators entering into subcontracts with other operator to carry out specific operations on their behalf, for instance part of the manufacturing process. The certification of subcontractors may be carried out as part of the certification of the main operators, who pay for the certification.

The contract or other declaration has to outline which activities are covered by the inspection and has to include a written commitment of the operator to adhere to the set organic standards as well as to accept the enforcement of sanctions in the event of infringements or irregularities. The operator also has to agree to grant the inspection body and competent authorities free access to his operation facilities and all related documentation. He must provide the inspection body or authority with any information deemed necessary for the purpose of the inspection. The operator also has to agree to notify the inspection body of any changes in his activities as well as in the case that he suspects or considers that a product which he has produced, prepared, dealt with or which has been delivered from another operator is not complying with organic standards.

Usually, this contract or written declaration remains valid until it is formally cancelled.

**Inspection Visits**

For the first inspection, the operator must draw up a full description of the unit and his activity and needs to define all practical measures to be taken in his operation to ensure compliance with the applicable organic standard. Usually the inspection body will support the operator by providing detailed questionnaires and other documents of guidance in order to fulfil this obligation.

The inspection body must make a physical inspection of the production/preparation units or other premises at least once a year. Moreover, the Inspection body is obliged to carry out random visits, announced or not. Samples may be taken for analysis of possible contamination and detection of non-conforming production methods. An inspection report must be drawn up after each visit, countersigned by the operator.

**Documentation Requirements**

Various types of documents (usually summarizing documentation as well as original receipts and financial records) must be kept in the organic operation to enable the inspection body to trace all suppliers and recipients of the organic goods, the product flow as well as the nature, quantities and use of all inputs.

The accounts must demonstrate the balance between the input and the output.

More details on the documentary accounts that are required on each organic production level (crop production, livestock production, manufacturer, etc.) are outlined in the related chapters below.

**Separation of Organic Qualities**

Operators throughout the whole chain of custody need to ensure the separation of organic products. This implies that organic products, i.e. organically grown products from defined certified organic fields, are being kept strictly separate from any conversion products or conventional (not certified) products. Sufficient separation is achieved and proven by all related measures such as appropriate labeling, different storage rooms, separate processing times, etc.

Many explicit requirements of Regulation (EEC) N° 2092/91 are actually measures deemed necessary to ensure appropriate separation and in order to enable the inspection body to control implementation processes (labeling rules, different storage areas, detailed purchase and sales documentation, detailed processing documentation etc.)

**Packaging and Labeling During Transport**

Operator need to ensure that organic products are transported to other units (e.g. the processing unit) only in appropriate packaging and containers:

- Containers/Boxes/Bags must be closed/sealed in such manner that the content cannot be exchanged or manipulated. This is, however, not necessary from a farm (production unit) to an organic processor.
- Containers/boxes/bags need to be clearly labeled with name and address of the operator (or owner of the products), the product and indication of the organic quality (organic or organic in conversion) and the name or code number of the inspection body that is certifying the sending operator. If appropriate, lot numbers or other clear identification marks also need to be indicated on the package.
- Instead of labeling the product containers/bags directly the above stated information can also be presented on accompanying documents, provided that the document is undeniably linked to the organic product lot.

**Storage**

For the storage of organic goods, specific measures are necessary to ensure identification of the organic lots and to avoid any mixing with or contamination by conventional products, e.g. by allocating specifically labeled areas in warehouses. Any contamination (e.g. by fumigation) must be avoided.

There has to be at least one physical inventory of the warehouse storage per year.

**Requirements for Inspection Bodies**

Within the European Union, certification bodies are accredited for activities in specific countries of activities only, i.e. for each member state there is a list of approved certification bodies that are entitled to perform inspections and certification according to the Regulation (ECC) N° 2092/91.

Operators outside the European Union must only show that their organic produce are produced and certified according to rules equivalent to those of the EU. The EU-Regulation thus includes the additional requirement that certification bodies performing inspections according to the standard in countries outside the regulation must satisfy the requirements laid down by EN45011 (equals the international standard IS 65). EU member countries have agreed on common guidelines to determine this conformity either by accreditation by an official accreditation service or by the competent authority in the country of origin or by the competent authority in the country of import. So far it is not clear whether IFOAM accreditation alone (without EN45011) is acceptable as evidence of this conformity, but it can be expected to be so in thevery near future.

For international operators looking for certification bodies to certify their production for export according to organic standards, it is important to ensure that their certification body is either EN45011 accredited by an approved/official accreditation body or directly accepted by the authority of import of the country of destination (one inspection body may be accepted in one member state of the EU and not accepted in another). Usually, the inspection agency will provide confirmation or proof of their accreditation when submitting all relevant information to the operator.

There are generally four types of certification bodies operating in exporting countries[37]:

a) **Local Certification Bodies:** If the exporting country is on the Art. 11 list (i.e. approved as a "third country", see chapter on EU-regulation) a certification body appearing in this Art. 11 list of Regulation (EEC) N° 2092/91 should be chosen. Also in some other countries (most exporting countries), local inspection bodies are operating and offering organic certification. In order to qualify as certification bodies according to Regulation (EEC) N° 2092/91, these local inspection bodies need to be either EN45011 accredited for certification according to the Regulation, or else directly recognized by the authority of import in the required country of import.

b) **Certification by a Local Branch of an International Certification Body:**
An international certification body, e.g. with its head office in Europe or the US may establish branch offices elsewhere. These local branch offices are in charge of inspection and all everyday contact with the clients. The final certification will usually tbe granted by the head office of the certification body, i.e. the operator will obtain e.g. a "European" certificate which may offer the best guarantee of easy access to the destined country of import.

c) **Certification by International Bodies**
An operator may choose to be certified by an international certification body. International certification is likely to be more expensive than local certification, but it may be the only solution in the short term. The certification body does not need to be European in order to enter the European market, but they need to be accredited by certification programs that fulfill the requirements of Regulation (EEC) N° 2092/91, or the requirements for other markets of import.

d) **Partnership between Local and International Bodies**
This partnership between international and local certification bodies can take various forms, but usually local bodies carry out the bulk of the activities leading to certification, while the international certifier periodically evaluated the implementation of certification procedures and sometimes issues the certificate[38].

[37] International Trade Center (ITC), 1999, Organic Food and Beverages: World Supply and Major European Markets, UNCTAD/WTO.

[38] International Trade Center (ITC), 1999, Organic Food and Beverages: World Supply and Major European Markets, UNCTAD/WTO.

## 6.4. Requirements for Crop Production

### Conversion Period

All organic standards require a certain time between the beginning of organic cultivation and the time that the crop can be harvested as organic. This time is usually referred to as the conversion period.

The required conversion period according to Regulation (EEC) N° 2092/91 is:

- **Annual Crops:** 24 months prior to sowing, i.e. all annual crops (e.g. beans, cereals, salad) that are to be sold as organic must be grown organically on land that has been cultivated organically according to the Regulation (EEC) N° 2092/91 for at least 24 months before it has been sowed out.
  If an annual crops has a vegetation period of more than 12 months after sowing, then basically the rules for perennial crops will apply.
  ***Example:*** *beans are sowed in June and harvested in September; the beginning of conversion was set to March 2000, then the first organic harvest of beans can be in September 2002. If the beginning of conversion was August 2000, then the first organic harvest would be in September 2003.*
- **Perennial Crops:** 36 months prior to harvest, i.e. all perennial crops (e.g. coffee, tea, apples, cocoa, etc.) that are to be sold as organic, need to be cultivated organically for at least 3 years before harvest.
  ***Example:*** *coffee is harvested in December, beginning of conversion was set to September 2000; first harvest as organic coffee is harvest December 2003.*
- **Grassland** as pasture for organic livestock: 2 years before harvest/use as organic feedstuff
- **Marketing during the Conversion Period:** All products that are produced according to the organic standards for at least 12 months can be sold as "organic in conversion" or "organic in transition". All crops produced in the first year of conversion (sometimes called "zero-year") cannot be marketed with any reference to organic production methods, i.e. although the production methods are already organic, the product must be marketed as conventional.
  ***Example:*** *a tea farm is converting to organic farming; the begin of conversion has been set to 3/2000 (last application of prohibited input). All tea harvested until 2/01 must be marketed as conventional, tea harvested between 3/01 and 2/03 could be marketed as organic in conversion, tea harvested from 3/2003 onwards may be sold as organic tea.*

The EU-Regulation determines the beginning of the conversion process for a given parcel of land not merely the time of last input of prohibited inputs, but instead a definition of the main production principles (use only of fertilizers and pest control measures that are permitted in the regulation; ensuring long term soil fertility, natural control of pests and diseases, no GMO's) that must have been fully met during the conversion period.

The new Annex I also defines the beginning of the conversion process as being the date that the operator applied for certification with the inspection body/notifies his activities to the inspection body. However, under certain circumstances the inspection body can recognize previous land use retrospectively as part of the conversion period. The beginning of conversion process can therefore only be set by the certification body in the course of the first certification and with due consideration of all supporting documentation provided by the operator, particularly with regard to the previous land use.

The conversion period also remains a very critical issue with regard to acceptance in the country of import. Several countries are considering drafting import regulations that exceed Regulation (EEC) N° 2092/91 in this particular issue. It appears at the moment that in the best case, a one year certified conversion period will still be required.

## Sustainable Management

Organic standards require a proactive, long-term program of ecological management. This includes implementation of:

- Soil building strategies: appropriate crop rotation with e.g. leguminous plants for annual crops or appropriate inter-cropping for perennials to ensure long-term soil fertility; appropriate fertilization measures designed to close the internal production cycles as much as possible (i.e. mainly operating the farms own sources of fertilization)
- Nature conservation measures, such as increasing bio diversity by leaving e.g. ecological buffer zones, nature reserves, hedges, biotopes, etc. this also includes planting e.g. trees on the organic farm or promoting rare local species, no de-forestation.
- Prevention of soil erosion, e.g. by means of bundles or contour planning, soil covering, weeding instead of hoeing weeds, etc.

## Fertilization

Long-term soil fertility is to be ensured by means of:

- Cultivation of leguminous and green manure plants as intercrops or parts of the crop rotation scheme.
- Use of organic livestock manure from the own operation (if feasible), up to 170 kg Nitrogen/ha/yr.
- Use of other organic material, preferably after composting into a well nutrient-balanced compost mixture.

Only in the case that measures can not ensure soil fertility and sufficient nutrient input, fertilizers as listed in Annex II, Part A of Regulation (EEC) N° 2092/91 may be used. For many of the fertilizers, the inspection body has to approve the need and therefore applications for the use of this input; thus these inputs need to be submitted to the inspection body well before planned use. Use may be restricted to certain maximum quantities and needs to be carefully documented in the farm documentation.

If purchasing any ready-made "organic fertilizers" for organic production, operators need to ensure that the fertilizers are actually certified as being appropriate for use in certified organic farming according to the applicable standard. Since certification standards for "permitted" off-farm inputs often differ considerably, operators should always ensure compliance before use of the input by submitting a request to their inspection body.

## Plant Protection

The choice of appropriate varieties, appropriate crop rotation programs, mechanical soil cultivation, protection of natural enemies of pests and flame weeding form the bases for organic plant protection. In case of immediate threat to the crop, plant protection products as listed in Annex II, Part B of Regulation (EEC) N° 2092/91 may be used.

Again, the need for the use of most of this products must be acknowledged by the inspection body and therefore many inspection bodies require an application process for the use of all off-farm plant protection inputs.

If purchasing any ready-made products for organic plant protection, operators need to ensure that the products are actually certified as being appropriate for use in certified organic farming according to the applicable standard. Since certification standards for "permitted" off-farm inputs often differ considerably, operators should always ensure compliance before use of the input by submitting a request to their inspection body.

The use of all plant protection agents needs to be documented in great detail (incl. quantities) and usually per each plot (e.g. in so-called plot application registers).

It is also the operator's responsibility to prevent any contamination by prohibited substances from conventional neighbors or his own conventional operation unit. This can be achieved by means of e.g. buffer zones (without cropping), no-harvest cropping zones, ditches, hedges or other wind breaks, no-spraying agreement with neighbors, etc.

### Seeds and Seedlings

For organic production only organically produced (=certified) seeds and seedlings may be used. If certified organic seedlings for the required variety are not available commercially, and this can be proven to the inspection agency, then conventional (not certified) seeds may be used when not treated with any prohibited agent. If the required seeds can be proven unavailable even in untreated conventional quality, then treated seeds may be used for a clearly restricted transition period; great efforts need to be taken to ensure organic seed supply in future. The use of conventional seeds in organic cultivation is authorized only until end of 2003.

The used seeds or seedlings must not be genetically modified.

### Management of Farms with an Organic and a Conventional Unit

A unit that grows organic produce must be clearly separate from those that produce conventional products. "Unit" is described at "land parcels and production and storage locations which are clearly separate from those of any other unit not producing in accordance with the organic standard".

The EU-Regulation prescribes that if the organic operator also runs conventional units in the same areas, these must also be inspected in the course of the inspection of the organic unit, but obviously only to a limited extent. The production of both conventional and organic crops within one operation is often referred to as split operation.

Split operation is permitted under Regulation (EEC) N° 2092/91, but it is prohibited under many private label schemes. Split organic operations need to fulfill a couple of additional requirements and inspection may need to focus in particular on appropriate separation of the organic (organic and conversion fields) and the conventional unit. Split operations need to ensure the following additional aspects in particular:

- The organic (organic and conversion fields under organic management) and the conventional unit must be clearly defined, separate units, i.e. they are usually clearly defined fields. All crops grown on the conventional fields are "conventional products" and may not be mixed at any time with the products grown on the organic unit. The definition of clearly separate organic and conventional units is of crucial importance when rotating annual crops. In this case, it must be ensured that organic crops only rotate on the organic fields and never to the conventional fields (unless it is planned to convert these fields also to organic fields and the conversion periods are respected)
- The inputs used in the conventional unit may not be stored at the same place as inputs used in the organic unit, even if inputs in stock happen to be allowed (e.g. lime used in both units needs to be stored in two different places).
- All measures need to be taken to prevent contamination of the organic crops by the conventional activities. Attention should therefore be paid e.g. to minimize the use of the same farming devices such as pesticide application devices, tractors, etc.
- The farm documentation of both units has to meet the basic standards for organic certification, i.e. all inputs used as well as harvest figures need to be carefully documented.
- The same varieties may not be produced in the organic and the conventional unit, unless certain additional requirements are fulfilled (see below). Production of a certain crop in both organic and conventional quality is often referred to as "Parallel Production".

Parallel production, i.e. production of the same or an in differentiable crop variety in both organic and conventional quality by the same operator is prohibited for all annual crops. Parallel production of perennial crops can be accepted if all of the following requirements are being met:

- The operation has a conversion plan where the last plot of the operation is converted to organic farming within a maximum of 5 years. The conversion plan has to be approved by the certification body.

- Appropriate separation measures are taken and documented to ensure permanent separation of the organic and the conventional products. Such separation measures usually need to be taken very seriously in order to really ensure separation in every day routines on a farm (e.g. often harvest is done by untrained workers who e.g. cannot acknowledge any difference between the organic and the conventional apples on two neighboring plots).
- The inspection body is notified of each harvest at least 48 hours in advance and is furthermore informed immediately after harvest regarding the exact harvest quantities together with a confirmation that separation has been guaranteed.

### Management of Organic Farms with Organic and Conversion Areas

The main requirement for organic operations in both organic and conversion fields requires taking strict measures to ensure that organic and conventional products are not mixed at any time.

If the same crop is produced in both organic and conventional quality, it is also sometimes called "parallel production", but since this is not the situation as outlined above and as defined in Par. 3 of Annex III, Part A1 it is referred to as "production of different organic qualities" in this handbook.

The production of the same crop in conversion and organic quality is not restricted per se, however the inspection may decide that, for instance, the separation cannot be realistically guaranteed and therefore de-classify the whole harvest (not areas) of the crop concerned to conversion (esp. for annual crops). Therefore operators are advised to plant different crops when converting additional fields to organic farming.

### Farm Documentation

The following records should be kept in a form that is suitable for the concerned operation:

- Records of purchased inputs such as fertilizer, plant protection agents, seeds, etc. The necessary records include both original receipts and often also a comprehensive purchase summary in order to facilitate the inspection
- Farm maps showing the whole operation (organic and conventional unit) with dates and some indication on important landmarks, plot numbers as well as zones with risk of drift.
- Field history records for all new fields, incl. any statements from former owners etc.
- Cultivation activity records, either as e.g. plot registers or farm diaries. In particular, any application of fertilizers and pest control agents needs to be recorded in details.
- Specification of used inputs or suppliers, for instance certification of seed supplier, certification of used off-farm organic fertilizer, specification of the used organic pest protection agent, etc.
- Harvest records (e.g. crop harvested, date , field #, quantity)
- Storage records (bin registers, warehouse in-out)
- Transportation records of the organic products: either from field to farm or to the next unit (e.g. processing unit)
- Sales records of the organic products (e.g. to the processing unit)

### Post-harvest Processing

All on farm post-harvest processing (e.g. threshing of wheat, cleaning of fruits, drying of spices, de-pulping of coffee berries, etc.) needs to comply with basically the same requirements as other organic processing units, except the requirements for documentation of the incoming goods. The requirements for organic processing are outlined in more detail below.

## 6.5. Requirements for Livestock Production

For certification of livestock the EU-Regulation defines very detailed requirements, which include various aspects such a conversion periods, fodder, housing, medication, animal welfare. These requirements are only summarized very briefly here as this handbook does not focus on certified livestock production.

The main requirements for organic husbandry are, however, also important for operators striving to rear their farm animals according to organic standards to the extent possible, even if not certified. In exporting countries, animal husbandry is usually considered as "conventional unit", from which input "manure" is transferred to the organic unit (=organic farm). However, obviously the ultimate aim is to also convert the animal husbandry fully to organic management.

- Pastures and Free Ranging Area must also be under organic management and certified.
- Fodder: Animals are to be fed with organic feedstuff, if feasible for the own farm: all feedstuff and additives as defined in Annex II, C are also permitted.
  In addition to organic fodder, conversion fodder may be used up to 30% (or 60% if from the own farm), depending on the animal species. Maximum 10% of the fodder may be conventional
- Certain Conversion Periods defined for each species, i.e. the time the animal must be under organic management before it or its products may be marketed as organic. E.g. 13 Months (or 3/4 of their live) for cattle for beef production, 3 months for milk producing animals.
- Animal Health needs to be ensured by appropriate varieties, high quality fodder, appropriate stock densities etc. Preventive use of allopathic medication, antibiotics, growth-increasing hormones etc. is prohibited. In case of acute disease phytotherapeutic and homeopathic medication may be given, and if not curable otherwise, allopathic medication applied up to 3 times a year. For a period after the application, the animals or their products may not be marketed as organic. All purchases and gestation of animals needs to be duly documented, including all medication.
- Housing needs to meet the natural requirements of the animals. Stables have to fulfil certain requirements (floors, light, sufficient room, maximum stock densities). Free roaming animals can only graze on well defined organic areas and need to have access to protective shelter (maximal densities defined).
  For each species, certain detailed requirements are defined.
- Animal welfare: tail cutting and removal of horns for cattle may not be performed systematically. Proliferation has to be natural; stress for animals before slaughtering is to be minimized.
- All activities, including purchase of new animals, fodder purchase, medication, gestation details, etc. need to be documented in written accounts and supported by the related receipts.

## 6.6. Requirements for Processors and Traders

### Incoming Goods

When receiving organic goods the processor or trader needs to verify that the incoming containers are labeled according to the requirements and sealed, ensuring that sufficient proof of the organic certification of the received goods is available, e.g. by demanding national transaction certificates from products purchased from other units that are certified by other certification bodies.

### Prohibited Methods

Products that are to be labeled as organic products must have fulfilled the organic standard throughout the whole custody chain. They may not contain genetically modified organisms or be radiated.

As a general rule, the EU-Regulation prohibits every ingredient/input that is not explicitly allowed, i.e. all inputs/auxiliaries/additives that are not listed in Annex VI in the related tables may NOT be used in organic products, except if exceptional permission has been granted by authority in the country of import.

### Ingredients and Auxiliaries

Each organic product must be clearly defined with regard to its composition (recipe) as well as origin, type and quantity of all ingredients, additives and auxiliaries. All recipes for organic products should usually be verified and approved by the inspection body prior to processing.

For processed goods to be labeled as "organic" the following are main requirements:

- Only such auxiliaries and additives as listed in Annex VI, Part A&B may be used. For most such auxiliaries declarations that they are not genetically modified will be required from the supplier.
- 95% of all ingredients or agricultural origin need to be certified organic. The remaining 5% may be of conventional quality, but all of these conventional ingredients must be listed in Annex VI, Part C, otherwise they must be organic. The same ingredient may not be used both in organic and conventional quality.

For products that are to be labeled as "X% of the agricultural ingredients were produced in accordance with the rules of organic production" the following requirement applies:

- Only such auxiliaries and additives as listed in Annex VI, Part A&B may be used.
- 70% of all ingredients or agricultural origin need to be certified organic. The remaining 30% may be of conventional quality, but all of these conventional ingredients must be listed in Annex VI, Part C.

Products containing less than 70% organic ingredients may not refer to the organic quality of any ingredients on their label.

Conversion products may not be used in multi-ingredient products in the EU, i.e. they can only be marketed as mono-products (e.g. fresh fruits, frozen vegetables, dried fruits, 100% fruit juice), but not e.g. in fruit jams, banana chips (oil and sugar added).

### Separation and Preventing Contamination during Processing and/or Storage

If the organic manufacturer also processes, re-packs or stores conventional goods, then all necessary measures have to be taken to identify the lots and to prevent them from commingling with conventional products.

- The processing dates for organic products are to be documented and announced to the inspection body in advance, and if requested (for rare processing events)
- The processing line (machines) must be cleaned thoroughly before processing organic products. If thorough cleaning is not possible, the first batches of organic processed products cannot be sold as organic

- In order to prevent contamination and accidental mixing of qualities, organic processing should be organized in blocks, e.g. every day, in the morning, organic processing, in the afternoon, conventional processing
- During all internal intermediate stages and storage, organic products also need to be labeled accordingly in order to prevent any commingling.
- Clear storage areas are needed for the organic goods (including intermediary stages).
- Workers need to be aware of the specific requirements for organic processing and need to be trained accordingly. The less experienced the workers are in organic processing and separation, the easier and clearer all separation measures need to be, e.g. use of differently colored boxes for organic, conversion and conventional products.
- Fumigation or irradiation of the produce is not allowed
- Facility pest management is not restricted per se, but may not contaminate the organic produce.

### Documentation

- The processing/trader documentation needs to enable the inspection body to verify the origin, nature and quantity of all incoming goods, the nature quantity and customer of all products leaving the operation.
- List of suppliers, list of customers, list of all incoming ingredients and sales statistics; original purchase invoices for all ingredients, additives, auxiliaries used, including their specification.
- Furthermore other information such as origin, type and quantities of all ingredients, additives or auxiliaries, as well as the composition of the final products needs to be available
- Recipes for each product; processing dairies also indicating the ingredients/additives used in a specific processing step
- Assortment list of all products produced in the operation (including conventional products) with their code numbers
- For every export shipment the exporter needs to apply for the issue of a "certificate of inspection" (also called import certificate or transaction certificate) to his certification body. These certificates of inspection will be described in more detail in the chapter "import procedures". The certificates will usually be sent directly to the importer, who needs them as a proof that the imported lot is actually certified organic.

### Export Labeling

The export labels for semi-processed goods need to fulfill basically the same requirements as transport between certified operators (e.g. processor and organic exporter): Bags/containers need to be closed so that their content cannot be exchanged, and need to be labeled with the name/address of the last processor/packer, the organic quality (e.g. "organic"), the name or control number of the certification agency that has certified the last processing or packaging step.

However, export labels for finally processed products, i.e. for products that are labeled with the final consumer label need to fulfill more detailed and complicated requirements, in particular in the case of multi ingredient products (several agricultural ingredients and/or additives/auxiliaries). In this case the recipe has to be checked in order to determine the correct labeling.

Consumer labels for conversion products may only refer to consumer labels for organic production methods by indicating the following sentence (in exact wording): "product under conversion to organic farming". Indications such as for instance "organic in conversion apples" are not permitted.

Normally export labels, and in particular if end consumer labels, will be verified by the inspection body, so if changes are made it might be necessary to check with the inspection body beforehand.

## 6.7. Additional and Differing Requirements for the US Market

The USDA National Organic Program (NOP) Final Rule came into force on 21st October 2002. This Act by the US Department of Agriculture (USDA) is the baseline certification standard according to which all products to label as organic (different labeling expressions defined, see below) need to be certified, this includes all imported organic products.

Therefore all products that are sold to the US as organic (i.e. for sales as organic) need to be certified according to this act by a certification body that is accredited by USDA. The Act can be downloaded from the USDA NOP Website: http://www.ams.usda.gov/nop/

Since most organic operators world-wide will most probably export to both the European and the US market, the following texts highlight the principal differences between the NOP and the EU-regulation with specific emphasis on all those aspects where the US Act exceeds the requirements of regulation (EEC) N° 2092/91 and where there are different requirements for livestock production.

### Applicability and Organic Production Handling System Plan

- Certain Operations are exempt from certification and submission of an organic system plan, e.g. any production / handling operation with organic sales total less than 5'000 USD or traders that only trade readily packed and labeled goods.
- Each organic operator must develop an organic production or handling system plan that is agreed to by the certification agent. The plan must include: description of practices to be performed and maintained, list of substances used as production or handling inputs, description of monitoring practices to verify that the plan is effectively implemented, a description of the record keeping system and all separation measures.
  The plan is then binding for the operator. Some agencies will provide specific questionnaires or other supporting documents to support the operator in preparing the organic production and handling system plan

### Additional Record Keeping Requirements

- All operator records must be kept available for at least 5 years.

### Conversion Period

- Conversion period is 3 years before harvest for all crops (also annual crops), beginning with the date of the last non permissible application.

### Fertilization:

- raw manure must be composted unless (a) on crops not for human consumption or (b) incorporated in the soil 120 days before harvest (if edible plant part in contact with soil) or for 90 days before harvest (otherwise)
- Composted plant and animal materials must be produced according to the following or equivalent efficient processes: initial C:N ratio between 25:1 and 40:1; maintained at 55-77°C for 3 days (in-vessel/ aerated system) or for 15 days (windrow composting system, materials turned at least 5 times) or equivalently efficient composting methods.; Uncomposted plant material may be used.
- Sewage sludge may not be used under any circumstances (not allowed in EU anyway)
- All other inputs listed in Annex II, Part A may also be used according to NOP National List

### Plant Protection and Weed Management, Seeds

- A few plant protection agents that are allowed according to EU are not allowed in the US (see National List). Generally, all non-synthetic substances are allowed, except if explicitly prohibited.

- Seeds treated with prohibited substances may not be used (also if not commercially available otherwise)
- The use of inputs that are used as disinfectants and sanitizers in the production/ (e.g. in irrigation system) is also restricted
- Buffer zones to conventional fields are required (cannot be replaced by other protection measures)

### Facility Pest Management:

- in an organic facility pests must be prevented by physical factors. If necessary pests can be controlled by traps, lures repellents with substances listed in the National List.
- under certain conditions, substances not listed may also be applied; but great care has to be taken (and documented) that the organic products are not contaminated.

### Label Categories:

- **100% organic:** 100% of all ingredients must be organic, i.e. also all auxiliaries/additives (even if allowed) must also be certified organic substances (e.g. only organically produced Lecithine may be used) Allowed: except water and salt.
- **organic:** 95 % of all ingredients must by (NOP-) organic, the other 5% must be commercially unavailable; certain restrictions for the conventional ingredients; all auxiliaries/processing aids listed in National list.
- **"made with organic (specified ingredients or food groups)":** only 70% of the ingredients must be NOP certified organic. The 30 % conventional ingredients must not be "commercially unavailable", certain restrictions for the conventional produce.
- **Products with less than 70% organic ingredients:** this type of product cannot be marketed as organic product in the EU!.

**Note:** the percentage is found by calculating the share of certified organic product of the TOTAL weight/volume of the finished product, while according to the EU regulation the percentage is calculated as the percentage of organic *agricultural* ingredients of the total weight/volume of *agricultural* ingredients.

### Contamination:

- Explicit requirements include that packaging material must be clean and must not pose any risk of contamination, and the material must not be treated with unpermitted substances
- In installations that get in contact with soil or livestock, no lumber treated with Arsenic may be used
- When residue testing detects prohibited substances at levels that are greater than 5 percent of the Environmental Protection Agency's tolerance for the specific residue detected or unavoidable residual environmental contamination, the agricultural product must not be sold, labeled, or represented as organically produced.

### USDA NATIONAL LIST

(only where stricter than Annex II of Regulation (EEC) N° 2092/91), for more details see original NOP National List (Subpart G of the Act)

**Disinfectants and sanitizers used in organic crop production (e.g. in irrigation system)**

*Allowed NOP, not regulated EU:* Alcohols, Ethanol, Isopropanol, Chlorine materials (residue chlorine levels lower than max. drinking water limit), Calcium hypochlorite, Chlorine dioxide, Sodium hypochlorite, hydrogen peroxide, soap-based algicides.

**Insecticides and Rodenticides**

*Allowed in EU but not allowed in NOP:* Gelatin (insecticide), hydrolyzed proteins (sometimes not considered plant protection product) , tobacco dust (no longer after 3/02) ; pyrethroids in traps

**Slug or snail bait**

*Allowed in EU but not allowed in NOP:* Metaldehyd (NOP: None allowed! )

**Plant disease control**
*Allowed in EU but not in NOP:* Lecithin (fungicide), potassium permanganat,
**Plant or Soil Amendments, Fertilizers**
*Allowed in EU but not in NOP:* ash from manure burning; use of trace elements is restricted to certain chemical forms (sulfonates, carbonates, oxides and silicate forms only and may not be used as defoliant, herbicide or desiccant); .raw manure restricted with well defined compost requirements
**Floating Agents in Post harvest handling**
*Allowed EU, but more restricted NOP:* Aquatic plant extracts (strict restrictions regarding extraction methods)
**Processing ingredients/ Auxiliaries**
*allowed by EU but prohibited NOP:* activated carbon, agar, argon, carrageenan, casein, egg white albumen, ethanol solvent, gelatin, karaga gum, tragacanth gum, hazelnut shells, isinglass, malic acid, potassium alginate, rice meal, sodium tartrate, talc, and tartaric acid (l(+)-).

## 6.8. Additional and Differing Requirements for the Japanese Market

The Japanese Agricultural Standard of Organic Agriculture defines the organic standard requirements that all products labeled in Japan as organic need to fulfill and need to be certified. Certifiers need to be accredited in order to be able to certify according to the JAS standards, but many Japanese certifiers offer re-certification according to JAS, verifying as such that the certified organic operator also fulfils the specific JAS requirements.

In addition to the mere fulfillment of the organic production standards for agricultural products (Notification 59 of MAFF) and for organic processed food (notification 60), the JAS regulations request, in their technical criteria of organic operators (Notification No. 819 ), that operators formulate their own internal regulation and procedures in a very detailed manner (almost equivalent to an ISO 9000 certification). Organic operators need to have internal regulation for production process management, grading regulations and must appoint an organic process manager and grading manager:

### Internal Regulation for Production Process Management:

All procedures to carry out quality management must be described in a practical and systematic way. The required content of the regulation is summarized in II-2 of No. 819. The internal regulation (description of internal procedures) has to cover all therein listed aspects[39]:

- Annual production plan
- Cultivation plan (fertilization, seeds, pest control, etc.)
- Maintenance, cleaning and washing of machinery, equipment and tools
- Lot control from harvest to shipment

[39] JONA: The Management System required by the technical criteria; documentation for JONA applicants, Feb. 2002.

- On-farm processing
- Record keeping (harvest, shipments, losses)
- Reporting to the certification body and obligation to undergo annual inspection and auditing by a certification body.
- Check and revision of the internal regulations (need to be reviewed periodically)
- Claim / Complaints policy and procedures
- Education and training of staff and workers

### Grading Regulations for Organic Products

This requirement is described in No. 819 IV: all procedures to inspect the production process of organic agriculture and to judge whether the products are compliant with organic JAS and if so, approve labeling JAS organic before shipping. The organic grading manager (different from the quality control manager, basically an internal inspector to re-evaluate all organic quality management)

- evaluate the conformity of the operation with internal regulations and the JAS standard by checking the operation records,
- must approve the grading (labeling) of the products as organic and the use of the JAS label,
- supervise storage and shipment of the organic goods,
- deal with unapproved products
- and supervise/co-ordinate the external inspection by the accredited certification body.

### Production Process Management Staff

Production process management staffs need to be appointed to be in charge of all organic production, including sub-contracted operations. All quality management staff needs to fulfill the following requirements:

- University degree in a subject related to agricultural production or degree from profession school with at least 1 year practical experience in agricultural production or guidance, investigation, etc. Or high school or secondary education school level with practical experience in agricultural production and guidance for more than 2 years OR experience in agricultural production or guidance for more than 3 years

For small operations it may be sufficient to have one quality control manager who has completed the curriculum concerning management and the grasp of the production process of the organic agricultural products. If there are several production process management staff, then a production process management director shall be elected from them.

The "agricultural production process management director" is according to JAS understanding basically the organic operator or its legal representative (farmers, a farmers co-operatives or managers of such operations)

### Organic Production Rules

The organic production rules as defined in the JAS Regulation No. 59 can be summarized as follows (with regard to differences to Regulation (EEC) N° 2092/91):

- **Production Units:** clear separation of organic and conventional fields required (if applicable buffer zones etc. must be installed), but parallel production is not prohibited
- **Conversion Period:** same as in Regulation (EEC) N° 2092/91 (36 months for perennial crops, 24 months before sowing for annual crops), but during the conversion period ALL organic production standards (including organic seeds, etc.) must have been fulfilled. On newly developed land or fields that have not been used for cultivation, prohibited substance must not have been used at least 2 years and the full set of criteria must have been fulfilled for at least one year.
  From 12 months after begin of conversion onwards products may be sold as organic in conversion.
- **Fertilization:** only certain by-products of agricultural origin permitted (rape seed cake, rice bran oil cake, soybean powder and cake) but all composts derived from "agricultural products and their derivates" may be used; peat may be used without restrictions; no blood meal, horn meal, meat meal, wool, fur, hairs; no magnesium carbonate, BUT there is a general

provision that allows all nutrition providing fertilizers that are a "natural substance" or those derived from a natural

- **Seeds and Seedlings:** The seed stock used must comply with the organic production rules, but it is not explicitly stated that it needs to be certified. Conventional seeds may be used if organic ones are "hard to obtain by ordinary means". Seeds must not be genetically modified
- **Pest and Disease Control:** not permitted compared with EU-Regulation: neem products (neem itself allowed, commercial neem products need to be authorized by MAFF)), gelatine, Lecitin, tobacco extract; quassia extract, all copper formulation except copper sulfate and copper wettable powder, metaldehyd, diammonium phosphate, soft soap, mineral oils (only vegetable oil and paraffin for spreaders permitted), potassium permanganate
- **Pest Control during Processing, Cleaning, Storage Packaging** and other processes is explicitly regulated: only products listed in the regulation may be used (all allowed plant protection agents with clearly defined processing auxiliaries only)

### Organic Processing Rules (Notification No. 60)

- **Ingredients:** conventional ingredients may be used up to 5% of total weight except salt and water (not irradiated and not GMO, and not the same ones as in organic quality. For labeling as "JAS organic," not more than 5% livestock and marine products may be in the product since these cannot be certified under JAS. Such products can however be labeled as "made with organic agricultural ingredients"
- **Food Additives:** shall be within necessary minimum for manufacturing; only as listed in regulation (no difference between processing aid and ingredients of non-agricultural origin)
  not permitted JAS(Compared to Regulation (EEC) N° 2092/91): tocopherol-rich extract, Calcium citrate, Potassium alginate
- **Labeling:** several Japanese wordings of the word organic are given; labeling as "organic" is also permissible. Organic in conversion products and all processed products containing conversion products are to be labeled with "under the conversion period" in front or in the rear of the word/signs for organic.

## 6.9. Additional and Differing Requirements Private Standards

| Table 100: General information on these private labels is described in the chapter "Private Labels" | |
|---|---|
| **Label (main market)** | **Most Important Additional Requirements** (for international operators, without livestock certification) |
| Demeter (international)<br>www.demeter.net | • According to the principles of bio-dynamic agriculture the entire enterprise, including all the fields and animal husbandry must be converted.<br>• cattle or other ruminants must be kept on agricultural farms,<br>• soil fertility is to be maintained primarily through the use of well rotted compost, which has been prepared with the biodynamic compost preparations,<br>• all areas are to be sprayed with the biodynamic horn dung and horn silica preparations,<br>• no use of copper in vegetables, use of copper on perennial crops is restricted to max. 3kg/ha/year. |
| Naturland (Germany, US, Europe)<br>www.naturland.de | • Entire operation must be converted to organic farming<br>• Focus on soil fertility and soil building measures, restricted total external organic fertilizer inputs<br>• Limits on the use of copper (3 kg/ha/yr)<br>• Seeds must not be treated (even not easily unavailable)<br>• Obligation to promote bio-diversity and have ecological balance areas<br>• No burning of trees or organic materials, not clearing of virgin forests<br>• Annual crops: at the very least 1/6 of agricultural area should be leguminous in the crop rotation pattern<br>• Detailed and well defined requirements for smallholder organizations internal control systems. |
| Soil Association (UK)<br>www.soilassociation.org | For crop production the main differences to the EU-Regulation are:<br>• no GMO crops (e.g. GM testing sites) in a radius of 9 km around organic farms; 5 years conversion period following the growing of a GM crop<br>• specific conversion requirements (soil building phase necessary, and may not be switched in and out of organic production)<br>• Maximum heavy metal levels in soil and manure<br>• 10 m buffer zone to conventional fields (if no hedge)<br>• Certain organic fertilizer restricted: peat (prohibited), sulphate of potash (restricted); certain crops may not be planted on the same field (potatoes, brassicas) for one year in four.<br>• Plant protection: metaldehyd prohibited |
| Bio Suisse (Switzerland)<br>www.bio-suisse.ch/uploads/e_bibliothek_9-1.pdf | • As per Swiss Organic ordinance, the conversion period for organic products is 2 years only; products may be labeled as "conversion" from the 5th month of conversion onwards. The begin of conversion is usually the date of the first inspection (if no unallowed inputs have been used from then onwards) and cannot be set retrospectively further than to January of the first year of inspection.<br>In addition to the requirements of the Swiss Organic Ordinance (in most aspects equivalent to Regulation (EEC) N° 2092/91), Bio Suisse projects are required to fulfill the following criteria:<br>• Overall Management Policy (whole farm operation must be managed according to Bio Suisse requirements, animal husbandry at least according to IFOAM minimum criteria); sometimes a binding 5 year conversion plan towards fully organic production is accepted.<br>• Areas set aside to foster biodiversity (hedges extensively managed pastures or meadows, extensively managed orchards, nature reserves, etc.) must comprise at least 7% of the land used for agricultural purposes<br>• Limits on the use of copper (max. 4kgneat Copper/ha/year or 1,5 kg/ha for pome fruits and 2 kg/ha for berries)<br>• Limits on the use of fertilizers (crops max. 225 kg N/ha/yr, 90 kg $P2O5$/ha/yr, for vineyards:180kg N, 70 kg $P2O5$ and fruit producers: 55 kg N, 20 kg $P2O5$ )<br>• Processors and traders also need to be inspected according to Bio Suisse criteria in particular with regard to handling Bio Suisse products separate from mere "organic" goods; Bio Suisse processing standards apply.<br>• No air shipment of goods; only products that are at the time of marketing not available in Bio Suisse quality within Switzerland can be labeled as Bio Suisse.<br>• Smallholder projects: Minimum requirements for participation as outlined in the Naturland Smallholder Certification Manual apply (see Chapter Certification Smallholders), with well-working internal control system that fulfils the high Bio Suisse standards, still 20% of all farmers need to be inspected annually by the inspection body (unless very well organized ICS; reasons for lower inspection rate stated and explained by certification agency) |

## 6.10. Certification Requirements for Smallholder Organizations

### Group Certification

Rules on the type and extent of inspections of smallholder organization in third countries must be equivalent (rather then identical) to the provisions of Regulation (EEC) N° 2092/91. The regulation requires an annual inspection of every organic farm; however, the majority of agricultural products are produced in countries of the third world, mostly by small growers in remote regions, who do not have access to adequate roads and infrastructure. Since huge numbers of farmers can be involved, it appears essential that a practical and cost-effective inspection scheme be applied that simultaneously enables the control body to guarantee effective, appropriate checks on the production, processing and marketing if organic products[40].

Therefore, many certification bodies have developed systems for inspection of small holder organizations based on the combination of an Internal Control System (ICS) operated and managed by the organization itself, and the external inspection and certification scheme, comprised of the supervision process for a certain percentage of farmers (e.g. 10%) as well as the ICS itself. This type of inspection is often referred to as "group certification".

Smallholder organizations can be regarded as a production unit in the sense of Regulation (EEC) No. 2092/91 if such an organization represents a certain structure comprising principles such as[40]:

- A legal relation is existing between the individual farmer and the organization. Also, the organization is the legal representative of the farmer with respect to inspection and certification of his agricultural production.
- The organization is in charge of the main responsibilities such as purchase and central marketing, implementation of production measures, supervision of the performance of the members.

Such organizations can be organized as co-operatives, federal associations of co-operatives or contract production (e.g. exporter with a certain number of contracted producers).

According to the IMO/Naturland Manual for Internal Control Systems in smallholder organizations[40], an internal control system consists of the following major elements that are described in more detail in the following chapters:

a) **Internal Regulation:** defining the criteria, standards and internal procedures to guarantee the quality of the organic production;
b) **Personnel:** responsible for running the total quality management program (supervisors, inspectors, committee members etc.) with clearly defined responsibilities;
c) **Infrastructure:** means of transport, adequate data processing facilities etc.;
d) **Training and Information:** of farmers and internal inspectors according to the principles of organic farming and the specific certification requirements that are laid down in the internal regulation; and training of staff.
e) **Internal Farm Control:**
    - Physical farm inspections: to prove the compliance of the production activities with the requirements laid down in the internal regulation. The inspection activities must cover 100% of all registered farmers.
    - Evaluation: to evaluate the results of the inspections and to grant approval or disapprove.
    - Documentation: To document all inspection and evaluation activities.
f) **Monitoring of Product Flow:** Monitoring and documentation of all steps of product flow (purchase, transport, stocking, processing, sales)

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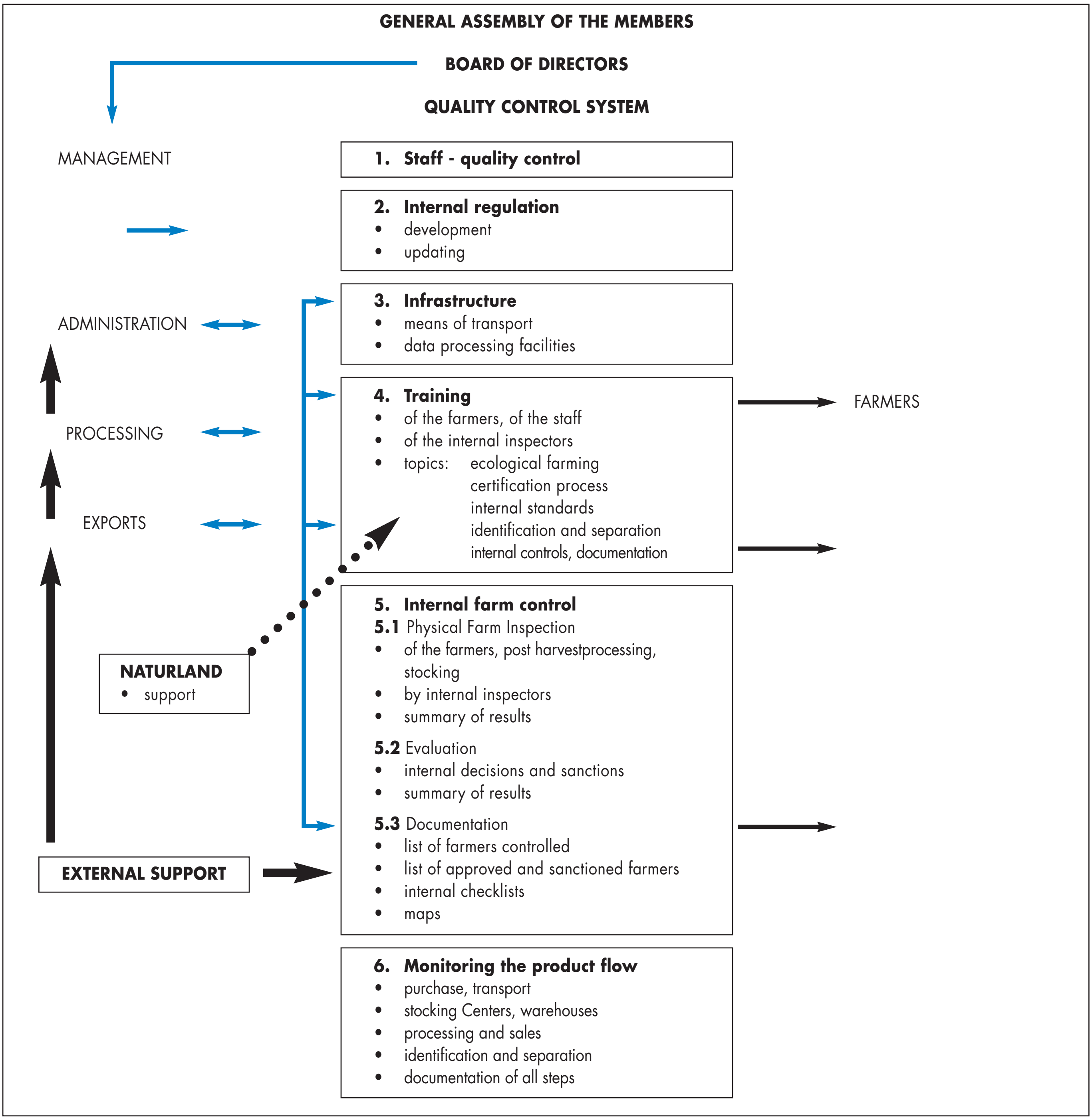
[40] Augstburger, F. et al, 2002, Manual for Quality Assurance: A Guideline of Internal Control Systems in smallholder Organisations, Naturland e.V. (www.naturland.de).

These elements are illustrated in the following organization chart:

**Figure 5:**
**Organisation chart of the quality control system of a small farmer's association**




Source: Naturland Guideline for Internal Control Systems (ICS) in smallholder Organizations[41]

## Applicability of Group Certification

A group of farmers wishing to apply for group certification usually should fulfill some basic requirements:

- The group should be big enough to make an ICS reliable and financially feasible.
- Farmers should be rather similar in terms of geographical location, products and production systems and also regarding the size (not many small farmers and a couple of huge farms)
- In principle group certification is designed for "small farmers", i.e. all farmers that cultivate more than about 25 ha (the average cultivated lad for small scale farmers may vary slightly in different countries or crops) must be inspected by the external control body on an annual basis. Also these farms need to keep their own farm documentation

## The Internal Control System

### 1. The Internal Regulation

The smallholder organization should define its own internal regulation with regard to various aspects and activities of the organization, and this has to be followed by the members and internal staff as well as contracted partners (e.g. processors). No farmer can be expected to read the EU-Regulation in order to understand how he needs to manage his farm, nor can purchase officers simply read a certain chapter of the regulation to be fully aware of their obligations. This is why it is very important to define clear and comprehensive rules for specific situations in the organization. The internal regulation is also the basis for the internal inspection and its content and completeness is verified in the course of the external inspection. Often the internal regulations are a combination of the content of farmers' agreements and internal working procedures, and may even exceed the regulation in certain aspects.

The following aspects should be clearly defined for the organization in writing. Obviously, when developing the internal regulation the organization has to keep in mind all the standards for which it is applying for certification, making sure to always at least define the minimum certification requirements that are relevant for its operation.

*Organic Production Standards*

- Principles (reference to the applicable standards): seeds, crop rotation, preservation of soil fertility, off-farm inputs
- Definition of the production unit of the farmer (e.g. organic crops, conventional cash-crops, home consumption crops, animal husbandry)
- Policy on conventional farm unit: usually conventional farm units cannot be accepted in smallholder organizations. If some members could not yet convert all their land and crops (esp. home consumption crops), plans to support farmers towards full conversion need to be worked out. The ICS has to also closely supervise the conventional fields, in particular if rotation annual crops are involved (no conventional fields may be used for organic production for 2 years) and the conventional unit needs to be defined clearly
  All the rules as described above for management of operations with an organic and a conventional unit apply (no risk of drift, separate storage of inputs, etc.)
  - Harvest and post harvest procedures: procedures for all on-farm processing by single farmer:
    - separation according to quality (already on the farm if necessary); only allowed processing inputs
    - maybe hygienic requirements for the farmers (not compulsory)
  - Purchase: only from those farmers that are listed in the farmers´ list that has been approved by the certification body (Approved farmers list "AFL") and only up to a maximum of those quantities that were certified for this farmer
    - detailed documentation of purchase in purchase book, receipts to farmers

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[41] Augstburger, F. et al, 2002, Manual for Quality Assurance: A Guideline of Internal Control Systems in smallholder Organisations, Naturland e.V. ('www.naturland.de)

- transport only in correctly identified and closed bags, labeling according to organic quality (organic, conversion)
- rules for organic processing (if applicable)

- Sanctions and approval:
  - definition of sanctions for different non-compliances: e.g. sanctioned for 3 years if non-permitted inputs are used, but only sanctioned for 1 year if he has failed to ensure some internal rules – only procedures – to ensure that farmers that have not complied with the internal regulation, especially regarding production standards, are sanctioned for the prescribed time. The internal control must supervise and document the enforcement of sanctions. It may be helpful to keep a list of sanctioned farmers (also listing farmers that have left the project) with date and reasons for sanctions/dismissal.
- Rules of participation: admittance of new farmers, obligations of participating farmers, formal commitment (written confirmation). A farmer can only be certified if he has signed this agreement with the organization.
- Formal commitment:
  - the farmer is obliged to comply with the production standard and the internal regulation, to grant the internal and external inspector unlimited access and to provide all documents needed. Sometimes the requirement is added that the farmer may only sell produce from his own certified land to the organization as organic (not from family members or neighbors)
  - the organization is obliged to train and inform its members on practices related to organic farming and also about all certification requirements, to establish quality and price criteria for the organic produce.
- Internal inspection: 100% inspection of all growers need to be inspected internally each year, before harvest (if clear harvest season); inspectors shall be neutral.

**2. Staff**

Qualified personnel is needed in order to guarantee the quality of organic products:

*The Quality Manager*

The quality manager carries the responsibility on the performance of the internal control system and is in charge of ensuring 100% of the internal inspection, instructing the internal inspectors, documenting all inspection activities, participating in approval procedures and co-ordinating the external inspection

*Approval Committee*

In larger organizations there may be need for an approval committee to revise all inspection reports and decide on approval or disapproval of member farmers. The members of the approval committee must be familiar with the organic system and shall not be directly involved in marketing activities

*Field Extensionist*

Some organizations choose to have field extensionists visiting and training the farms on a regular basis. Obviously, this provides some continuous supervision of the farmers, but still there should be one complete internal inspection by an internal inspector per year. Field extensionists shall be especially well trained in organic production methods such as e.g. soil management, erosion control, biological pest control, etc.

*The Internal Inspector*

An internal control system requires a sufficient number of internal inspectors to perform 100% of the internal inspections per year. The internal inspectors must be fluent in the local language, know local conditions and farming methods well, be trained in organic requirements and procedures. He must not have conflicts of interest, e.g. should not inspect farms of his own or of relatives, etc. If the project also has an extension service, the internal inspector may also be an extensionist, but be dedicated to inspecting farmers from another extension group.

### 3. Infrastructure

Obviously the organization needs to be able to provide necessary infrastructure so that internal control can be realized and documented in an efficient manner, e.g. means of transport, purchase localities, data processing facilities, etc.

### 4. Training and Information

***Farmers:*** need to be regularly trained in all relevant aspects of organic farming as well as the content and implications of the internal regulation. Often such training can be offered by local NGO's.

***Internal Inspectors:*** regular training of internal inspectors in crucial to ensure that every inspector evaluates the farms in a similar way and easily recognizes deficiencies. Sometimes it is also helpful to exchange internal inspectors from different project parts, so that they can give each other the feedback on the quality of their inspections.

***Other Personnel:*** purchase personnel in particular need to be well trained in organic requirements.

All training activities shall be documented and available for the external inspection.

### 5. Internal Farm Control

*Physical Farm Inspections*

The main purpose of the physical farm inspections is to verify that all farms registered in the organic program are working according to the production standards set as part of the internal regulation and that all farmers that do not comply are sanctioned immediately.

To meet this requirements the internal inspection has to be organized in a professional way:

- For the first inspection of a new farmer a full description of his farm unit shall be drawn up: definition of land parcels (all plots cultivated by the farmer), storage and production premises, post-harvest measures (if applicable). A map of the farm unit must be drawn. The last use of non-permitted inputs on any plot need to be recorded. All measures to ensure compliance with the internal regulation need to be discussed and confirmed by the farmer.
- 100% internal control have to be ensured (see above) by a neutral inspector. Also, suspended or "passive" farmers need to be inspected if they wish to be re-registered again in the organic program later. The inspection shall be finalized before harvest, since the resulting farmers´ list with exact yield estimations is the basis for the organic purchase and provides the necessary control that farmers only deliver their own produce (and not those from their neighbors, etc.)
- the inspection visit has to cover all fields that are managed by a farmer, but focuses on the organic production unit (with cash crops) as well as home consumption units. If there is a conventional unit is also shall be checked in order to ensure the separation of units. Also, animal husbandry shall be taken into consideration. Checks must be made to see if the total certified area has changed and if new fields have been bought in the field history; should this be the case, these plots have to be verified.
- the use of all off-farm inputs (incl. seeds) has to be checked carefully. Also, soil management is assessed.
- Post harvest facilities, warehouses and storage premises need to be inspected.
- On a spot check basis the sales information from the farmers shall be cross-checked with the purchase documentation.

*Evaluation*

- The results of the internal inspection as summarized in the internal inspection reports need to be evaluated farm by farm against the production and other relevant standards in the internal regulation.
- The results of the evaluation including imposed sanctions need to be documented and communicated to the responsible parties. The final decision with regard to certification of a farmer is taken, however, by the external inspection body in the course of the annual certification.

*Documentation*

- An internal inspection report (checklist) needs to be filled in documenting the results of the inspection (seeds, fertilization, plant protection, risk of contamination, sustainability of farming system, animal husbandry, areas under main cash crop(s), harvest estimation, compliance statement (and possibly conditions to farmer), signature internal inspector as well as farmer).
- An annual summary of the results of the internal control is prepared. This is usually the list of farmers (organic, conversion, sanctioned). The list should include the following information for each farmer: location, farmers code, full name, first year of inspection, total area, surface under main cash crop (or N° of trees if better), conversion and conventional areas, yield estimation, name/ code internal inspector, date internal inspection, result of internal inspection. If feasible, the amount delivered to organization in previous year shall also be listed.
- For each farmer the following documents need to be available:
  - map on which all plots can be seen, preferably on cartographic maps, but otherwise as hand-drawn sketch (if appropriate several neighboring farms with their respective plots can be on one map) needs to be up to date (and dated); new plots have to be indicted accordingly, conventional fields have to be clearly labeled, different rotation crops can be indicated in the maps instead of plot list. etc.
  - farmers agreement
  - internal checklist(s) since begin of certification
  - if applicable: other farm documentation e.g. held by the extensionist for the farmers

**6. Monitoring the Product Flow**

Besides farm inspections the product flow of organic products from fields to export has to be monitored by the ICS.

*Purchase:*

- The purchase officers need to have an updated farmers' list (for most up to date harvest estimations and possibly sanctioned farmers') as well as the farmers' list that has been approved by the inspection body (for determination whether farmer has been certified or not).
- Organic produce may only be bought from farmers named on the list, according to the different qualities (organic, conversion, conventional) and only up to the quantities indicated in the column harvest estimation
- Detailed records on the purchase from each farmer have to be kept: purchase books with signature of farmers, receipts, etc.
- Organic produce must not be mixed with conversion or conventional produce. For transport, the received goods have to be packed in closed bags and labeled according to their organic quality as well as lot number (if applicable).

*Storage and Processing*

In the warehouse and in all following processing and transport steps the organic goods must always be kept strictly separate from any other produce and labeled accordingly.

*External Inspection by the Certification Body*

Each year, the external certification agency inspects the smallholder organization. The inspection will focus on the supervision of the internal control system by checking:

- Internal documentation, esp. internal inspection checklists, farmers files, internal regulation
- Verification of the effectiveness of internal control by spot checks. Presently at least 10% of all farmers are visited each year. In certain cases, lower or higher levels of external control may be required, according to the country of import.
- Internal procedures and capacities of personnel
- Inspection of all processing and export units.
- Verification of product flow; cross-checking between different documents and sources of information.

In order to perform the inspection in an efficient manner, good preparation is required and all documents need to be readily available.

In addition to the annual inspection, spot checks may be conducted.

## 6.11. Import Procedures for Organic Goods into the EU

As described in chapter 6.3, there are basically two ways that imported produce can be marketed as organic in the European Union (EU)

- the country of origin is listed on the Art. 11-list of third countries that are considered equivalent to the EU-Regulation. In this case, no import authorizations are required, but each shipment needs to be accompanied by a certificate of inspection (transaction certificate). Presently there are only 6 countries on this list: Israel, Argentina, Australia, Switzerland, Czech Republic and Hungary.
- For all other countries, the importer in the EU has to apply for import authorization for each exporter he wishes to import organic produce from. In addition for each shipment a certificate of inspection (transaction certificate) is required.

Since this is by far the most prominent venue, organic goods enter the EU, this option id described in more detail in this chapter. However, it has to be noted that the requirements and interpretations given in this chapter may change quickly and therefore always need to be verified with the certification agency and the trading partners.

### Import Authorizations

An import authorization, also called "individual authorization", is the legal act issued by a competent authority in the country of import, that organic goods imported by a certain importer in Europe from a certain exporting project outside the EU can be considered equivalent to EU-produced organic produce, and may therefore be marketed as organic in Europe.

Since import authorizations are granted by the competent authority in the country of import, presently a large number of authorities is active in assessing this equivalency, and producers as well as decisions may vary quite considerably from one country of import to another.

The importer usually has to complete a particular application form that has to be complemented by documents issued by the inspection body of the exporter that confirm the equivalence of the organic produce. All these application documents (that may include the full inspection report) are sent to the competent authority, who then issues the import authorization that is valid for one to several years.

An import authorization usually clearly defines: the exporter as well as all involved production and processing units. This is also important to keep in mind as an exporter, because it implies that if produce are purchased from new certified operations (not from new smallholders, but e.g. from other organizations), the importer has to be informed in order to update his import authorization. Sometimes even new products may need to be explicitly announced to the import authorities.

Generally, it is the importer's responsibility to ensure correct and complete documentation for import authorization, but the exporter may be required to provide certain information (e.g. inspection report) or to inform his inspection body to provide the necessary documents and information.

The following table highlights some important features for import authorizations into the most important European countries:

**Table 101: Important Features for Import Authorizations into European countries**

| Country | Brief description of procedures and special issues |
|---|---|
| GERMANY AND AUSTRIA | • Different competent authorities for different federal states ' requirements and focus of the authorities can vary considerably; often low acceptance of retrospective approval of conversion period;<br>• Application form defines all exporters, processing units production units as well as produce. A confirmation of equivalence needs to be signed by the inspection body of the export; inspection reports are required. |
| France | • Very detailed application form (dossier) instead of submitting the full inspection report<br>• Application form need to be completed by inspection body of exporter or inspection body of importer on basis of inspection reports<br>• Higher external control rates may be required esp. for smaller smallholder organizations |
| Holland | • Simple procedures with importers competing application form and sending in the inspection reports of exporters and producers to LASER. |
| England / UK | • Application form to DEFRA/UKROFS rather detailed, no inspection report required, but several confirmations issued by the certification agency of the exporter (GMO confirmations, no sodium nitrate confirmation, confirmation that precautionary measures are effectively applied), certain information may be needed from exporter/inspection body in order to even complete the application form.<br>• Considering national law to demand at least 1 year certified conversion |
| Sweden, Denmark, Norway, Finland | • Simple procedures with importers completing application form and sending in the respective inspection reports to their competent authorities. |
| ITALY | • Very slow processing of import authorizations (up to one year)<br>• Inspection reports and certificates required and application form to be filled in by importer. All documents need to be originals from the certification body of the exporter. |
| SPAIN | • Inspection reports and certificates required and application form to be filled in by importer. |
| BELGIUM | • Applications for import authorizations can only be prepared/pre-evaluated by the two registered certification agencies BLIK and Ecocert Belgium. These will require the inspection reports for processing the application.<br>• Special requirements for smallholder organizations may apply. |
| SWITZERLAND | • Detailed application form to be completed by importer; attestation of equivalence needs to be completed by inspection body of exporter<br>• Different definition of conversion period ; no conventional farm units permitted ' see remarks on certification requirements for Bio Suisse. |

### Certificates of Inspection (Import Certificates, Transaction Certificates)

In addition to the import authorization that remains valid for a longer period, the importer requires a certificate of inspection for each shipment/delivery of organic goods received(also referred to as import certificate or transaction certificate) issued by the inspection body of the exporter.

Article 11, Par. 1b and 3 of Regulation (EEC) N° 2092/91 deals with certificates of inspection and inspection. On 1st Nov. 2002 (planned for 1.7.02 and postponed to November) the new additional legislation Regulation (EEC) N° 1788/2001 of 7.9.2001 came into force , laying down detailed rules for implementing the provisions concerning the certificate of inspection for import from third countries.

The new requirements that were drafted as a result of various cases of fraud are extremely detailed and are expected to make international organic imports even more complicated. The most important aspects now required for organic exports will be:

- For import of all countries (countries on Art. 11 list as well as all other countries) a certificate of inspection is required for each consignment. The inspection certificate will in most cases be issued by the inspection body of the exporter in the third country on basis of certification documents, transport papers (bill of lading) and commercial export invoice.
  It may not be altered and there is only one original document.

- The content, appearance and format of the certificate is defined in the regulation and may not be altered
- The original certificate has to be presented at customs in order to release organic goods for free circulation in the European Community. Information on the certificate is to be counterchecked with all transport documentation and physical labeling of goods (lot numbers)
- The competent import authority who has issued the import authorization for the respective importer needs to confirm the existence of a valid import authorization in Field 16 of the certificate. This can be used in different states in different ways. Presently, the method chosen by most member states is to issue the importer an original authorization confirmation with all origin and product details to be presented together with the inspection certificate at the customs.
- The term "import" as defined in Regulation (EEC) N° 2092/91 is now clearly related to the physical flow of goods, i.e. it is not the entity who appears on sales invoices who is to be considered as the importer, but instead the entity for which the goods are custom cleared into the European Union.
  *E.g. an Italian importer buying organic coffee from a coffee wholesales in Holland but receiving the coffee shipments directly from Bolivia, and therefore custom clearing them in Italy ,is now to be considered the importer, and is hence obliged to hold his own import authorization*
- First companies consigned in the European union (i.e. mostly warehouse companies) now have to confirm in field 18 of the certificate that the reception of the goods has been carried out in accordance with Regulation (EEC) N° 2092/91, Annex III, Part C, Par.7

If a consignment is spilt into small consignments before custom clearing an extract of the certificate of inspection can be issued.

ANNEX

1

# Further Literature and Useful Webpages

## Chapter A: Further Literature

*IFOAM Training Manual on Organic Agriculture in the Tropics, Compiled by FiBL in June 2002. Download at **www.ifoam.org.***
This training manual offers a resource basis for trainers with the idea of encouraging individual adaptation and further development of the material according to the needs. The training manual can be used as a guide and source book to implement training programs on organic agriculture in the tropics.

*IFOAM-Proceedings of the 13th International IFOAM Scientific Conference. Compiled by T.Alfoeldi et al. Vdf Zurich 2000, **ISBN 3 7281 2754 X.***
656 abstracts of the participants of the 13th International IFOAM Scientific Conference. Many interesting contributions from tropical and subtropical countries.

*IFOAM-Proceedings of the 14th Organic World Congress. Compiled by R.Thompson. Canadian Organic Growers, Ottawa 2002, **ISBN 0-9695851-5-2.***
656 abstracts of the participants of the 14th Organic World Congress. Many interesting contributions from tropical and subtropical countries.

*Organic Coffee, Cocoa and Tea. Market, certification and production information for producers and international trading companies. Swiss Import Promotion Programme (SIPPO), Forschungsinstitut für biologischen Landbau (FiBL), Naturland, Zürich /Frick /Gräfelfing, February 2002, **ISBN 3-906081-06-0***
The attractively designed handbook offers production and market information for producers and international trading companies. In addition, the handbook provides an easily accessible overview of the production, processing and trade requirements applicable in Switzerland and the EU. The handbook contains an extensive collection of addresses (trading companies, authorities, certification bodies, organizations etc.) and Internet websites.

*The Market for Organic Food and Beverages in Switzerland and the European Union. Overview and market access information. Swiss Import Promotion Programme (SIPPO) und Forschungsinstitut für biologischen Landbau (FiBL), Zürich/ Frick Januar 2001, **ISBN 3-906081-03-06***
The aim of this handbook is to inform operators in emerging markets and markets in transition about the market potential and the conditions for access to the European and Swiss markets for organic products. To that end, it assembles useful facts and figures, notes and comments and contact addresses.

*Organic Agriculture Worldwide 2002. Compiled by M.Yussefi and H.Willer. SÖL Sonderausgabe 74, 2002, **ISBN 3-934499-42-2***
The complete and actual collection of statistics and future prospects about organic agriculture worldwide. This publication can be downloaded from the internet at http://www.soel.de/inhalte/publikationen/s_74_04.pdf

*Agricultura orgánica. Compiled by Albrecht Benzing, Neckar-Verlag, Villingen-Schwenningen (D) 2001, **ISBN 3-7883-1912-7.***
A detailed compilation of the scientific base and many examples of organic farming in the Andes of Latin America.

*Raising and Sustaining Productivity of Smallholder Farming Systems in the Tropics. Compiled by Willem C.Beets. AgBé Publishing, Alkmaar (NL) 1990. **ISBN 974 85676 1 3**.*
This book collects many useful smallholder farming practices of the tropics.

*Agroforestry for Soil Management. Compiled by A.Young, CAB International Oxon (UK) and New York (USA) 1997, **ISBN 085199 189 0.***
This book summarizes the present state of knowledge and indicates needs for research.

## Useful Webpages

**http://www.ifoam.org**
The homepage of the International Federation of Organic Agriculture Movements. From this homepage, it will be possible to download the IFOAM Training Manual on Organic Agriculture in the Tropics. Furthermore, it contains many useful links.

**http://www.soel.de**
The website of Stiftung Ökologie & Landbau (SÖL) (Foundation Ecology & Agriculture). Contains European and world wide organic farming statistics (it is possible to download the publication ”Organic Agriculture Worldwide”) and a useful address database as well as many useful links.

**http://www.fibl.ch/**
The website of the Research Institute for organic agriculture (FibL) provides information on organic agriculture, training opportunities and contacts to other organizations involved in organic agriculture

**http://www.isofar.org**
The homepage of the International Society of Organic Agriculture Research (ISOFAR). Its objective is to promote and to encourage research in all branches of organic agriculture and to facilitate the co-operation of scientific activities, education and knowledge transfer on a global scale by means of various membership services, its publications, events and scientific structure. The homepage wants to improve the world-wide scientific dialogue in Organic Agriculture and enable participatory research and stakeholder dialogue.

**http://www.organic-research.com**
Organic-research.com is an online community for organic farming and food, developed by CABI Publishing. Organic-research.com will be of particular interest to those actively involved in organic farming research and development.

**http://www.organicxseeds.com**
The organicXseeds database lists organic seed and transplants supplied by seed companies from all over Europe. A special service offered by organicXseeds allows you to request the seeds and transplants you require directly from the supplier.

## Chapter B: Further Literature

*Citricultura: laranja, limao e tangerina. Compiled by O.K. Koller, Editora Rigel LTDA, Porto Alegre (Brazil) 1994,* ***ISBN 85-85186-59-3.***
This book describes the brazil way of citrus production. Pests and diseases are described in detail.

*Manual para productores de naranja y mandarina de la region del rio uruguay. Compiled by Instituto Nacional de Tecnologia Agropecuaria (INTA), Argentina 1996,* ***ISBN 950-9853-72-0.***
This book shows how citrus is produces in South America. Pests, diseases and weeds are good illustrated.

*Citrus – Crop Production Science in Horticulture Nr. 2. Compiled by F.S. Davies and L.G. Albrigo. CAB International Oxford 1994,* ***ISBN 0 85198 867 9.***
This manual gives a complete overview on citrus production and considers the most important production regions.

*Tropical and Subtropical Fruits. Compiled by P.E. Shaw, H.T. Chan Jr. And S.Nagy. AGSCIENCE, INC, Auburndale, Fl (USA) 1998,* ***ISBN 0-9631397-6-2.***
A large number of scients contributed to this complete introduction in tropical and subtropical fruits.

*Fruticultura Tropical. Compiled by J.A. Samson. Editorial Limusa, Mexico 1991.* ***ISBN 968-18-4009-7.***
A short but valuable introduction in tropical and subtropical fruits.

*Tropical Fruits. Compiled by CAB Internacional, Wallingford 1998,* ***ISBN 0-85199 254 4.***
This book shows the different tropical fruits in a general point of view.

*Bananas and plantain. Compiled CAB Internacional, Wallingford 1996,* ***ISBN 0-85198-985-3.***
A complete review on banana production.
*Report of the expert consultation on avocado production development in Asia and the Pacific. Compiled by FAO REGIONAL OFFICE FOR ASIA AND THE PACIFIC, Bangkok (Thailand) April, 1999*
A good overview on the avocado production techniques in selected countries.

## Chapter C: Further Literature

Nippon 2000 business facts and figures (JETRO)

Marketing Bulletin 1999, 10, 24-37; Philip Gendall: Japanese Market for Organic Fruit and Vegetables

Sogo Market Research (2000)

Organic Monitor: European Market for Organic Fruit and Vegetables (2000)

IFOAM/SOEL: World Organic Agriculture Report (2002)

Organic Trade Association (OTA): Organic Export Study (2000) (order through website: www.ota.com)

The Market for Organic Food and Beverages in Switzerland and the European Union. Overview and market access information. Swiss Import Promotion Program (SIPPO) und Forschungsinstitut für biologischen Landbau (FiBL), Zürich/ Frick Januar 2001, ISBN 3-906081-03-06

FIBL/SYNERGIE: Der Fachhandel für Bio-Produkte in Europa (2002)

FAO/ITC: *World markets for organic fruit and vegetables: Opportunities for Developing Countries in the Production and Export of Organic Horticultural Products (2001)* (2001, TC/D/Y1669E/9.01/6730) book can be ordered through the ITC Website: www.intacen.org

FAS-Report Organic Products in Singapore (2001)
www.intracen.org/mds/sectors/organic/
Website of ITC on organic agriculture

# Part D: Further Literature and Useful Websites

**Further Literature**

*The Market for Organic Food and Beverages in Switzerland and the European Union. Overview and market access information. Swiss Import Promotion Program (SIPPO) und Forschungsinstitut für biologischen Landbau (FiBL), Zürich/ Frick Januar 2001, **ISBN 3-906081-03-06***
The aim of this handbook is to inform operators in emerging markets and markets in transition about the market potential and the conditions for access to the European and Swiss markets for organic products. To that end, it assembles useful facts and figures, notes and comments and contact addresses.

*EU Regulation "Organic Farming". Compiled by H.Schmidt and M.HacciuS. Margraf Verlag 1998, **ISBN 3-8236-1288-3***
A well ordered and very detailed discussion of the EU Regulation. Helps to understand the often unnecessarily complicated structure and language of this regulation.

**Useful Websites**

**http://www.codexalimentarius.net**
This is the only official website of the Codex Alimentarius Commission. It provides information about Codex Alimentarius. The Codex-Alimentarius-Guidelines on organic agriculture can be downloaded from:
www.fao.org/codex/standard/organic/gl99_32e.pdf

**http://europa.eu.int/eurlex/de/lif/dat/1991/de_391R2092.html**
The EUR-Lex website contains all texts pertaining to EU Regulation No. 2092/91 on organic production in all the languages of the EU.

**http://www.usda.gov**
Donwload the US Organic Foods Production Act.

**http://www.wto.org/**
The website of the World Trade Organization gives the current status of the negotiations on the Agricultural Agreement and international commitments to reduce agricultural subsidies.

**http://www.iafinc.org/**
The Mutual Recognition Agreement (MLA) may be viewed on the website of the International Accreditation Forum (IAF).

**http://www.european-accreditation.org/**
The Multilateral Agreement for inspection and certification bodies is available on the homepage of the "European co-operation for Accreditation" organization.

**http://www.iso.ch/**
The homepage of the International Organization for Standardization (ISO), which has its headquarters in Geneva, contains details of ISO 65 pertaining to certification bodies.

**http://www.cenorm.be/**
The web pages of the European Committee for Standardization (CEN) give full details of EN Standard 45011.

**http://www.ifoam.org/accredit/index.html**
This is the accreditation program of the International Federation of Organic Agriculture Movements.

**http://www.blw.admin.ch/nuetzlich/links/d/zertifstellen.htm**
On the homepage of the Swiss Federal Office for Agriculture there is a downloadable list of European certification bodies.

**http://www.blw.admin.ch/**
The website of the Swiss Federal Office for Agriculture provides detailed information on:

- The Swiss Organic Farming Ordinance
- Forms for attestation of equivalence and individual authorization to import
- Direct payments for organic farms
- Cultivation of organic products.

**http://www.zoll.admin.ch**
Customs tariffs of the Federal Customs Administration.

**http://www.sas.admin.ch**
The Swiss Federal Office of Metrology is the accreditation body for inspection and certification bodies in Switzerland.

**http://www.sippo.ch**
The homepage of the Swiss Import Promotion Programme (SIPPO) contains information on Swiss activities to promote imports from emerging markets and markets in transition, downloadable documentation.

**http://www.bio-suisse.ch**
The website of BIO SUISSE (Association of Swiss Organic Agriculture Organizations, Vereinigung Schweizer Biolandbau-Organisationen) provides detailed information onStandards relating to farming and processing; approval procedures for the Knospe, and market and prices

**http://www.Naturland.de**
The website of Naturland – Association for Organic Agriculture from Germany.

**http://www.demeter.net**
The website of Demeter-International. It gives information about the network of individual Demeter certification organisations world-wide.

**http://www.maxhavelaar.ch/**
The website of Max Havelaar Switzerland, one of the most important Fair Trade organizations.

The complete JAS Regulations can be downloaded at:
**http://www.maff.go.jp/soshiki/syokuhin/hinshitu/organic/eng_yuki_top.htm**

**http://www.cbi.nl**
The website of the Centre for the Promotion of Imports from Developing Countries.

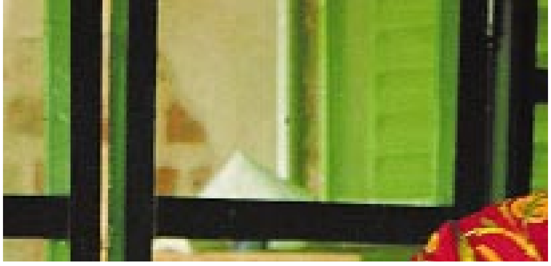
**http://www.intracen.org**
The website of the International Trade Centre (UNCTAD/WTO (ITC). Provides statistic information on exports/imports worldwide and on markets of different sectors.

**http://www.fao.org**
The website of the food and agriculture Organization (FAO) provides general information about organic agriculture and the programs of FAO.

**http://www.sida.se**
The website of the Swedish International Development Co-operation Agency - Department for Infrastructure & Economic Co-operation (SIDA).

**http://www.grolink.se**
The website of a swedish organic certifier Grolink, giving information about Certification, Training and studies on organic agriculture.

**http://www.gtz.de**
The website of "Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH provides information about projects, GTZ international services and Public Private Partnership.



A N N E X

2

# List of trading companies, certification bodies and authorities by country

This annex lists a number of trading companies, certification bodies and authorities by country. The collection makes no claim to being complete.

## USA

**Organic Fresh Produce Importer/Distributors**

ALBERT'S ORGANICS
1330 East, 6th. Street
Los Angeles, CA 90021
Tel: +1- 213-891-1310
Fax: +1- 213-891-9291
www.albertsorganics.com
Leading wholesale distributor of organic fresh produce with warehouses in Los Angeles, New Jersey, Colorado and Florida

BEST FRESH PRODUCE INC.
220 Food Centre Drive
Bronx, NY 10474
Tel: +1- 718-617 8300 ext. 243&227
Fax:+1- 718-991 9748
markhill@orderfresh produce.com
www.orderfresh produce.com

BETA PURE FOODS
335 Spreckels Drive Ste. D
Aptos, CA 95003
Tel: +1- 831-685-6565
Fax: +1- 831-685-6569
Morr@betapure.com
www.betapure.com
Supplies ingredients to natural food industry

BOCCHI AMERICAS, INC.
1113 Admiral Peary Way, Navy Yard, Philadelphia, PA 19112
Tel: +1- 215-462-7540
Fax: +1-215-462-7542
Bam@bocchiamericas.com

BOULDER FRUIT EXPRESS, INC.
340 South Taylor Ave.
Louisville, CO 80027
Tel: +1- 303-666-4242
Fax:+1- 303-666-0323
www.boulderfruit.com
Promotes and distributes organic perishables through the Rocky Mountains and Midwest.

DEL CABO
2450 Stage Road
Pescadero, CA 94060
Tel: +1-415-879-0580
Fax: +1-415-879-0930
Importer/wholesaler/distributor

CF FRESH/ROOTABAGA ENTERPRISES
PO Box 665
Sedro-Woolley, WA 98284
Tel:+1- 530-676-9147
Fax:+1- 530-676-9148
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Sheila.tanquist@chrobinson.com
www.chrobinson.com

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PO Box 7348
Nogales, AZ 85628
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Fax:+1- 808-966-4167
crown_pacific@yahoo.com

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Fax: +1- 215-467-1144
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**Certification Bodies**

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Contact Sue Teneyck
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Fax: 831-423-4528
www.ccof.org

FARM VERIFIED ORGANIC
Contact: Annie Kirschenmann
5449 45th Street SE
Medina, ND 58467
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Fax: 701-486-3580
FVOINTL@aol.com

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www.foginfo.org

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Fax: 937- 593-9507
kananen@logan.net

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Contact: Diane Bowen
1001 Y Street, Suite B
Lincoln, Nebraska 68508-1172
Tel: 402-477-2323
Fax: 402-477-4325
info@ocia.org
www.ocia.org

ORGANIC GROWERS AND BUYERS ASSOCIATION (OGBA)
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Fax: 763-315-2733
ogba@goldengate.net
www.ogba.org

OREGON TILTH CERTIFIED ORGANIC
Contact: Pete Gonzalves
1800 Hawthorn NE - Suite 200
Salem, Oregon 97303
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http://www.tilth.org
organic@tilth.org

QUALITY ASSURANCE INTERNATIONAL (QAI)
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12526 High Bluff Dr, Suite 300
San Diego, CA 92130
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Fax: 858-792-8665
qai@qai-inc.com
www.qai-inc.com

WASHINGTON STATE DEPARTMENT OF AGRICULTURE
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www.thebigcarrot.ca

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(department fruits and vegetables)
www.billa.at

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(department fruits and vegetables)
www.spar.at

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Fax: +43/512/52015-15

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Fax 02262/674143
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4552 Wartberg
Tel: 07587/7177 14
Fax 07587/7177 11

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Fax 01/3688555 20

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Fax. +33-5 53 87 26 18
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Fax: +33-1 44 68 82 48

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Fax: +33-5 62 07 1167
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www.ecocert.fr

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Fax: +49-7151-9951555
info@beutelsbacher.de
www.beutelsbacher.de
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Fax: +49 - 2381 - 5432540
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Fax: +49 - 30 - 631 69 75
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Fax: +49- 89 80 82 90
E-mail: naturland@naturland.de

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E-mail: bcsgermany@AOL.com

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Fax: +49-5522 951 164
E-mail: ecocert@compuserve.com

GFR GESELISCHAFT FUR
Ressourcenschutz
Prinzenstr.4
D-37073 Goffingen
Tel: +49-551 586 57
Fax: +49-551 587 74
E-mail: info@gfrs.de
http://www.gfrs.de

ÖKOPRÜFZEICHEN (ÖPZ)
GMBH
Rochusstrasse 2
D-53123 Bonn
Tel: +49-228 9777700
Fax: +49-228 9777799

## GREAT BRITAIN

**Wholesaler , Retailer**

ASDA
Asda House
Great Wilson St.
Leeds LS11 5AD
Tel: + 44 1132 435435
Fax: + 44 1132 418304
www.asda.co.uk

FRESH & WILD
210 Westbourne Grove
London W11 2RH
Tel: +44-20-7792 9020
Fax: +44-20-7792 1341
www.freshandwild.com

GRIFFIN & BRAND EUROPEAN LTD

Trophy House, Leacon RD

Ashford, Kent TN23 4TU

Tel: + 44 1233 645 941

Fax: + 44 1233 639 340

griffin.brand@dial.pipex.com

Wholesaler of fruit and

vegetables

INFINITY FOODS

67 Norway St.

Portslade, East Sussex

Tel: + 44 1273 424060

Fax: + 44 1273 417739

www.infinityfoods.co.uk

Importers and wholesalers of

wide range of organic produce

ORGANIC FARM FOODS OF WALES

Llambed Estate, Lampeter

Carmarthenshire SA48 8LT

Tel: +44-1570 423099

Fax: +44-1570 423280

E-mail: petersegger@offcom

www.organicfarmfoods.co.uk

Extensive range, incl. fresh fruits and

vegetables and exotic

specialities

PLANET ORGANIC

42 Westbourne Grove

London W2 5SH

Tel: +44-207-221 7171

Fax: +44-207-221 1923

www.planetorganic.com

SAINSBURY LTD

Stamford House

London SE1 9LL

Tel: +44-207-6950024

Fax: +44-207-6957507

www.sainsbury.co.uk

TESCO

Tesco House

Delamare Rd., Cheshunt

Hertfordshire EN 8 9SL

Tel: +44-1992-646372

Fax: +44-1992-644075

www.tesco.com

WAITROSE

Doncastle Rd.

Southern Industrial Area

Bracknell, Berkshire RT12 4YA

Tel: +44-1344-424680

Fax: +44-1344-825072

www.waitrose.com

**Processor and Importer**

BABY ORGANIX

Organix Brands plc

No.4 Fairfields Close

Christchurch

Dorset BH23 1QZ

Tel: + 44 1202 479701

Fax: + 44 1202 479712

www.babyorganix.co.uk

Fast growing processor /importer/distrib-
utor of baby foods

CONGELOW PRODUCE LTD

Den Farm Lane, Collier Street

Tonbridge, Kent TN 12 91DX

Tel: +44-1892 730447

Fax: +44-1892 730566

Fruits and vegetables

COMMUNITY FOODS

Brent Terrace

London NW2 1 LT

Tel: +44-181 450 9411

Fax: +44-181 208 1551

Processed organic products, incl. dried fruit and nuts, teas, vegetable oils, cere-als, dried leguminous vegetables

HIDER FOOD IMPORTS

Wiltshire Road

Kingston upon Hull HU4 6PA

Tel: +44-1482 561137

Fax: +44-1482 565668

www.hiderfoods.co.uk

Nuts and dried fruits, leguminous vegeta-bles, herbs and spices, cereals, coffee, bananas

HARLEY FOOD

Blindcrake Hall, Blindcrake

Cockermouth GA13 OQP

Fax. +44-1900 828276

Dried fruit, leguminous vegetables,

grains,

herbs, cereals, rice

JUNIPER FINE AND FOODS

Unit 2,

Downs Way Industrial Estate

Tinwalds Downs Road, Heathall

Dumfries DG1 3RS

Tel: +44-1387 249333

Fax: +44-1387 249900

Fresh, chilled and deep-frozen foods and beverages, cereals

MACK MULTIPLES
Tranfesa Rd
Paddock Wood
Kent, TN12 6UT
Tel: + 44 1892 835 577
Fax: + 44 1892 834 890
www.mackmultiples.com
Imports of fruit and vegetables

ORGANIC MARKETING COMPANY
Unit 1,
Leighton Court Lower Eggleton,
Ledbury Herefordshire HR8 2UN
Tel: +44-1531640819
Fax- +44-1531 640818
Fruits and vegetables

SUMA WHOLEFOODS
Lacy Way
Lowfields Industr. Park
Elland, West Yorks
Tel: +44 845 458 2290
Fax: +44 845 458 22 95
www.suma.co.uk
Wholesaler and manufacturer of organic vegetarian and vegan products

THE QUIET REVOLUTION
The Coach House
6 Duncan St.
London N1 8BW
Tel: + 44 207 278 2121
Fax: + 44 207 278 1958
Processors of fresh organic soups

TROPICAL WHOLEFOODS
Unit 9 Industrial Estate
Hamilton Rd
London SE27 9SF
Tel: + 44 208 670 114
Fax: + 44 208 670 1117
Specialist in trade in tropical products from Africa - mainly dried fruit and vegetables

WEALMOOR LTD
Jetha House
Springfield Rd.
Hayes, Middx EB4 OJT
Tel: + 44 208 867 3770
Fax: + 44 208 867 3700
wealmoor@wealmoor.co.uk
www.wealmoor.co.uk
Leading UK producer, importer, packer and distributor of conventional and organic, exotic fruit, vegetables and legumes

**Label Programmes and Certification Bodies**

BIO-DYNAMIC AGRICULTURAL ASSOCIATION (DEMETER)
Woodman Lane
Clent, Stourbridge
West Midlands DY9 9PX
Tei: +44-1562 884933

ORGANIC FARMERS AND GROWERS
50 High Street, Soham, Ely
Cambridgeshire CB7 5HF
Tel: +44-1353 720250

ORGANIC FOOD FEDERATION
The Tithe House, Peaseland Green
Elsing, East Dereham
Norfolk NR20 3DY
Tel: +44-1362 637314
Fax: +44-1362 637398

SCOTTISH ORGANIC PRODUCER ASSOCIATION
Milton of Cambus Farm, Doune
Perthshire FK16 6HG
Tel: +44-1786 841657
Fax: +44-1786 841657

THE SOIL ASSOCIATION
40-56 Victoria Street
Bristol BS1 6BY
Tel. +44-117 914 2400
Fax: +44-117 925 2504
E-mail: fblake@soilassociation.org

## ITALY

**Wholesaler , Retailer**

ADRIA FRUIT
Piazza Rossetti 2/8 – 16129 Genova
phone +39 010 5767229
fax +39 010 5767249
E-mail: info@adriafruit.it
Bananas

BILLA ITALIA SRL
Via Postumia 15
35010 CARMIGNANO DI BRENTA (PD)
Tel: +39.049.942.34.44
Fax +39.049.943.02.44
www.billa.it

BOTTEGA E NATURA
Via Crea, 10
10095 GRUGLIASCO (TO)
phone ++39-011-77708948
E-mail: info@bottegaenatura.com
www.bottegaenatura.com

BRIO SPA
Via Manzoni 99
I-37050 Campagnola di Zevio (VR)
Tel: +39-045-8951777
Fax: +39-045-8731744
brio@briospa.com
www.briospa.com

CONAD-CONSORZIO NAZIONALE
Dettaglianti scarl
Via Michelino 59
40127 BOLOGNA (BO)
Tel: +39.051.508.111
Fax +39.051.508.247-
++39.051.508.414
E-mail: olg@conad.it
www.conad.it

COOP ITALIA SCRL
Via del Lavoro 6-8
40033 CASALECCHIODI
RENO (BO)
Tel: +39.051.596.111
Fax +39.051.596.304-
Fax +39.051.596.218
www.e-coop.it

DESPAR ITALIA SCRL
Via Caldera 21
20153 MILANO (MI)
Tel: +39.02.409.091
Fax +39.02.409.18.177
www.edespar.it

ECOR SPA
Via Palù, 23
Loc Zoppé – I-31020 San Vendemiano
(TV)
Tel: +39-0438-7704
Fax: +39-0438-770447
info@ecor.it
www.ecor.it

ESSELUNGA
Via Giambologna 1
20090 LIMITO (MI)
Tel: +39.02.92.367
Fax +39.02.926.72.02
www.esselunga.it

FINIPER
Via Mameli 19
27054 MONTEBELLO
DELLA BATTAGLIA (PV)
Tel: +39.0383.894.511
Fax +39.0383.592.257

GRANDI MAGAZZINI E
SUPERMERCATI IL GIGANTE SPA
Via Clerici 342
20091 BRESSO (MI)
Tel: +39.02.240.42.51
Fax +39.02.26.22.43.02

GS SPA – CARREFOUR
Via Caldera 21
20153 MILANO (MI)
Tel: +39.02.48.251
Fax +39.02.482.02.325
www.carrefour.com

KI-GROUP
Tel: +39-011-7176700
Fax: +39-011-7176811
info@kigroup.com
www.kigroup.com

NATURASÌ SRL
Via Mura S. Bernardino, 1
37123 VERONA (VR)
Tel: +39-045-8030021
Fax +39-045-8031371
E-mail: naturasi@naturasi.com
www.naturasi.com

PAM
Via delle Industrie 8
30038 SPINEA (VE)
Tel: +39.041.549.51.11
Fax +39.041.999.393

RINASCENTE/GRUPPO AUCHAN
Strada 8, Palazzo N - Milanofiori
20089 ROZZANO (MI)
Tel: +39.02.575.81
Fax +39.02.57.51.24.38

SELEX COMMERCIALEMARKANT
ITALIA SPA
Via Cristoforo Colombo 51
20090 TREZZANOSUL
NAVIGLIO (MI)
Tel: +39.02.484.571
Fax +39.02.48.45.77.00
http://users.libero.it

VERITAS BIOFRUTTA SPA
Via San Francesco 5
36060 MAROSTICA (VI)
Tel: +39.0424-471.921
Fax +39.0424.471.920
E-mail: verybio@verybio.it

VERONA BIO FRUTTA SCARL
Via dell'industria 3
37059 Zevio VR
Tel: +39 045 7851701
Fax +39 045 7851576
E-mail: veronabiofrutta@iol.it

**Processors and Importer**

ABAFOODS SRL
Via Ca' Mignola vecchia 1775
45021 Badia Polesine RO
Tel: +39 0425 594489
Fax +39 0425 594496
E-mail: abafoods@libero.it
www.abafoods.it
concentrated juices

APOFRUIT SCARL
Via Ravennate 1345
I-47023 Cesena (FO)
Tel: +39-0547-643111
Fax: +39-0547-643166
info@apofruit.it
www.apofruit.it

BAULE VOLANTE srl
Via E. Matti, 48/11 H
I-40138 Bologna
Tel: +39-051-6008411
Fax: +39-051-538869
baule@baulevolante.it
www.baulevolante.it

BESANA SPA
Via Ferrovia 206
80040 SAN GENNARO
VESUVIANO (NA)
Tel: +39 -081-86.59.111
fax +39-081-865.76.51
www.vbesana.it
(only nuts and dried fruits)

COTRAPO SCARL
Via Trento 778-2
45024 Fiesso Umbertiano RO
Tel: +39 0425 740274
Fax +39 0425 741322
E-mail: cotrapo@cotrapo.it
www.cotrapo.it

CONFRUIT
Via Emilia Ponente 4
48018 Faenza RA
Tel: +39 0546 623411
Fax +39 0546 621548
E-mail: info@ilpuntog.it
www.ilpuntog.it

HANS ZIPPERLE SRL
Via M. Valier 3
39012 Merano BZ
Tel: +39 0473 274100
Fax +39 0473 274222
www.zipperle.it

HERO ITALIA SPA
Via E. Fermi 6
37135 Verona
Tel: +39 045 8097111
Fax +39 045 8097200
www.hero.it

ORGANICSUR
Via Andrea Costa,
112/2
I-40067 Rastignano (BO)
Tel: +39-051-6260361
Fax: +49-051-6265252
francodepanfilis@organisur.it
www.organicsur.it

SWEET
Via Duchessa Isabella 6
10011 AGLIÈ (TO)
Tel: ++39.0124.429.011
Fax ++39.0124.429.928
E-mail: sweet@rivarolo.alpcom.it
nuts and dried fruits

**Certification Bodies and Organizations of the Organic Sector**

AIAB Certification body
Strada Maggiore, 29
40125 BOLOGNA
phone ++39-051-272986
fax ++39-051-232011
E-mail: aiab@aiab.it
Web page: www.aiab.it

ASS SUOLO E SALUTE
Certification body
Via Abbazia, 17
61032 FANO (PS)
phone ++39-0721-830373
fax ++39-(0)721-830373
E-mail: suoloesa@tin.it
Web page: www.suoloesalute.it

BIOAGRICOOP
Certification body
Via Fucini 10
40033 CASALECCHIODI RENO (BO)
phone ++39-051-6130512
fax ++39-(0)51-6130224
E-mail: bioagri@mail.asianet.it
Web: www.bioagricoop.it

BIOS Certification body
Via Monte Grappa, 7
36063 MAROSTICA (VI)
phone ++39-0424-471125
fax ++39-0424-476947
E-mail: itbios@tin.it

CODEX
Certification body
Strada Naviglia, 11/A
43100 PARMA (PR)
phone ++39-0521-7759001
fax ++39-0521-775900

CCPB
Certification body
Via Barozzi, 8
40126 BOLOGNA
phone ++39-051-254688
fax ++39-051-254842
E-mail: ccpb@ccpb.it
Web: www.ccpb.it

ECOCERT
Certification body
C.so delle Province, 60
95127 CATANIA
phone ++39-095-442746
fax +39-095-505094
E-mail: ecocertitalia@ctonline.it

IMC
Certification body
Via Pisacane, 53
60019 SENIGALLIA (AN)
phone ++39-071-7928725
fax ++39-071-7910043
E-mail: imcert@tin.it
Web: http://www.imcdotcom.com

QC&I
Certification body
Villa Parigini, Loc. Basciano
53035 MONTERIGGIONI (SI)
phone ++39-0577-327234
fax ++39-0577-327234
E-mail: lettera@qci.it
Web: www.qci.it

GRAB-IT
Organic Research,
Market research
c/o DIBIAGA-University of Ancona
Via Brecce Bianche
60125 ANCONA (IT)
phone ++39-071-2204929
fax ++39-071-2204858
E-mail: grabit@agrecon.unian.it

FIAO
Umbrella body grouping most
certification bodies
Via Barozzi, 8
40126 BOLOGNA
phone ++39-051-254688
fax ++39-051-254842
E-mail: fiao@greenplanet.net

## JAPAN

**Importers and Distributors**

CHIKITA FRUITY JAPAN CO LTD
Plaza Monznen-Naka-Cho Building
3F, 1-4-8 Monzen-Naka-Cho, Koto-ku,
Tokyo 135-0048
Tel: +81 3 52458287

DAIEI CO LTD
Hamamatsu-cho Office Centre
building, 9F, 2-4-1, Shiba-koen, Minato-ku,
Tokyo 105-8514
Tel:+ 81 3 3433-9684

DOLE JAPAN LTD
(MAIN IMPORTER ITO CHU TRADING
COMPANY)
Sanbancho Yayoikan
6-2 Sanbancho Chiyoda-Ku
Tokyo 102-0075
Tel: +81 3 32371492
www.dole.co.jp/

GLOBAL FRUITS CO LTD
Ikaida Building 7F, 3-14-8
Hacchobori, Chuo-ku,
Tokyo 104-0032
Tel: +81 3 3553-5444

JAPAN PRODUCE CO, LTD
Daiichi-Nakamira Building 5F, 2-
8-10 Shinkawa, Chou-ku, Tokyo
104-0033
Tel: ++81 3 3297-6211

JUSCO Co Ltd (Food
Commodity Division)
5-1,1-Chome, Nakase, Mihama-ku,
Chiba-shi, Chiba, 261-8515
Tel: +81 3 432126164

ITOCHU CORP (FOOD DEPARTMENT)
2-5-1 Kita-Aoyama, Minato-ku,
Tokyo 107-8077
Tel: +81 3 3497-6255

MITSUBISHI CORPORATION
(FOOD HANDLING DIVISION)
Mitsubishi Shoji Building
Bekkan 2-3-1 Maranouchi,
Chiyoda-ku,
Tokyo 100-8086
Tel: +81 3 32106786

MITSUI & CO LTD
2-1 Ohtemachi 1 Chome
Chiyoda-ku, Tokyo 100-0004
Tel: +81 3 32855668
www.mitsui.co.jp

**Processor**
MUSO CO LTD
3-7-22 Nishitenma, Kita-ku,
Osaka 5300047
Tel: +81 6 63166104

MITOKU CO LTD
Room 257 Tokyo Building
2-7-3 Maranouchi,
Chiyoda-ku,
Tokyo
Mail: C.P.O Box 780 Tokyo, 100-91
Tel: +81 3 32016701

## SWITZERLAND

**Wholesaler, Retailer**
COOP Schweiz
Thiersteinerallée 152
CH-4002 Basel
Tel: +41-61-3366666
Fax: +41-61-3367491
www.coop.ch

MIGROS Genossenschafts-Bund
Limmatstrasse 152
CH-80005 Zürich
Tel: +41-1-2772111
Fax: +41-1-2772333
www.migros.ch

**Processor, Distributor, Importer**
ANDROS
Ch. de la Crétaux
C.P. 413
CH-1196 Gland
Tel: +41 - 22 995 08 00
Fax: +41 - 22 995 09 46
Orange juices

AGREXCO LTD.
Jungholzstr. 6
CH-8050, Zürich
Tel: +41 - 1-315 76 20
Fax: +41 - 1-315 76 70
www.agrexco.com
Fruits/vegetables

BARGOSA S.A.-GENÈVE
25. rue Biavignao,
CH-1227 Carouge-Genève
Tel: +41-22-343 71 60
Fax: +41-22-342 80 72
www.bargosa.ch
Fruits/vegetables

BIOFAMILIA AG
Brünigstrasse 141
CH-6072 Sachseln
Tel: +41 - 41 666 25 55
Fax: +41 - 41 666 25 50
www.bio-familia.com
Process nuts, sugar, dried fruit
into muesli

BIOFARM-GENOSSENSCHAFT
Postfach 18
CH-4936 Kleindietwil
Tel: +41 - 62 957 80 50
Fax: +41 -62 957 80 59
www.biofarm.ch
Dried fruit and nuts, sugar

BIOFORCE AG
Abt. Heilpflanzenanbau
CH-9325 Roggwil
Tel: +41 - 71 - 454 61 61
Fax: +41 - 71 - 454 61 62
www.bioforce.ch
Herb salts, processed vegetables,
whole grain rice

BIOGEMÜSE GALMIZ
Zährli 9
CH-3285 Galmiz
Tel: +41 - 26 – 670 42 42
Fax: +41 - 26 - 670 27 72
www.biogemuese.ch
Fresh vegetables

BIOTTA AG
Pflanzbergstr. 8
CH-8274 Tägerwilen
Tel: +41 - 71 - 666 80 80
Fax: +41 - 71 - 666 80 81
Juices, fresh vegetables

BLATTMANN
Seestrasse 201
CH-8802 Wädenswil
Tel: +41 - 1 783 40 40
Fax: +41 - 1 783 40 00
www.blattmann.ch/
Cereals and cereal products, oil-seeds, protein plants

BONATURA AG
Industriestrasse 7
CH-3210 Kerzers
Tel: +41 - 31 750 14 26
Fax: +41 - 31 750 14 24
www.bonatura.ch
Fresh fruits (raspberries)

CLARO AG
Byfangstrasse 19
Postfach 69
CH-2552 Orpund
Tel: +41 - 32 - 356 07 00
Fax: +41 - 32 - 356 07 01
www.claro.ch
Tea, coffee, sugar, sweeteners (muscovado), fruits (only fair trade products!)

EICHBERG BIO AG
Seetalstrasse 60
CH-5705 Hallwil
Tel: +41 - 62 767 61 61
Fax: +41 - 62 767 61 67
www.eichberg-bio.ch
Protein plants, wine, sugar, honey, coffee, cocoa, tea, cereals,
oil-seeds, fresh fruits, juices, vegetables, dried fruit and nuts

FAIRNESS HANDEL
Sedelstr. 32
CH-6020 Emmenbrücke
Tel: +41 -41-268 11 22
Fax: +41 -41-268 11 33
www.caritas.ch
Fair trade produce

FIRST CATERING PRODUKTION AG
Grindelstr. 11
CH-8303 Bassersdorf
Tel: +41- 1-838 50 00
Fax: +41 -1-838 50 01
www.firstcatering.ch
Vegetables/fruits

FRIGEMO AG PRODUCTION CRESSIER
Rte de Neuchâtel 49
CH-2088 Cressier
Tel: +41 - 32 758 53 69
Fax: +41 - 32 757 17 38
www.frigemo.ch
Fresh vegetables

FRUCTO LTD.
Schlosstrasse 1,
CH-4654 Lostorf
Tel: 62-298 30 35
Fax: 62-298 30 36
E-mail: frutco@frutco.ch
Banana puree, mango pulp, etc.

J. CARL FRIDLIN AG
Bösch 61
CH-6331 Hünenberg
Tel: +41 -41-780 55 22
Fax: +41 -41-780 28 08
www.fridlin.ch
Spices

GRANOSA  AG
Eisenbahnstr.asse 41
CH-9401 Rorschach
Tel: +41 71 844 98 20
Fax: +41 71 844 98 30

GUGGER-GUILLOD SA
Rte de l'Industrie 5
CH-1786 Sugiez
Tel: +41 - 26 - 673 23 73
Fax: +41 - 26 - 673 19 04
www.gugger-guillod.ch
Fresh vegetables

GEORGES HELFER SA
Chemin De Fontenailles
CH-1196 Gland
Tel: +41 -22-9999999
Fax: +41 -22-9999988
www.helfergroup.ch
Avocados

HESS IMPORT
Haldenstr. 38 – CH-8142 Uitikon
Tel: +41 -1-400 42 41
Fax: +41 -1-400 42 42
Dried fruits

HILCONA AG
FL-09494 Schaan
Tel: +41 - 75 235 95 95
Fax: +41 - 75 232 02 85
www.hilcona.ch
Vegetables, cereals, cereal products, oil-seeds

HPW MARKETING GMBH
Laurenzenvorstadt 79
CH-5000 Aarau
Tel: +41 -62-8221515
Fax: +41 -62-8222664
Pineapples

HÜGLI NÄHRMITTEL AG
Bleichestrasse
CH-9323 Steinach
Tel: +41 - 71-4472211
Fax: +41 -71-4472994
www.huegli.com
Ready-to-serve products

IFIR HANDELS AG
Wengistrasse 7
CH-8026 Zürich
Schweiz
Tel: +41 - 1 297 27 62
Fax: +41 - 1 297 27 02
www.ifirtrading.com
Cereals and cereal products, oil-seeds, protein plants

KNOLL NATURPRODUKTEHANDEL GMBH
Talackerstrasse 14
CH-8274 Tägerwilen
Tel: +41 -71-699 22 34
Fax: +41 –71-669 22 34
www.kanne-brottrunk.ch
"Brottrunk", a health drink made of fermented bread

MAX SCHWARZ
Hauptstr. 49
CH-5234 Villigen
Tel: +41 - 56 297 87 37
Fax: +41 - 56 297 87 01
www.schwarz.ch
Transplants/Seedlings

ERICH MEIER FRÜCHTE + GEMÜSE
Amriswilerstrasse 36
CH-8589 Sitterdorf
Tel: +41 –71 422 15 16
Fax: +41 - 71-422 49 76
Vegetables/fruits

MORGA AG
CH-9642 Ebnat-Kappel
Tel: +41 - 71-992 60 40
Fax: +41 - 71-992 60 56
www.morga.ch
Tea, health food products,
mushrooms, dried fruits

NARIMPEX AG
Schwanengasse 47
CH-2501 Biel
Tel: +41 - 32 366 62 62
+41 - 32 366 62 66
www.narimpex.ch
Honey, nuts, dried fruits

NESTLÉ SUISSE SA
Entre-Deux-Villes
CH-1800 Vevey
Tel: +41 - 21-924 31 11
Fax: +41 - 21-924 30 19
www.nestle.com
Foods for children, cocoa,
coffee, fruits etc.

OBIPEKTIN AG
Industriestr. 8
CH-9220 Bischofszell
Tel: +41 - 71-424 73 00
Fax: +41 - 71-424 73 90
www.obipektin.ch
Fruit extracts

PHAG SARL
abr. de prod. aliment. hygièniques régimes
a Lignière
Case postale
1196 Gland VD
Tel: +41 - 22-364 11 18
Fax: +41 - 22-364 53 63
Health food products

PRONATEC
Stegackerstr. 6
CH-8404 Winterthur
Tel: +41 - 52 234 09 09
Fax: +41 - 52 235 09 19
www.pronatec.com
Sugar and sweeteners (agave syrup), cocoa,
vanilla

SANBRO PRODUKTE
CH-7417 Trans
Tel: +41 - 81-6301020
Fax: +41 - 81-6301021
Sea buckthorn

SCHLÄPPI & CO.
Stationsstr. 1
CH-3076 Worb 2
Tel: +41 - 31-839 22 05
Fax: +41 - 31-839 90 45
Dried fruits

S'LOTUSBLÜEMLI
Sagmattstr. 7 – CH-4710 Balsthal
Tel: +41 - 62-391 00 80
Fax: +41 - 62-391 00 80/02
www.lotusbluemli.ch
Health food products

SOMONA GMBH
Bodenackerstr. 51
CH-4657 Dulliken
Tel: +41 - 62-295 46 46
Fax: +41 - 62-2953259
www.somona.ch
Health food products

TRAWOSA AG
Eisenbahnstrasse 41
CH-9401 Rorschach
Tel: +41 71 844 98 40
Fax: +41 71 844 98 49
www.trawosa.ch

UNIPEKTIN AG
Bahnhofstr. 9
CH-8264 Eschenz
Tel: +41 - 52-742 31 31
Fax: +41 - 52-742 31 32
www.unipektin.com
Concentrates

VANADIS AG
Fischingerstr. 66
CH-8370 Sirnach
Tel: +41 - 71-966 37 77
Fax: +41 - 71-966 54 21
www.vanadis.ch
Health food products

VARISTOR AG
Weststrasse 5
CH-5426 Lengnau
Tel: +41 - 56 266 50 60
Fax: +41 - 56 266 50 70
www.vairstor.com
Processed vegetables, dried fruit and nuts,
culinary and medicinal herbs, tea

VIA VERDE
Brunnmatt
CH-6264 Pfaffnau
Tel: +41 - 62 - 747 07 47
Fax: +41 - 62 - 747 07 37
www.viaverde.ch
Fresh fruit, juices, vegetables, dried fruit and
nuts, sugar, honey, wine, oil-seeds, cereals,
cereal products, culinary and medicinal herbs

W. KÜNDIG & CIE
Stampfenbachstr. 38 – P.O. Box 6784
CH-8023 Zürich
Tel: +41 - 1 368 25 25
Fax: +41 - 1 362 84 14
www.kuendig.com

Cereals and cereal products, protein plants

**Certification Bodies and Label Programmes and Advisory Bodies**

BIO INSPECTA AG
Ackerstr. – Postfach
CH-5070 Frick
Tel: +41-62-865 63 00
Fax: +41-62-865 63 01
e-mail:admin@inspecta.ch
www.bio.inspecta.ch

BIO TEST AGRO AG
Im Grutt
CH-3474 Ruedisbach BE
Tel: +41-62 968 19 77
Fax: +41-62 968 19 77

FIBL (RESEARCH INSTITUTE OF ORGANIC AGRICULTURE)
Ackerstr.
Postfach
CH-5070 Frick
Tel:+41- 62-865 72 72
Fax: +41-62-865 72 73
E-mail: admin@fibl.ch
www.fibl.ch

IMO (INSITUTE OF MARKETECOLOGY)
Weststr. 51
CH-8570 Weinfelden
Tel:+41-71-626 0 630
Phone: +41-71-626 0 623
E-mail: imo@imo.ch
www.imo.ch

SIPPO (SWISS IMPORT PROMOTION PROGRAMME)
Stampfenbachstr. 85
P.O.Box 492
CH-8035 Zürich
Tel: +41-1-365 52 00
Fax: +41-1-365 52 02
E-mail: info@sippo.ch
www.sippo.ch

SDC - Swiss Agency for Development and Cooperation
Freiburgstr. 130
CH-3003 Bern
Tel: +41-31-322 34 75
Fax: +41-31 324 13 48
E-mail: info@deza.admin.ch

SQS (SCHWEIZERISCHE VEREINIGUNG FÜR QUALITÄTS- UND MANAGEMENT-SYSTEME)
Insutriestr. 1
CH-3052 Zollikhofen
Tel: +41-31-910 35 35
Fax: +41-31 910 35 45
E-mail: headoffice@sqs.ch
www.sqs.ch

## THE NETHERLANDS

**Distributor, Importer, Processor**

ARIZA BV
Overhorst 9
5707 PP Helmond
Tel: +31-492 528 364
Fax: +31-492 545 151
www.ariza.com

DE TRAAY
Platinastraat 50
8211 AR Lelystad
Tel: +31-320 282 928
Fax: +31-320 282-028

DOENS FOOD INGREDIENTS BV
Oraniestraat 40A
Postbus 10
4515 ZG IJzendijke
Tel: +31-117 302 020
Fax: +31-117 301 811
E-mail: wdtrade@zeelandnet.nl
www.doensfood.com

DO-IT BV
Prins Hendrikweg 19
3771 AK Barneveld
Tel: +31-342 422 829
Fax: +31-342 422 192
E-mail: organic@euranet.nl
www.organic.nl

EOSTA BV
Postbus 132
3980 CC Bunnik
Tel: +31-30 656 6000
Fax: +31-30 656 6040
E-mail: info@eosta.com
www.eosta.nl

EUROHERB BV
Dynamostraat 12
3903 LK Veenendaal
Tel: +31-318 543 288
Fax: +31-318 542 458
www.euroherb.nl

GOOD FOOD FOUNDATION
Alike Last
Postbus 219
NL-3850 AE Ermelo
Tel: +31-341 560 210
Fax: +31-341 562 913
E-mail: goodfood@xsall.nl
www.goodfood.nl

GREEN, FRESH & ANYWHERE BV
Postbus 327
2990 AH Barendrecht
TeL +31-186 668 585
Fax: +31-186 668 588

GREENFOOD INTERNATIONAL BV
Bellstraat 7
3861 NP Nijkerk
Tel: +31-33 247 1030
Fax: +31-33 247 1035

HORIZON NATUURVOEDING BV
Postbus 77
3400 AB IJsselstein
Tel: +31-30 688 7730
Fax: +31-30 688 7142

HOOFDKANTOOR NATUURVOEDINGS
WINKEL ORGANISATIE B.V. (NWO)
Postbus 193
NL-3840 AD Harderwijk
Tel: +31-341- 464294
www.denatuurwinkel.nl

MARFO
Postbus 137
8200 AC Lelystad
Tel: +31-320 293 894
Fax: +31-320 232 096
E-mail: martinairfood@wxs.nl

NEUTEBOOM BV
Aadijk 41
7602 PP Almelo
Tel: +31-546 864 062
Fax: +31-546 864 062
www.neuteboom.nl

ODIN INTERNATIONAL BV
Postbus 225
4190 CE Geldermalsen
Tel: +31-345 577 133
Fax: +31-345 576 848
www.odin.nl

RENCO BV
Postbox 46
6600 AA Wijchen
Tel: +31-24 641 5304
Fax: +31-24 641 5314
E-mail: mderooij@renco.raftir.be

RHUMVELD WINTER & KONIJN BV
Postbus 29216
3001 GE Rotterdam
Tel: +31-10 233 0900
Fax: +31-10 233 0574
www.rhumveld.com

RIJK ZWAAN
NEDERLAND BV
Postbus 40
2678 ZG De Lier
Tel: +31-174 532 300
Fax: +31-174 515 334
E-mail: a.van.velden@rijkzaan.nl
www.rijkzwaan.com

THE GREENERY INTERNATIONAL
Ben Linthorst
Postbus 79
NL-2990 AB Barendrecht
Tel: +31-180-655140
Fax: +31-180-655201
www.thegreenery.com

TRADIN ORGANIC
AGRICULTURE BV
Latexweg 12
1047 BJ Amsterdam
Tel: +31-20 407 4499
Fax: +31-204972100
E-mail: postmaster@tradinorganic.com
www.tradinorganic.com

TROUW BV
Piekstraat 63-65
3071 EL Rotterdam
Tel: +31-10 486 6332
Fax: +31-10 4886 0928
www.trouw-buckwidge.nl

ZANN BIO-CENTER
Marconistraat 1-11
NL-3029 AE Rotterdam
Tel: +31-10-4775688
Fax: +31-10-4775070

**Wholesalers, Retailer**

ALBERT HEIJN
Project Organic Products
Proviancialeweg 11 – Postbus 3000
1500 HA Zaandam
Tel: +31-75 659 2218
Fax: +31-75 659 8644
E-mail: leontine.gast@corp.ah.nl
www.ah.nl

DE NIEUWE BAND
Noorderringweg 12
9363 TC Marum
Tel: +31-594 644 3355
Fax: +31-594 643 385
E-mail: info@nieuweband.nl
www.lekkerwijntje.nl

DE NIEUWE WEME BV
Postbus 90 – 8440 AB Heerenveen
Tel: +31-513 630 333
Fax: +31-513 650 170

DE RIT NATUTIRPRODUKTEN BV
Retsezijstraat 4
4011 JP Zoelen
Tel: +31-344 681 653
Fax: +31-344 681 404

DEKAMARKT BV
Postbus 86 – 1940 AB Beverwijk
Tel. +31-251 276 600
Fax: +31-251 276 680
www.dekamarkt.nl

KONMAR BV
De Werf 13
2544 EH Den Haag
Tel: +31-70 3215121
Fax:+31-70 329 1174
www.konmar.nl

NATUDIS BV
Postbus 376 – 3840 AJ Harderwijk
Tel: +31-341 464 211
Fax: +31-341 425 704
www.naturdis.com

NWO (DE NATUURWINKEL/
GIMSEL/DE GROENE WINKEL)
Postbus 193
3840 AD Harderwijk
Tel: +31-341 464 2 11
Fax: +31-341 464 204

E-mail: info.nl@denatuurwinkel.com
www. denatuurwinkel.com

TERRASANA NIL BV
Postbus 70 – 2450 AB Leimuiden
Tel: +31-172 503 338
Fax: +31-172 503 355
www.terrasana.com

UDEA BV
Postbus 478
5400 AL Uden
E-mail: jvdboogaard@ekoland.con
www.udea.nl

VOMAR VOORDEELMARKT BV
Postbus 217 – 1970 AE IJmuiden
Tel: +31-255 563 700
Fax: +31-255 521 649
www.vomar.nl

**Authorities, Organizations and Certifiers**

B-D ASSOCIATION (Vereniging voor Biologisch-Dynamische Landbouw)
Postbus 17
3970 AA Driebergen
Tel: +31-34 353 1740
Fax: +31-34 351 6943
E-mail: Bd.vereniging@ecomarkt.nl
www.ecomarkt.nt/bdvereniging

CBI
(Centre for the Promotion ofImports from developing countries)
WTC Beursbuilding,
5th floor
Postbus 30009
3001 DA Rotterdam
Tel: +31-10 201 3434
Fax: +31-10 411 4081
E-mail: cbi@cbi.nl
www.cbi.nl

DUTCH FOOD INSPECTION SERVICE
Ministry of Welfare, Health and Cultural Affairs
Postbus 5840
2280 HV Rijswijk
Tel: +31-70 340 5060
Fax: +31-70 340 5435

FAIR TRADE ASSOCIATION
Beesdseweg 5
Postbus 115
4100 AC Culemborg
TeL +31-345 545 151
Fax: +31-345 521 423

GOOD FOOD FOUNDATION
PO Box 219
3850 AE Ermelo
Tel: +31-341 560 210
Fax: +31-341 562 913
E-mail: goodfood@xs4all.nl

MINISTRY OF AGRICULTURE
PO Box 965
6040 AZ Roermond
Tel: +31-475 355 555
Fax. +31-475 318 939

SKAL
Postbus 384
8000 AJ Zwolle
Tel: +31-38 426 8181
Fax: +31-38 421 3063
E-mail: SKAL@euronet.nl
www.skal.com

STICHTING BIOLOGICA - PLATFORM BIOLOGICA
Postbus 12048
3501 AA Utrecht
Tel: +31-30 230 0713
Fax: +31-30 230 4423
E-mail. biologic@xs4all.nl
www.platformbiologica.nl

STICHTING MAX HAVELAAR
Lucasbolwerk 7
3512 EG Utrecht
Tel: +31-30 233 4602
Fax: +31-30 233 2992
E-mail: maxhavelaar@maxhavelaar.nl
www.maxhavelaar.nl

## DENMARK

**Importers**

BIODANIA
A.M.B.A
Grønttorvet 6
DK 2500 Valby
(Copenhagen)
Tel.: +45 3630 2429
Fax: +45 3630 2479
biodania@biodania.dk
www.biodania.dk
fruits and vegetables

BIO TRADING A/S
Abenravej 9
Kiskelund
6340 Krussa
Tel: +45-70 23 15 15
Fax: +45-70 23 15 16
E-mail bio@bio-trading.com
www.biotrading.dk
Sugar, malt, starch, eggs, seeds, dried fruit and nuts, cocoa and chocolate, oils, spices, processed fruit

BLÆRE FRUGT
Kelddalvej 33
DK-9600 Års
Tel: 9866 6090
Fax: 9866 6011

DANORGANIC A/S
Vesterbjergevej 1
DK-7280 Sdr. Felding
Tel: 9719 8899
Fax: 9719 8903
E-mail. danorganic@danorganic.dk
www.danorganic.dk

DAGROFA A/S
Gammelager 11-13
2605 Brondby
Tel: +45-43 22 82 82
Fax: +45-43 22 84 04
www.dagrofa.dk

GARTNERIET MARIENLYST
Tåstrupvej 86
DK-8462 Harlev
Tel: 8694 2167
Fax: 8694 1043
www.marienlyst.net

H. LEMBCKE A/S
Grønttorvet 244-260
PO BOX 427
DK-2500 Valby
(Copenhagen)
Tel: 3615 6222
Fax: 3615 6223
www.lembcke.dk

HANS KJAER TRADING A/S
Piniehøj 23
DK-2960 Rungsted Kyst
Tel: 4557 1312
Fax: 4557 0048
E-mail. hanskjaer@juice.dk
(fruit juices, concentrates and
pulp, frozen fruits)

F-I MEJERIFRUGT
Hestehaven 3
DK-5260 Odense S
Tel: 6613 1370
Fax: 6613 4410
(fruits and berries for
the dairy industry)

N.A.F. INTERNATIONAL AMBA
Fanøgade 15
DK-2100 Copenhagen Ø
Tel: 3916 9000
Fax: 3916 9080
E-mail. naf@naf.dk
www.naf.dk

NATUR FRISK BREWERY
Lillehoivej 18
8600 Silkeborg
Tel: +45-86 80 37 67
Fax: +45-86 80 24 55
Fruit juices

NUTANA A/S
Ringstedvej 531
4632 Bjaeveskov
Tel: +45-56 86 96 00
Fax: +45-56 86 96 16
www.nutana.dk
Juices, spreads, baked beans,
chilli beans, deep-frozen ready-meals,
deep-frozen vegetables, muesli,
rice, pasta, beans, seeds, grains,
flour and fruit

SOLHJULET
Storhedevejen 32, Taul
DK-8850 Bjerringbro
Tel: 8668 6444
Fax: 8668 6275
E-mail. info@solhjulet.dk
www.solhjulet.dk

SVANHOLM IMPORT
Svanholm Allé 2
DK-4050 Skibby
Tel: 4756 6656
Fax: 4756 6667
www.Svanholm.dk

SØRIS I/S
Sørisvej 2A
DK-3650 Ølstykke
Tel: 4733 4003
Fax: 4733 4017

SUNPROJUICE DENMARK APS
Huginsvej 2-4
4100 Ringsted
Tel: +45-57 67 11 77
Fax: +45-57 67 1145
E-mail: sunpro@post4.tele.dk
www.ecoweb.dk/sunprojuice
Processed fruits

SVANSØ FOOD A/S
Strandvejen 1
5800 Nyborg
Tel: +45-65 3141 00
Fax: +45-65 30 10 41
Jams and marmalades,
pasta, olive oil,
deep-frozen fruits
and vegetables

UNIKOST A/S
Over Hadstenvej 58
8370 Hadsten
Tel: +45-86 98 0144
Fax- +45-86 98 00 48
E-mail: jan@jan-import.dk
www.jan-import.dk
Dried fruit and nuts,
pasta, rice, seeds, sugar,
grains and flour

URTEKRAM A/S
Klostermarken 20
9550 Mariager
Tel: +45-98 54 22 88
Fax: +45-98 54 23 33
E-mail: urtekram@inet.uni2.dk
www.urtekram.dk
Dried fruit and nuts,

herbs and spices, cereal
products, vegetable oils,
vinegars, tea, beans,
lentils, sweeteners,
wine, cosmetics

**Wholesalers Retailers**

DANSK SUPERMARKED A/S
Bjodstrup 18
8270 Hojbjerg
Tel: +45-89 30 30 30
Fax: +45-86 27 65 63

FDB (COOP DENMARK)
Roskildevej 65
2620 Albertslund
Tel: +45-43 86 43 86;
Tel: +45-43 86 48 11
Fax: +45-43 86 42 09;
Fax: +45-43 86 33 86
E-mail: fdb@fdb.dk
www.fdb.dk

IRMA A/S
Korsdalsvej 101
2610 Rodovre
Tel: +45-43 86 38 22
Fax: +45-43 86 38 09
www.irma.dk

ISO SUPERMARKED
Vermlandsgade 51
2300 Copenhagen S
Tel: +45-31548411;
Tel: +45-32 69 76 00
Fax: +45-31 54 3142;
Fax: +45-32 69 76 01
E-mail: iso@iso.dk
www.iso.dk

MATAS A/S
Rormosevej
3450 Allerod
Tel: +45-48 16 55 55
Fax: +45-48 16 55 66
www.matas.dk/OKOLOGI.HTM

NETTO I/S
Industribuen 2
DK-2635 Ishøj
Tel: 4356 8811
Fax: 4354 3288
www.netto.dk

SUPERGROS A/S
Knud Højgaards Vej 19DK-7100 Vejle
Tel: 7010 0203
Fax: 7572 3528
E-mail. Johnny_Wham@supergros.dk
www.supergros.dk

**Label Programmes and Certification Bodies**

DEMETERFORBUNDET
(The Demeter Association)
Birkum Bygade 20
5220 Odense SO
Tel: +45-65 97 30 50
Fax: +45-65 97 30 50

DET OKOLOGISKE FODEVAREDD
(The Organic Food Council)
Strukturdirektoratet
Udvikiingskontoret
Toldbodgade 29
1253 Kobenhavn K
Tel: +45-33 63 73 00
Fax: +45-33 63 73 33

INFOOD
Langballevaenget 102
8320 Marslet
Tel +45-86 12 86 38
Fax: +45-86 12 86 37
E-mail: infood@post8.tele.dk
www.ecoweb.dkfinfood

LANDSFORENINGEN OKOLOGISK
Jordbrug (LOJ), (The Danish Association
for Organic Farming)
Okologiens Hus
Frederiksgade 72
8000 Arhus C
Tel +45-87 32 27 00
Fax: +45-87 32 27 10
E-mail: ecojord@ecoweb.dk,
www.ecoweb.dk/oekoland

MAX HAVELAAR FONDEREN
c/o Folkekirkens Nodhjaelp
Norregade 13
1165 Copenhagen K
Tel: +45-33 11 13 45
Fax: +45-33 11 13 47
E-mail: maxhavelaar@dk,
www.maxhavelaar.dk

OGRUPPEN – DANSK
Okologileverandorforening
Udgarden 30
Lading
8471 Sabro
Tel: +45 86 12 77 66
Fax: +45 86 12 77 41
E-mail: gruppen@ecoweb.dk
www.ecoweb.dk/gruppen/

Okologisk Landscenter (OLC),
(The Danish Organic Service Centre)
Okologiens Hus
Frederiksgade 72
8000 Arhus C
Tel: +45-87 32 27 00
Fax: +45-87 32 27 10
E-mail: ecoinfo@ecoweb.dk
www.ecoweb.dk/ecoinfo