TRAINING NOTEBOOK

- ENVIRONMENTAL MANAGEMENT -

SUSTAINABLE WASTE MANAGEMENT

COLEACP

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This publication is an integral part of a COLEACP collection, which is made up of educational and technical tools and materials. All of them are suited to different types of learners and beneficiaries and levels of education found in agricultural supply chains, production and sales.

This collection is available online for COLEACP members and beneficiaries.

FIT FOR MARKET

SUSTAINABLE WASTE MANAGEMENT

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 visualize 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 – INTRODUCTION: DEFINITIONS AND CATEGORIES OF WASTE

- Introduction: waste definitions and waste categories
- Hierarchy in waste management
- National and international waste legislation
- Impacts of agri-food sector waste on soil, water, air, health and living environment
- The circular economy
- Who deals with waste from the agricultural industry?

CHAPTER 2 – EVALUATING YOUR WASTE PRODUCTION

- Waste generation assessment
- The cost of waste and squandering
- The environmental benefits of good waste management
- Definition of the 4 R's...

CHAPTER 3 – REDUCTION OF WASTE GENERATION

- Reduction of waste production
- Implementation of a company program for waste
- Implementation of an integrated waste management plan (IWMP)

CHAPTER 4 – WASTE AND ORGANIC MATTER RECOVERY

- Waste recovery and reuse of organic matter
- Soil enrichment

CHAPTER 5 – WASTE TREATMENT

- Wastewater treatment
- Hazardous waste treatment
- Final waste treatment

Training leaflets

LEAFLET 1

Introduction: definitions and categories of waste

TRAINING OBJECTIVES

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

- define and categorise waste;
- understand the hierarchy in waste management;
- be familiar with national and international waste legislation;
- identify the impacts of waste from the agri-food sector;
- know the principles of circular economy;
- identify the actors who deal with waste from the agricultural industry.

KEY MESSAGES

1) Definition of waste and waste categories

- 'Waste' means any unwanted or unusable substance, material or object, discarded or disposed of after its main use.
- Waste can be divided into four main categories (biological, household, industrial and solid).
- Biological waste mainly contains natural organic materials.
- Household waste is usually generated in residential and urban areas.
- Industrial waste is liquid, solid or gaseous and comes from the manufacture of specific products.
- Solid waste includes municipal waste and may include hazardous materials such as industrial and commercial waste, sewage sludge, waste from agriculture, livestock and other related activities, rubble and mine tailings.

2) Hierarchy in waste management

- Waste disposal is a term used to describe the removal, destruction or storage of damaged, used or unwanted domestic, agricultural or industrial products and substances.
- Disposal includes: burning, burial in landfill or in the seabed.
- Landfilling, incineration and disposal of waste in controlled dumps are the least recommended options.
- Diversion (or waste diversion) is the process of diverting waste from landfill.
- The success of landfill diversion can be measured by comparing the size of the landfill from one year to the next.

- Landfills are facilities created for the specific purpose of permanently storing solid waste. They cannot be built in environmentally sensitive areas and must be designed in such a way as to protect public health and minimise the impact on the environment.
- Other options than landfill are to be favoured: prevention, reduction, reuse or recycling, recovery, disposal, upgrading or even incineration.
- Waste reduction or prevention aims to reduce the amount of waste at the place where it is generated: this is the most environmentally friendly strategy.
- Prevention has two key advantages in terms of GHG emissions: (1) it avoids emissions associated with production; (2) it avoids emissions associated with methane produced by waste.
- Reuse and recycling of waste: used items can be reused (after sorting and processing into raw materials) in new products. It is basically a question of reinjecting these materials into the economy.
- Recycling can include aerobic composting and anaerobic digestion of food waste, and other organic materials.
- Aerobic composting (with oxygen) avoids the formation of methane associated with anaerobic composting (without oxygen), which consists in treating waste in a closed container.
- Waste incineration can reduce the volume by 90%; the remaining 10% (ash) is then sent to landfill.
- In summary, key elements of on-farm waste management include:
  - the collection, sorting and recycling of as much waste as possible;
  - the reuse of as much waste as possible (composting of organic waste);
  - the safe disposal of empty containers;
  - efforts to reduce the production of greenhouse gases;
  - raising awareness on the farm of safe waste management and processes.

3) National and international waste legislation

- The “London Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter” (1972) originally allowed dumping at sea, unless expressly prohibited.
- The ‘Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal’ (1989) was adopted following the scandal of toxic waste deposits imported into Africa from abroad.
- The ‘Bamako Convention on the Ban on the Import into Africa of Hazardous Wastes and on the Control of Transboundary Movements and Management of Hazardous Wastes in Africa’ (1994) supplemented the Basel Convention.
- The ‘Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade’ (1998 and revised in 2015) aims to address concerns about the dramatic increase in the production and trade of chemicals (including pesticides) and the potential risks associated with their importation.
- The “Stockholm Convention on Persistent Organic Pollutants (POPs)” (2001) is a global treaty to protect human health and the environment from chemicals that remain intact in the environment for long periods of time.

- Industrial or commercial standards, such as GLOBALG.A.P., although not integrated into international legislation, constitute a widely applied set of standards that also cover waste treatment in the horticultural sector.

4) Impacts of waste from the agri-food sector

- Waste plant protection products and fertilisers have a negative impact on the soil composition and, ultimately, on its productivity.
- Groundwater can be contaminated by the plant protection products themselves or by their decomposing packaging. This contamination can have toxic effects on the population and biodiversity that depend on this water for their consumption.
- Incineration of packaging can release toxic substances such as dioxins into the air, which pollute the air and can contribute to acid rain. Ashes may contain heavy metals and other toxins.
- The negative effects of chemical waste can be transmitted along food chains ('biomagnification').
- Toxic substances can enter the human body through any of the above pathways, causing all kinds of effects, including respiratory problems, cancer, hormonal disturbances and nervous system disorders.
- Decomposing organic matter affects the natural environment because it can infiltrate watercourses, causing an accumulation of algae that depletes oxygen levels in the water, killing fish and other aquatic organisms.
- The effects of waste related to the use of mechanical engines are diverse.
  - On biodiversity and human health: batteries contain toxic and corrosive acids that can cause poisoning and burns to people and animals.
  - On the ground: oil from poorly maintained machines will infiltrate the ground under the effect of rain. This can affect the ecology of the soil, for example its water retention capacity and biological composition, and therefore also crop yields. Gasoline and diesel fuel contain dangerous substances, such as benzene, that can be harmful even in small quantities.
  - On water: when oil and corrosive substances seep into the soil, they can eventually contaminate groundwater, a source of drinking water for humans and animals. It takes very little gasoline to contaminate the water.
  - On human health: inadequate disposal of organic waste attracts pests such as flies and rats, which spread infectious diseases through contamination of human food and bites.
- Irrigation system waste and other miscellaneous items have a variety of effects:
  - On biodiversity: equipment such as irrigation system tubes and pipes, plant trays and plastic bags, containers, mulching films and bale packaging can be harmful to animals tempted to eat them.
  - On human health: when plastic waste, rubber and other non-biodegradable materials are burned, toxic chemicals pollute the air and can seriously harm human health, causing lung damage, cancer and endocrine disruptions.
- Plastic waste (plastic bags and films) can easily disperse into the environment from garbage cans and landfills, and pollute it.

5) The circular economy

- Turning waste into resources is one of the keys to a circular economy.
- The basic concept of the circular economy is that the transformation, reuse and recycling of waste from one sector results in raw materials for another sector.
- It is the most sustainable model, eliminating waste and ensuring the efficient use of resources throughout the product's life cycle.
- Important elements of the EU Action Plan for the Circular Economy for Food include:
  - the fight against food waste;
  - eco-design;
  - the review of waste energy recovery processes;
  - water reuse;
  - the legislative framework for fertilisers;
  - the launch of innovation agreements;
  - a proposal for a Directive on the sale of goods online;
  - the integration of the circular economy into permits for industrial installations;
  - measures concerning ecological character claims.

6) Stakeholders dealing with waste from the agricultural industry

- At the farm level, waste management concerns: the farm manager, the designated waste manager, harvesters.
- At processing and packaging sites, this includes:
  - all personnel involved in sorting, grading, cooling, cleaning, processing and packaging of products;
  - personnel involved in the purchase of products and packaging materials, R&D, quality assurance and all administrative staff.
- Also affected by this issue are personnel involved in transport (vehicle selection, delivery schedule planning) and distribution (including retailers).

PERSONAL NOTES AND REFERENCES OF THE MATERIALS USED

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LEAFLET 2

Evaluate your waste production

TRAINING OBJECTIVES

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

- identify the nature of the waste produced on an operation and at what point in the process this waste is produced;
- evaluate waste production (nature, volume);
- understand the cost of waste and waste to the community (induced effects on water resources, land, GHGs, etc.);
- understand the benefits of good waste management;
- define the '4 R's' (reduction, reuse, recycling, reuse, recovery).

KEY MESSAGES

1) Waste generation

- Waste is generated throughout the value chain, from production to consumption included.
- Waste from horticultural production can range from organic waste generated at farm level (plants and animals) to non-organic waste (glass, metals, plastics used in packaging), to hazardous waste such as chemicals and fuels used throughout the production process, to household waste (generated by individual workers).
- Agricultural production: losses are due to mechanical damage and/or rejects during harvesting operations (e. g. threshing or fruit picking), as well as sorting and disposal of the crop.
- Post-harvest handling and storage: losses associated with these operations include losses due to deterioration and degradation of products during handling, storage and transport between the farm and processing units.
- Processing: losses resulting from spoilage and degradation during packaging as well as processing processes, such as juice production and canning.
- Distribution: losses and waste come from the marketing system in wholesale markets, supermarkets, retailers and traditional fresh produce markets.
- Consumption: losses and waste exist during consumption and occur at different stages of the food chain; they are closely linked to consumers' standard of living.

2) Waste and waste costs

- Waste or spoilage of resources puts pressure on food security: the global volume of food losses and waste is estimated at 1.6 billion tons of 'primary products', including 1.3 billion tons for edible parts.
- Spoilage of water resources: the total volume of water used each year to produce wasted food is 250 km^3 (equivalent to the annual flow of the Volga River in Russia or 3 times the volume of Lake Geneva).
- Land spoilage and fertile soil depletion: 1.4 billion hectares of land, or 28% of the world's agricultural area, is used each year to produce food that is wasted or lost.
- Rising input costs: According to the first resolution of the Abuja Declaration on Fertilisers, African governments will need to increase the use of fertilisers from an average of 8 kg of nutrients per hectare to 50 kg by 2015 to achieve sufficient yields for food security.
- The impact on the carbon footprint of food losses and waste is estimated at 3.3 billion tons of CO_2 equivalent of GHG emissions released into the atmosphere.

3) Benefits of good waste management

- Reduction of the GHG production.
- Reduction of environmental degradation due to uncontrolled waste disposal.
- Resource and energy conservation through material recovery.
- Access to international finance.
- Generation of other sources of income from waste.
- Revenues from energy and material recovery.
- Improvment of infrastructure, transport and trade routes.
- Promotion of better hygiene for workers and local authorities.
- Capacity building in the conservation of products harvested for consumption or sale, especially in small farms.
- Improved resource management for greater efficiency in agriculture and improved livelihoods.

4) Definitions of the 4 Rs

- R for Reduction: waste reduction is the most important part of the strategy for sustainable waste management in the food chain.
- R for Reuse: the products or materials of an item can be cleaned and reused.
- R for Recycling: reuse discarded materials and incorporate them into new products. The most common waste recycled by households is paper, metals and plastics.
- R for Revaluation: Interest in finding effective ways to obtain biofuels and bioproducts from food waste is growing.

LEAFLET 3

Reduction of waste production

TRAINING OBJECTIVES

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

- understand how to reduce waste generation;
- develop a 'business program' to reduce or recover waste;
- understand how to implement an integrated waste management plan (IWMP).

KEY MESSAGES

1) Reduction of waste production

- Crop that is harvested in too hot weather eventually wilts and spoils. The solution is to plan the harvest according to weather conditions and transport availability.
- Harvesting should be done at the coolest time of the day: early in the morning or late in the afternoon.
- Fruits and vegetables should not be harvested when they are wet by dew or rain. Wet fruits and vegetables will overheat if they are not well ventilated, and are more likely to decompose. Some fruits and vegetables may be more sensitive to damage when wet, e.g. stains and bark breakdown in some citrus fruits.
- Harvested products in the field should be protected by shading and airing them when transport is not immediately available. Products exposed to direct sunlight become very hot. For example, aubergines and potatoes exposed to tropical sunlight for four hours can reach temperatures of nearly 50 °C.
- Products for local markets can be harvested early in the morning. When markets are further away, it may be advantageous (if appropriate transportation can be arranged) to harvest in the late afternoon and transport the products to the market at night or early the next morning.
- When harvesting cannot be done under optimal conditions due to high temperatures, the solution may be to implement pre-cooling systems after harvesting and before transport.
- The harvested product may be covered with mould if the harvesting equipment is dirty. An adequate sanitation system must be put in place for all harvesting equipment, including harvesting containers, knives, pruning shears and other tools.
- Losses occur if products are improperly handled or selected during harvest. One solution is to improve the harvesting hygiene, selection and technique of all farm workers.
- Losses occur if a crop is very damaged and eventually scrapped. One solution is to

improve the selection and use of field containers (crates).

- The crop is not always harvested at its optimal maturity. One solution is to improve the timing of harvesting by carefully planning according to the type of crop and the market

2) Implementation of a 'business program' for waste

- The first step in developing a waste management plan (or program) is to determine the baseline:
  - Where are we now?
  - What waste streams do we produce and in what quantities?
  - Where is the waste currently being transported and for what purpose?
- Life cycle assessment (LCA) of products is very useful for understanding and raising awareness of waste generation.
- A waste management strategy must be defined and based on the contributions of a number of stakeholders in the company or supply chain.
- The strategy must be implemented through the implementation of various waste management activities and their monitoring for continuous improvement over the long term.
- A waste stream survey should be carried out by making an inventory of all vegetable and non-vegetable materials (marketable, compostable, reusable etc.).
- The volume of each waste stream must be estimated as accurately as possible.
- It is necessary to identify the causes/origins of the production of each of the waste streams.
- An inventory of possible options for reducing each waste stream should be carried out, starting with the one where the potential for gains is greatest.
- Options should be sought for the repositioning (reuse) of each waste stream (e.g. composting or fertiliser production).
- Local recycling options must be identified.
- It is necessary to identify the materials that must be disposed of in landfills or incinerated, and to search for materials that can replace them.
- To be cost-effective and efficient, the solutions adopted must be adapted to the local context.
- A monitoring program with reduction targets over time should be put in place and who is responsible for implementing the plan should be identified.
- To reduce food losses in the supply chain, it is possible to diversify production.
- It is necessary to consider the maintenance, repair, recovery of equipment (PPE, irrigation installations etc.) or waste recovery (e.g. office).
- A waste reduction and procurement policy (WRAP) must be developed.

3) Integrated waste management plan (IWMP)

- In a IWMP, there are five main areas of intervention:
  - identification of potential waste streams;
  - evaluation of the reuse and recycling program;

  - exploration waste collection strategies;
  - determination of locations or criteria for waste management sites;
  - consideration of health and safety issues in waste management operations.
- A IWMP for the farm operation must have both short and long-term objectives in accordance with the following steps:
  - step 1: establish an on-site solid waste management system;
  - step 2: effective waste disposal and treatment to minimize environmental and social impact;
  - step 3: definition of the recycling, reduction, reuse system as a priority;
  - step 4: monitoring and updating the plan.
- COLEACP proposes a waste self-assessment model: it is useful for identifying key areas for improving data collection and monitoring.

PERSONAL NOTES AND REFERENCES OF THE MATERIALS USED

LEAFLET 4

Waste and organic matter recovery

TRAINING OBJECTIVES

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

- understand the value of using biomass (recycling or other options);
- know how to recover waste and/or reuse organic matter (OM);
- identify waste that can be used to enrich the soil or to make compost and materials that should never be placed in compost;
- understand how to use waste to enrich the soil with OM.

KEY MESSAGES

1) Waste recovery and reuse of organic materials

- Waste recovery allows the reuse of organic materials through recycling, reuse and composting to produce energy, enrich the soil and reduce pollution and the exploitation of natural resources.
- Recycling (conversion) has environmental, economic and social benefits:
  - it reduces the demand for new resources;
  - it prevents environmental pollution (less landfilling);
  - it reduces the amount of waste in landfills;
  - it allows the use of materials that would otherwise be wasted;
  - it saves money by reducing the additional costs associated with new materials and reducing the costs associated with transporting waste; it avoids the manufacture of new items and the waste of resources;
  - it allows energy to be recovered by transforming waste into energy, thus reducing energy costs.
- For plastics, glass and metal, there are usually reusing and recycling options (but they must be organised and implemented).
- 'Biomass' presents an opportunity for conversion, because it is a natural and clean energy source.
- The valorisation of biomass can also be a vector of economy (reduction of costs due to the non-use of fossil/forest fuels) and also a vector of employment.
- Using biomass has some advantages:
  - energy self-sufficiency;
  - environmental benefits;

  - solution for excess waste;
  - etc.
- Animal and green waste is destined for composting.
- Manure is a resource, but the following steps are important in developing a ‘manure management plan’ on a farm:
  - assessment of needs;
  - know where and when to apply manure;
  - know how to conserve manure nutrients.
- A composting plan and a composting schedule should be developed.
- Several mistakes should be avoided when composting organic waste. For example, some materials should not be used for composting:
  - charcoal ash: the high carbon dioxide content interferes with the supply of oxygen to the composting system, slowing down the process;
  - dog and cat excrement: they contain harmful pathogens;
  - any organic material that may be contaminated by pests or diseases;
  - eucalyptus and cassia leaves or any biomass suspected of containing substances toxic to microbes;
  - meat and animal fat.

2) Soil enrichment

- Healthy soils need a good balance of nitrogen (N), potassium (K) and phosphorus (P) in the fertiliser.
- Straw can also be left on the ground to prevent water evaporation, reduce soil warming and keep moisture in the soil until it turns into organic matter that can be used by the soil.
- Composting is one of the few methods available to quickly create a ‘soil’ type material on rapidly eroded land.
- Use of wood waste, or by-products of the wood processing industry, such as chips, bark and sawdust, is of interest.
- Forest residues are mainly composed of tree tops and branches that remain after the wood harvest.
- Some forest residues must be left on the forest floor, where they will decompose to return nutrients to the soil.
- The planting and cultivation of local herbaceous plants, in alternation, allows the oxygenation of the soil and the reuse of the plant in compost or as dry grass after cutting left on the ground.

LEAFLET 5

Waste treatment

TRAINING OBJECTIVES

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

- understand the principles of wastewater treatment;
- understand how to dispose of, recycle or treat waste according to its nature and hazardousness;
- understand how to manage and dispose of hazardous waste.

KEY MESSAGES

1) Wastewater treatment

- Before being treated, wastewater must be settled: heavy materials reach the bottom to form sludge while light materials rise to the surface.
- Wastewater treatment uses filtration methods or the use of chlorine.
- In a water filtration system from a conditioning station, a mesh must be installed to trap solid waste before water can enter.
- Riparian areas improve water quality by trapping sediment and nutrients.
- Permanent soil cover must be maintained, especially in winter, to prevent nitrogen runoff.
- The anaerobic baffle reactor is a kind of septic tank, improved due to the series of baffles over which incoming wastewater is forced to flow, thus allowing for more efficient treatment.
- Producers are required to apply good agricultural practices and must:
  - practice scheduled irrigation, with monitoring of plant needs and the state of soil water supplies to avoid water loss through drainage;
  - prevent soil salinisation by limiting water supply to requirements and recycling water as much as possible;
  - avoid crops with high water needs in a region where water availability is limited;
  - avoid drainage and runoff of fertilisers;
  - maintain permanent soil cover, especially in winter, to prevent nitrogen runoff;
  - carefully manage the groundwater table, limiting large water flows;
  - restore or conserve the wetlands;
  - provide good water points for livestock;
  - collect water *in situ* by digging catchment pits, crescent-shaped dikes across slopes.

2) Hazardous waste treatment

- Hazardous waste must not be buried in the ground, placed on the ground, disposed of in local landfills not equipped to receive it, disposed of in septic tanks, or disposed of in open combustion dumps.
- Hazardous waste can contaminate water, soil and therefore crops and affect the health of populations.
- Hazardous waste must be either:
  - disposed of in suitable disposal sites and controlled by approved bodies;
  - disposed of in an incineration plant with controls for air emissions and ash treatment;
  - recycled or reused where possible.
- Otherwise, it is recommended to store hazardous waste until an appropriate solution is found for its safe disposal.
- Hazardous waste can be physically treated by solidification (e.g. in cement blocks), chemical treatment or incineration in cement kilns.

3) Final waste treatment

- Some of the waste is recycled and some of the waste is composted which will provide fertiliser. Some of the waste is non-recoverable (hazardous waste) and some of the waste will go to the incinerator and then to landfill.
- Waste recovery techniques must be applied if they are economical, efficient, cost-effective and environmentally friendly.
- Appropriate structures should be created to collect data on the types, sources and composition of waste to enable planning and investment, and to independently monitor and evaluate results.
- Authorities and private partners must charge for waste collection in an appropriate way.
- Appropriate incentives can promote the use of recycled, recyclable and/or biodegradable items for daily use, or the reuse of agricultural waste as an energy source.
- The creation of regional networks can promote the recycling and reuse of waste.
- Waste disposal should be carried out in appropriate landfills (depending on the type of waste) and controlled to avoid contamination of water and soil.
- Safe disposal of waste can be achieved in incineration plants.
- A standard procedure must exist for the acceptance of waste at a landfill site in order to avoid any risk.

Summary of the manual

Sustainable waste management

1. INTRODUCTION TO THE WASTE ISSUE, DEFINITION AND CATEGORIES OF WASTE

According to the United Nations Environment Programme (UNEP), we currently produce 2.12 billion tonnes of waste per year, including 1.3 billion in urban areas alone. The World Bank estimates that the average volume of waste produced per person per day is 1.2 kg, but the volume and type of waste varies considerably by region and income.

In low-income countries, each person produces 0.60 kg of waste per day, while in higher-income countries, this volume reaches 2.13 kg per day. By 2025, waste generation in cities is estimated to increase to 2.2 billion tons per year as the population and its standard of living increase.

Global problems to be solved

In summary, the **most pressing global problems associated with waste** are as follows.

- **Unsustainable waste levels:** solid waste generation will increase by 70% from 2010 levels (3.5 million tonnes per day) to reach more than 6 million tonnes by 2025. Urban waste alone is already enough to fill a line of 5,000 km long garbage trucks every day. According to research, by 2100, a growing urban population will produce three times more waste, with widespread social and environmental consequences for cities around the world.
- **Waste disposal:** about 4 billion people use unregulated or illegal landfills that receive more than 40% of the world's waste. The operation of waste disposal services requires effective integrated systems, but **more than half of the world's population does not have access to regular waste collection.** Research suggests that infrastructure (waste sorting and treatment facilities, closed dumps, landfills, garbage bins, skips, trucks and transfer centres) in low- and middle-income countries **are already being used to the maximum and are not sufficient** to serve a growing urban population. The lack of effective waste management systems, as well as practices related to unregulated landfills or open burning, have **serious consequences for health, safety and the environment**. Uncollected solid waste contributes to flooding, air and water pollution, and has potential public health impacts, such as respiratory diseases due to burning, diarrhoea and dengue fever, due to open dumps. Poorly managed landfills are fertile ground for pests and diseases.
- **Links to climate change:** when organic matter such as food waste decomposes in landfills, **it releases methane** (a greenhouse gas 21 times more powerful than carbon dioxide). Methane emitted represents 12% of total global emissions and almost 5% of total greenhouse gas emissions. **This makes waste disposal the fourth largest source of greenhouse gas emissions other than carbon dioxide.** Carbon dioxide from organic biomass in municipal waste is considered to be climate-neutral. Indeed, the carbon emitted during combustion or biodegradation of plants is equivalent to the carbon they absorb during their growth. Biomass carbon returns to the atmosphere, whether it is burned for energy or as a result of biodegradation or forest fire. It includes CO_2 from composting (aerobic) as well as CO_2 from burning methane in a generator or a flare to produce electricity.
- **Importance of the cost of waste management:** according to the World Bank, population growth and rising consumption levels will increase the cost of waste management from $205 billion per year in 2010 to $375 billion in 2025. Since **solid waste management in developing countries can use up to 50% of a municipality's budget,** countries about to move from low- to middle-income status will be particularly

affected, as they lack tax or tariff structures to support solid waste management programmes and have a population used to using open dumps for free.

- **Social impact of waste:** worldwide, waste management industries rely on **workers in the informal sector.** 15-20% of waste is managed by individuals or micro-enterprises that are not officially registered or recognised.
- **Food loss and waste: for the horticultural industry, the issue of waste is particularly important.** FAO estimates that about 1.3 million tonnes of food, or one third of global food production for human consumption, is lost or wasted each year. 30% of losses and waste are in cereals, 40-50% in root crops, fruit and vegetables, and 20% in oilseeds, meat and dairy products. At the consumer level, the annual estimate of food waste *per capita* is between 95 and 115 kg in Europe and North America, and between 6 and 11 kg per year in sub-Saharan Africa and South Asia.
- **Waste of limited natural resources:** population growth will lead to increased demand for agricultural products. It is estimated that 2,000 to 5,000 litres of water are needed to produce a person's average daily food intake. OECD research (2015) suggests that we will need to produce nearly 50% more food by 2030. Soil erosion, water scarcity, land and ecosystem degradation are already a growing concern, so we cannot afford to lose or waste food. **These global problems mean that we will have to become much more resource-efficient and explore ways to reduce and reuse waste.** This applies to all sectors of the economy, but especially to agriculture, given the current volume of losses and food waste in the world.

Definition of 'waste'

'Waste' means any unwanted or unusable substance, material or object, discarded or disposed of after its main use. The OECD states that waste can be generated during the extraction of raw materials, the processing of raw materials into intermediate and finished products and their final consumption.

Waste can be divided into **four main categorie.**

1. Biological waste: mainly contains natural organic materials (plant remains animal excrement, biological sludge from wastewater treatment plants, etc.). Biological waste can take the form of solid or liquid waste and can also come from household waste.
2. Household waste: this refers to waste usually produced in residential and urban areas. This category includes waste with similar characteristics, which is produced in the course of economic activities and can be treated and disposed of with household waste. Household waste is mainly biological and may also include solid waste.
3. Industrial waste: liquid, solid and gaseous waste from the manufacture of specific products.
4. Solid waste: solid waste includes municipal waste and may include hazardous materials such as industrial and commercial waste, sewage sludge, waste from agriculture, livestock and other related activities, rubble and mine tailings.

2. NATURE AND MANAGEMENT OF WASTE FROM AGRICULTURAL OPERATIONS

The types of waste from the farm range from biological waste (vegetable and animal residues) to household waste (kitchen, plastic waste, paper) and solid waste (metals, empty chemical containers and fertiliser bags).

Effective integrated waste management on farms **requires producers to identify the types of waste produced and reduce their impact on people and the environment** through effective disposal, reuse or recycling. For example, on an agricultural holding, holes dug to accommodate waste **must be away from water sources**, and rainwater must not be allowed to accumulate there. In addition, effluents from the processing of food discharged directly into water bodies can have an impact on the water catchment area of entire communities, which can then be exposed to the risk of drinking polluted water. **It is essential to raise farmers' awareness of** the different processes and the safe management of waste, in order to ensure an effective waste disposal system.

Farm waste can become a reusable resource. To do this, they must be separated and clearly sorted into different categories, such as paper, metals, organic waste and plastics. Inorganic waste cannot be broken down, but can be used for different purposes on the farm and at home. However, **mixed and unsorted waste cannot be reused.**

Composting of organic waste

Organic waste from the farm can be used to make compost which, when added to the soil, improves its fertility. Composting is the microbiological decomposition of organic substrates in the presence of oxygen (aerobic conditions).

Food waste, fruit pulp, cocoa pods, banana stems, fallen or damaged fruit can all be turned into fertiliser after composting, reducing the need to buy chemical fertilisers. Animal excrement from poultry to livestock can also be used to produce manure and added as fertiliser. In a typical composting process, 40 to 70% of the organic matter present is degraded, with the output weight of the compost representing 30 to 50% of the input weight. In the case of manure, for composting to be effective, the dry matter content must be at least 30 to 40%.

Waste and hazardous materials disposal

Poorly managed waste management programs, such as open burning and leachate from open dumpsites, contribute not only to climate change, but also significantly to water and soil contamination. This type of behaviour presents significant dangers to humans, wildlife and biodiversity. When disposing of hazardous waste in recycling companies or municipal landfills, it must be ensured that operators dispose of the waste responsibly and do not release the waste into the environment or incinerate it illegally. One way to do this is to verify that the site has a waste management permit.

Waste incineration

Incineration of waste (including leaf debris or cut grass) **pollutes the air and soil, and damages human health** through the release of toxic gases. The use of an incinerator to burn waste is only allowed if there is technical data indicating that the incinerator reaches **sufficiently high temperatures** (at least 1100 °C for several seconds) not to produce toxic fumes.

Structures must be built away from living areas, and the operation must hold the necessary permits for the legal and safe operation of the incinerator. Waste, such as plastic agrochemical containers, should not be reused as household containers, discarded or burned, but washed and perforated to ensure that they will not be reused. In general, the types of waste that can be disposed of by incineration, without requiring an environmental permit, are limited to untreated vegetation, wood and timber. The following wastes may be burned in a garden fire or incinerator: fallen or felled logs and tree branches; untreated lumber from fence repairs; untreated lumber packaging; hedge trimming waste; crops and vegetation; leaves and bark.

Crop residues should not be burned, as this releases greenhouse gases into the atmosphere and **can deprive the soil of valuable organic matter.** The best alternative to burning crop residues is to **make compost to enrich the soil.**

Reducing climate impacts

Waste contributes to GHG emissions in the same way as methane and CO_2. One of the main ways to reduce carbon dioxide emissions is to produce energy from waste. Examples include the use of waste as fuel (from damaged products) to produce biogas from organic waste, the production of compost from organic waste, and the recycling and use of waste instead of incineration.

3. WASTE AT FOOD PROCESSING SITES AND IN THE SUPPLY CHAIN

FAO estimates that in developing countries, 40% of food losses and waste occur during harvesting, processing and storage. Food losses and waste result in a loss of income for producers and higher prices for consumers. There is a need to reduce emissions and waste flows from agriculture and food processing to the environment.

In fact, **waste reduction and conversion has become the new leitmotiv for horticultural companies seeking to reduce their production costs,** both at the operating and plant level. The quest for greater resource efficiency is based on the realisation that in the future we will have fewer natural resources. Therefore, greater resource efficiency is the **ultimate goal of reducing waste.**

According to UNEP, 5 billion tons of biomass are produced annually from agriculture. This is equivalent to 1.2 billion tons of oil, or 25% of current world production. Several options for reusing waste at food processing sites exist.

Mechanical processing/mill

The mechanical treatment of organic waste makes it possible to **modify the size, morphology and/or density of the waste.** A relatively simple technology is the calibration of organic waste by shredding. The result is a product with uniform maximum dimensions, suitable for direct application as compost or for further processing. This option is potentially interesting when it comes to transporting waste over long distances.

Anaerobic digestion, biogas and fuel production

Anaerobic digestion is **the biological degradation of organic matter in the absence of air to produce combustible biogas** and a nutrient-rich organic by-product (Farming Futures). The process is based on the principle of wet fermentation. The result is the production of biogas, which is a **valuable energy carrier.**

The process involves the collection of organic materials from agricultural waste, wastewater and household waste. These organic materials are then stored in a closed, airless container that acts as a 'digester'. During the fermentation process, which lasts three to four weeks (depending on the internal temperature of the digester), the bacteria break down the raw material and generate biogas. Biogas is a mixture of several gases and vapors, mainly methane and carbon dioxide. As it is a slow biological process, reactors (digesters) tend to be large. **Biogas can be used directly to produce heat,** for example in boilers, but it can also be **converted into electricity, or purified and pressurised for use as an automotive fuel.** The other main product of anaerobic digestion is **digestate**, a high nitrogen input that can be used **as a fertiliser.**

FAO estimates that in industrialised countries, **40% of food losses and waste occur at the retail and consumer level,** often due to standards that require a given quality, size, appearance and shelf life for a product. Food losses are highest in the categories of fruit and vegetables, roots and tubers.

The types of waste produced by consumers vary according to income level. **Low – and middle – income countries tend to have a higher proportion of organic waste**, accounting for up to 64% of the total waste stream.

Populations in higher-income countries tend to consume more inorganic materials (plastic, paper and aluminium), with organic waste accounting for only 28% of the total waste stream.

To address the management of existing waste streams with consumers, a collaborative framework, known as the **WRAP initiative,** has been created to raise public awareness about sustainable waste management and the use of natural resources. The mission of the WRAP initiative is to accelerate the move towards a sustainable and resource-efficient economy by:

- reinventing the design, production and sale of products;
- rethinking the way people use and consume products;
- redefining what is possible through reuse and recycling.

4. HIERARCHY IN WASTE MANAGEMENT

The hierarchy in waste management refers to a generally accepted management process developed in the 1970s and known as Pollution Probe in Ontario. This hierarchy covered the 'three Rs', *i.e.* reduce, reuse, recycle, and now includes a fourth 'R' for (re)recovery. It recognises that there is no single approach to waste management that is valid for the management of all materials and waste streams. The hierarchy ranks the different management strategies from the most environmentally friendly to the least environmentally friendly and encourages the reduction of GHG emissions.

According to the hierarchy, waste management is classified as follows:

- **Waste disposal:** a term used to describe the removal, destruction or storage of damaged, used or unwanted domestic, agricultural or industrial products and

substances. Disposal includes burning, burial in landfills or in the seabed. Landfilling, incineration and disposal in controlled landfills are the least recommended options.

- **Waste diversion**: or diversion of landfilled waste is the process of diverting waste from landfills. The success of landfill waste diversion can be measured by comparing the size of the landfill from one year to the next. If the size of the landfill increases very little or remains the same, landfill waste diversion policies are considered effective.

The preferred options are as follows.

- **Waste reduction:** also known as waste prevention, this approach aims to reduce the amount of waste at the place where it is generated. This is the most environmentally friendly strategy. This can take the form of reusing or reducing packaging and redesigning products to allow consumers to recycle. It has two key advantages in terms of GHG emissions: first, it avoids emissions associated with production and, second, it avoids emissions associated with methane produced by waste.
- **Waste reuse and recycling:** all activities associated with the collection of used, reused or unused items, the sorting and transformation of these products into raw materials and their reuse in new products. It is basically a question of reinjecting these materials, into the economy.
- **Waste recovery:** by aerobic composting and anaerobic digestion. Recycling can include composting food waste and other organic materials. Aerobic composting (with oxygen) avoids the formation of methane associated with anaerobic composting (without oxygen), which consists of treating waste in a closed container and is often associated with wastewater treatment. The latter produces methane can be flared or used to produce heat and/or electricity. It is also known as energy recovery.
- **Incineration:** waste incineration can reduce the volume of waste by 90%. When this process involves energy recovery, by converting non-recyclable waste into electricity and heat, it can generate a renewable energy source and reduce GHG emissions, offsetting energy needs from fossil sources and reducing methane production in landfills. However, when incineration does not include energy recovery, it can be costly and cause serious air pollution due to open burning. After incineration, about 10% of the waste volume remains in the form of ashes which are then sent to landfill.
- **Landfill**: landfills are facilities created for the specific purpose of permanently storing solid waste. They cannot be built in environmentally sensitive areas and must be designed in such a way as to protect public health and minimise the impact on the environment. These sites must be monitored and controlled to verify groundwater contamination and landfill gas. Although it is possible to recover energy from these sites through the aerobic decomposition of organic matter and methane (capture of 50% of landfill gas), developing countries often lack adequate facilities.

In summary, **key elements of on-farm waste management include:**

1. the collection, sorting and recycling of as much waste as possible;
2. the reuse of as much waste as possible (composting of organic waste);
3. the safe disposal of empty containers;
4. efforts to reduce the production of greenhouse gases;
5. raising awareness on the farm of safe waste management and processes.

5. NATIONAL AND INTERNATIONAL WASTE LEGISLATION

Three global multilateral treaties dominate global waste disposal agreements. These are some of the texts.

- The 1972 London Convention, or 'Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter', which originally allowed dumping at sea, unless expressly prohibited. This convention was updated with the 1996 protocol to take a more cautious approach and subsequently prohibited the dumping of all waste at sea unless specifically authorised. The new protocol required countries to demonstrate that the discharge of waste would not have an impact on the environment. It is important to note that as of June 2007, countries such as the United States and the Netherlands had still not ratified the 1996 Protocol.
- The 1989 Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, adopted in response to the public outcry over the dumping of toxic waste imported from abroad in Africa. Between 1986 and 1988, it is estimated that 15 African countries were targeted by Western companies who offered them money in exchange for land to be used as toxic waste repositories. The international community's response has increased as awareness of environmental and social impacts has increased. The Convention prohibits the shipment of hazardous waste to non-Party States, as well as the shipment of waste to States that have expressly prohibited its import. Where the transfer is not prohibited, the Convention establishes a control system. It is important to note that, with the exception of Antarctica, the Convention does not prohibit any particular destination for hazardous waste. A proposed amendment to the Convention now specifies that, instead of leaving it to States to decide whether they do not want to import waste, the disposal of hazardous waste from developed to developing countries must be totally prohibited. With this ban, the Basel Convention has effectively moved from a control system to a prevention system.

Legislation on safe disposal and recycling

National legislation on waste management is the responsibility of local authorities and varies from country to country. That said, most countries and cities around the world are encouraged to adopt **integrated waste management plans (IWMPs)** that cover systematic issues related to waste collection, transport, recovery and disposal. These plans are increasingly integrated into national legislative frameworks and developed in consultation with stakeholders from local authorities, NGOs, the private sector, the informal sector and service users.

According to the Dutch NGO WASTE, **national waste management legislation should follow the following principles:**

- equity of all citizens in access to waste management systems;
- system efficiency to safely dispose of waste;
- efficiency to maximise benefits and minimize costs;
- environmental, social, economic and institutional sustainability.

The United Nations Habitat Framework **also identifies three key elements of the system** that need to be addressed in legal frameworks to ensure integrated waste management:

1. ***Ensuring public health:*** this is an important concern and driver for most legislation, as waste management is essential to maintaining public health. Research suggests that if solid waste is not properly collected, it can lead to cholera and that there

are 'significantly higher rates of diarrhoea and acute respiratory infections among children living in households where solid waste is dumped or burned nearby'. Uncollected waste also clogs sewers, and causes flooding and the subsequent spread of waterborne diseases. Relevant legislation may include:

- landfill directives setting out the technical requirements for waste destined for landfills and setting targets for the reduction of biodegradable waste;
- hazardous waste regulations;
- waste regulations concerning toxic gases resulting from waste incineration;
- regulations on the transport and shipment of waste;
- regulations concerning toxic gases resulting from waste incineration.

2. **Ensure environmental protection:** the improvement of waste disposal and/or the development of engineered landfills have been motivated by the protection of public health and the environment. **Landfilling at unregulated sites presents significant risks.** Environmental threats include **groundwater and surface water contamination** by leachate. In a number of developing countries, major accidents have also occurred, involving landslides of unstable solid waste mountains in illegal landfills.
3. **Efficient resource management:** the global market for recyclable materials is expanding, saving energy and money. For example, the **scrap market** is estimated at 400 million tonnes per year. However, developing country governments still rely on public funding mechanisms and tax revenues to safely manage and dispose of waste.

National integrated solid waste management (ISWM) plans

Countries and cities around the world are encouraged to develop what are formally called integrated solid waste management (ISWM) plans that establish a clear framework for waste treatment.

In theory, **ISWM should include:**

- national policies with clear waste management goals, objectives and initiatives;
- specific scales for national, regional or local plans, in accordance with population distribution;
- data on waste generation, including projections for the waste management plan (usually over a period of 15 to 25 years);
- an inventory of the options proposed for the collection, transport, treatment and disposal of the different types and quantities of waste, covering financial and technical aspects, governance, measurement and monitoring of plans.
- an assessment of the most environmentally friendly options for the safe disposal of waste, integrating technical, environmental, social and financial resources;
- institutional reforms and related regulatory provisions necessary to support the plan;
- details of the proposed monitoring and control measures to be implemented and their reporting frameworks;
- a financial evaluation of the plans, including the costs of investing in facilities and services, over the life of the plan;
- the sources of income (e.g. taxation) that can be realistically considered, including subsidies and user fees;

- requirements for the management of all untreated solid waste generated, the facilities required and the associated service providers, and the allocation of costs;
- an overview of the consultation processes with interested stakeholders, including local authorities and business enterprises;
- a long-term (5 to 10 years) and short-term (1 to 3 years) implementation plan;
- an overview of major treatment facilities (e.g. landfills, composting plants and transfer centres);
- an assessment of GHG emissions and the role of ISWM.

As a general rule, **strict controls should apply to hazardous waste from the moment it is generated, during transport, management and recovery.**

6. TYPES OF WASTE AND THEIR IMPACTS

Plant protection products and fertilisers

The waste of these chemicals (obsolete stock, excess mixing, empty packaging and containers, etc.) has an impact on the following elements.

- **Soils:** soil ecology – composition that ultimately determines the richness and productivity of the soil for crops that can be significantly altered by pollution from plant protection products.
- **Water:** groundwater can be contaminated by the products themselves or by decomposing packaging. This contamination can have toxic effects on the population and biodiversity that depend on this water for their consumption. Effects can also occur along the food chain; fish swimming in a river polluted with chemicals can transmit their toxicity to humans who consume them.
- **Air:** incineration of packaging can release toxic substances such as dioxins, which pollute the air and can contribute to acid rain. Ashes may contain heavy metals and other toxins
- **Biodiversity:** the negative effects of chemical waste can be transmitted along food chains, causing 'biomagnification': impacts are multiplied at each level of the food chain, resulting in very significant changes for local biodiversity. The number of pollinating insects such as bees and butterflies can decrease, which reduces pollination levels and therefore crop yields.
- **Human health:** toxic substances can enter the human body through any of the above pathways, causing all kinds of effects, including respiratory problems, cancer, hormonal and nervous system disorders.

Waste from engines, batteries, oil, etc.

This waste has an impact on the following elements.

- **Biodiversity and human health:** batteries contain toxic and corrosive acids that can cause poisoning and burns to people and animals. Engine oil can have toxic effects on biodiversity. For example, oil that seeps into soil vegetation or water can kill or contaminate fish.
- **Soils:** oil from poorly maintained machinery will infiltrate the soil under the influence of rain. This can affect the ecology of the soil, for example its water retention capacity and biological composition, and therefore also crop yields.

- **Water:** when oil and corrosive substances seep into the soil, they can eventually contaminate groundwater, a source of drinking water for humans and animals. This can have serious short- and long-term health effects.

Organic waste

This waste can have negative impacts on the following elements.

- **Human health:** inadequate disposal of organic waste attracts pests such as flies and rats, which spread infectious diseases through contamination of human food and bites. In addition, when organic matter is left in piles, standing water pools formed after rains can be fertile ground for mosquitoes that carry diseases.
- **The natural environment:** decomposing organic matter can infiltrate watercourses, causing an accumulation of algae that depletes oxygen levels in the water, killing fish and other aquatic organisms. The decomposition of organic matter can also cause unpleasant odours that intensify in hot weather, making areas uninhabitable for humans.

Wastes related to the irrigation system and other miscellaneous items

This waste can have negative impacts on the following elements.

- **Biodiversity:** equipment such as irrigation system tubes and pipes, plant trays and plastic bags, containers, mulching films and bale packaging can be harmful to animals tempted to eat them.
- **Human health:** when plastic waste, rubber and other non-biodegradable materials are burned, toxic chemicals pollute the air and can seriously harm human health, causing lung damage, cancer and endocrine disruptions. In addition, toxic smoke can be carried in the air over long distances, affecting people and places much further away from the original source of pollution.

Waste of fossil energy

Waste of energy can have negative impacts on the environment. Gasoline and diesel fuel contain dangerous substances, such as benzene, that can be harmful even in small quantities. It takes very little gasoline to contaminate the water. The impacts on biodiversity are also extremely negative. When fuels spread on the ground or infiltrate the ground after rains, the negative effects on soil ecology result in a decrease in crop germination and therefore a reduction in yields for the farmer.

Other wastes

Many non-organic waste disposed of as ordinary waste can last hundreds or even thousands of years in the environment. For example, plastic waste (such as bags and films) can easily be dispersed from bins and landfills. Much of this lightweight material presents a range of hazards to wildlife and domestic animals that can become entangled or choked if they accidentally confuse these wastes with food. The chemical composition of the plastic makes its decomposition very slow in the environment. It can travel long distances without decomposing.

7. WHO DEALS WITH WASTE FROM THE AGRICULTURAL INDUSTRY?

All actors in the food chain should address the issue of agricultural waste in order to improve efficiency and reduce costs. This is why **it is important to involve all actors in the supply chain in order to ensure a coherent action plan for waste reduction.**

In addition, at each stage of the supply chain, for example, at the farm level, all staff must be trained in proper waste management to ensure their commitment to strategy and responsibility.

- At the farm level: the farm manager, the designated waste manager, but also the harvesters.
- On processing and packaging sites:
    - all personnel involved in sorting, grading, cooling, cleaning, processing and packaging of products;
    - personnel involved in the purchase of products;
    - personnel involved in the purchase of other materials, such as packaging materials;
    - etc.
- At the transport and distribution level: personnel involved in vehicle selection and delivery schedule planning; personnel responsible for loading products; drivers...
- At the retail level: purchasing staff; R&D staff; quality assurance staff; workshop staff – including the designated waste manager.

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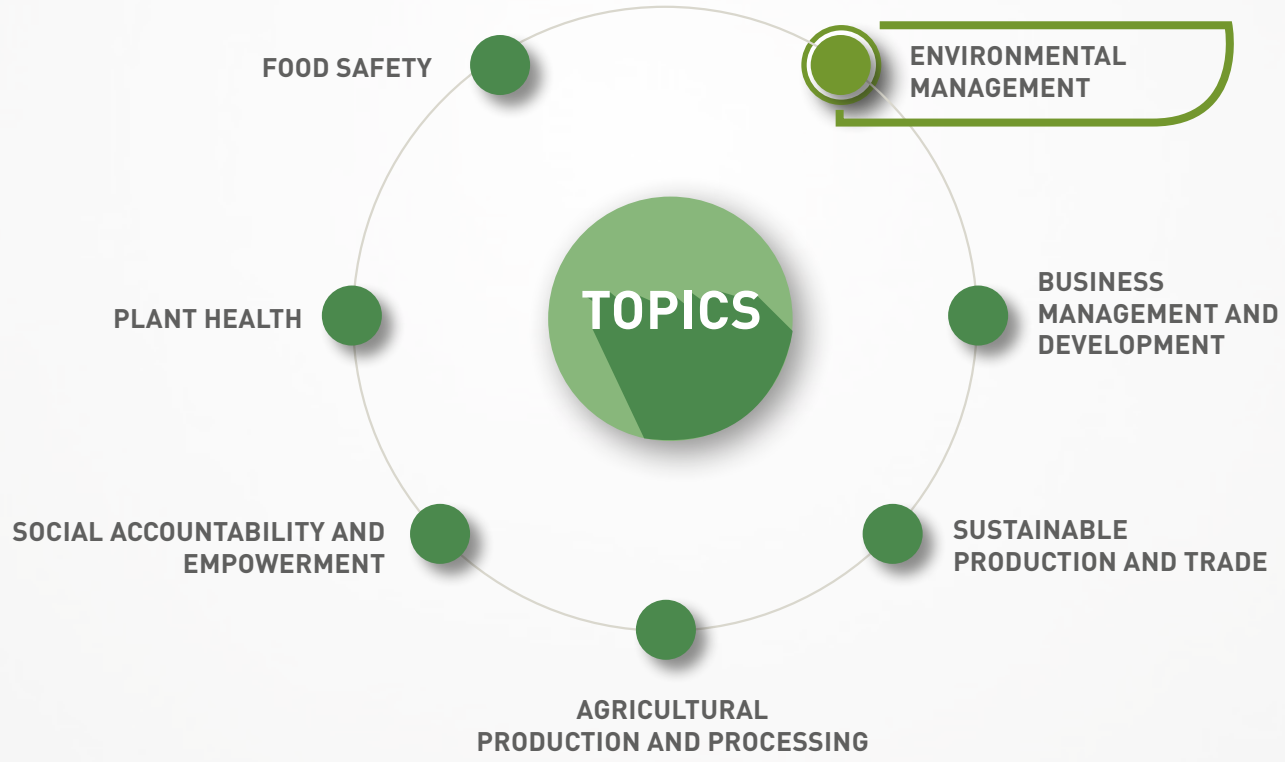

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