4. ORGANIC FARMING

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INTRODUCTION

This unit will initially present introductory concepts related to Organic Farming and will attempt to define Organic Farming, its potential and challenges in reorienting production methods and the institutional framework that regulates organic production in European Union countries and Czech in particular, and to introduce the principles, cultivation techniques and practices of organic production. The second unit of this chapter will present the main practices and techniques of organic farming in greater detail, with focus on organic cultivation of cereal crops.

EXPECTED RESULTS

When you have finished this chapter, you will be able to:

- List and describe the main principles and implementation methods of organic farming.
- To understand and describe the main points of EU regulation regarding organic production.
- To understand cultivation practices and the tools and materials used in plant protection, fertilisation and other farming techniques and tools permissible in organic farming.
- To understand and apply the basic principles of organic production when farming in practice; in other words, to effectively apply the appropriate methods of fertilisation, plant protection and other farming techniques.
- To deal with problems in cultivation according to the principles and practices of organic farming.

KEY CONCEPTS

Organic farming, Crop rotation, Companion planting, Intercropping, Green manure, Compost-composting, Plant protection materials, Plant diseases, Organic treatment, Weeds

4.1. Introductory concepts in Organic Farming

4.1.1 What is Organic Farming

Organic farming is an alternative form of farming, as compared to conventional farming (chemical farming).

In **organic farming**, only organic cultivation methods are used; these are methods that do not rely on the use of chemical fertilisers, chemical herbicides and pesticides or any kind of synthetic hormones. On the contrary, in **conventional farming** (chemical farming) chemical methods are used to combat each disease or pest, meaning that chemicals which are made in laboratories are used, with the result that the environment is polluted along with the flora and fauna in general. It also results in chronic serious illnesses in humans (cancer, allergies, skin conditions, nerve system damage, among others).

Specifically, organic farming is described as a philosophy-production practice that promotes the sustainability of the production method and involves the least possible energy-consuming input and minimum impact on the environment. In general terms, Organic Farming does not permit the use of inorganic chemical fertilisers (except for trace elements), chemical biocides (fungicides, insecticides, acaricides) and pesticides. On the contrary, it permits the use of natural substances, such as natural rocks and certain simple chemicals (sulphur, copper), while it requires crop rotation and organic fertilisation. Organic farming is a method of farming that ensures a balance in nature and a harmonious environment; it is the cooperation between nature and the microorganisms in the soil.

This natural method of farming respects the natural world (plants-animals), protects the environment, produces healthy and flavourful products and makes use of modern achievements in science, farming experience and local tradition.

Put simply, **organic farming** is an agricultural system of management which provides consumers with fresh, good-tasting, authentic foods while at the same time respecting the balance between ecosystems.

Organic farming **seeks to:**

- maintain a vital, healthy soil to support robust and healthy plants adapted to a particular environment
- maintain the greatest possible variety of animal and plant organisms in the ecosystem of cultivation
- ensure maximum stability and control of plant parasites
- achieve the most intensive recycling of materials possible
- ban the use of synthetic chemical substances

Organic farming uses mild cultivation methods and plant protection and fertilisation products that do not constitute a danger to the environment by utilising modern scientific achievements.

A few years ago, organic farming movements from all over the world formed an international federation known as **IFOAM (International Federation of Organic Agriculture Movements).**

The **principles declared** as goals in this area were as follows:

- Maintenance of ground fertility.
- Avoidance of environmental pollution and contamination.
- Production of food of high organic value.
- Reduction in energy use.
- Improvement in living conditions and the establishment of quantity in daily life.
- Assurance of satisfactory returns and respectable income.
- Development of a positive relationship with the environment.

4.1.2 Potential and challenges in reorienting toward organic methods of production

Organic farming, as applied by many farmers in European countries, is now on the right track for producing products with high nutritional value. This method is superior to conventional or classic farming, as far as ecology and soil fertility are concerned. Anyone who owns land can farm organically, as long as he is willing to cooperate with nature and the microorganisms in the soil, to care for the organic substance known as "humus" and to implement mulching, intercropping and green manure.

The decision to start or to make a change will not be so easy to implement at first. Persistence, patience and hard work will be required until some of the ecological balance is regained in the organic cultivation unit. Avoidance of any kind of chemical pesticides to combat harmful pests, of chemical fertilisers, hormones and others is a prerequisite for organic farming.

This method is not a return to the "stone age," as many people believe. Modern science and progress made in biology and ecology have recognised and acknowledged the value of organic substances and the contribution of microorganisms in soil productivity.

In the past, about 50 years ago, farmers had hoes, spades, scythes, etc. as essential tools in their production. They lived with pests, controlling them with traditional means of protection, and their products were adequate for themselves and their farm animals. Today, despite overproduction and easier methods of farming, farmers are not satisfied and they are often the target of criticism. It is no secret and no one can deny that the natural environment is full of dangers and most people have given up as they wait for the final blow. Modern humans are simple observers, unable to do anything to defend themselves in the face of polpute underground and surface water, acid rain, chemical residues in food and all sorts of other dubious commodities. Nevertheless, it is not too late for those who value their lives and respect the natural environment.

Farmers with the fields they cultivate, the animals they raise and the market vegetables they produce are a **business** that must **provide quality products** for themselves, their families and the market. But that is not all. They must also ensure the **productivity and the fertility of the soil they cultivate.** That is the only way they will be able to guarantee their own future and that of their families through a stable and profitable business.

In addition, farmers must ensure the **balance of the natural environment (ecosystem)** with the fewest possible modifications, wastes and residues. The maintenance and propagation of microorganisms in the soil must be the main goal of organic farmers. The ecosystem has a certain tolerance level, which farmers must be aware of and not exceed. How much the natural environment can tolerate or how much waste and residues of technology it can assimilate and process depends on whether the various models and methods being proposed truly suit the environment. It also depends on whether the goal being pursued and its economic benefits is within the ecosystem's limits.

If farmers overlook the ecology of the soil, the results will not be long in becoming apparent in the form of soil exhaustion, nutrient deficiency, soil leaching, poor quality of foods, diseases in livestock, etc. The problem will be even more apparent when the business is threatened and remedial measures are called for, which means more expense, time and effort. In this case, it is the economic aspect of the problem that must be dealt with.

A **farming business** is defined by **ecology** and the **economy**, which are stable limits and must not be violated.

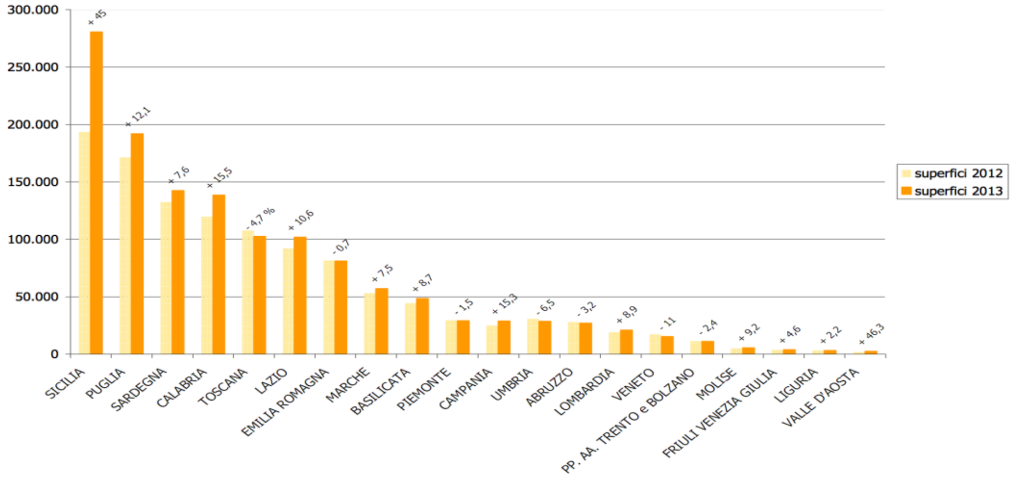
Organic farming is now considered one of the most dynamic agricultural sectors in the European Union and is characterised by a dynamic growth, contributing to the revival of agricultural economies through sustainable growth and creating new employment opportunities. The promotion of these organic farming activities creates new jobs that require a high level of skills, while traditional jobs are evolving so as to respond to the needs of sustainable development and environmental management.

In this development framework, there are modern and innovative agricultural enterprises and model organic farms that have been in operation for a decade in countries of the EU. Based on data on the development of the sector to date and the potential for its future course, it is apparent that the emphasis on sustainable management of plant production, the expansion of organic farming and the increase in demand for organic products requires increased expertise and an emphasis on human resources so that farmers who are active or who wish to turn to organic farming will be able to respond to the multifaceted demands of organic production and an integrated management of organic agroecosystems.

4.1.3 Organic farming in Europe and in Italy

The evolution of new forms of agricultural aimed to a better protection of the quality product, consumers health and environmental protection.In 2005, the area used for organic farming in the EU-25, was 4%. The data collected by the European Commission point out that, over the last 10 years, from 2001 to 2011, the amount of land under organic farming has increased each year half a million hectares (+ 13%) and Europe currently has over 186 000 organic farms. There are a lot organic farms are located in France, Italy, Germany, Belgium, UK and Croatia. Between 2003 and 2010 the number of organic farms European grew by 10 times. 45% relates to permanent pasture, 15% of the crops of cereals and 13% other varieties. The analysis also highlights a particular aspect of the age of organic farmers, who are younger than the average. In 2010 61.3% of the organic farmers had less than 55 years, compared with 44.2% of conventional farmers[1]. In Italy, the data provided to the Ministry of Agriculture and Forestry by the Control Bodies (CBs) operating in Italy to 31 December 2013, there was an increase in the number of workers by 5.4%, compared to 2012. In the complex Traders are 52,383, of which 41,513 exclusive producers; 6,154 preparatory exclusive (including companies involved in the operation of retail); 4,456 used both for production activities of preparation and 260 operators performing import. Even in the case of the cultivated area under organic farming, there was an increase of 12.8%, with a total of 1,317,177 hectares. The main guidelines are productive pastures, forage and cereal.

Fig. 1. Regional distribution of surface: percentage change from 2012 to 2013



[1] www.ec.europa.eu

Thedistribution of farmers in Italy highlights, as for the past years, among the regions with the highest number of organic farms, followed by Calabria, Sicily; while the number of processing companies engaged in the sector emerges Tuscany followed by Emilia Romagna and Puglia (Figure 2)[2].

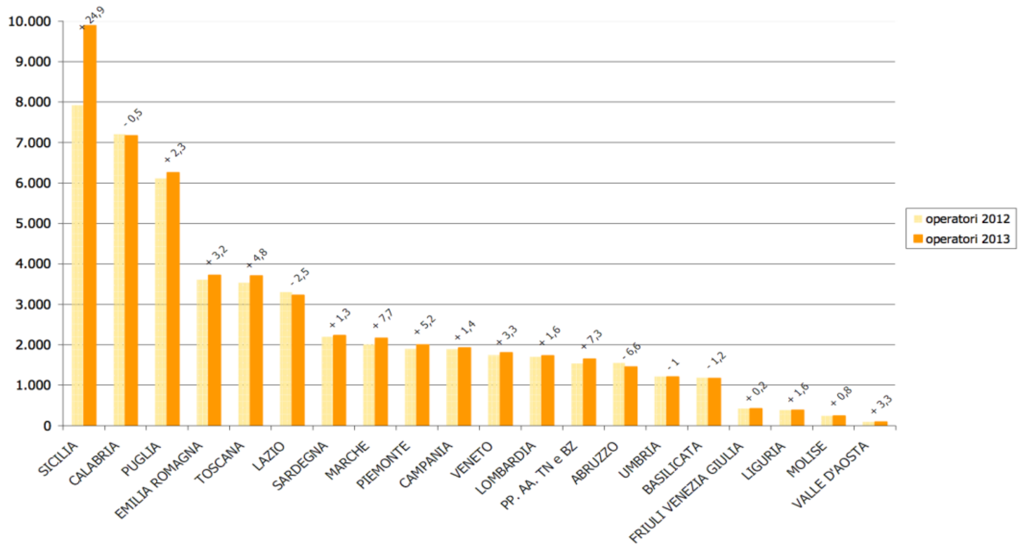


Figure 2 Percentage change in the number of operators per region: comparison 2012-2013

In Germany the numbers show a growth of organic farming; in 2011 it exceeded the amount of one million hectares of cultivated area under organic farming (1,015.625 hectares) and also shows an increase of + 2.5% of companies, compared to the previous year. Of the 22,506 organic farms in Germany at present, two-thirds are in the areas of Baden-Wurttemberg and Bavaria[3]. In France, there was an increase of 5.4%, compared to 2013, the number of hectares used in organic growing, reaching 1,120,000 in 2014 of companies that adopt the method of organic farming.

The production is varied and there is more than 20% of the area dedicated to the production of dried vegetables and 13% for forestry and scented plants, aromatic and medicinal, and 8% for vineyards. Even for animal breeding is widespread method of organic farming, particularly in the areas of beekeeping and egg production, respectively, 12.6% of the number of hives and almost 8% of laying hens.

The development of organic farming for all animal species. The most dynamic sectors are those of cattle and sheep milk.

The main regions which apply the method of organic farming are Midi-Pyrenees (145 409 ha), Pays de la Loire (115 570 ha), Languedoc-Roussillon (100,789 hectares), Rhône-Alpes (96 331 ha) and Provence- Alps-Cote d'Azur (93 184 ha)[4].

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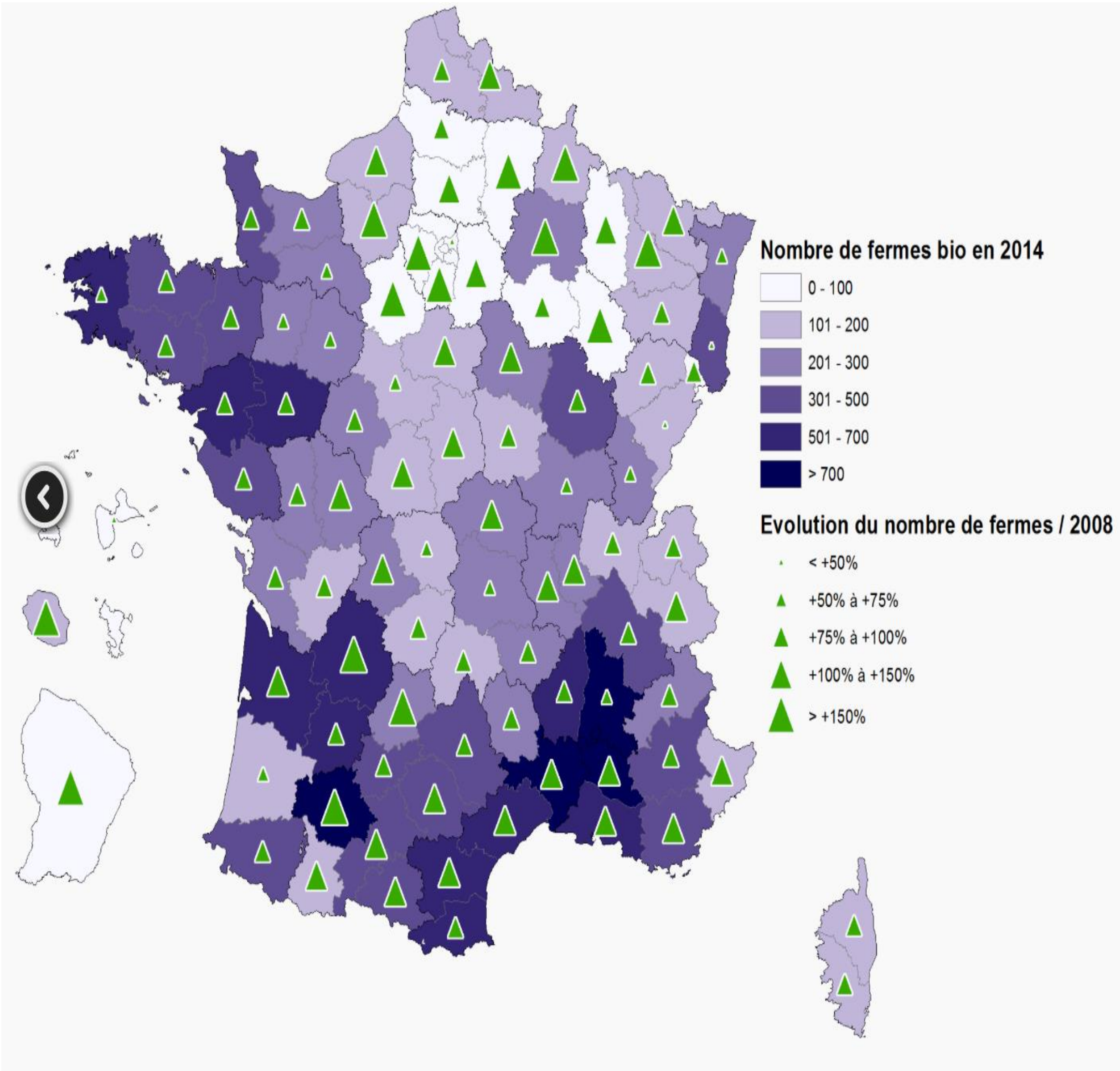
[2] *Bio Report "In Cifr"e 2014*, Sinab, September 2014

[3] www.bmel.de

[4] www.agencebio.org

Fig. 3. Distribution department of the companies engaged in the biological end of 2014 and evolution compared to 2008



Another example of a country where organic farming is becoming increasingly popular is the Czech Republic. According to official statistics (Table 1), at the end of 2009, the share of organically cultivated area was approximately 9.38% of the total area of agricultural land (a significant increase over the previous year). The most significant results have covered the ground in pastures with 329,232 hectares and the area of arable land, which is increased to a total of 44,906 hectares. The number of organic farmers has increased to 501, and there was a total of 2,689 organic farms in the Czech Republic. The number of organic food producers grew from 122 companies, up to a total number of 501.

The growing demand for organic raw materials from manufacturers, has led to increased interest in organic farming by farmers.

Organic farming has developed since the early 90's and later were developed various methods and systems, than agriculture alternative, supported by a limited range of people, to produce state-approved and defined by the law, while respecting the 'environment and well-being.

The permanent pastures are predominant (mostly over 80%), while the calculation of arable land is around 5-10%, especially in South Moravia, (Vysočina Highlands) and the Central Bohemia Region. The orchards are mainly in the regions of Prague, South Moravia, Olomouc, Zlín and Central Bohemia; while the vineyards in the region of Southern Moravia.

The average size of an organic farm has declined over the past two years, it has gone from more than 100 hectares, less than 90.

The extensive farming on permanent pasture and prevails in the region of Karlovy Vary, with nearly 54,500 hectares and the region of South Bohemia with 47,500 hectares, reaching the first and second place, in terms of area cultivated organically.

In the Czech Republic, the largest organization active, capable of bringing together organic farmers, producers, sellers and consumers of organic food, it is the association PRO-BIO organic farmers[5]. The association, in 2009, had 606 members, including farmers, producers and sellers of organic food; of which I have appointed a higher percentage organic farmers (437 members) and organic food stores (89 stores). The association in collaboration with the main European associations of organic agriculture, developing their own guidelines, which apply both to agriculture and the processes of production, conforming to the European standard.

The association PRO-BIO provides its members, also, consulting services, interest-free loans, organizes training courses, assists in sales / marketing and promotion, and is member of IFOAM (International Federation of Agriculture Movements organic)[6]. The association, from the administrative side, is broken down by individual regional centers, providing services to members of the region.

4.1.4 Institutional framework Council Regulations

The procedures and regulations for the implementation of organic farming in countries of the European Union were determined by Council Regulation (EEC) no. 2092/91 of 24 June 1991 on organic production of agricultural products and related guidelines for agricultural products and foodstuffs, as well as additions or amendments that were made later. The definition of organic production, logos and labelling systems are included in the Council Regulation on organic methods of production and labelling of organic products, which was adopted by the European Union

[5] www.pro-bio.cz
[6] www.ifoam.bio

Council on 28 June 2007 and replaces the previous regulation (EEC) no. 2092/91. The Regulation refers to the way in which plant cultivation and feeding of animals must be carried out, as well as how foodstuffs and animal feed must be processed in order that they can be labelled "organic." These new regulations for production, control and labelling went into effect on 1 January 2009. However, certain of these new provisions on labelling will not take effect until 1 July 2010.

Commission Regulations

Commission Regulations

The following Commission Regulations have been instituted so far:

• Commission Regulation (EC) no. 889/2008 of 5 September 2008 with detailed rules for production, labelling and control, including its first amendment related to the regulations for production of organic yeast

Commission Regulation (EC) no. 889/2008 regulates all levels of plant and animal production, from the cultivation of land and keeping of animals to the processing and distribution of organic foods and their control. The Regulation goes into great technical detail and for the most part is an extension of the original Regulation on organic products, except where this was regulated differently by the Council Regulation.

Many Annexes are attached to the Commission Regulation. These include the following:

- Products which are permissible in organic farming, such as fertilisers, soil conditioners and pesticides.
- Minimal requirements with regard to the size of stabling and exercise yards, including pastures, for organic livestock, according to species of animal and stage of development.
- Non-organic animal feed, feed additives and aids used in processing compound feed and pre-mixed feed permitted in organic farming.
- Non-organic ingredients, additives and processing aids permitted in organic food production (including yeast production).
- Requirements related to the EU logo.

For the complete EU legislation related to organic farming, as well as related legal information (regulations on imports, etc.), visit the official EU website on legislation that governs organic farming (in Czech)

4.1.5 Principles of Organic Farming

Organic farming is based on goals and principles, as well as on common practices designed with the aim of ensuring minimal human intervention and environmental impacts, while at the same time guaranteeing that the system functions as naturally as possible.

Typical organic farming practices include:

- **Crop rotation** as the main prerequisite for the correct use of available natural resources.
- **Very strict limits on the use of plant protection products** and **synthetic fertilisers, animal antibiotics, preservatives** and **additives in food processing** as well as **other inputs.**
- **Complete ban** of the use of **genetically modified organisms.**

- **Use of self-produced resources,** such as animal manure or foods produced on the farm.
- **Selection of plant and animal species** which are resistant to diseases and are adapted to the local conditions.
- **Breeding of free-range animals**, rather than confined animals using organic feed.
- Applying breeding practices appropriate to the various breeds of animals.

4.1.6 National legislation on organic agriculture

The new EU Regulation on Organic Farming (834/2007) with its implementation rules (889/2008) has been in force since 1 January 2009. It refines rules for organic production, use of the EU logo, export and import rules and replaces the former regulation 2092/91. National legislation is another tool used for implementing some of the rules of organic farming. The CR uses this instrument in the form of its Act on Organic Farming (242/2000), which mainly deals with administrative measures eg. registration of farmers or sanctions.

The Act on Organic Farming stipulates that any misuse of legislation and its rules will be strictly punished by the Ministry of Agriculture, as it is now. It will continue to be impermissible to use genetically modified organisms (GMOs) in the production of organic foods. A very strict threshold for GMO content in organic foods has been set. The slight toleration of 0.9% has been introduced, to protect organic farmers from sanctions for traces of contamination in the foods, not caused by them.

The "Organic Farming" Programme for Sustainable Consumption and Production

This programme, prepared by the Ministry of Agriculture in association with non-governmental organisations and experts, and approved by the Government Council for Sustainable Development, strives to tie into the Action Plan for Organic Farming, and to promote the introduction of the principles of sustainable consumption and production in agriculture and the food industry.

Information Campaign in Support of Organic Farming and Organic Foods

The European Commission approved financial support for the Czech Republic for a three-year national promotion campaign to support organic farming and organic foods. The main goals of the campaign are to inform consumers about the principles and advantages of organic farming, increase awareness of the labelling of organic foods, and increase the consumption of organic foods in the Czech Republic. The campaign was launched in 2007 and is supervised by the Marketing Department of the State Agriculture Intervention Fund (SZIF).

4.2. Cultivation practices and techniques in organic production

This section will present the main practices and techniques in organic farming in detail. These include:

Crop rotation

Companion planting (Intercropping)

Organic and green manure – Production and use of special fertiliser preparations

Plant protection using organic methods and techniques – Use of special preparations and plant protection techniques

Organic control of crop pests and diseases

4.2.1 Crop rotation

The term "**crop rotation**" means the systematic and planned cyclical variation of crops on the same field.

The planned **rotation of crops** is used:

- as a means of **fertilisation**, utilising the nitrogen-producing plants used in the crop rotation programme;
- for **soil improvement**, using plants which leave a considerable quantity of residual roots;
- for **soil protection** through continuous mulching[7] and the cultivation of perennial legumes; as well as
- a **tillage tool**, using deep-rooted legumes.

Experience has shown that when crops are rotated, the soil better maintains its biological action and structure, while plants are rendered healthier and more resistant to parasites.

Crop rotation may only be carried out on annual crops (arable crops, market produce and so on). The types of plants are rotated based on a specific schedule which is devised after taking into consideration plant requirements for nutrients, organic elements, the nitrogen they provide to the soil (legumes) after their harvest, their root system, their economic importance, the cultivation they require and the parasites each is susceptible to.

The **selection of successive crops** is made based on various **criteria**, such as:

- The morphology of the plants (root depth, etc.);

- Physiology (Cation Exchange Capacity [CEC] etc.)

- Nutrient requirements;

- Pests and diseases adapted to the crop;

- Chemical mediators that each plant produces or to which it responds.

Example

One example of a three-year crop rotation is tomato-wheat-chickpeas. The legume is always sown after the grain so that the nitrogen it releases will be used first by the tiller and then by the grain, which would lodge if it took up the nitrogen first.

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[7] Mulching is used as a means of protecting the soil and of increasing the beneficial and predatory microorganism and insect populations. A healthy soil maintains balance among beneficial bacteria, viruses and other microorganisms and pathogens.

Another example of crop rotation that takes plant morphology into consideration is grain-sugar beet-grain. In this case, the shallow-rooted plant (grain) uses different layers of soil than a deep-rooted plant (sugar beets). In addition, the intervention of a botanically different plant like the sugar beet between two cultivations of grain interrupts the cycles of pests and diseases in grain crops.

In the rotation of grain - fallow period – corn, the intervention of a fallow period between the grain and the corn improves the soil characteristics, reduces pests and interrupts the cycle of natural enemies while allowing microorganisms to multiply. It should be noted that the use of chemical fertilisers and other chemicals is the leading cause of reduced microorganisms in the soil.

Finally, a system in which a perennial legume, such as alfalfa, takes part is examined.

Wheat – barley - alfalfa

The presence of a perennial legume in the crop rotation protects the soil from erosion and enriches it with nitrogen while improving the soil structure because of the underground residues left by growing alfalfa.

The contribution of crop rotation to the safety of production is great. In wheat production, the yield of continuous cultivation was 50-70% that of wheat inducted into a crop rotation programme.

4.2.2 Companion planting (Intercropping-Multicropping)

With the concurrent presence of different plants, we can take advantage of a broad range of mutually beneficial relationships and positive interactions which are due to different active biological substances, such as: antibiotics, growth hormones, repellent and appetite-suppressant substances.

Whether intercropping in organic farming is completely appropriate or not is not yet known. There is no scientific basis yet, as such a determination requires studies, time and effort. Nowadays, farmers and gardeners who cultivate **land** organically are experimenting on their own or rely on the results and experience of others who have tried earlier with satisfactory results. Under this system, produce is planted at variable maturation and harvest times in the same bed. Plants with different root systems and plants with different requirements for nutrients are combined. This is an interesting system that requires thought and a well-planned planting scheme.

The species which mature early should be replaced by different species which nevertheless will suit the surrounding plants.

However, it is a fact that **plants in intercropping do better than those in monocropping.** The plants make up a **type of plant society** that adapts to the environment where they grow and are in continual competition with each other. One species depends on the other; they protect each other and are influenced in a positive way and at the expense of harmful insects and other diseases.

Example of intercropping-multicropping

- Early in spring, the **spinach** is sown in rows and around the end of April, **turnip** is planted in between. When the spinach is harvested, **leek** is planted in its place. Later, once the turnips are collected, **Brussels sprouts** are planted in their place and a row of **lettuce** is planted next to them.

- **Carrots** and **spinach** are sown in rows. After the spinach is harvested, **onions** are planted in its place. When the carrots are collected, **cauliflower, cabbage** or **broccoli** is planted in their place after spreading manure there, as the vegetables are very demanding in nutrients. Finally, at the end of summer, **valerian** can be sown in place of onions for a winter salad while at the same time serving as a cover of green manure.
- Turnips and lettuce are sown in rows. After the lettuce has been harvested, **beets** are sown in turn. In the place of turnips, **celery** takes a turn, while onions (shallots) are planted along the sides in autumn so they will be ready in early spring.
- The lettuce is sown in rows and **green beans** are planted in between in May. When the lettuce is harvested, a type of **cabbage** is planted in its place. By the time the cabbages open their leaves, the beans will be ready for harvest so the cabbage will be able to utilise the nitrogen the beans have fixed in the soil, which is a characteristic of legumes.
- In this way, keeping in mind which plants make good neighbours and which should precede which, it is possible to devise many combinations in the garden. Naturally, this method of cultivation is intensive and the nutrients in the soil are quickly exhausted. The enrichment of the soil with organic substances (compost), with green manure and animal manure should either precede or follow each planting.
- Using this method, not only is it possible to get large quantities of produce from a smaller area, but also to economise on irrigation because of the continued mulching, to combat weeds without chemical pesticides and, most importantly, take advantage of the repellent properties of many plants to keep harmful insects and various diseases at a distance.

Plants which indicate soil with high moisture content:	Plants that indicate dry and rocky soil:
Mentha arvensis Ranunculus repens Equisetum Tussilago farfara Fumaria officinalis Lamium purpureum	Legousia speculum-veneris Erodium cicutarium Falcaria vulgaris
Plants that indicate dry and rocky soil:	**Plants that indicate nitrogen in the soil:**
Stellaria media Mercurialis annua Urtica urens Galinsoga parviflora Euphorbia	Galium aparine Chenopodium album Echinochloa crus-galli Lamiaceae Urtica dioica Mercurialis annua Senecio vulgaris
Plants that indicate soil acidity greater than 7:	**Plants that indicate soil acidity less than 7:**
Salvia pratensis Onobrychis viciifolia Viola tricolor Sinapis arvensis Euphorbia chamaesyce	Veronica officinalis Stachys arvensis Galeopsis tetrahit

4.2.3 Soil and fertilisation techniques in Organic Farming

In Organic Farming, great emphasis is placed on soil and fertility maintenance.

In order that there is regular and smooth plant growth with satisfactory yield in production, plants must be supplied with certain nutrients which they get mainly from the soil. The soil, however, is not an inexhaustible source and at some point it stops supplying the plant with the essential nutrients.

At that point, the farmer must intervene and replenish the substances that were used up by the plants as they grew, matured and were harvested. It has been wisely said that if we do not give to the soil, we will get nothing from it. The main nutritional elements that plants require are nitrogen (N), phosphorus (P) and potassium (K).

These elements are absorbed in great quantities by plants either directly, from chemicals and organic fertilisers applied by farmers, or indirectly, from various plant residues (roots, leaves, fruit, etc.) and the remains of microorganisms in the soil.

In addition to the main nutritional elements plants need to grow and bear fruit, there are also the so-called **trace elements (copper, iron, molybdenum, sodium and chlorine)** which are found in the soil in small quantities but play a significant role in increasing yield and quality. In organic farming, these elements are found in abundance and in the correct proportion. **Organic substances (manure), green manure** and the use of **mulching** and **intercropping** provide and maintain these elements in the soil. Conditions of drought - and this happens frequently with bare soils – excessive water and chemical fertilisers are often responsible for the absence of trace elements and if there are any, they are not taken up by the plants. Trace elements help plants produce **vitamins.** For example, copper in the soil means vitamin C and provitamin A. Boron is responsible for vitamin B_1; manganese for vitamin E, etc.

The fertility of the soil in organic farming is maintained and/or increased through the following techniques:

Through the cultivation of legumes (see previous sub-unit "Crop Rotation")

Green manure

Cultivation of deep-rooted plants within an appropriate multi-year crop rotation programme (see previous sub-unit)

With the incorporation of manure in the soil from organically raised livestock

With the incorporation in the soil of other organic, decomposed or non-decomposed substances produced in other organic enterprises

<u>Green manure</u>

One class of organic fertilisers essential for organic farming is **green manure.** The aim of using green manure is to **improve the soil structure**, to **increase organic substances** and in that way to **increase microbial activity.**

The green manure method largely uses **nitrogen-fixing plants (legumes)** which are incorporated into the soil in a **green state** or in the flowering phase.

This **biomass** is rich in **water, starch, protein** and **nitrogen.** It is an essential factor in improving soil fertility and can have a positive impact on the subsequent crop.

The green matter contains nutritional ingredients that are slowly extracted and assimilated by the plants being cultivated.

Superfluous nutrients are retained by microorganisms without the risk of leaching.

Green manure facilitates the impact of an appropriate crop rotation that can combat weeds and various diseases and help loosen the subsoil with deep-rooted legumes.

It is not necessary to apply green manure every year. Every 4 to 6 years would be enough for tilling the soil while at the same time combating nematodes and supplying food for worms which turn green matter into humus.

Example

Wheat is grown on a particular field for 4 consecutive years, whereby the following observations are made:

- **Harmful insects have increased overwhelmingly.**
- **Crop residues (stalks) are not absorbed by the soil, thus making cultivation difficult.**
- **There is an increase in weeds and they are difficult to combat.**
- **The yield of the particular field has dropped with the result that more fertiliser is needed.**
- **Organic substance is reduced, while there is evidence of soil leaching, particularly in areas with an incline.**

The following year, chickpeas for livestock feed are grown on the same field and are incorporated into the soil.

The benefits of this action become apparent when wheat is once again planted on this field and include the following:

- **There is a reduction in harmful insects due to the interruption of their cycle resulting from the change in crop.**
- **There is a drastic reduction in weeds.**
- **The soil's need for nitrate fertilisers is minimised, as chickpeas are legumes and have the ability to fix nitrogen from the atmosphere.**
- **The soil's ability to absorb water is increased due to the improvement in soil structure (it becomes lighter).**
- **The soil is enriched by organic matter because of chickpeas being incorporated, with the result that microorganisms in the soil are increased (they help the soil to assimilate the residues of other crops and make humus).**
- **Leaching is minimised, as there is mulching year round.**
- **There is an increase in yield in the years following the application of green manure.**

The above would indicate that green manure is beneficial for the improvement of yield and environmental protection (fewer losses, particularly of nitrates), while providing a much better economic result for farmers themselves. <u>**Advantages of green manure**</u>**

- Accumulation of nitrogen in the soil (N)
- Accumulation of humus in the soil
- Nutrient leaching is avoided
- Utilisation of rain water (construction of biomass)
- Less erosion (wind, water)
- Mulching and bolstering of soil biology
- Loosening of subsoil through deep roots
- Control of weeds (inadequate light)
- Control of various harmful factors (nematodes) and greater production as a result of fewer fertilisers and pesticides
- Easier ground cultivation (loose, light, porous soil rich in humus)

Plants suitable for green manure
Buckwheat (Fagopyron)
Peas (Pisum sativum)
Yellow trefoil (Medicago lupulina)
White mustard (Sinapis alba)
Radish (Raphanous sativus)
Vetch (Vicia sativa)
Sunflowers (Helianthus annuus)
Rapeseed (Brassica napus)
Winter Vetch (Vicia villosa)
Red peas (Lathyrus cicera)
Phacelia
Yellow lupin (Lupinus luteus)

Compost - Composting

Compost is stabilised organic material resulting from **aerobic decomposition of organic waste** and its **conversion** to **humus** with the **help of microorganisms.**

It is a storehouse of organic substances and fertilisers that can nourish plants and trees in a field. For organic farmers, compost is very important, as it constitutes a group of various organic substances that are combined by nature into a harmonious balance.

The **use of compost**, among other things, contributes to the control of diseases. It has been found that compost (depending on its origin) contains fatty acids which are toxic to many phytopathogenic fungi and bacteria. Surface composting was found to be an effective means of controlling fungi that cause decay in roots and stems. Natural hormones called cytokinins have been discovered which contribute to plant resistance to nematodes. Fewer larvae manage to penetrate the roots and those which do are suspended in the environment they come into. Cytokinins are identified in the waste of earthworms, which are present in great numbers when the soil is rich in organic material.

The process of producing compost is called **composting** and the quality of the resulting compost depends mainly on the type and quality of materials added during the composting phase. Other factors also impact the quality of the resulting compost, including the way it is stacked, placement during production, the speed of material decomposition, the course of fermentation, maturation, development of humus, and others.

A. Materials used in Composting

The more and varied substances a compost pile contains in its production phase, the better the resulting manure will be and the final product (manure) will contain more nutrients.

The materials used in composting must be able to be processed by the millions of microorganisms present. It goes without saying that all materials must be organic matter. However, even some organic substances are not suitable for composting.

The materials that are suitable or unsuitable for inclusion in a compost pile are presented in the table below.

Suitable Materials		**Unsuitable Materials**
Plant materials	- Crop residues: leaves, plant trimmings, weeds, cut grass, straw, wood shavings - Kitchen waste: peelings from vegetables, fruit etc. - Waste from agricultural businesses: olive tree leaves from olive presses, grape marc from wineries, cotton ginning residues, etc.	- Parts of plants that have been sprayed with pesticides - Diseased plants - Leaves from eucalyptus, white cedar (thuja), fig trees - Oils from food, leftover cooked food
Animal Materials	- Various types of manure: from cows, goats and sheep, horses, rabbits, poultry - Blood meal, meat meal, animal hair and fur, ground egg shells	- Bones, offal, meat, dairy products, leftover cooked food
Various	- Seaweed - Wood ash (non-chemically treated) - Rock dust, lime - Some amount of old compost (works as "starter" for new fermentation)	- Plastics, metal objects, glass, coloured paper, paints and chemical substances in general

B. Balancing compost materials

Attention must be paid to mixing the materials in order to achieve a proper ratio of constituents containing carbons and nitrogen so that these two elements will be present in a ratio of 15:1 in the compost mix, in other words, 15 parts carbon (C) to 1 part nitrogen (N). The table below shows some examples of mixes in amounts that approximate the desired ratio.

Relation of carbon (C) to nitrogen (N) in organic materials	
Animal urine	0.8
Animal blood	3
Manure (cows, sheep) digested for eight months	10
Manure digested for 4 months without soil	15
Grass	12
Kitchen waste	23
Pine needles	30
Oat straw	50
Rye straw	65
Fresh wood shavings	208

The ratio of C/N in the compost mix can be found with this formula **A*r1*B*r2*+C*r3 =z,**

A+B+C

where A, B, C are weight in kilos of materials in the compost before they are wetted; r1, r2, r3 etc are the ratios of materials (r1=C/N of material A); z is the C/N ratio when the materials A, B, C are mixed.

If **z > 15**, then materials with a C/N ratio < 15 should be added.

If **z < 15**, then materials with a C/N ratio > 15 should be added.

Compost needs 1-3 years to mature. If within a year there is no **digestion (humus production)**, it means the compost is not active and intervention is required. It should be turned or stirred, adding some stable manure, lime or other organic substances like clay.

Humus production in composting

To achieve speedy and correct humus production (digestion) of the manure, there should be as many microorganisms in the manure as possible. So that the microorganisms multiply and function quickly and correctly, it is essential to keep the following in mind:

Aerating the compost

Aeration must be done regularly so that aerobic organisms can survive. If oxygen levels are inadequate, anaerobic organisms flourish in the compost with the result that the manure develops an unpleasant odour. Properly prepared manure never has an unpleasant smell. It smells like forest soil.

Moisture in compost

The mobility and vigour of microorganisms in compost, particularly of bacteria, is perceptively impeded by dryness. For that reason, the compost should be kept steadily damp, but not excessively so, as then oxygen will be impeded and cause the manure to rot and develop an unpleasant odour.

Temperature in compost

Along with moisture and correct aeration in quickly and correctly produced humus from organic materials, temperature is also essential. The fact that manure digests more quickly in summer than in winter is due to higher temperatures.

Acidity in compost

It has been shown that microorganisms in the manure develop and flourish better in moderate acidity (pH) between 5.5 and 7.5. Organic farmers who tend and monitor the manure's progress should measure the acidity in the compost from time to time. In the event that results indicate a relatively high acidity (i.e. less than 5.5 (pH), small doses of calcium achieve greater alkalinity.

C. Composting Preparation-Procedure

1. Forming the compost pile

The following steps are taken to form the compost pile:

Step 1: Collect the materials to be composted based on the information in the previous unit (material suitability, balance of materials).

Step 2: Once the material is collected, thick pieces (e.g. branches) are cut up or removed and the pile begins to be formed. For better results, it is possible to dig a ditch about 30cm deep and 2m wide and any desired length. The soil in the trench should be live and porous, not collect rain water, be in a shady location and be protected from strong winds. It is a good idea to ensure that earthworms in the ground can get into the compost.

Protection from wind is necessary to prevent the compost from drying out, as moisture is essential for microorganism function.

Step 3: Some of the thicker materials (e.g. cut up or whole branches which will not digest along with other materials but will aid in aeration of the compost) are laid in the middle and along the trench. These materials create a strip that serves as an aeration channel. The remaining materials are mixed together and uniformly moistened. They should not become muddy, but just soften with the moisture.

Step 4: The trench is then filled with materials as the level gradually rises. As the level rises, the width of the pile decreases. The surface soil can be added to the mix before it is piled up and after it has been moistened or it can be added in thin layers every 20cm of other mixed materials. The pile ultimately acquires the shape of an isosceles trapezium with the wider base at the bottom. The height can be from 1 to 1.30m.

ATTENTION! The pile should not be compressed so that the pores remain open and internal aeration can take place. In addition, there should not be any compressed masses inside the pile nor large gaps where the pile could collapse.

Step 5: Finally, the pile is covered with a layer of soil 5-10cm thick and then covered over the top with a layer of dry grass or hay about 20cm thick. The cover should be uniform and no gaps should be left. The compost pile can be formed with a pitchfork and spade or with a back hoe for large quantities.

2. Aerating the compost

Aerating the compost is necessary to encourage the growth of aerobic bacteria (those that breathe oxygen) and other microorganisms. If the materials are too tightly compressed or too much water is applied and they get muddy, the pores close and anaerobic organisms take over the decomposition process. Then the pile will exude an unpleasant odour and the microorganisms will produce harmful substances for plants and soil life.

Aeration must be performed regularly so that aerobic organisms can survive. If oxygen levels are inadequate, anaerobic organisms flourish with the result that the manure has an unpleasant odour. Correctly made compost manure never smells unpleasantly; it has a forest soil smell. Good aeration is needed (for good development of aerobic organisms), in combination with the necessary moisture that does not cause asphyxiation. If the appropriate aeration is not provided, the high temperatures needed to destroy pathogenic bacteria are not achieved.

Aeration is achieved by turning the pile, but it is better if it has been built up correctly from the beginning so there is good air circulation from the bottom. In cases where piles take up more than $1m^2$, air channels should be created.

Other techniques that can be used in addition to or instead of turning:

- **Make** the first layer from a rough material (e.g. wood chips) to ensure there is aeration from the bottom.
- **Shred** the leaves, hay and garden waste first. Materials like paper and grass are used in small quantities, as they tend to form an impermeable layer when wet.
- **Place** pieces of wood on the pile while constructing it. These will be removed later. In this way, air outlets are created. Holes are made with a rake or crowbar.

− Some plastic water pipes that have had holes drilled in them are **buried** in the pile. Sunflower stems and straw do the same thing, but not wheat because it does not bend well as it decomposes.

− **Limit** the height and width of the pile to 2m at most to avoid compression. There is no limit to length.

3. Moisture in the compost

The compost mass should be damp. Dampness in the interior of the compost favours the growth of bacteria and biological digestion. All living organisms in the soil that take up oxygen play a role in digestion. Materials processing goes through the following stages:

- each group of organisms leaves the prepared material with the appropriate substances behind for the next group;

- an increase in temperature indicates that digestion is under way.

If the temperature rises **above 69 degrees,** the pile should be opened and dampened with cold water; soil is added and the pile reformed. If the temperature remains lower at **less than 45 degrees**, it can be helped to rise by spraying the compost with a solution of water, sugar and yeast.

after a few months when the temperature falls to 25 degrees and the earthworms enter the compost, they eat the mass, process it through their systems and deposit the humus.

In relation to the soil it is found in, earthworm manure contains:

- 7 times more phosphoric acids;
- 19 times more potassium;
- 2.5 times more magnesium;
- 2 times more calcium.

4. Protecting the compost

The compost should be covered with a type of skin to retain temperature and moisture and for protection from the sun's radiation. The cover should allow the compost to breathe.

A good cover starts with a thin, light layer of soil (10cm) and then straw about 20cm thick. Instead of soil, a thick layer of dried cut grass can be placed under the straw.

5. Turning over the compost

The compost must be overturned and mixed:

- when it gets very wet (that can checked by taking up a fist-full and squeezing it; it should not drip liquid. If water runs off or it is muddy, it should be turned over until it dries);

- When it has an unpleasant odour (that means it is not being properly aerated);

- When it dries out (take a fist-full and squeeze; your hand should feel damp).

In addition to the above, the compost has to be overturned completely until the outer parts move to the centre about 2 months after the pile has been formed.

In order to turn the pile over, the cover layers have to be removed, then the top parts of the pile are removed and placed at the base of a new pile formed next to the first pile. The outer parts of the pile are removed and placed in the centre of the new pile. Finally, the centre of the base of the old pile is placed on the top part of the new pile, which is once again covered with grass and straw.

6. Digestion and compost use

The digestion in the pile should not take very long (not more than 6 months). As soon as the compost has digested, it should be used. These are the steps in practice:

√ Immature compost for mulching

About **6-8 weeks after the pile has been formed**, when the various straws and other natural parts of the pile are still recognisable but can be cut easily, the compost is still in an immature state and the first high-temperature phase has passed. The compost can be used, but only for surface mulching. It is spread to a thickness of about 3cm on the surface of tilled ground. This mulching prevents weeds from developing, protects the ground from dryness and provides nutrition for the microorganisms in the soil.

This mulching should be kept damp and not allowed to dry out completely; it should be moistened periodically or covered with a layer of grasses. The underside of the mulching gradually digests and then a new layer is added to create a type of surface composting.

Immature compost can be spread under fruit-bearing trees or plants that have already grown and are more tolerant (tomatoes, etc.). If the immature compost is dug in too deep or spread in a layer that is too thick, substances that are poisonous to plant roots may be produced.

√ Mature compost for mixing into the soil

In the final phase of digestion, after about 5-6 months when the straw is no longer visible, the compost is mature, digested and ready. At this stage, the earthworms have retreated, the compost has a pleasant odour and it looks like dark brown soil. Mature compost can be safely applied to the soil, used for seedlings or for sowing, etc.. The soil to which the compost is added should be slightly damp - not muddy - and tilled (the crust should be broken) and it should not be frozen.

For example, compost can be prepared at home with organic materials from the garden and from domestic waste by following this method step by step.

Anyone can prepare compost in just a few square metres of a flower bed or vegetable garden, collecting materials in piles or in small, improvised structures of wood or wire mesh. For reasons of aesthetics and hygiene, the compost area should not be near residential areas. The compost can be made in a simple pile if the volume is at least 3 cubic metres. The height of the pile should not exceed 2m to prevent compression and to make turning of the pile easier. The pile base should be at a slight incline to aid in water drainage. The base layer can be made with well-pressed soil, sand or gravel.

The size of the materials significantly affects the bacterial activity, as shredding increases the surface area where bacterial enzymes act and reduces the number of air pockets. It would be a good idea to place a base layer of dry, uncompressed material like wood chips at the bottom of the pile to ensure good aeration from beneath. Then, a layer of damp materials, e.g. grass, fruit peelings, is placed, followed by a layer of absorbent material, e.g. straw, dry leaves, ash. As each layer is added, it should be moistened with water. Finally, the pile is protected from the weather and covered with straw or with an oil cloth on top.

Once the pile is formed, the increase in temperature indicates the beginning of bacterial activity.

In the first two or three 24-hour periods, the temperature increases and may rise above 70°C for several days. A temperature of around 55°C - 60°C is essential for a certain period of time (1st phase), as it results in partial pasteurisation of the materials. During the 2nd phase, the optimal composting temperature is between 30°C - 37°C, and if it drops to less than 20°C, decomposition is slowed.

This decomposition is an aerobic process, which means that the organisms that take part must be supplied with the necessary oxygen. If the fermentation becomes anaerobic, various malodorous gases are released from the pile, such as hydrogen sulphide, methane and ammonia. That is corrected by eliminating excessive dampness and turning the pile. Moisture is checked every 5-10 days and water is added when the pile is turned. Moisture should not be greater than 70%. The secret to fast composting is frequent turning. It ensures good aeration and microorganisms literally work feverishly. The temperature is monitored and as soon as it drops, the pile is turned. Piles should be stirred every 7-10 days. To achieve the best possible aeration, the turning should be two-way - inside-out and upside-down.

When composting is completed, there is a 65-70% reduction in material volume.

4. BASIC PRINCIPLES OF COMPOSTING

The table below presents **9 points to remember** when preparing compost. **1. The maintenance of the complex of life in the soil must be ensured.** Life in the soil is supported if appropriate nutritional materials are provided. It is for this reason that appropriate seed mixtures are sown to provide green manure while additionally applying humus to the soil surface.
2. Compost has greater value when there is greater variety in the materials used to create it. It is a good idea to include even a small quantity of each of the materials mentioned in the previous unit to ensure a rich variety. If some of the materials are difficult to collect, it does not mean that good compost cannot be prepared. A compost pile with less variety is still better than nothing.
3. The richer the variety and the quantity of aerobic microorganisms in the compost, the greater the value of the humus produced. The difference between aerobically and anaerobically digested compost is evident in the roots of plants. In the former (aerobically digested), the roots develop and penetrate the compost while in the latter (anaerobically digested), the roots grow in the opposite direction from the compost.
4. For proper digestion, compost needs a protective covering to maintain its temperature and moisture, but it also needs to be aerated.

The compost should be covered to retain heat and moisture and for protection from the sun's radiation.
5. Good compost is the product of aerobic biological processes **Digestion is accelerated if the pile is aerated frequently without allowing it to dry out. Care must be taken with aeration so that it is not overdone, as too much aeration will dry out the compost and digestion will cease.**
6. Immature compost should not come into contact with roots and seeds; it should only be used for surface mulching. **If the immature compost is tilled in too far, anaerobic fermentation is set off and substances that are poisonous to the plant roots are produced, rendering the plants vulnerable to diseases.**
7. The soil comes alive with compost **Compost brings fertility and a diversity of life which fully develops in the soil. This life inoculates the soil with beneficial microorganisms and revitalises it.**
8. Soil denudation is harmful to the life of the soil **Soil denudation is truly destructive. Nature shows the right way – it does not tolerate bare soil and quickly covers it with plants.**
9. The appropriate mulching with organic materials significantly reduces the need for water, weed pulling and tilling. **Gardening work is simplified if a bed of mulching is continuously maintained. Either immature or mature compost can be used and covered lightly with dry grass or straw. Care should be taken to ensure that the mulching is permeable to air.**

4.2.4 Plant protection methods and techniques in organic farming

Conventional farming with inputs used (particularly chemical pesticides and fertilisers) create already familiar problems in the environment. Products which can be used in organic farming are clearly milder and harmless (generally of natural origin).

However, is organic farming just a farming method that "replaces" chemicals with some other harmless inputs? Of course not. Organic farming is based on a completely different rationale:

the rehabilitation of natural functions through the farming system. As an ulterior motive, it aims to reduce or eliminate inputs, where and if that is possible.

Before plant protection products that can be used in organic farming are discussed, it should be noted that particularly in organic farming, it is important to minimise any intervention to the most essential, and then only if the risk exceeds a significant level of economic loss.

Control of parasites, diseases and weeds is achieved through the selection of appropriate species and varieties, a suitable crop rotation programme, with mechanical methods of cultivation (destruction of weeds, insect traps, etc.), as well as by protecting and sustaining the natural enemies of parasites. The general principle in controlling parasites in organic farming is that farmers must rely mainly on preventive means of plant protection and resort to the use of chemicals only if the circumstances for parasite development require it.

As in the case of fertilisers, Regulation No. 2092/91, Annex II, includes a positive list of substances which can be used in organic farming. This list includes categories of products which are permissible for use by organic farmers, such as:

Example

There is a prevalent opinion that in order to produce a product organically, it is enough not to use chemical fertilisers and pesticides. That is not true, however, as organic production is based on a completely different rationale.

Let's say we want to grow tomatoes and aubergines organically in a field. All the preparations needed in order to produce organic produce with the least amount of input are outlined.

- **Tolerant seeds are chosen which originate in the cultivation area so they will be able to withstand various diseases and enemies (they may become diseased but they will be able to produce).**
- **The ground chosen for growing vegetables should be enriched with an organic substance and should not have been treated with any chemical pesticides or fertilisers in the previous 2-3 years.**
- **The cultivation area should not border on another field being cultivated in the conventional way.**
- **There should be wild plants or trees nearby that can house nests for insect predators near the tomato and aubergine crop.**
- **Basil, which has natural insect-repelling properties, can be planted in between the rows of plants (it repels insects with the scent it exudes).**
- **If despite all these measures, there are problems related to attack from insects or diseases, they are combated with natural methods.**

For example, the presence of snails is combated by spreading ash around the crop plants. The ash sticks to the snails and they cannot move nearer the plants.

Substances of plant or animal origin

These products, though non-toxic to humans and other mammals, are quite effective and broad-spectrum, so care must be taken when using them as a last resort.

<u>Pyrethrum</u>

It contains natural pyrethrin and comes from the Chrysanthemum cinerariaefolium plant (a species of chrysanthemum). It may also contain a synergist.

<u>Rotenone</u>

A preparation from extracts of Derris elliptica, Tephrosia sp. and Lonchocarpus sp. tropical plants. It is not recommended for use in areas near water as it is toxic to fish.

<u>Neem / Azadirachtin</u>

It originates from the Azadiracta indica plant. In addition to being an insecticide, it is also an insect repellent.

Other than those mentioned as examples above, this category also includes lecithin, gelatin, beeswax and others.

- ✓ Microorganisms

These include **bacteria, viruses** and **fungal antagonists.** For example, the best-known species used in organic applications are:

Bacillus thuringiensis: an organic insecticide used against lepidopteran larvae with many applications, as it is easy to use (sprayed on), non-toxic and very eclectic (it does not affect beneficial species).

Included in this category are a large number of organisms now being used in practice. To a great extent, these are used for integrated control in greenhouses.

- ✓ **Substances that can be used only in traps**

Pheromones

In addition to their use in traps, they can also function as an independent method to disrupt mating in insects. In organic farming, spraying them onto plants is prohibited; only their slow release in dispensers is permitted. In practice, these compounds are quite effective, but also expensive, and their use focuses more on monitoring various insect populations – usually the flight of males.

This category includes two types of synthetic pyrethrins (deltamethrin and cyhalothrin) for limited use.

- ✓ **Substances traditionally used in organic farming**

Copper

The use of copper salts (copper sulphate) is permitted, as well as its hydroxide. Its use should be justified in practice and should be used only if unavoidable. In that event, the number of applications should be limited along with the concentration used (e.g. recommended: 0.5%).

Sulphur

This is another traditional mineral and fungicide with many applications. The same restrictions as mentioned for copper apply.

In addition to the inorganic fungicides referred to above as examples, this category also includes parafin oils, mineral oils, Bordeaux mixture, Burgundy mixture, sodium silicate, sodium bicarbonate, potassium (soft) soap, and others.

Plants used in plant protection techniques in organic farming

Nettle

The use of these is recommended: Stinging nettle (Urtica dioica) and Dwarf or Small Nettle (Urtica urens). If these species cannot be found, Roman nettle (Urtica pilulifera) may also be used if necessary.

The nettle is a very valuable plant. It improves the soil no matter where it is grown. It contains enzymes, iron, vitamins, various salts and formic acid. It is to the latter that the itching brought on by the nettle is due. The hairs present in the leaves and stems break when pressed and release the formic acid they contain. Cold extracts can be used against aphids, but also as a tonic.

<u>Common Horsetail</u> (for fungal infestation)

This is Equisetum arvense.

It grows in damp and acidic, sandy or clay soil, in mountains and forests. Equisetum arvense has light green shoots and thin ridges along the stems (visible with a simple magnifying glass). The branches of the plant can be used while fresh or they can be dried in a dry, shady place and kept all year.

The parts of this plant contain up to 105 silicic acids.

Boil 500g dried Equisetum arvense for 30 minutes in 5 litres of water. Strain and add 20 litres of cold water.

Spray trees and vegetables to protect against fungal infections (downy mildew, powdery mildew, Fusicladium, monilia and others).

<u>Essential oils</u>

There are certain plants on which insects and bugs that normally attack crop plants do not alight, e.g. aphids do not alight on white cedar, lavender, rosemary, thyme and cardamom.

This is because of their scent. Something similar occurs with the elderberry shrub (Sambucus nigra), which rats and moles avoid. The scents of these plants originate from the essential oils they contain. Essential oils are volatile substances, meaning they evaporate easily and can be detected by smell.

The green parts and/or the flowers of the selected plants are used (e.g. lavender). They are collected at a time when their scent is most intense, usually in spring, and various extracts are made. They should not be boiled more than 2 or 3 minutes at most; otherwise, the essential oils are lost. There are ready-made extracts of various essential oils on the market, such as lavender, pine, mint, camphor and others. The extracts are used as sprays.

<u>Seaweed extracts</u> (sea algae)

Seaweeds known as rockweed (Ascophyllum nodosum) and bladderwrack (Fucus vesiculosus) are usually used. Organic farmers in Northern and Central Europe find them on the shores of the Atlantic and the North Sea. The juices and extracts from the seaweeds are used to improve the soil with irrigation or as a sprayed-on tonic for plants.

<u>Ferns</u>

These plants are cryptogams. They are so called because they do not produce flowers; instead, they produce spores on the underside of their leaves which are transported great distances by the wind.

Ferns grow in damp, shady areas. They are found in forests of generally broadleaved trees, in ravines and generally in places with moisture.

<u>The species of interest are:</u>

a) Bracken (Pteridium aquilinum)

(for scabies and branch aphids)

This species of fern, where it is plentiful, can be used (in addition to spraying with its extract) as a ground cover on vegetable crops and to cover tree basins.

b) Male fern (Dryopteris filix-mas)

(for leaf aphids and other plant-sucking pests)

A preparation can be made with it to combat leaf aphids, branch scabies and other plant-sucking bugs.

Eucalyptus – camphor – mint - spearmint

(for plant moths and worms)

The essential oils from the leaves of these plants are used, either alone or with other substances, to get rid of various annoying worms (caterpillars) and species of plant moths, e.g. the vine moth (Eupoecilia ambiguella) caterpillar and other insect larvae which form a spider-like web and can be repelled by essential oils.

Garlic (Allium sativum)

(General plant protection, enhances other preparations)

Garlic contains amazing biological compounds, such as allicin, which gives its characteristic, pervasive odour. It contains vitamins A, B and C, nicotinic acid, hormones, enzymes, traces of uranium and others. Recently, it has been shown to regulate blood circulation in humans and act as a natural antibiotic.

It is very beneficial in plant protection of crops when used in intercropping, e.g. when planted among roses, fruit-bearing trees, strawberries and others, it repels several annoying insects and protects plants from fungi. Intercropping with tomatoes in the greenhouse prevents the development of nematodes.

It is also possible to chop cloves of garlic and add them to water along with other plants that must steep for two days before they are ready, such as nettles, ferns, horsetail and others.

Onion (Allium cepa)

(fungicide, enhances other sprays)

Onions contain quite a few active compounds, such as essential oils, organic acids, vitamins and sulphenic acid esters, a substance which stimulates the human heart but is beneficial to plants. All these substances become germicides and fungicides. Another compound in onion.

Carrot (Daucus carota var. sativa)

Carrot leaves have a very characteristic smell. A tea can be made from these to protect onions, leeks and strawberries from insects. The onion fly is particularly susceptible to this tea. Onions and the surrounding area are sprayed with the tea when there is a risk of insect infestation.

Onions and carrots may be intercropped. One or two rows of onions can be alternated with one or two rows of carrots so that they are mutually protected.

Tomato (Lycopersicum esculentum)

(for caterpillars in cabbages, cauliflower and other insects) Tomato leaves have their own scent. When leaves are cut under the branches, fingers may turn brown from substances that also act against certain insects.

Absinthe or wormwood (Artemisia absinthium)

(repellent for flies and other insects)

It contains essential oils and enzymatic substances. The most effective parts for plant protection are the upper leaves and their stems and when they are cut just before they flower or as flowering begins. More leaves can be cut and dried in shade for keeping all year round. It can be combined with other herbs.

Rhubarb (Rheum rhabarbarum)

(for caterpillars, aphids and fungi)

It is propagated through the tubers of its roots. It requires fertile soil and moisture and is therefore planted in a shady area of the garden. For plant protection, the most suitable variety is Rheum palmatum var. tanguticum maximowiczii. This spray acts against fungi, as well as aphids and caterpillars, perhaps due to the oxalic acid it contains.

Pyrethrum (natural insecticide)

Pyrethrum is a perennial plant that resembles daisies and grows into a shrub with lobed leaves. The active compound pyrethrin, which is a natural insecticide, is extracted from its flowers. Pyrethrin has been used since antiquity to combat flies, mosquitoes and other insects. Powder was made from carefully dried pyrethrum flowers.

Species of the Chrysanthemum genus that can be cultivated and which contain pyrethrin include: Chrysanthemum cinerarieafolium, Chrysanthemum roseum-coccineum, Chrysanthemum marshallii.

Rotenone (natural insecticide)

Rotenone is the active substance that derives from the legume Derris elliptica. It is grown in Indonesia and Central America. The roots of this plant are collected, dried and ground.

The powder is combined with solvents to bring out rotenone, which is left once the solvents have evaporated. The action of rotenone is similar to that of pyrethrine, which means it is a complete insecticide, though it is slower acting. Rotenone is not used so much for flying insects as for slow-moving pests, such as worms (insect larvae), for soil fleas and for washing animals to repel horseflies. Rotenone acts on contact, but also through the digestive system of insects. It is dangerous to fish and its use is prohibited in some countries. There are ready-made preparations on the market for organic cultivation that combine pyrethrin and rotenone. Rotenone does not affect warm-blooded species.

Quassia (natural insecticide)

The active substance Quassia was used to combat flies and lice until the 1950s. It is derived from the wood of the tropical plants Picrasma excelsa and Quassia amara**,** which grow in Jamaica and the West Indies and are somewhat difficult to find nowadays. Quassia is harmless to humans and in fact was made into a special tea to combat intestinal worms.

Nicotine (a poison)

Nicotine is an active substance derived from tobacco plants (Nicotiana tabacum). Nicotine is extracted from tobacco. Though it does not kill all insects, including flies and mosquitoes, it is effective against aphids, scabies and other plant-sucking insects. Because nicotine kills many beneficial species and is harmful to humans, it is used as a last resort and only for immediate treatment, never as a preventive treatment.

Extracts from various plants

These preparations are made as follows: The plants are cut into small pieces and placed in a container (wooden or hard plastic). They are completely covered with water. They remain there for 7-8 days. If the weather is cold, they should soak for a few days longer.

a) To repel rodents, thuja leaves and shoots are chopped up (care should be taken because thuja is very poisonous, even to humans), along with pine and fir needles and leaves from walnut and elderberry trees.

b) To repel ants, use leaves from larkspur, lavender and tomato.

c) To repel caterpillars from cabbage, use tomato leaves and marigold flowers.

d) To repel flies on carrots, use onions, garlic and leeks. Spraying should be repeated every week during the period that flies are active.

Traps

Traps can be separated into the types that are used to monitor populations and those which are placed more closely together to contribute to insect control.

a. **Monitoring.** Other than McPhail traps (which are already available in several varieties), the Deltoid traps, which use pheromones, are also used to detect lepidoptera (grapevine moth, olive moth, etc.) There are also plant traps.

b. **Mass trapping.** Significant research has been conducted and various traps have been developed, particularly against the olive fruit fly (Daucus oleae). The most suitable for mass use are probably the rectangular ones made of wood, metal (with glue), fabric or paper-plastic laminate. The latter seem to effectively combine the use of insecticide, bait and minimal labour costs. The traps may be used with pheromones or without.

4.2.5 Organic control of crop pests and diseases – Treating plant diseases

A disease in plants, or a plant disease, is any irregularity in the appearance and physiology of the plant with such intensity and duration that the plant's normal development or the quality of its products are affected periodically or permanently.

When a plant disease is manifested, one of the following is probably taking place:

- The soil does not have the appropriate structure, composition, incline etc. for the plants that have been planted there. In some cases, the soil may not be draining because some of the layers have become compressed through inappropriate ground cultivation. The soil may be light on the surface, while a few centimetres lower it is hard and compressed. It may also be due to unsuitable structure (lacking in argilliferous clusters), inability to retain moisture or inadequate aeration. Therefore, it lacks the wealth and variety of microorganisms and beneficial creatures, such as earthworms.
- The climatic conditions in the area may be averse for the specific plants being cultivated; alternatives should be selected.

- Crop rotations and/or intercropping are not suitable and a different programme of alternating crops should be formulated.
- Imbalance in the environment (between beneficial and so-called harmful entities) is too great. Until balance in the environment is restored as much as possible, species that are not vulnerable to specific insects, etc. should be selected for cultivation.

The causes of plant diseases are known as **pathogenic factors** or simply as **pathogens.** Organisms which compete with pathogens are called **antagonists.**

Plant diseases may be:

● Transmittable – non-transmittable.

● Parasitic – non-parasitic.

Parasitic plant diseases are a result of: bacteria (bacterial infections) – fungi (fungal infections) – viruses (viral infections) – spermatophytic parasites (parasitoses).

The principles guiding treatment of plant diseases are:

- ✓ **Avoidance:** This means managing or utilising environmental factors in plant protection with the aim of benefiting from the absence of or lack of susceptibility to infection, or from the disruption of the biological cycle of the pathogen.

Crop-rotation is one way to avoid infection of a particular crop by disrupting the biological cycle of a particular enemy. Another way is through cultivation tasks, e.g. tilling, which exposes insect eggs to the weather elements (sun, wind) and helps destroy them.

- ✓ **Exclusion:** This involves preventing the dispersion of pathogens to uninfected areas, or preventing them from becoming established.

This method of combating plant diseases is used in isolated areas or where areas are bordered by the sea (islands), mountains, etc. The transport of plants or any other material that could infect these areas is prohibited without express permission to prevent the transmission of diseases.

- ✓ **Uprooting:** The elimination of pathogens from areas where they have become established.

There are diseases which have infested a cultivation area and which cannot be combated effectively. In this case, they can be combated through an uprooting programme, whereby all plants are uprooted and destroyed. This action results in the disappearance of the particular pathogen from the area.

- ✓ **Protection:** This involves the prevention of economic damage to a crop caused by a pathogen through the use of a chemical or natural barrier between the infection and the plant. Protective measures should be taken either shortly before the infection affects the plants or at the beginning of incubation.

In the event that infection must be prevented at all costs in a particular area (nurseries), strict regulations must be established to achieve this goal. In this case, any plants, tools, vehicles or packaging materials which may introduce infection must be kept away.

- ✓ **<u>Treatment:</u>** This involves the application of natural or chemical means to destroy pathogens inside the plant.

For example, this is the usual method of treating diseases. Usually, chemical preparations are used to spray the plants. These include acaricides, insecticides, etc.

- ✓ **<u>Increasing resistance:</u>** This involves managing the morphology or physiology of a cultivated plant with selective improvement methods or hybridisation so that the pathogen cannot become established.

For example, there are diseases which are endemic and cannot be combated with chemicals. One such disease is grapevine downy mildew. In this case, scientists have created varieties which are resistant to the diseases and as a result, though grapevines become infected, they are still able to produce normally.

The term **organic disease treatment** means the quantitative reduction of a pathogen that causes the disease and it is achieved through the use or intervention of one or more organisms, other than humans. The cultivable surface soil is rich in bacterial activity. In fact, it is a rich breeding ground for mutually interactive microorganisms, both in terms of numbers and in terms of species.

Therefore, **techniques used in organic treatment of diseases** are:
- **Modification of cultivation techniques with the aim of enhancing existing bacterial antagonists.**
- **The application of antagonists by introducing them into the environment where plants are grown or directly onto the plants.**
- **Inoculation of plants with microorganisms of low pathogenesis or with viruses similar to the pathogens in order to enhance plant resistance**

More specifically:

Propagation of antagonists found in the plant environment with adaptation of cultivation techniques

Cultivation tasks may help create an environment that is conducive to antagonists so that managing their populations may result in an organic action against phytopathogens. The addition of organic substances, such as compost, green manure and plant residues at the end of the season all act against pathogens. They interrupt pathogen development; temporarily or permanently deactivate infections; fix nitrogen to encourage antagonism among microorganisms; and serve as nutrients for microorganisms that produce antibiotics or toxins against pathogens or which favour the production of volatile substances which in turn suspend the growth of pathogens.

Introduction of antagonists in the environment or onto plants

Many species of fungi and bacteria function as antagonists and biologically impact one or more phytopathogens. The characteristics of a good antagonist are as follows:
- To survive and grow in the rhizosphere, in the seed environment and in general in the plant environment (so as to prevent infection).
- To survive and grow in an infected environment or in the soil or above ground (so they can

restrict infection growth).

- To produce broad-spectrum and highly toxic antibiotics against the pathogen so as to be effective in small concentrations while at the same time not being absorbed by the soil.
- The antibiotics produced by antagonists should not affect other antagonists.
- The antagonist may become commercially available.
- Its spores should germinate quickly (at least as quickly as the pathogens do), while onset of dormancy should take place more slowly than that of pathogens.
- It should adapt to the environment better than the pathogen.

Other means and methods of combating plant diseases in organic farming

Some of these methods are related to **management, hygiene, energy and cultivation.** More specifically:

Quarantine

To protect a particular crop, countries should prohibit the importation of plant products, propagation material, soil and any other materials that could contain infectious pathogens to which the crop might be susceptible.

Hygiene measures

These are effective in greenhouse operations. Pathogenic sources, such as waste bins, pests and open liquid containers should be removed from greenhouses. Employees' clothing should be washed regularly and those not directly involved in working there should not be allowed on the premises. Tools should be cleaned and disinfected and workers should wash their hands regularly.

Change in sowing time

Sowing time can often be moved earlier or later within a time period as long as it is within the season that the crop needs to be established. There is also some leeway in increasing or decreasing sowing density. Such adjustments can reduce weed problems to some degree.

Aeration

Aeration aims at reducing moisture, which encourages pathogen growth. This is achieved either by thinning the leaves or through sparser planting.

Mulching

A natural mulching with plant residues of various types (dry grasses, straw, wood shavings etc.) can impede pests, raise temperatures and retain moisture without any side-effects. It offers the additional benefit of gradually fertilising and producing humus in the soil, thus improving its structure. The growth of weeds can also be prevented as a result of toxin excretion (reciprocal function). This method has applications in the cultivation of trees and grapevines, usually among the plant rows, but also of vegetables and small fruit, particularly strawberries.

Crop rotation

The results of crop rotation can be particularly important in controlling weeds. With appropriate crop rotation, significant problems with weeds could be resolved, such as those in wild oats with "stifling" crops like clover or rye.

Fallow period

At the conclusion of a crop and after cultivating the soil, the field is allowed to rest for a period of time. During the fallow period, plant residues are destroyed by microorganisms, along with pathogenic pollutants. This method is very effective, particularly if a warm summer intervenes.

Thermal treatment

This does not necessarily mean burning (though that is one well-known method used since antiquity), but the effect of flame with infrared radiation. The use of thermal treatment has long been accepted practice and is another specific method for controlling weeds without harmful environmental effects. It is based on the principle that when undesirable plants in their early stages are exposed to high temperatures for short periods of time, their proteins are solidified (60-80^{0}C) and the cell walls become inflated and break. The plant can no longer conduct its normal functions and soon dies. The fuel used is usually gas (propane). In essence, only the already germinated weeds, as well as the seeds found on the soil surface, are affected, as the heat penetrates only to a depth of 2-3 cm. Selective thermal treatment is possible in linear crops which have already grown, such as corn or cotton, as well as in arboriculture. It can also be applied non-selectively in produce farming after the planting bed has been prepared and before planting.

4.2.6 Combating weeds in organic farming

In organic farming, weed management is conducted through preventive and mechanical measures.

Preventive cultivation measures

- **Regulating sowing time and sowing density.** Sowing time can often be moved earlier or later within a time period as long as it is within the season that the crop needs to be established. There is also some leeway in increasing or decreasing sowing density. Such adjustments can reduce weed problems to some degree.
- **Mixed cropping.** (intercropping, e.g. legumes with grains). In addition to all other advantages, it can also help exclude weeds to a great extent
- **Crop rotation.** The results of crop rotation can be particularly important in controlling weeds. With appropriate crop rotation, significant problems with weeds could be resolved, such as those in wild oats with "stifling" crops like clover or rye.
- **Prevention of weed proliferation.** Seeds and other stem organs are the ways in which weeds are disseminated or multiply. Prevention and appropriate intervention are needed to reduce the severity of some weed-induced problems.
- **Means of mechanical cultivation**

A number of small tools (spades, hoes), larger mechanically driven cutting tools (edge trimmers, hedge trimmers) and the use of tractors to pull equipment (harrows, rotary cultivators, ploughs) are the main means for combating weeds in organic farming.

Mulching

This may be accomplished with artificial or natural materials: covering the soil with black plastic sheets is quite an effective measure for controlling weeds. At the same time, it helps to better retain soil moisture. However, the plastic material is eventually destroyed and the remains become a source of pollution, at least aesthetically. That is one of the reasons that lead to the use of natural mulching.

A natural mulching with plant residues of various types (dry grasses, straw, wood shavings etc.) can impede weeds, raise temperatures and retain moisture without any side-effects. It offers the additional benefit of gradually fertilising and producing humus in the soil, thus improving its structure. The growth of weeds can also be prevented as a result of toxin excretion (reciprocal function). This method has applications in the cultivation of trees and grapevines, usually among the plant rows, but also of vegetables and small fruit, particularly strawberries.

Organic means

- **Higher plants.** As weed antagonists. Mulching crops such as clover, in combination with perennial or linear cultivation, can eliminate weed growth through shading and interference**.** Legumes, along with some grains, can be used in particular with very good results, at least in areas with adequate ground moisture. In addition to controlling weeds, erosion control is another very important advantage. Attention should be paid to the matter of antagonism with the crop being cultivated, particularly where ground moisture is a restrictive factor in healthy plant growth (dry zones).
- **Microorganisms.** Usually, phytopathogenic fungi with specialised action against difficult weeds may be used to control them. Such fungi are already available in the USA in the form of special biopesticide preparations.
- **Insects.** Organic control of weeds using insects is a particularly interesting method. It is based on the introduction of plant-eating insects into an area where they are natural enemies (specialised, in fact) of the target weed.
- **Higher animals.** To a certain degree, controlled grazing of cattle, sheep and goats in perennial groves or in arboriculture may be considered a method of control as it can significantly reduce the severity of the problem caused by some weeds. Naturally, the introduction of animals into an agricultural ecosystem presents other advantages (manure recycling, utilisation of animal feed, etc.).

4.3 Organic cultivation of cereals2

4.3.1. Organic grain

Growing small grains organically means using sustainable methods that exclude the use of fertilizers, synthetic pesticides, preservatives, and growth regulators. Organic farmers rely on crop rotations, crop residues, animal manures, legumes, green manures, off-farm wastes, mechanical cultivation, mineral-bearing rocks, and biological pest control to maintain soil health, supply plant nutrients, and minimize insects, weeds, and diseases. The basis of a successful organic grain crop is the **fertility of the soil** in which it is grown. Soil fertility is based on the physical, biological and chemical components of the soil environment. Physical soil fertility in an organic farming system can be promoted by:

• adequate supply of organic matter through green manuring and pasture phases,

• good soil structure through minimising cultivation,

• moisture retention and good drainage,

<u>Biological fertility</u> refers to the diversity and activity of soil organisms. Soil organisms play a fundamental role in recycling nutrients for plant growth. The soil environment that is most beneficial for these organisms to operate has plenty of oxygen, a neutral pH, and organic matter that contains sufficient levels of nitrogen.

Chemical fertility refers to the level of available nutrients required for plant growth. Wheat has a requirement for phosphorus, nitrogen and potassium. Options that are available to organic producers to ensure adequate phosphorus supply for crop growth include to maintain soil pH between 5.5 and 6.5 ($CaCl2$) to achieve maximum phosphorus availability, and to encourage biological activity with sufficient high quality organic matter.

Details on small-grain production practices— such as planting dates, seeding rates, varieties, and harvesting methods—vary widely among regions, but are largely the same for conventional and organic systems. Some of the techniques used in intensive small-grain production—such as narrow rows, thickerthan- normal stands, and tram lines (an uplanted strip used to drive on, which allows precision application of inputs)—also provide benefits to farmers who do not use synthetic chemicals and fertilizers.

However, these intensive practices may increase disease incidence. Some disease problems can be minimized with resistant cultivars and variety mixing. Variety mixing involves **planting several different small-grain varieties in a mixture**, each with a different type of disease resistance. Mixed fields may lose individual varieties to specific pests or diseases, but the chance of total crop failure is greatly reduced. Alternatively, a grower could decide to plant different fields of separate varieties. Under this system, a specific pest or disease may ruin one field but not affect the others.

4.3.2 Weed control

Weed control strategies in organic small grains include crop rotation and a limited amount of mechanical cultivation. The narrow-row spacing associated with drilled grains affords significant crop competition with weeds. However, rotation to other crops is still necessary to break weed life cycles. Management to reduce the seed bank of weed species prior to wheat production has to occur during the pasture phase. A range of options exist for producers to manage weed species in pastures:

• strategic heavy grazing of pasture to prevent seed set in late spring,

• cutting hay or silage,

• green manuring,

• mowing, and

• growing a forage break crop between the pasture and crop phases.

Continuous small-grain cropping creates a haven for weeds with similar ecological niches (e.g., coolseason grasses, buttercup, and others). Including a late-spring-planted crop such as sunflower or proso millet into the winter-wheat fallow system reduced winter-annual grass weeds such as downy brome and jointed goatgrass. Unlike row crops, in which weed control can be obtained through cultivation, drilled crops are less conducive to mechanical weed control. Harrowing or rotary hoeing can help reduce weed problems but it can only be done lightly when the small grain is a few inches high, and weeds have germinated but not emerged.

4.3.3 Grain harvest and storage

Organic wheat is harvested in the same manner as conventional wheat. Care needs to be taken to ensure that the harvest sample is as clean as possible of weed seeds and other material, as penalties apply for foreign material in cereal grain. Harvesting equipment that can collect weed seeds through the seconds bin allows for more flexibility in the harvesting process and better weed management. Wheat grain should be harvested at or below the receival limits for moisture; this is usually 12.5% for wheat. Seed cleaning services are available but these will reduce the gross margin of the organic crop.

4.3.4 Conversion to organic wheat production methods

Important changes conventional wheat farmers may need to consider when converting to an organic system relate to the following aspects:

Soil conditions and fertility. Developing soil conditions suitable for organic wheat production can take several years.

Soil **chemical** imbalance or nutrient deficiency can be corrected over time with appropriate amendments like lime, dolomite, gypsum, reactive phosphate rock, potassium sulfate and trace elements. Emphasis is given to the balance or proportions of different elements in the soil, especially the ratio of calcium to magnesium and other cations. Nitrogen is generally grown on site through the use of legume-based pasture phases and green manure crops. Various soil or foliar sprays are permitted like humates, seaweed, fish emulsion and other naturally derived substances.

Soil **biological** activity is the key to enhancing nutrient mineralisation and release to plants, and to regenerate soil structure. Several years of legume-based mixed pasture, or green manure ploughed under, are used to provide vital soil organic matter to feed soil biological activity. Various biological and other formulations are used to improve soil biological processes.

Soil **physical** properties improve with soil chemical balance and biological activity. Deep rooted annual and perennial pasture or crop plants (like lupins or canola) combined with rotational grazing, soil amendments and appropriate deep ripping are used to improve poor soil structure. Good deep soil structure without hardpan compaction allows extensive deep root growth to exploit soil reserves for moisture and nutrients.

Crop rotations. Sustainable rotations typically include a well-managed legume-based pasture phase for several years to rebuild soil chemical, biological and physical condition suitable for successful cropping. As well, rotations can be designed to break pest and disease cycles and reduce weed burden. One example of an organic rotation on strong soils may be pasture (vetch or medic hay)>pasture>wheat>chickpeas>fallow>wheat. On lighter soils a rotation may consist of pasture> pasture (green manure)>wheat>oats or simply pasture>pasture>wheat.

4.3.5 Weed Control in Organic Wheat

Management of weeds in wheat should be designed to tip the balance of competition towards the crop. Do not aim to remove all annual weeds because wheat can cope with a reasonable population of low growing annuals, with benefits for biodiversity and habitat for beneficial insects.

Within the Rotation

Wheat should be part of a rotation in which opportunities to control weeds should be taken wherever possible:

- Grass breaks of more than 2 years provide a good way of reducing the seed bank of many arable weeds. They can also provide an opportunity for digging out the odd dock or other perennial if at low levels, or by routine cutting deplete their root reserves in high infestations.

- Wide row crops and potato crops also provide good breaks for weed management, and utilise stubble and fallow management wherever possible.

Within the Wheat Crop

In wheat itself, a number of management practices can help you improve the competitiveness of the crop. What that management should be depends on individual circumstances, and in particular what serious weeds you have, such as perennials (for example, docks and thistles), large grass weeds and cleavers:

- Do not sow earlier than mid-October wherever possible, unless you are in a late area. Delaying sowing reduces autumn weed emergence, allowing the crop to get established before the spring weed flush.

- Use high tillering varieties that can compensate for establishment problems and give good early ground cover (prostrate).

- Sow in narrow rows to increase shading of the ground to reduce annual weed growth; narrow rows also tend to yield more. Cross drilling reduces weed growth further.

- If you have perennial, tall grass or other difficult weeds, sow in wide rows (23-30cm)to allow the passage of a hoe.

- If sowing in narrow rows, preferably use varieties with rapid spring growth,

maintaining a prostrate or planophile shading habit. If you have to select between

upright or erectophile varieties, then select types that are tall with large leaves.

- If sowing in wide rows, use varieties that maintain a planophile habit, or if erect, use very tall varieties with large leaves.

QUESTIONS FOR SELF-ASSESSMENT

A. Mark true (T) or false (F) to the following questions:

1. Organic farming seeks to eliminate all plant parasites.

a) True

b) <u>False</u>

2. The organised provision of supplies and plant protection products is a prerequisite for the expansion of organic farming.

a) <u>True</u>

b) False

3. Quarantine is a management method of controlling plant diseases.

a) <u>True</u>

b) False

4. Organic farming involves only the replacement of chemical fertilisers and insecticides with natural products.

a) True

b) <u>False</u>

5. Aeration is achieved either by thinning the leaves or through sparser planting.

a) <u>True</u>

b) False

B. Select the correct answers to the questions below:

1. Mulching with organic materials:

a<u>. reduces the need to water</u>

b. Increase agricultural work

c. Increase the weeds

d.Increase the need of water

2. Of the chemicals-nutrients below, a trace element is:

a. potassium

b. phosphorus

c. nitrogen

d. copper

3. Hygiene measures effective:

a. In all crops

b. in greenhouses

c. in grains d. in vineyards

4. Greenhouse crops are more advantageous than field crops in that:

a. they are smaller in size b. they need less fertilisation

c. they have a controllable microclimate d. they have a good yield in all crops

5. Antagonists and pathogens act:

a. as supplements

b. independently of each other

c. as antagonists

d. both are harmful

ACTIVITIES:

1. Try to make compost using materials from home and your crops for a month. Set aside a small piece of land and apply compost fertiliser in the first subsequent growing period.

2. We have an irrigated field in a particular area. We would like to plan a crop rotation that will utilise the field in the best possible way while at the same time:

Reducing the need for nitrogen fertiliser

Interrupting the cycle of enemies and weeds

3. Make a list of natural essential oils available in your country. Check the instructions for use and select those that would be useful for a particular crop or for flowers.

FOR MORE INFORMATION: http://ec.europa.eu/agriculture/organic/logo/index.htm

ADDITIONAL SOURCES OF INFORMATION

1. EU Action plan for organic food and farming

http://europa.eu/legislation_summaries/agriculture/food/l60038_en.htm

2. Action Plan of the Czech Republic for the Development of Organic Farming by 2010

http://www.agronavigator.cz/ekozem/attachments/AP_angl.pdf

3. Organic farming in Czech Republic

http://www.organic-europe.net/country_reports/pdf/2000/CZ.pdf

4. 2007 Yearbook Organic farming in the Czeck Republic

http://www.bioinstitut.cz/english/documents/RocenkaEZ_2007-angl_KOMPLET.pdf