TRAINING NOTEBOOK

- ENVIRONMENTAL MANAGEMENT -

SUSTAINABLE PRODUCTION

COLEACP

AFD
AGENCE FRANÇAISE DE DÉVELOPPEMENT

STDF

FIT FOR MARKET

SUSTAINABLE PRODUCTION SYSTEM

Dear trainers, some advice...

WHY A TRAINING NOTEBOOK?

The 'Manuals' edited by COLEACP are valuable training materials. To write them, COLEACP approached the best experts in the field with the aim of producing a technical document for a large public on a given theme that brings together and structures most of the current knowledge. These manuals are intended to be as accurate and complete as possible, adapted to the ACP context and focused on cross-cutting issues in horticulture. But the objective was also to make them affordable, understandable and enjoyable to read by people who are not necessarily experts in the field. Nevertheless, it is a considerable effort to assimilate all the material collected in a short time.

The training manuals, which are aimed primarily at experts and the most qualified people, are often voluminous and complex, and it was necessary to help the expert trainers to identify the most important elements to retain, and to collect for them a list of 'key messages' to be disseminated to learners during COLEACP training. This Training Notebook is therefore a valuable and practical tool that is at your disposal to help you prepare your training on the topic covered in this Booklet.

WHAT DOES THE TRAINING NOTEBOOK CONTAIN?

Each Training Notebook contains:

1. The list of materials to be delivered to participants during the training

This is a summary table of contents of the Training Manual. This list allows you to have an **overview of** all the **main points that** will have to be covered during the training. The **order of the list does not necessarily have to be respected,** as the organisation of the sequences is left to your discretion and may depend on other factors (e.g. availability of an expert trainer; timing of the training sequences; space reserved for exercises...).

In some cases, **only certain aspects** (or chapters) of the **subject will be covered** (for example: if the participants have a perfect command of certain parts of the subject covered in the training, it is not necessary to present them in detail; a small reminder may be sufficient and effective to cover the rest).

However, when you cover part of the material (a chapter), the main 'points' listed for each chapter allow you to organise your presentations and animations in a logical and relevant way for the learner. **You are also advised to present all the points of a chapter.**

2. Training leaflets

A Training Notebook contains as many 'leaflets' as there are chapters in the training manual (only the 'case study' is not included). Each sheet contains, on the one hand, the **Training objectives** of this part of the subject to be delivered (what the learner must be able to deliver...), and on the other hand, according to the structure of the table, the 'key messages' (what the learner must absolutely have assimilated at the end of the training). It is therefore very important to ensure that **all messages are well distributed during the training sequence.**

3. A summary of the content of the manual

A summary of the manual has been included in this Training Notebook. Structured in the same way as the manual, it contains most of the content in 15-20 pages but remains much less complete (the summary does not include figures or case studies).

This summary is **primarily intended for the trainer.**

- **At the beginning of the mission**, when preparing its intervention sequences and supports, it allows you to quickly become familiar with all the content you will need to address and to visualise the links between the different parts of the material to be delivered.
- **During the training,** you can use this summary **to prepare your daily summaries,** reminding participants of the essential elements seen during a day (15-20 minute summary at the end of the day with answers to questions).
- **At the beginning or end of the training**, if you wish, you can give participants a copy of this summary. If the summary is distributed at the beginning of the training, it is advisable to ask participants to highlight the passages mentioned in your end-of-day summary (benchmarks in the subject).

The summary is also useful for learners at the end of the course: it will allow them to **remember in a** few minutes the **main part of the topic covered** (for example, before an assessment of prior learning), whereas reading the entire manual could be tedious.

HOW CAN THIS TRAINING NOTEBOOK HELP YOU PREPARE YOUR TRAINING INTERVENTIONS?

The intention of making this Training Notebook available to you is to **help you prepare your training sequences and structure your program day by day.**

- **Consider that each leaflet represents a whole:** if there are, for example, 4 leaflets, it means that there must be 4 distinct parts in your training. Sufficient time must therefore be allowed in the programme for each of these 4 parts. Each part of the subject will also have to be subject to a competency assessment.
- **Then consider the training objectives:** this will help you to choose: (a) the most appropriate training method for achieving your objectives (e.g. should you plan exercises, simulations, group activities etc.); (b) the method for evaluating the learning acquired in this part.
- **Finally, prepare your materials** (e.g. PowerPoint, flipcharts or animation sheets, evaluation questions) by ensuring that all key messages are included ("Have I planned to discuss all these points? Have I planned an evaluation on each key point?").

DON'T FORGET TO COMPLETE THIS TRAINING NOTEBOOK!

This Training Notebook is made **for you**... It is **a tool that must live!**

At the end of each leaflet, a space was left free to add your personal notes: as a trainer you can note some thoughts on how to get messages across, note your questions, participants' reactions, points that raise difficulties... *i.e.* **capitalise on your experience as a trainer!**

You can also **note the types of media you have used.** This will be very useful when you have a new session to facilitate on the same theme. COLEACP provides you with many tools and materials, but do not hesitate to create others or use other existing materials that may be available... the **rule is to master each of the materials used in training** and to ensure that they help to convey key messages more effectively than in their absence.

Materials to be delivered

CHAPTER 1- SUSTAINABLE AGRICULTURE AND INTEGRATED PRODUCTION

- Impact of agriculture on the environment
- The environmental requirements of the various standards
- Implementing an environmental protection policy: a practical illustration

CHAPTER 2 - SUSTAINABLE PRODUCTION METHODS AND RISK ANALYSIS OF AGRICULTURAL PRACTICES

- Production methods and environmental impact
- Analysis of the risks associated with agricultural practices for the environment

CHAPTER 3 - SUSTAINABLE LAND MANAGEMENT

- Soil and maintaining soil fertility
- Soil degradation and contamination
- Soil erosion (mechanisms and consequences)
- Soil protection (prevention techniques)
- Reasoned soil fertilisation (soil analysis and input management)
- Soil requirements as part of quality procedures

CHAPTER 4 - SUSTAINABLE MANAGEMENT OF ORGANIC MATTER AND WASTE

- Sustainable management of organic matter
- Forms of organic matter and amendments
- Management and risks of organic fertilisers
- Production, use and treatment of organic waste

CHAPTER 5 - SUSTAINABLE WATER MANAGEMENT

- Sustainable water management
- The risks of water contamination
- Prevention of point or accidental pollution
- Buffer zones, development and drift reduction
- Post-harvest washing and water contamination
- Regulatory standards and water quality
- Saving water

CHAPTER 6 - SUSTAINABLE MANAGEMENT OF BIODIVERSITY

- Definitions and dimensions of biodiversity (levels, structures, functions)
- Biodiversity: importance and threats
- Protect and improve biodiversity management
- Effects of pesticides on biocenoses
- Selectivity of plant protection products and respect for auxiliaries

CHAPTER 7 - SUSTAINABLE ENERGY MANAGEMENT

- Climate change and energy management
- Energy needs and basic energy saving
- The energy transition

Training leaflets

LEAFLET 1

Sustainable agriculture and integrated production

TRAINING OBJECTIVES

At the end of this training sequence, the participant must be able to:

- understand the impact of intensive agriculture on the environment, including the effects of inappropriate inputs or agricultural practices;
- know the environmental requirements of the different standards and compare the different standards in terms of recommendations;
- identify the best approaches and best practices that will lead to better environmental protection and agricultural sustainability.

KEY MESSAGES

1) Impact of agriculture on the environment

- Intensive agriculture, as practiced mainly in developed countries, uses many inputs (fertilisers, pesticides) and mechanisation of work, and has many negative impacts on the environment. Groundwater pollution by chemicals and agricultural waste is a significant problem in almost all developed countries, and is becoming increasingly so in developing countries.
- As a result, the presence of residues of plant protection products, sometimes in high concentrations in soil, water and even in the air, a loss of biodiversity, landscape changes (particularly due to the use of herbicides) etc., can be observed.
- Intensive agriculture is the first emitter of nitrogen pollution and the second emitter of phosphorus (use of fertilising materials).
- Agricultural land is threatened by phytotoxicity due to the accumulation of heavy metals from chemical fertilisers, sewage sludge and animal waste (slurry, manure).
- Soil compaction and reduced soil productivity are caused by certain intensive agricultural practices.
- Soil erosion is increasing through this type of agriculture, causing, for example, mudflows.
- The damage caused by this agriculture severely disrupts other economic activities that depend on the same natural resources, particularly water quality: tourism (algal explosions or water hyacinth invasion), fish farms (pesticides and toxic algae), agri-food industries (nitrates).
- Intensive agriculture, in order to produce more and more, uses a lot of synthetic fertilisers as well as toxic pesticides. These inputs have many impacts precisely on human health and on the environment.

- There are a series of diseases and problems in humans (cancers, Parkinson's disease, Alzheimer's disease etc.).
- On landscapes and ecosystems, we notice that wetlands are drained, hundreds of thousands of km of hedges are uprooted, massive deforestation, fallow land removal etc.
- This agriculture is the main user of biodiversity (90% of European maize comes from a single strain; by 1990, a single apple variety (Golden) accounted for 75% of sales).
- The repeated use of plant protection products has increased resistance (more than half of the insects are resistant to organophosphates, more than 150 species of pathogenic fungi are resistant, wild grasses resistant to glyphosate have been found since 1998).
- Pollutants (nitrates, pesticides, hydrocarbons) can accumulate in the food chain and harm predators who eat contaminated fish (e.g. birds).

2) Environmental requirements of different standards

- Consumers are demanding to be able to choose local, authentic and diversified products, from the land, combining cultural traditions and concern for the environment.
- The preservation of the environment by the producer is now explicitly perceived as an indication of consumer respect, at least as much as a certain guarantee of the sanitary quality of the product.
- Faced with the environmental and socio-economic damage caused by agricultural practices, it is therefore becoming necessary for producers to redirect their choices and production models in a direction more compatible with sustainable development.
- Compliance with the GLOBALG.A.P. standard is based on the implementation of a quality management system based on the application of 'Good Practices' at all stages of the agricultural, livestock and aquaculture production process through the implementation of the principles of integrated pest management and the rational use of inputs.
- The TESCO Nurture standard recommends the rational use of crop protection products; mineral and organic fertilisers; the efficient use of energy, water and other natural energies.
- This standard promotes the prevention of pollution; the protection of human health and working conditions; recycling and reuse of materials and is based on the principle of the enhancement of fauna, flora and landscape.
- The food industry and supermarkets are keen to introduce more and more 'environmental requirements' into their specifications (e.g. GLOBALG.A.P., PERFECT Charter, Sustainable Agriculture...) etc.
- Compliance with the Nurture's Choice Code of Practice aims to ensure that products are grown and handled in accordance with regulatory requirements and TESCO's customers' high expectations regarding product quality and safety, environmental protection and improvement, health protection, and the rational use of natural resources and agrochemical products.
- The FLO standard, which focuses on working conditions, the correct income of workers and their well-being, but nevertheless includes the environmental aspect. The standard focuses on ecological agricultural methods to protect and maintain biodiversity.

- The FLO standard strongly encourages small producers to choose organic practices when this choice is socially and economically feasible.
- The wording of the control points and their titles vary between ‘Private Voluntary Standards or NVPs’. (e.g. GLOBALG.A.P.), but their requirements are similar.
- Soil conservation and erosion control.
- NVPs recommend the rational use of inputs (water, plant protection products, fertilisers).
- NVPs recommend sustainable waste management and the reduction of pollutants.
- NVP recommends the application of integrated pest management principles.
- NVPs recommend the promotion of environmental protection (fauna, flora).

3) Environmental protection

- The recommendations for the protection of the environment focus first on the application of ‘Good Practices’ (agricultural, hygiene, handling or transport...).
- Compliance with the principles of integrated pest management improves environmental protection.
- The implementation of a waste management policy is essential.
- Integrated and sustainable management of biodiversity (fauna and flora) offers opportunities through the provision of ecosystem services.
- Awareness of Good Practices is necessary for staff to claim environmental protection.

PERSONAL NOTES AND REFERENCES OF THE MATERIALS USED

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PERSONAL NOTES

LEAFLET 2

Sustainable production methods and risk analysis related to agricultural practices

TRAINING OBJECTIVES

At the end of this training sequence, the participant must be able to:

- understand what defines so-called ‘conventional’ (or industrial) agriculture;
- understand the differences between the modes or ‘production systems’ and, for each, their characteristics and main impacts (positive or negative) on the environment;
- know the risks related to agricultural practices for the environment;
- understand the steps involved in an environmental risk analysis process.

KEY MESSAGES

1) Production methods and environmental impact

- So-called ‘conventional’ or rather ‘industrial’ agriculture : is highly mechanised, consumes a lot of fossil energy and inputs, and, in the long term, damages soil quality as there is a decrease in organic matter (OM) content, loss of structure, decline in soil biological activity, accumulation of toxic products in the soil.
- The so-called ‘reasoned’ agriculture: it does not differ much, but observations show that the long-term effect slows down the phenomenon of degradation of normal soil fertility.
- Integrated production: tillage is limited and soil fertilisation is practiced at the ‘fairest’ level, bringing us closer to the objectives of sustainable agriculture.
- Organic agriculture: it refuses the use of synthetic chemicals and implements best environmental practices, allowing a high degree of biodiversity, the preservation of natural resources while protecting the soil.
- Conservation agriculture, sometimes called ‘ecologically intensive agriculture’: it restores the soil to its role as a pillar in plant production because it is considered, not as an inert support, but as a living environment. The supporters of this agriculture present it as a valuable tool for the sustainable management of a local area.
- Permaculture: it is a mode of ecological land use planning whose pillars are: taking care of people and the land (protecting its soils), producing and sharing resources equitably.
- The so-called ‘agroforestry’ production is based on the principle of complementarity (the tree – the soil – the crops). It reduces the loss of soil nutrients, provides protection for water and soil against erosion, allows sustainable control of cultivated areas and helps to combat the greenhouse effect.

- Agro-ecology, the definition of which has yet to be determined, is based on the maximum use of nature as a factor of production. It aims to reduce dependence on chemical inputs, strengthen biological interactions and promote ecological processes and services.
- Climate-intelligent agriculture: it is an approach designed to develop the technical, political and investment conditions necessary to achieve sustainable agriculture that meets the challenges of food security in a context of climate change.

2) Risk analysis and conservation agriculture

- Risk analysis identifies environmentally harmful agricultural practices and sources of pollution in order to propose corrective measures.
- This acquisition/reflection is achieved through a methodical approach; farm managers can use this method to analise their practices.
- The method consists of 4 steps:
    - Identify hazards (causes of degradation and/or pollution);
    - Characterise the nature and effects of these hazards;
    - Estimate the probability of their occurrence under operating conditions;
    - Characterise the risks involved and determine whether or not they are acceptable.
- The analysis leads to an action plan to be put in place: a coherent set of actions that must contribute to preserving the quality of the environment and guaranteeing the sanitary and phytosanitary quality of the products harvested.
- Conservation agriculture is one of the methods recommended by the integrated and sustainable management of agro-ecosystems because it allows a sustained improvement in productivity while preserving the environment.
- The action plan must be drawn up following the risk analysis in order to reduce the risk of point and non-point pollution to a minimum, and to preserve the quality of the environment (water, soil, air), and guarantee the sanitary and phytosanitary quality of the products harvested.
- The producer must carry out, or at least participate himself in all the stages of the diagnosis and development of the action plan since he/she will be responsible for his/her monitoring and evaluation of the results.
- Measures to control environmental risks include the 'reasoning' for the use of pesticides and fertilisers based on their use of objectively measured necessity in a specific context; decision taken by the producer before or after the establishment of the plantation.
- The conditions and constraints for the implementation of the processing operations: information (subscription to a newspaper and a technical advisory service independent of marketing) and training, observation of representative plots and recording of practices.
- Reduce the dispersion of pesticides in the environment: adapt the use of plant protection products to environmental conditions; reduce losses on application (improve application techniques and comply with application conditions limiting losses); reduce transfers within and outside the plot (grassed areas, hedges); intercept polluting flows (buffer zones or other facilities such as forest strips, hedges etc.).

- Reduce pesticide use: diversification of pest management methods and design of cropping systems that reduce pest risks: use crop resistance to pests and focus on non-chemical control techniques (biological control, integrated pest management).
- Producers need to know how their practices relate to environmental issues in order to better manage inputs and their use, and implement better agricultural practices with regard to the environment.
- A risk analysis is desirable to precisely identify the risks of accidental pollution or to detect the presence of diffuse sources of contamination, and to specify, on this basis, the lines of an 'action plan', with arrangements adapted to the scale and context of the operation.
- The purpose of risk analysis is to guide the producer to minimise the risk of pollution (e.g., contamination of water by plant protection treatments; pollution by groundwater nitrates; accumulation of obsolete pesticides; soil pollution by heavy metals; presence of dioxins in the soil...).
- Risk analysis identifies and prioritises sources of pollution in terms of contribution (quantities of pollutants) and urgency (toxicity to humans and the environment; damage to the quality of harvested products).
- Factors to consider in the analysis at the farm level:
    - environmental factors, which explain the vulnerability of water;
    - land use;
    - type of pollution (point or diffuse sources) and pollutant (physico-chemical characteristics of the pollutant);
    - cultivation practices;
    - input management (purchasing, employment intensity, storage conditions);
    - Etc.

PERSONAL NOTES AND REFERENCES OF THE MATERIALS USED

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PERSONAL NOTES

LEAFLET 3

Sustainable soil management

TRAINING OBJECTIVES

At the end of this training sequence, the participant must be able to:

- understand the importance of soil and the maintenance of soil fertility;
- know the types of degradation and identify the factors of soil contamination;
- know the mechanisms and consequences of soil erosion;
- know the techniques of soil prevention;
- understand the principles of reasoned soil fertilisation;
- know the requirements related to soil fertility.

KEY MESSAGES

1) Importance of soil and maintenance of soil fertility

- Soil is one of the most precious natural resources.
- The soil is home to most of the biosphere.
- Soil is a source of food, biomass.
- Soil is a source of raw materials.
- Soil stores, filters and processes many substances, including water, nutrients and carbon.
- Soil is the world's most important carbon sink.
- Some production systems are more favourable to the preservation of soil fertility.
- Agroforestry reduces the loss of soil nutrients, provides protection against erosion, water contamination and the greenhouse effect.
- Conservation agriculture: improves biodiversity (integration of plants, livestock, trees and pasture) and soil biological processes improving overall soil quality.
- The zaï technique (basins or micro-basins to trap sand, silts of organic matter): concentrates water locally, controls runoff, erosion, restores macroporosity and the production potential of degraded soil.
- The zaï technique revitalises the surface layer, corrects deficiencies, removes aluminic and manganic toxicities from the soil while improving its biological activity.
- The zaï technique homogenises the soil and secures production through its effectiveness in water management.
- The half-moon cultivation technique: it is a method of rehabilitating degraded land that aims to collect the runoff water necessary for crop growth.

- The half-moon cultivation technique increases infiltration, soil water stock, improves soil fertility and productivity.
- The half-moon cultivation technique makes it possible to recover encrusted soil.
- Reduce tillage, which is necessary and the approach preferably adopted by conservation agriculture: 'ecological tillage' and alternative techniques.
- Plant cover to protect the soil from heat, erosion, evaporation and leaching of nutrients by rain.
- Adopt Integrated Soil Fertility Management (ISFM) by always combining fertiliser inputs with organic matter inputs.
- Amend the soil by providing it with elements such as organic matter and lime, which will make it possible to maintain a good structure on the one hand, and to naturally boost its biological activity on the other hand.
- Use irrigation sparingly, avoiding uncontrolled water inflows, and ensure good drainage to avoid salt accumulation in the surface layer of the soil.
- Respect the integrity of the soil by avoiding polluting the soil with toxic compounds (pesticides, heavy metals present in certain fertilisers or fertilisers, hydrocarbons, household waste).
- Avoid salting the soil by irrigating with salt water and applying certain forms of fertiliser (KCl)

2) Types of degradation and factors of soil contamination

- There are several types of soil degradation:
    - physical degradation due to erosion, compaction and crusting;
    - chemical degradation related to nutrient loss and acidification or chemical contamination (toxicity to soil organisms);
    - biological degradation associated with the loss of organic matter;
    - degradation of drainage conditions leading to waterlogging or salinization.
- Various contaminants can affect the soil:
    - heavy metals (cadmium, cobalt etc.) that are caused by the addition of contaminated soil improvers or fertilisers (e.g. copper in some manure, cadmium in some fertilisers);
    - atmospheric deposition (to soil and plants) caused by human activities (the incineration of plastic materials that generates the presence of dioxins in the fumes emitted);
    - pesticides: soil contamination by accident, either through negligence or lack of knowledge or practice of the handler.

3) Soil erosion (mechanisms and consequences)

- Erosion is a natural process in which soil particles are detached and transported over a distance.
- The transport and deposition of soluble and solid soil elements is possible under the influence of water (water erosion) or wind (wind erosion), but can be of natural or human origin (anthropogenic erosion caused by tillage).

- Erosion can present a major danger to soils, either by selectively depleting the surface horizon of its vital substance or by scouring the surface horizons sometimes down to the rock.
- But erosion is also at the origin of the rejuvenation of mountain soils and the formation of the most fertile plains. Erosion does not become a problem when soil loss significantly affects productivity.
- The first process, the most important in water erosion, is the effect of the impact of water drops on the soil.
- Several factors affect the actual rate of soil erosion by water: rainfall erosion, soil erodibility, topography, vegetation cover, production system and soil conservation practices.
- Water erosion is caused by poor agricultural practices that result in excessive runoff and sediment transport.
- Water erosion results in: loss of upper soil elements; formation of gullies and ravines; sedimentation or deposition of fine elements; water pollution (fine suspended solids or toxic products discharged by agriculture or industry); and filling of river beds in downstream areas.
- In wind erosion, particles are set in motion by the wind.
- Wind erosion damage is disturbance, serious illness in urban, rural, domestic or wild animals; crop damage, especially in the very early stages of growth; filled or silted fences, ditches and canals; choked or buried grasses, trees, bushes and hedges; insects and weed seeds carried by the wind into healthy fields.
- Often the soil is dragged to the point of stripping the roots of seedlings or unsprouted seeds, which compromises harvesting.
- The disappearance of vegetation cover, particularly trees, contributes to erosion, soil leaching and the appearance of laterites. The main causes of deforestation identified are:
    - forest burning to clear the plots,
    - various bush fires,
    - uncontrolled grazing renewal fires,
    - illegal logging (charcoal, timber...),
    - the collection of firewood.

4) Soil prevention techniques

- Wise use of land (crop rotation). It improves the soil structure produced by the root system of forage plants, and by the relatively high input of organic matter that can be returned to the soil.
- Organic matter input. Soil in good conditions have a granular structure. These soils are porous and tend to absorb rainfall.
- Direct sowing. This method consists of not ploughing the soil, planting a cover crop that will fix nitrogen in the air, stabilise the soil, keep rainwater moist and protect the soil from hard radiation from the vertical sun (no laterite formation).
- Mulching before or after planting. Leaving plant residues on the surface tends to lower the soil temperature and increase its moisture content. Plant residue litter prevents soil heating during the day and heat loss at night.

- Green manure cultivation, made to improve the soil after burial. The main soil improvement is due to nitrogen fixation by legumes and the addition of easily decomposable organic matter when the crop is buried.
- Establish and maintain vegetation or plant residues that will protect the soil.
- Windbreaks, tree curtains, hedges etc., by exerting resistance and deflecting the air stream, slow down wind speed over a distance in the vicinity of the surface and thus provide a resistance against erosion.
- Establishing wind barriers or fastening strips at intervals reduces wind speed.
- Cultivation according to contour lines, a method that facilitates soil and water conservation, as each row is a barrier to water flow.
- Terraces, techniques that defend the land against erosion by reducing the length of the slope and directing runoff water to an outlet, perpendicular to the slope, at a rate where it does not cause erosion.
- Liming, one of the oldest practices in land use, is of considerable importance. If a soil is acidic, liming should be the first step in restoring fertility.
- Reasoned application of fertilisers, compost.
- Agroforestry. The trees that are kept in the plots prevent the loss of soil by erosion.
- Avoid compaction of the soil by trampling or the passage of machinery that destroys the structure and hinders the circulation of air and water.
- Etc.

5) Reasoned fertilisation

- The farmer must implement reasoned fertilisation to maintain/improve soil fertility, avoid soil degradation and reduce soil contamination (by fertilisers).
- Each crop must be fertilized sufficiently for its nutrition, adapting the spreading period to its needs and avoiding any excess: “The right dose at the right time”.
- Fertilisation is based on three general laws:
    - restitution law (or advances): exports of mineral elements by crops and losses outside the plot must be compensated by refunds to maintain the chemical fertility of the soil;
    - law of the minimum (or interaction): the importance of the yield of a crop is determined by the element that is in a lower quantity than the needs of the crop;
    - law of less than proportional increases: the yield increases obtained are smaller and smaller as the quantities of fertiliser applied increase.

6) Requirements in relation to the ground

- The producer has the responsibility to assess the risks (risks of soil and water contamination by inputs, amendments and farming practices, risk of soil pollution...), and to ensure that the products harvested on his land cannot harm the health of consumers.
- The producer has the obligation to verify that he /she will be able, under the conditions of the crop, to respect the maximum permissible concentration limits for each type of contaminant (chemical and biological).
- The producer must regularly check his/her soils (analyses) to determine their characteristics (presence of contaminants) and fertility.

PERSONAL NOTES AND REFERENCES OF THE MATERIALS USED

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PERSONAL NOTES

LEAFLET 4

Sustainable management of organic matter and waste

TRAINING OBJECTIVES

At the end of this training sequence, the participant must be able to:

- understand the role played by soil organic matter;
- understand the principles of sustainable organic matter management;
- identify the forms and roles of organic matter and amendments;
- know the management methods and risks related to organic fertilisers;
- understand the production of organic waste and how to recycle it in agriculture;
- know the steps of composting and distinguish the different types of composting.

KEY MESSAGES

1) Sustainable management of organic matter

- The best way to manage organic matter (OM) by the producer is to use rustic, inexpensive and relatively easy-to-implement techniques such as composting.
- The contribution of compost has an important role to play in maintaining good soil quality to fully satisfy plant requirements.
- OM is the carbonaceous material generally produced by living beings, plants, animals and micro-organisms.
- The soil OM, under the action of animals, bacteria and fungi, produces humus.
- Humus allows the soil to remain friable, aerated, efficiently retain water between rains, and therefore limit the leaching of fertilisers and minerals from the soil carried to depths or to rivers by water flowing through the soil, limiting pollution of groundwater tables and surrounding watercourses.
- The decomposition of organic matter provides nutrients to plants. These elements are gradually released as the material decomposes.
- When residues are buried at the beginning of the season, they enrich the light fraction of soil organic matter.
- Organic amendments incorporated into the soil as manure or compost also enrich the light fraction and are a source of nitrogen.

- If the fertiliser is rich in plant matter, this method of fertilisation is very beneficial for soil quality.
- Organic manures are used as food by soil organisms and help maintain complex food chains in the soil.

2) Forms of organic matter and amendments

- The OM comes in different forms that have their own characteristics.
- Manure are the excrements of herbivorous animals mixed with an exclusively vegetable litter (straws).
- Compost is derived from the rest of the controlled decomposition of organic matter.
- Manure and slurry are a mixture of farm animal manure (urine, excrements) and water in which the liquid element dominates. It may also contain small amounts of litter residues (straw).
- Poultry droppings (excrement) are appreciated because they are rich in mineral salts.
- 'Guano' is the name given to the excrement of seabirds and bats.
- Green manures, which are plants grown specifically to return underground by ploughing, return their organic matter to the soil.
- Soil amendments are organic or physical.

3) Management and risks of organic fertilisers

- The adoption of Good Agricultural Practices guarantees the sustainable management of organic fertilisers because they delay the depletion of soil OM.
- These good practices include, among others:
    - crop rotation;
    - complete mineral fertilisation;
    - tillage leaving a rough surface;
    - minimum tillage combined with residue bedding in the field;
    - the establishment of set-aside land.
- Nitrogenous organic fertilisers (manure, slurry...) can indirectly release large quantities of nitrates and phosphates.
- If the soil is low in humus, nitrates and phosphates, they can be more easily carried to groundwater and watercourses.
- Slurry is potentially richer in animal pathogens and sewage sludge is potentially richer in human pathogens. It may also contain heavy metals.
- Runoff, erosion and rainfall tend to bring nitrates not taken by terrestrial biomass (and therefore absorbed by plants) to lakes, rivers, oceans and groundwater.
- The presence of nitrates above the permissible limits in drinking water (50 mg/l) or in vegetables (especially 'leafy vegetables') also poses a risk to the consumer.
- In the absence of specific treatment, sewage sludge and slurry can produce unpleasant odours.

4) The production, use and treatment of organic waste

- The ‘organic waste’ is completely degraded in the soil until it becomes carbon dioxide and water again.
- The fertilising elements of the OM will return to a mineral form, assimilable by plants (virtuous cycle).
- Energy production by waste incineration induces biogas production (coupled with compost production).
- The best form of valorization of OM is the production of substrates by the producer for the needs of his exploitation.
- Composting organic waste (by-products of cultivation or agro-industry) is a technique for the recovery of OM.
- Composting can be carried out using various techniques but is based on the same phenomenon: fermentation.
- Fermentation in a compost is carried out in two stages: an intense aerobic fermentation with high temperature (50-70 °C) under the action of bacteria, followed by a maturation stage which leads to the biosynthesis of humic compounds.
- There are open-air composting, pit composting, pile and bin composting.

PERSONAL NOTES AND REFERENCES OF THE MATERIALS USED

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PERSONAL NOTES

LEAFLET 5

Sustainable water management

TRAINING OBJECTIVES

At the end of this training sequence, the participant must be able to:

- know the principles of sustainable water management;
- know the risks of water contamination;
- know how to prevent point or accidental pollution;
- understand buffer zones, development and drift reduction;
- understand post-harvest washing and water contamination;
- know the regulatory standards and water quality;
- know how to save water.

KEY MESSAGES

1) Principles of sustainable water management

- Agriculture must use all resources, including water, more effectively and efficiently.
- Sustainable water management must include the optimisation of irrigation programs and the development of more efficient irrigation systems, such as drip irrigation.
- The efficiency of water absorption by crops can be ensured through a demand-based irrigation programme, taking into account water needs and the growth stage of the different crops.
- Good management must be applied to all stages of the irrigation system put in place.
- The different steps are: sampling or pumping, transport and distribution to the field and drainage. Each step is a 'system' to be analyzed.
- Effective and efficient management means water conservation.
- Water conservation is possible through any reduction in water use, loss or waste.
- Sustainable water management in agriculture can be improved by minimizing evaporation losses of soil water from plant transpiration.
- Water conservation also refers to improved water management and agricultural practices that optimise the use of water resources for the benefit of people and the environment.

2) The risks of water contamination

- Agricultural activities can cause environmental pollution from fertilisers/soil amendments and plant protection products used.
- This pollution can be:
    - diffused when pesticides applied in the field pollute surface water either by runoff or infiltration;
    - accidental or due to negligence (by loss during handling, leaks, drift of spray drops etc.).
- Possible contamination of water by pathogens (*Escherichia coli*, coliforms...) from, for example, certain organic fertilisers (manure, slurry).
- Fertilisers can lead to eutrophication of surrounding watercourses, deforestation of watersheds and watercourses bordering cultivated land or irrigation ditches.
- The decrease in oxygen in the water, due to the presence of organic waste (manure, slurry, fish droppings from fish farms, soil humus removed by erosion etc.) that is discharged into the water, affects the life of aquatic organisms.
- Due to abnormally nutrient-enriched water (especially phosphates in the case of fresh water), aquatic plants on the shoreline and suspended plant planktonic organisms proliferate.
- Fertilisers resulting from the decomposition of OM promote the growth of suspended algae (plant plankton) and aquatic plants. The water is then more or less cloudy and greenish because of the suspended sediments and the many planktonic organisms (microscopic animal and plant organisms that live in suspension in the water).
- Deforestation of watersheds and along watercourses bordering cultivated land or irrigation ditches promotes fertiliser leaching and thus eutrophication of watercourses.

3) Prevention of point or accidental pollution

- Preventing the risk of water pollution consists in intervening on each of the factors that contribute to this pollution.
- The reduction of the risks of point source water pollution requires compliance with Good Practices for Plant Protection (GPPP) and Best Agricultural Practices (BAP) before, during and after the application of the treatment.
- Reducing risks is possible, in particular through :
    - the reduction of phytosanitary treatments (integrated pest management, biologist);
    - the (re)development of agricultural sites (e.g. setting up buffer zones and/or grassed areas, preservation of hedges, plot management etc.);
    - to the choice of the product according to its characteristics;
    - soil improvement to restore fertile soils capable of rapidly degrading products;
    - drift reduction (anti-drift nozzles, pressure control);
    - the development of a waterproof preparation and cleaning area with water recovery.
- Spray mixture preparations and treatments should be avoided near water points, rivers, catchments, ditches and as far away as possible.

4) Buffer zones, development and drift reduction

- A ‘buffer zone’ or ‘untreated area’ is a strip of the plot located near water bodies (stream, pond, pond, wet ditch...) that must not receive any direct application of the product.
- The establishment of such a zone is a precautionary measure to limit:
  - runoff over the watershed;
  - phytotoxicity damage to neighbouring crops and wild flora;
  - toxic effects on non-target animals;
  - surface water contamination via drains and ditches.
- Installing a grassed strip requires at least 5 m wide at the water’s edge, with a hedge high enough and wide enough to retain spray mist.
- Drift reduction requires action on several aspects (installations, nozzles, practices, adjustment, wind and weather control).
- A 5-10 m wide strip allows the interception of more than 90% of the drift.

5) Post-harvest washing and water contamination

- The cleaning of harvested products, when carried out with care and under running potable water, makes it possible to remove most of the dirt (soil, sand, small worms, insects...).
- It also removes some of the micro-organisms (bacteria, fungi, viruses) and soluble chemical residues.
- Washing will only remove a portion of the residues on the surface (mainly those that are soluble in water), but not the residues of products that have penetrated into the skin and flesh of the products.
- The cleaning operation can contaminate the washing water (contamination by traces of pesticides, biocides, organic matter, pathogens).

6) Regulatory standards and water quality

- In response to the problems of chemical and biological water quality, various regulations have been put in place, but private standards have also incorporated this issue by adding requirements.
- European legislation imposes standards for the content of pesticides in water.
- Environmental quality standards as benchmarks for the protection of human health.
- The ‘water footprint’ concept corresponding to the volume of water used at all stages of its production chain.
- The Water Framework Directive (European legislation) is based on the concept of pollution reduction and proposes a comprehensive strategy for combating chemical pollution.
- Only an analysis can tell if a water, whether it is distributed, from a source or a well, is free of any chemical or biological contaminants, and if it is really ‘potable’.

7) Water saving

- Farmers must be taught to analyse water needs and manage resources.
- Rational management of water resources is an essential element of any strategy for sustainable development and the maintenance of biodiversity.
- Long-term water management policies should be developed.
- Private standards that have ‘sustainable development’ as an objective (e.g. GLOBALG.A.P.) will naturally impose sustainable water management and pollution prevention on producers.
- Farmers should be taught irrigation techniques (e.g. drip irrigation).
- It is necessary to remove perverse financial incentives (unbearable irrigation costs for farmers).
- New resources should be exploited (use of treated water).
- Better information for better adaptation (water resources exploitation index) should be provided.
- To enable sustainable water use, farmers need to be provided with more efficient technologies, adequate financial incentives, water saving tips and assistance to adapt and reduce their ‘water footprint’.
- Projects such as the creation of dams to store water or in desalination plants to make water drinkable should be developed.
- It is generally agreed as acceptable to use water from fruit and vegetable washing; water from bleaching/sterilization; water from rapid freezing.

PERSONAL NOTES AND REFERENCES OF THE MATERIALS USED

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LEAFLET 6

Sustainable management of biodiversity

TRAINING OBJECTIVES

At the end of this training sequence, the participant must be able to:

- know how to define biodiversity and know the dimensions of biodiversity (levels, structures, functions);
- understand the importance and threats of biodiversity;
- know how to protect and improve biodiversity management;
- identify the effects of pesticides on biocenoses;
- understand the selectivity of plant protection products and the respect for auxiliaries.

KEY MESSAGES

1) The definition and dimensions of biodiversity

- Biodiversity refers to the diversity of all forms of life (plant, animal, microbe etc.) but also their habitat.
- Biodiversity has three dimensions:
    - composition (what is present);
    - structure (the organisation of the elements present in relation to each other);
    - function (the processes that generate biodiversity).

2) Services rendered and threats

- Biodiversity can be considered as our green capital. It is the guarantee of the balance of our planet and provides a set of services essential to our survival such as the production of oxygen, food, medicines, climate regulation etc.
- The preservation of biodiversity is justified by the services it provides to humans or will provide to future generations (soil fertility, food taste, aesthetic pleasure etc.) and the benefits that humans can derive from the use of genetic resources in ecosystems.
- Biodiversity is essential to agriculture:
    - it is the origin of plants and animals used in agriculture today;
    - it allows pollination;
    - it contributes to soil fertility (microfauna and microflora action);
    - it participates in the rational control of pests and diseases (nematodes, insects and auxiliary mites);
- Biodiversity increases productivity, food security and profitability.

- Biodiversity reduces the pressure of agriculture in fragile areas, forests and on endangered species.
- Biodiversity makes agricultural production systems more stable, robust and sustainable
- Biodiversity contributes to the rational control of pests and diseases; captures carbon; contributes to sustainable intensification.
- Biodiversity diversifies products and income opportunities.
- Biodiversity reduces and shares risks between individuals or nations.
- Biodiversity helps to maximise the efficient use of resources and the environment and reduces dependence on external inputs.
- Biodiversity improves human nutrition and provides supplies of medicines and vitamins.
- Biodiversity protects the ecosystem structure and the stability of species diversity.
- Biodiversity is threatened by the practices implemented by so-called conventional agriculture (monoculture, intensive use of fertilisers and chemical plant protection products etc.).
- Pesticides have many effects on non-target species and animal communities (bees, birds, soil fauna etc.) and therefore on the overall biological balance.
- Some pesticides accumulate in the body (bioaccumulation) and their concentration can increase at each stage of the food chain (biomagnification).

3) Preservation and management of biodiversity

- Install hedges and grassed devices.
- Associating cultures in space (intercropping) and time (rotation).
- Work with selective phytosanitary products;
- Promote the action of auxiliary insects (biological control).
- Respect crop rotation to preserve soil quality.
- Provide intercrops and cover crops, especially legumes, that add nutrients, fix nitrogen and ‘pump’ nutrients to the soil surface.
- Promote associated crops.
- Use mulch and green manure (through harvesting and spreading crop residues, surrounding area residues, organic and/or harvested materials).
- Reduce the use of agrochemicals: limit treatments (especially toxic nematicides that destroy organic matter and useful soil organisms) and manage inputs intakes (perform leaf and soil analyses).
- Reduce soil treatments, even by physical methods (steam or solarisation) because they deeply disturb the biocenosis of the soil.
- Again, the environmental risk analysis method can be used to implement the set of actions.

4) Effects of pesticides on biocenoses

- Pesticide effects have short- or long-term toxic effects on non-target species and animal communities.
- The toxicity of pesticides is a concern for bees, daphnia, birds, soil fauna (carabids, springtails etc.), algae and micro-organisms.
- Pesticides modify biological balances, impacting not only terrestrial environments but also aquatic environments and organisms (fish, frogs, aquatic invertebrates).
- Bioconcentration is the concentration of a pesticide in a living being over time (affinity of some pesticides for fat).

5) Selectivity of plant protection and auxiliary products

- Pesticide selectivity is a necessary element in ‘integrated pest management’ programs.
- The use of pesticides that are selective for beneficial insects against natural enemies is frequently required in specifications and quality standards.
- Producers must use plant protection products that are able to save:
  - all biological control agents;
  - pollinators (bumblebees, bees), which ensure the fertilisation of many plants;
  - earthworms, termites and all animals and micro-organisms that promote soil fertility.

PERSONAL NOTES AND REFERENCES OF THE MATERIALS USED

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PERSONAL NOTES

LEAFLET 7

Sustainable energy management

TRAINING OBJECTIVES

At the end of this training sequence, the participant must be able to:

- understand climate change and energy management;
- know the energy needs and the basic energy saving;
- understand the energy transition.

KEY MESSAGES

1) Climate change and energy management

- Climate change affects the agricultural sector.
- Climate change affects the availability of adequate natural resources and the quality of the atmosphere, soil and water.
- Climate change causes CO_2 to be concentrated in the atmosphere.
- Several options can be applied to help reduce GHG emissions:
    - energy conservation and efficiency;
    - switching from fossil fuels, such as coal to natural gas, and RE (renewable energy).
- Smart Agriculture for Climate (SAC) contributes to the achievement of sustainable development objectives.
- SAC integrates the three dimensions of sustainable development (economic, social and environmental) by jointly addressing food security and climate challenges.
- The combination of appropriate energy technologies, equipment and facilities improves energy efficiency, reduces greenhouse gas (GHG) emissions and contributes to food security.

2) Energy needs and energy saving

- Existing production and processing practices on and off the farm can be adapted to consume less energy and at the same time provide food in a safe and environmentally friendly way.
- Renewable energy technologies are preferred over fossil fuels despite the fact that start-up costs are generally higher than those of fossil fuels.
- Natural air ventilation can be promoted through thermal chimneys that are added to existing structures or included in the design of new facilities to ensure natural cooling of the packaging station environment.

- Solar energy and biodiesel (eco-energies) must be used in irrigation and greenhouses, for cooling and transport.
- Agricultural production patterns influence energy consumption and organic farms offer opportunities for indirect energy savings (fewer inputs).
- High efficiency heating systems offer an ideal solution for heating while protecting the environment and saving energy.
- The energy supply mix should be purchased at the lowest possible price per unit of useful energy production.
- Energy rationalisation can be considered after analysing energy availability and costs, ways to reduce energy consumption, and the economic and environmental gains generated.
- Simple hand pumps should be used in the production stage for phytosanitary treatments, perforated trays and drainage basins.
- At the harvesting stage, it is advisable to work during the cold periods of the day and use low-tech solutions for drying and cleaning operations.
- In the post-harvest stage, more manual work should be encouraged for cleaning, sorting, grading and packaging.
- Natural ventilation is a point of reduction in energy consumption in agricultural businesses.

3) Energy transition

- The energy transition refers to the shift from certain traditional energies to a more sustainable production and consumption model that addresses socio-economic and environmental issues.
- This implies reducing independence from fossil fuels, energy production costs and environmental impact by initiating an energy transition process based on appropriate, adapted and available technologies.
- The energy transition could not only help reduce GHG emissions and energy losses, but also help individual companies to:
    - develop their operations in a sustainable way;
    - improve both their own health and that of their employees;
    - help generate local employment opportunities.
- Two factors have an impact on the energy consumption of actors of all sizes involved in agri-food chains.
- The first is to understand how agricultural businesses use energy directly in the form of fuel (gasoline, diesel, natural gas) and electricity and, indirectly, by using energy-intensive inputs.
- The second factor is to adopt new ideas that aim to use energy efficiently for several so-called co-benefits: reducing GHG emissions; ensuring long-term food security; reducing operating costs and increasing profits.

Summary of the manual

Sustainable production systems

1. IMPACTS OF INTENSIVE AGRICULTURE AND SUSTAINABLE PRODUCTION METHODS

While the mission assigned to agriculture – to produce more at the lowest cost – has benefited society as a whole, this **has had adverse environmental impacts.** Not without difficulty, everyone now agrees that intensive agriculture as practised in many parts of the world is a **pollutant**.

Agriculture is the **largest consumer of water** (50 to 80%), the **largest emitter of nitrogen pollution** (65%) and the **second largest emitter of phosphorus** (20%). 25% of European groundwater exceeds the accepted standard for nitrates, and a large proportion of freshwater resources do not meet the maximum accepted standard for plant protection products. The concentration of plant protection products in rainwater commonly reaches 1 to 2 or even 3 pg/litre. In the air, agriculture emits more than 90% of NH_3, half of CH_4 and a quarter of N_2O. The accumulation of **heavy metals** (Cu, Zn, Cd) from fertilisers, sludge and animal excreta threatens some lands with phytotoxicity. Some farming practices have led to **soil hardening, soil erosion and reduced soil productivity.**

Intensive agriculture is the **first to affect landscapes and ecosystems:** drained wetlands, hundreds of thousands of kilometres of hedges torn down, massive deforestation, fallow land removal etc. It is also the **main destroyer of biodiversity:** the search for high-performance varieties has greatly reduced the diversity of cultivated species.

The repeated use of plant protection products has **increased resistance** (more than half of the insects are resistant to organophosphates, more than 150 species of pathogenic fungi are resistant, wild grasses resistant to glyphosate have been found since 1998).

All attempts to transform agriculture into an industrial branch, independent of nature, have led to dramatic damage to our living environment.

Damage caused by certain intensive agricultural practices **severely disrupts other economic activities** that depend on the same natural resources, including water quality: tourism (algal explosions or water hyacinth invasion), fish farming (pesticides and toxic algae), agri-food industries (nitrates). Intensive production techniques have resulted in contamination or even **pollution of the environment (water, soil, air)**, impoverishment of biotopes and degradation of agricultural land.

Intensive agriculture is an agricultural production system based on an increase in agricultural production that is optimised in relation to the availability of production factors (human resources, equipment and cultivated areas). **Despite all the benefits that these techniques provide to farmers, these practices have a significant impact on ecosystems.**

Environmental and human consequences

Intensive agriculture is accused of being practiced at the expense of environmental considerations. **Many disastrous effects have been observed on the environment**, as the environment is directly contaminated by the use of pesticides that are extremely toxic to fauna and flora. These pesticides eliminate insects, birds and small mammals, and the mass consumption of some will even cause these species to disappear. **Groundwater** is poisoned by all these chemicals through an infiltration process because the inputs used by intensive agriculture infiltrate the soil, runoff, to reach groundwater and underground watercourses. In 2013, an INSERM study identified some 15 pathologies (cancers, neurological diseases or reproductive disorders) that are presumed to be related to pesticides.

Responses to the consequences of intensive agriculture

In response to these impacts, conservation policies and regulations are being put in place to promote and implement more environmentally friendly and proactive agricultural policies, and to take concrete measures to prevent the further destruction of natural resources.

Consumers, perceiving these environmental and socio-economic damages, demand to be able to choose products that combine authenticity, proximity and environmental protection. This is reflected, among other things, in the **introduction of environmental requirements into the specifications of the agri-food industry.**

The adoption of a resolution supporting the UNEP-led strategic approach to international chemicals management aims to promote synergies and coordination among regulatory bodies. **Environmental protection concerns everyone, not just industrialists** and not just farmers, who are often blamed. Efforts cannot therefore be envisaged without real **social coordination: farmers must no longer be considered as the only ones legitimately entitled to manage rural areas.** Residents, companies, associations, water agencies, public health services etc. are all stakeholders in the preservation of the environment.

Farmers must adopt certain techniques to cope with the consequences of intensive agriculture.

- **Integrated production**

  It implies for the producer to respect a technical itinerary where each intervention on the crop (planting, sowing, management, fertilisation, irrigation, phytosanitary treatment, harvesting) is rationalised by taking into account local potentialities, the real needs of the plant, the expectations of the consumer. This agricultural system uses natural resources and regulatory mechanisms to replace environmentally damaging inputs. The producer must set up a technical itinerary where each intervention is rationalised with the objective of optimising all production factors (soil, water, fertilisers, pesticides etc.). This optimisation requires the producer to acquire a set of data on his farm and to reflect on/work with it.

  Integrated production has several objectives:

  - produce sufficient quantities of foodstuffs that meet a guaranteed quality based on measurable or detectable criteria;
  - develop, maintain or set up agro-ecosystems that do not disturb the environment and allow sustainable management of the rural area (layout of plots, crop rotation etc.);
  - seek a better balance in nutrient cycles by making the best use of natural resources and regulatory mechanisms;
  - ensure reasoned phytosanitary protection;
  - promote greater ecological diversity in production areas and preserve wildlife;
  - preserve soil fertility and environmental quality;
  - maintain producers' incomes and a social fabric throughout the territories.

- **Environmental risk analysis**
  In order to know the impact of their practices on the environment, farm managers can use this method. This one includes 4 steps:
  - identify the dangers of degradation and pollution;
  - characterise these hazards and their effect;
  - estimate the probability of their occurrence;
  - characterise the risks on the supply chain.

  After identifying the hazards, risks and critical intervention thresholds (scores achieved), it will be necessary to identify prevention methods and implement sufficient corrective and remedial measures to ensure that the dangers of environmental degradation and/or pollution are controlled.
- **Environmental requirements of the different standards**
  GLOBALG.A.P., TESCO Nurture's choice or Fair Trade Labelling Organisation (FLO) have requirements that include :
  - soil conservation and erosion control;
  - rational use of inputs (water, plant protection products, fertilisers);
  - management of waste and polluting substances;
  - application of the principles of integrated pest management;
  - protection of the environment (fauna, flora).

Various **production methods or systems seek to minimise environmental impacts**, including conserving, improving or restoring soil fertility or environmental biodiversity. We can distinguish between 'reasoned' agriculture, 'integrated' production, 'organic' production, 'conservation' agriculture, 'permaculture' production, 'agroforestry' production, 'agro-ecology', 'climato-intelligent agriculture'. These modes of production are interesting to study because they make it possible to compare what is called 'conventional agriculture' (which is widely practiced in the North), which too often serves as a technical reference model, with other approaches, other ways of thinking about agriculture, the role of soils and biodiversity, the benefits of traditional techniques etc.

Here are the contributions of these modes of production.

- They aim at the optimal use of natural resources: use of goods and services provided by nature, primarily water, as functional inputs; preference for a less energy-intensive local supply. It does this by using natural and regenerative processes, such as precipitation, nutrient cycles, biological nitrogen fixation, soil reconstitution and natural enemies of pests, natural pollination.
- They limit the sector's contribution to the greenhouse effect.
- They limit the production of non-reused waste by creating interdependencies with other economic activities, with the aim of achieving greater overall efficiency, and promote the use of by-products of agricultural or other activities.
- They use practices that limit erosion and soil degradation, and reduce the use of inputs to protect water resources.

- They do not compromise the integrity of individuals, in particular by limiting the use of natural or synthetic pesticides that can harm the health of farmers and consumers.
- They protect biodiversity.

2. SUSTAINABLE SOIL MANAGEMENT

Definition and importance of soil

As an invaluable resource, the soils are **particularly affected by various human activities.** Therefore it is important to better know the soils, to protect them and to preserve them. The word 'soil' refers to all unconsolidated mineral and organic substances present on the Earth's surface and used as a natural environment for plant growth. In its traditional sense, soil is the natural environment for plant growth. It thus determines primary productivity and, consequently, life on Earth. Soil represents the loose surface layer of the Earth's crust resulting from the transformation of source rock enriched by organic inputs.

Soil is one of the most precious natural resources. It is an extremely complex and variable environment. Soil is the interface between land, air and water, and is **home to most of the biosphere.** It consists of degraded and decomposed bedrock, water and air, organic matter from rotten plant and animal substances, and thousands of biological forms, mainly micro-organisms and insects. They all play a role in maintaining the complex ecology of healthy soil.

Soil degradation factors

Soil is contaminated with various chemical pollutants that affect its fertility.

Each person handling **pesticides** is responsible for the consequences of their use on the environment. Whenever a plant protection product is used, there is a risk either by accident, negligence or lack of knowledge that part of the product may contaminate an area outside the treated area.

Organic pollutants released into the atmosphere and falling back to the soil are a major problem because soils keep chemicals in 'memory': especially dioxins and PCBs (polychlorinated biphenyls), which are persistent pollutants in soils, or PAHs (polycyclic aromatic hydrocarbons), or heavy metals such as lead (Pb), cadmium (Cd), copper (Cu) and zinc (Zn). Industrial pollution is very high around urban centres, where industries and the high use of leaded fuel have contaminated the lead soil. But intensive agricultural practices can also have a lasting 'impact' on the soil.

Soil degradation may be due to one or more of the following processes:

- physical degradation due to erosion, compaction and crusting;
- chemical degradation related to nutrient loss and acidification;
- biological degradation associated with the loss of organic matter;
- degradation of drainage conditions leading to waterlogging or salinisation.

Understand and respect some basic principles to prevent soil degradation

To effectively prevent soil fertility degradation, **it is necessary to analyse, at the level closest to the ground, the risks induced by the** nature of the soil and its organic matter content, farming practices (especially tillage and fertilisation), topography (particularly the slope), climate (especially rainfall pattens),, and the type of crops planted, (*i.e.* soil cover).

Adherence to a number of basic principles will already significantly reduce or slow the risk of fertility degradation:

- Reduce **tillage** to what is really necessary and prefer the approach adopted by conservation agriculture: 'ecological tillage' and alternative techniques.
- **Plant cover** to protect the soil from heat, erosion, evaporation and leaching of nutrients by rain.
- **Adopt Integrated Soil Fertility Management (ISFM)** by always combining fertiliser inputs with organic matter inputs.
- Amend the soil: providing it with elements such as organic matter and lime, which will make it possible to maintain a good structure on the one hand, and to naturally boost its biological activity on the other hand.
- Use irrigation sparingly: avoid uncontrolled water inflows, and ensure good drainage to avoid salt accumulation in the top layer of the soil.
- Respect soil integrity: avoid polluting the soil with toxic compounds: pesticides, heavy metals present in certain manures or fertilisers, hydrocarbons, household waste.

Opt for techniques to control water and wind erosion

Soil erosion is one of the most critical problems facing agriculture today. This concern has led to the experimentation and development of techniques to control **water and wind erosion.**

- Agroforestry: principle of complementarity (tree – soil – crops). It reduces the loss of soil nutrients and provides protection against erosion, allows the control of cultivated areas by protecting soils, water and combating the greenhouse effect.
- The zaï technique (basins or micro-basins to trap sand, silts of organic matter): it concentrates water locally, controls runoff, erosion, restores macroporosity and the production potential of degraded soil. Zaï revitalises the surface layer, corrects deficiencies, removes aluminic and manganic toxicities from the soil while improving its biological activity. Zaï homogenises the soil and secures production through its effectiveness in water management.

The **fight against water erosion** requires knowledge of the causes of this type of erosion, the evolution of the process and the relationships between erosion and soil conditions. Then, we can choose the improvement and control measures that are always based on the following principles:

- Reducing the force of the impact of raindrops;
- The improvement of the stability or the resistance of the soil;
- Reducing the amount of water causing runoff;
- Reducing water speed and controlling runoff discharge;
- Reduced soil compaction: soil compaction and wheel marks that concentrate water increase runoff.

The presence of a **crop that covers the soil well** is an effective way to control water erosion because, first, it reduces the force of rain drops. Secondly, it reduces the speed of runoff water and finally increases the stability of the soil, its permeability resulting in the infiltration capacity of the water.

The **fight against wind erosion** is organised on two levels: increasing the cohesion of the material in the face of this aggression and reducing the wind speed at the soil surface. The principles of control are based on:

- An increase in the **cohesion of the material**: the addition of organic matter to the soil's surface horizons improves its structure;
- An increase in the **roughness of the soil** surface: these are cultivation techniques that leave large clods or ridges on the soil surface perpendicular to the prevailing wind direction.

In areas subject to high winds, but with **regular directions,** the installation of hedges and windbreaks are appropriate methods. They **slow down wind speed to** reduce evaporation and wind erosion. In the event that dangerous winds blow from **several sides**, wind-permeable fabrics are used instead, thanks to a mesh size of about 5 to 10 mm.

For very desert and sandy areas, **dune fixation** is also effective and efficient. Its purpose is, on the one hand, to extinguish the source of the sands and, on the other hand, to fix the dunes in place.

3. SUSTAINABLE MANAGEMENT OF ORGANIC MATTER

Soil organic matter, roles and valorisation

Organic matter is the carbonaceous matter **produced by living beings**, plants, animals, or micro-organisms. These include notabily carbohydrates, proteins and fats. It is formed by the decomposition action of micro-organisms (bacteria and fungi), nematodes, earthworms and insects.

The shape of organic matter greatly influences its decomposition rate. Some of the molecules, such as simple carbohydrates, starch, hemicelluloses, pectins and amino acids, are easily degradable. Cellulose, a larger polymer, is more resistant. Lignin and other aromatic polymers, which are extremely strong, will be degraded later, more slowly and incompletely.

The **forms of organic matter** most commonly used in agriculture are those that provide **nitrogen**: manure, compost, slurry, liquid manure, poultry droppings and guano, green manures. In addition, there are **organic amendments** containing humic compound precursors (for products with little or no composting, such as fresh manure, green manure, agricultural or agri-food by-products) or humic compounds (for composted products, for vermicompost).

The best form of valorisation of OM is the **production of substrates** by the producer for the needs of his/her exploitation. This will use rustic, inexpensive and relatively easy to implement techniques, such as **composting**, for **example**.

Composting organic waste (by-products of cultivation or agro-industry) is a recovery technique. This operation can be carried out using various techniques but is based on the same phenomenon: fermentation. This fermentation is carried out in two stages: an intense aerobic fermentation with high temperature (50-70 °C) under the action of bacteria followed by the maturation stage which leads to the biosynthesis of humic compounds.

4. SUSTAINABLE WATER MANAGEMENT IN AGRICULTURE

Agriculture is undoubtedly the most water-consuming sector of activity. Since the beginning of the 20th century, the area of cultivated land in general, and that of irrigated land in particular, has increased significantly to cope with population growth and food needs.

Water is a unique and limited natural resource. Water is constantly purified in the hydrological cycle, but the total amount of water on our planet is invariable. Considerable amounts of water are used for agriculture, but up to 60% of the water used for irrigation are wasted. In addition, pollution of rivers and lakes also reduces the value of water resources.

Water pollution

Water is already a scarce resource in many parts of the world, both in quantity and quality (according to WHO, 4 million children die each year from diarrhoea caused by waterborne infections). The water that flows through the soil carries soluble nutrients (fertilisers) with it to groundwater tables or to nearby streams.

Water pollution is a physical, chemical, biological or bacteriological degradation of its natural qualities caused by **man and his activities.** It disrupts the living conditions of aquatic flora and fauna.

Water bodies in agricultural areas are particularly sensitive to this type of **organic pollution**. Due to abnormally nutrient-enriched water (especially phosphates in the case of fresh water), aquatic plants on the banks and suspended plant planktonic organisms proliferate. Vegetation grows and a lot of organic matter settles on the bottom of the water where it is decomposed by aerobic bacteria. The increase in OM decomposition causes a decrease in oxygen levels, particularly at the bottom of the watercourse. Decomposers breathe oxygen: the more numerous and active they are, the more oxygen they consume. An increase in decomposition will decrease the oxygen content of the water.

Agricultural activities can cause pollution by:

- Fertilisers/amendments used;
- Phytosanitary products;
- Pathogens.

Prevention of water pollution

Good Agricultural Practices have major impacts on the prevention of water pollution. In **organic farming**, farmers use proven techniques to maintain their crops. For weeding, they can use mechanical means or thermal means such as flame weedkillers. For pest control, they use techniques from nature, such as sexual confusion, natural parasites or plant decoctions and other solutions registered for organic farming.

All these techniques are also increasingly used in **conventional agriculture**, combined with dose reductions for spread products. The conservation and/or planting of hedges and grasslands also helps to limit pollution, as vegetation acts as a barrier to the transport of residual particles.

The **Water Framework Directive (WFD) establishes** regulations for the prevention and reduction of chemical pollution of surface and groundwater. It provides for the implementation of measures to prevent, reduce emissions and control production processes to limit the input of chemical substances into water and compliance with '**environmental quality standards** (EQS)'.

5. SUSTAINABLE MANAGEMENT OF BIODIVERSITY

Definition and importance of biodiversity

Biodiversity is the **group of living beings that form a given environment.** It refers to the variety of living organisms studied at three levels: ecosystems, the species that live there and the genes found in each species.

Biodiversity is important for the survival of all species. Different habitats are needed for different species, as each species is adapted to a particular set of environmental conditions. Species **depend on each other to survive**, and when one of them disappears, the species that depends on it may also disappear. Special characteristics may allow some species to adapt to environmental changes, but many species cannot adapt if their habitat and food chain are too disturbed.

The different levels of biodiversity constitute **an ecosystem.** When biodiversity loss occurs, ecosystem health is affected. The ecosystem is less resilient when some of its components are lost due to extinction or disappearance. The more extinct species there are, the less the ecosystem can resist ecological change and the less likely it is to function as a whole. An automobile, for example, works well when all its components are in good condition. When a part stops working, such as a headlight, the car can still run normally. However, if the second headlight is also defective, it becomes dangerous to drive at night and if the engine is removed, the car no longer runs at all. Similarly, the disappearance of species causes disturbances in the ecosystem and, eventually, completely destroys its balance.

Even the disappearance of a single species is a concern, as its importance could be as crucial as that of the engine in the automobile. Even if all other automotive parts are functional, without an engine, it cannot start. This is because all other vehicle parts depend on this part to operate. Therefore, the **extinction of a single species can compromise the survival of the entire ecosystem.**

The ecosystem is a dynamic set of living organisms that interact with each other and with the environment in which they live. Genes are important in the structuring of living organisms and, from an ethical point of view, the survival and preservation of biodiversity depend on them.

Biodiversity is important because it contributes to human well-being, protects human health and ensures food security. It appears that biodiversity is a vital resource for all living beings that take most of their needs, such as food, raw materials and therapeutic needs, from this biodiversity. The diversity of living organisms is involved in the formation of ecosystems, habitats, climate regulation and water quality. Biodiversity makes more efficient use of the environment's natural resources. It promotes technological innovation, protects against soil erosion, ensures the deployment of the forest and provides so-called 'ecosystem' services. The main ecosystem services are: supply service, regulatory service, cultural service and support service.

Threats to biodiversity

The notion of **remarkable wild biodiversity** highlights the issue of biodiversity threat. The rate of biodiversity loss, mainly of human origin, is accelerating. Scientists summarise the anthropogenic mechanisms responsible for biodiversity loss into five main categories: destruction, reduction and fragmentation of natural habitats; biological invasions; overexploitation of certain species and environments; pollution and biocontamination of water, soil and air; and global climate change.

The impacts of agricultural practices on biodiversity are mainly found in deep ploughing, the use of mineral fertilisers and chemical pesticides. The use of hybrid varieties and genetically modified organisms (GMOs) also contributes to the loss of biodiversity.

The large-scale use of mineral fertilisers (NPK) contributes to the increasing productivity of agriculture. However, the nitrogen and phosphorus in these fertilisers can have serious consequences on biodiversity. Agricultural practices, such as **farm consolidation** (exchanging land for more large parcels in one piece), leading to the disappearance of paths and the uprooting of hedges, are gradually and profoundly reducing the heterogeneity of landscapes.

Invasive alien species often have destructive impacts on native species, causing extinctions and affecting both natural and cultivated ecosystems. The various species extinction crises are due to human action on the environment, mainly through agriculture, deforestation and urbanisation.

Biodiversity restoration strategies at the farm level

For development to be sustainable, agriculture's commitment to economic, environmental and social performance is inevitable. As such, to start an action in favour of biodiversity, it is first necessary to draw up a 'situation analysis' of biodiversity on the farm and analyse agricultural practices and their impacts.

In implementing biodiversity restoration strategies at the farm level, the deployment of biodiversity-friendly practices will consider, not each plot independently, but the entire farm, in a global approach where actions complement each other, where imbalances offset each other.

There are three points to remember when implementing biodiversity restoration strategies at the farm level.

- Implementation requires the **identification of possible concrete actions, and the coordinated and integrated organisation of action and management plans**, to be carried out at operational level and monitored with well-defined evaluation indicators.
- The implementation of concrete actions on exploitation is a direct response in favour of species and areas identified as in need of conservation or restoration. It is necessary **to stop the loss of wild and domestic biodiversity through selected actions.**
- It is necessary to restore and maintain the capacity for biodiversity change through the implementation of **protection measures, enhancement measures, measures to repair natural environments and species, and measures to compensate for damage.**

Favourable maintenance of ecosystem components helps to maintain or restore ecosystems and species: thoughtful agricultural production in terms of potential impacts on the environment, with agricultural practices that do not affect or are favourable to biodiversity. Safeguarding, restoring, conserving biodiversity as a whole and producing in a sustainable way means informing and training all stakeholders/users of the agricultural world.

6. SUSTAINABLE ENERGY MANAGEMENT

The challenges of climate change for the agricultural sector

The agricultural sector faces challenges at different levels, mainly related to the **effects of climate change.** These climate changes, caused by human activities, **have affected the availability of adequate natural resources and the quality of the atmosphere, soil and water.** Never before have farmers had to rely so much on 'innovation' and 'creativity' to survive in local, regional, national or global markets, and to cope with unprecedented pressure on the planet's life support systems. In short, climate change is **affecting the ability of the agricultural sector to ensure food security for** local populations.

The most affected sectors appear to be agriculture and agricultural enterprises in countries heavily dependent on agricultural inputs as a proportion of GDP. These countries, which include ACP countries, are particularly vulnerable to the effects of climate change and the additional pressure of expanding populations. Predictions suggest that by 2050, the world's population will increase by a third and that a large proportion of these additional people will live in countries with low GDP.

Therefore, the agricultural sector must really transform itself to feed a growing world population, to lay the foundations for continued economic growth and to reduce poverty in countries with lower GDPs. Unfortunately, the impact of climate change will make this task much more difficult in a business-as-usual scenario, due to the negative impacts on agriculture and the increasing costs required to address these impacts.

Much more alarming is the fact that **more than a third of food production is lost or wasted, and with it about 38% of the energy consumed in the** agri-food chain.

Fortunately, several options can be applied to help reduce GHG emissions from the energy system while meeting global demand for energy services.

Interaction between climate change and the use of renewable energy technologies

Climate Smart Agriculture (CSA)

Climate change is already having a significant impact on agriculture and food security due to the increased prevalence of extreme weather events and the emerging unpredictability of weather patterns. Climate Smart Agriculture, as defined and presented by FAO to the The Hague Conference on Agriculture, Food Security and Climate Change in 2010, contributes to the achievement of sustainable development objectives.

CSA integrates the three dimensions of sustainable development (economic, social and environmental) by jointly addressing food security and climate challenges. It is composed of three main pillars:

1. Increase agricultural productivity and income in a sustainable way;
2. Adapt and strengthen resilience to climate change;
3. Reduce and/or eliminate GHG emissions.

Intelligent energy supply systems

The way forward for those who produce and those who process 'beyond' the farm is to move towards energy-efficient food systems. These systems improve energy efficiency, increase the use and production of renewable energy, and expand access to modern energy services in agri-food chains.

Sustainable energy for all

The global energy transition needs the objectives of the SE4All initiative (sustainable energy for all), which are as follows:

- A rapid increase in energy productivity;
- A new generation of institutions to manage our energy systems;
- An integrated approach to energy that includes both centralised and decentralised sources;
- An ever-increasing share of renewable energies in the mix.

The energy transition must be a 'fair' transition, all stakeholders must be taken into account and none should be left behind.

The principle of the energy transition and the benefits associated with an energy transition

To be successful, an energy transition must define common objectives, strengthen energy independence, preserve health and the environment and fight global warming.

The principle of the energy transition is **based on the fight against waste and the promotion of the circular economy:** from product design to recycling, simplify and clarify procedures to improve efficiency and competitiveness.

The energy transition could not only help reduce GHG emissions and energy losses, but also help individual companies to:

- develop their operations in a sustainable way;
- improve both their own health and that of their employees;
- help generate local employment opportunities.

Renewable energy technologies for agri-food chains

The farmer, or business owner, must be able to choose the appropriate renewable energy source, or the optimal mix of sources. The type of preferred energy source will always depend on the resources available on the site and the financial investment associated with this type of energy transition. The technologies used to exploit renewable energy resources and convert them into useful forms of energy are called renewable energy technologies.

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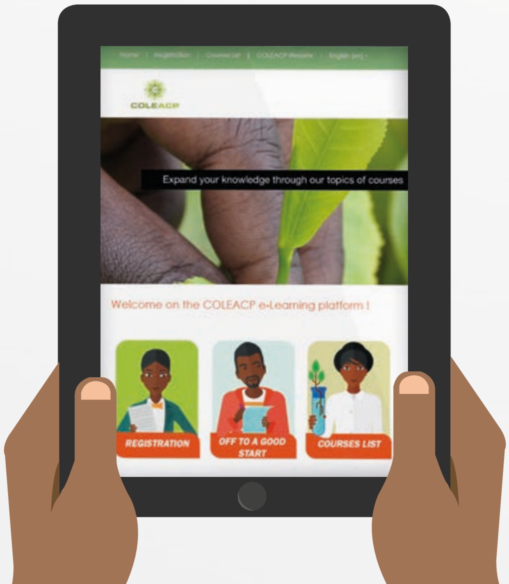

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