Environmental, Health, and Safety Guidelines for Perennial Plantation Crop Production

Introduction

1. The Environmental, Health, and Safety (EHS) Guidelines are technical reference documents with general and industry-specific examples of Good International Industry Practice (GIIP). When one or more members of the World Bank Group are involved in a project, these EHS Guidelines are applied as required by their respective policies and standards. These industry sector EHS Guidelines are designed to be used together with the General EHS Guidelines document, which provides guidance to users on common EHS issues potentially applicable to all industry sectors. For complex projects, use of multiple industry-sector guidelines may be necessary. A complete list of industry-sector guidelines can be found at www.ifc.org/ehsguidelines.

2. The EHS Guidelines contain the performance levels and measures that are generally considered to be achievable in new facilities/farms and forests by existing technology at reasonable costs. Application of the EHS Guidelines to existing facilities/farming and forestry systems may involve the establishment of site-specific targets, with an appropriate timetable for achieving them.

3. The applicability of the EHS Guidelines should be tailored to the hazards and risks established for each project on the basis of the results of an environmental assessment in which site-specific variables, such as host country context, assimilative capacity of the environment, and other project factors, are taken into account. The applicability of specific technical recommendations should be based on the professional opinion of qualified and experienced persons.

4. When host country regulations differ from the levels and measures presented in the EHS Guidelines, projects are expected to achieve whichever is more stringent. If less stringent levels or measures than those provided in these EHS Guidelines are appropriate, in view of specific project circumstances, a full and

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1 Defined as the exercise of professional skill, diligence, prudence, and foresight that would be reasonably expected from skilled and experienced professionals engaged in the same type of undertaking under the same or similar circumstances globally. The circumstances that skilled and experienced professionals may find when evaluating the range of pollution prevention and control techniques available to a project may include, but are not limited to, varying levels of environmental degradation and environmental assimilative capacity, as well as varying levels of financial and technical feasibility.
detailed justification for any proposed alternatives is needed as part of the site-specific environmental assessment. This justification should demonstrate that the choice for any alternate performance levels is protective of human health and the environment.

Applicability

5. This document includes information relevant to large-scale commercial plantation crops and outgrower systems and focuses on the main primary production through farming and plantation crops, including banana, citrus, sugarcane, olives, palm oil, coffee, and cacao forestry of major multi-year food, fiber, energy, ornamental and pharmaceutical, located in both temperate and tropical regions. It includes tree crops (such as olives, citrus, coffee, rubber, and cacao) as well as banana, sugarcane, palm oil. It does not include the processing of raw materials into semifinished and finished products. Annual crop production is addressed in the EHS Guidelines for Annual Crop Production. Annex A contains a full description of industry activities for this sector. This document is organized according to the following sections:

Section 1.0 — Industry-Specific Impacts and Management
Section 2.0 — Performance Indicators and Monitoring
Section 3.0 — References and Additional Sources
Annex A — General Description of Industry Activities
1.0 Industry-Specific Impacts and Management

6. The following section provides a summary of EHS issues associated with plantation crop production, along with recommendations for their management. Additional guidance on EHS issues that may be common across industry sectors is presented in the General EHS Guidelines.

7. Farm or forest management plans often serve as an underlying framework for the management of environmental and social risks and impacts for perennial crop production. A farm or forest management plan would normally cover, among other things, the risks and issues presented in this document.

1.1 Environment

7.8. Environmental issues in plantation crop production primarily include the following:

- Stress on water resources
  - Soil erosion conservation and loss of productive capacity management
- Pesticide use
- Eutrophication of aquatic environments
  - Biodiversity Nutrient management
- Impacts
  - Crop residues residue and other solid waste management
- Atmospheric emissions
  - Stress on Water Resources management
  - Water Pest management
  - Storage, Handling, Application, and Disposal of Pesticides
  - Use of Fertilizers
  - Biodiversity
  - Genetically Modified Organisms (GMOs)
  - Energy Use
  - Air Quality
  - Greenhouse gas (GHG) Emissions
Soil Conservation and Management

9. Physical and chemical degradation of soils may result from unsuitable management techniques, such as use of inappropriate machinery or earthworks associated with plantation preparation and infrastructure development. Chemical degradation of soil may result from insufficient or inappropriate use of mineral fertilizers, failure to recycle nutrients contained in crop residues, and failure to correct changes in soil pH that result from long-term use of nitrogen fertilizers and excessive use of poor quality water, resulting in salinization.

10. Soil erosion may result from poor crop canopy closure after land preparation and lack of soil conservation structures on sloping land planted with perennial crops. Soil loss prevention practices include appropriate use of the following techniques:

- Practice reduced and zero tillage (often known as "low till" or "n till") as well as direct seeding and planting, to minimize damage to soil structure, conserve soil organic matter, and reduce soil erosion.
- Minimize soil compaction, damage, or disturbance by using appropriate land preparation machinery at the right time of year.
- Use cover crops such as Crotalaria, Canavalia, Mucuna or Tephrosia; intercropping along contours with legumes such as Cajanus, Sesbania, Lupinus, Tritolium, and creating multi species shelterbelts, and/or windbreaks to reduce evapotranspiration and soil loss through aeolian and water erosion.
- Replenish soil organic matter by recycling crop residues, compost, and manures.
- Implement earthworks when weather conditions pose the lowest risk of causing environmental damage.
- Employ erosion control management practices (e.g., contour and strip planting, terracing, discontinuous trenching, intercropping with trees, and grass barriers) in sloping areas.
- Draw up mitigation plans for planting or harvest operations that must take place during unsuitable periods.
- Use flow control weirs and diversion canals to reduce erosion in areas with field drainage.
- Restrict the width of roads to the minimum that will provide the means for efficient and safe transport.

11. The following approaches are recommended to maintain soil productivity over the long term:

- Cultivate crops that are suited or adapted to the local climate and soil conditions and adopt good agronomic practices\(^3\) to optimize crop productivity.
- Collect meteorological data on precipitation, evapotranspiration, temperature, photosynthetically active radiation, and use information to inform and guide agronomic and silviculture management techniques.
- Use soil maps and soil survey results to determine crop suitability and appropriate soil management practices.
- Develop and implement a soil monitoring and management plan that includes soil and terrain mapping and erosion risk identification.
- Conduct regular surveys to monitor soil structure and chemistry in order to identify areas where remedial action is required.
- Recycle and/or incorporate organic materials (e.g., crop residues, compost and manures) to replenish soil organic matter and improve soil water-holding capacity.
- Minimize the use of pesticides by implementing a pest and disease early warning system, by using biological pest and disease control methods, and by implementing control measures before outbreaks require large-scale control.

**Nutrient management**

12. Nutrient management strategies\(^4\) should aim to maintain and/or improve soil fertility and optimize crop yield, while conserving minimizing off-site environmental impact (e.g., contamination of groundwater resources and eutrophication of surface water resources from surface runoff and leaching of nutrients). Consider the following practices:

- Use green manures, cover crops, or mulching techniques to maintain soil cover, reduce the loss of nutrients, replenish soil organic matter, and capture and/or conserve moisture.
- Incorporate nitrogen-fixing legume crop plants and cover crops in the cropping cycle.
- Draw up balanced fertilizer programs for each soil management unit based on the results of mapped fertility results, soil and leaf analysis, and crop assessment.

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3. Food and Agriculture Organization (FAO) Good Agricultural Practices Principles 2007. Among others, good practices include those that select cultivars and varieties on an understanding of their characteristics, including response to sowing or planting time, productivity, quality, market acceptability and nutritional value, disease and stress resistance, edaphic and climatic adaptability, and response to fertilizers and agrochemicals; maximize the biological benefits of weed control by competition, mechanical, biological and herbicide options, provision of non-host crops to minimize disease; apply fertilizers, organic and inorganic, in a balanced fashion, with appropriate methods and equipment and at adequate intervals to replace nutrients extracted by harvest or lost during production; maximize the benefits to soil and nutrient stability by re-cycling crop and other organic residues.

• Assess EHS risks associated with the nutrient management plan and mitigating strategies to minimize potential adverse EHS impacts
• Time the application of crop nutrients to maximize uptake and minimize nutrient runoff.
• Assess soil pH periodically and apply soil amendments (e.g., agricultural lime) to correct changes in soil pH as required to ensure that nutrients are available for plant uptake.
• Conduct periodic soil analysis to detect changes in soil fertility, inform decisions on fertilizer application rates, and avoid unsustainable nutrient depletion and overfertilization.
• Establish and respect setbacks from watercourses—including appropriate buffer zones, strips, or other “no-treatment” areas along water sources, rivers, streams, ponds, lakes, and ditches—to act as a filter for potential nutrient runoff from the land.
• Select and maintain fertilizer application equipment to ensure desired application rates are used and overbroadcasting of solid fertilizers and overspraying liquid fertilizers are minimized.
• Implement nutrient planning and documentation, which includes the use of a fertilizer logbook to record the following information:
  o Dates of purchase, dates of use, amount of fertilizer and nutrient used (kg/ha), purpose of use, and crop growth stage.
  o Weather conditions before, during, and after application.
  o Methods used to minimize nutrient loss (e.g., incorporation into the soil, split applications, irrigation after application).
• Provide farm operators with training in nutrient management following published principles and agricultural practice manuals.\(^5\)
• Ensure that all personnel are trained in and use appropriate management procedures for the storage, handling, and application of all types of fertilizers, including organic wastes.
• Personal Protective Equipment (PPE) should be used according to the Material Safety Data Sheets (MSDS) of the product or to a risk assessment of the fertilizer product. MSDS should be available at each management unit.

**Crop Residue and Solid Waste Management**

13. In all plantation systems, residues can be recycled beneficially to improve soil organic matter and soil structure, as well as to reduce soil loss. In addition to annual or intermittent residues, many plantation crops also result in major residues at the end of their commercial life. These residues are valuable sources of organic matter and carbon and can lead to the extended release of nutrients during the development

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(growth) phase of the next crop cycle. Prevention and control strategies for potential risks and impacts include the following:

- Develop and implement a residue management plan in combination with results from nutrient management research and planning.
- Recycle residues and other organic materials by leaving the materials on site or through composting (and spreading).
- Consider the potential for harboring and spreading pests and diseases before implementing this practice.
- Disperse (or mulch) large vegetative structures (e.g., trunks, branches), unless there are compelling habitat and biodiversity benefits identified in the Biodiversity Management Plan.
- Consider using crop residues for other beneficial purposes, such as animal feed, bedding, or thatching, when leaving residues in the field is neither practical nor appropriate.
- In cases where crop residues are in excess of those needed for nutrient management, consider using as a thermal energy source for agriculture processing or for the generation of heat and/or power. Relatively high atmospheric emissions (such as of particulate matter and carbon monoxide (CO)) are possible when using crop residues for thermal combustion and handling, storage and processing may present risks of fire such as from spontaneous combustion of improperly stored damp residues or explosion of combustible dust. Strategies to prevent and control risks and impacts include:
  - In the planning phase, obtain physical and chemical data on the fuel and implement advice from a qualified specialist.
  - Undertake tests with the “new” residual biomass fuel prior to introducing it, and demonstrate that expert advice and feedback have been followed.
  - Adopt management practices in line with General EHS Guidelines in managing risks for fire and explosion.
- Avoid using harmful residual chemicals at end of crop life when preparing for removal.

14. Non-crop wastes from the production systems (e.g., pesticide containers, waste pesticides, and packaging) often have the potential to contribute to adverse health, safety, or environmental impacts. Considerations for the prevention and control of potential impacts from these wastes include:

- Ensure all packaging for pesticides and herbicides is returned to the farm or forest after use and properly stored until final disposition.
• Do not burn packaging, plastics, or other solid waste. Dispose of this waste in designated waste disposal facilities or by recycling. Manage solid waste in accordance with the General EHS Guidelines.
• Consider large container and/or bulk systems for fuels, oils, fertilizers, and chemicals to reduce the volume of waste containers.
• Examine alternative product formulations and packaging (e.g., biodegradable material).
• Manage expired and unwanted pesticides as hazardous wastes in accordance with the General EHS Guidelines and Food and Agriculture Organization (FAO) Guidelines for the Management of Small Quantities of Unwanted and Obsolete Pesticides.6,7

Water Management

8.15. Water management for plantation crop production should aim to conserve the quantity and quality of water resources while optimizing crop yield. Surface or groundwater resources used for irrigation should be managed in accordance with the principles of Integrated Resource Water Management,8 consistent with the following recommendations:9

• Determine the quantity and quality of water needed for crop production;
• Evaluate the capacity of groundwater or surface water resources and collaborate with national or regional institutions to ensure that the project considers existing or emerging plans for water management and monitoring;
• Select crops compatible with water availability;
  • Determine rain or water irrigation requirements of the crop based on internationally recognized guidelines while recognizing seasonal variations and regional norms. When irrigation is practiced, develop an appropriate irrigation plan and schedule, and monitor consumption and compare regularly with these targets.
• Maintain soil structure and soil organic matter. Use of crop residues and mulches will assist in maintaining soil organic matter levels, retain soil humidity, and reduce surface evaporation.
• Maximize the use retention of available precipitation (“rainwater through appropriate “rain harvesting”), where feasible, by techniques, which may include:
  • Reducing runoff by methods such as conservation tillage, terraces, and raised ridges that follow the land contour;

7 In the event that disposal of pesticides involves overseas shipments, the project must ensure compliance with the country’s commitments under the Stockholm, Rotterdam, and Basel Conventions.
8 Global Water Partnership.
9 FAO (2002a).
- Diverting water within the catchment area toward the crops themselves by diverting spate flow from wadis, directing runoff with low walls, and diverting flow toward crops from roads and paths toward crops thus storing water in the soil and reducing the effect of short dry spells;
- Storing runoff from rainy periods for use during dry spells by using tanks, ponds, cisterns, and earth dams;
- Implementing controlling weeds through the use of cover crops, mulching, or herbicides to encourage beneficial but low-water-use soil cover plants.
- Maintain protective vegetation in canals and drainage systems to reduce canal bank scouring and slow runoff.

**When irrigation is used, implement irrigation water conservation measures techniques, such as:**
- Ensure regular maintenance of the irrigation system, as well as that of its associated channels and infrastructure.
- Maintain a water management logbook that records time and quantity of rainfall evaporation and the amount of irrigation applied, and soil moisture levels (%), in order to verify both that irrigation is being used according to crop need and to develop an understanding of long-term trends in water use.
- Reduce evaporation by avoiding midday irrigation and using irrigation during periods when evaporation is elevated (e.g., in periods of higher temperatures, reduced humidity, or high winds). Use trickle or drip irrigation techniques (if practical), or using “install under canopy rather than overhead sprinklers.”
- Reduce evapotranspiration by using shelterbelts and windbreaks.
- Reduce seepage losses in supply channels by lining them or using closed conduits/pipes.
- Control weeds on inter-row strips and keep them dry.
- Consider collecting runoff water (tailwater) through catchments and pumps.
- Employ a cutback furrow irrigation technique, slowing or stopping irrigation well before the water reaches the end of the furrow and discharges to the environment.
- If herbicides are used, ensure they are applied at the appropriate time of year to most effectively control undesirable vegetation and reduce their water consumption.

**The following measures are recommended to prevent and control the contamination of water sources:**
Avoid over- and under-irrigation to decrease potential for soil salinization;
Maintain border vegetation in canals and drainage systems;
Maintain a water management logbook that records precipitation, rainfall, and evaporation, as well as time and amounts of irrigation applied, in order to develop an understanding of long-term trends in water use.

**Soil Erosion and Loss of Productive Capacity**

- Soil degradation, which may result from poor in the leaching of nutrients and contaminants.
- Ensure appropriate soil moisture by active monitoring of soil humidity
- Use harvesting methods (such as directional felling) or other appropriate measures to minimize the amount of debris deposited in streams.
- Establish and respect setbacks and buffer zones in riparian areas. Buffer widths should be based on the specific risk, land management especially due to excessive use of machinery and over-intensive farming practices. Soil erosion regime, and slope of the area.
- Remove harvest debris from streams and consider the use of debris traps such as trash lines where possible.

9.16 Sediments may be exacerbated by heavy rainfalls, storms, and steep or long slopes, and may contribute to subsequent sedimentation of surface water bodies. Soils should be managed to prevent sediment generation. Sediment is become a significant pollutant due to its physical properties, potential chemical interactions, and total contribution to nutrient loads. Suspended sediment carried in surface water carry pollutants such as pesticides, nutrients, and trace metals, causing water quality problems. Suspended sediment chemically and physically deteriorates causing water quality problems, resulting in reduced use. The settling of suspended sediment affecting water quality. Sediment loading reduces storage and flow capacities of streams, lakes, and reservoirs, may adversely affect water supplies, and increasing flood potential increases the risk of flooding. Soil loss prevention practices include: are presented in the "Soil Conservation and Management" section.

**Practice Integrated Pest Management**

- Nutrient management (INM) (see below) to avoid nutrient depletion or accumulation;

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FAO (2002)
Use crops suited or adapted to the local climate and soil conditions;  
In areas with steep slopes, carefully consider planting zones and the direction of planting in relation to land contours to avoid erosion caused by precipitation or irrigation;  
Use stone barriers, vegetative cross-slope barriers, terraces, or drainage and diversion canals to prevent wind and water erosion;  
Use appropriate machinery to avoid soil compaction caused by excessively heavy equipment;  
Avoid the use of overly saline water for irrigation to prevent salinization;  
Use plant cover or intercrops and shelterbelts to reduce erosion from wind and heavy rain;  
Increase the organic matter content in the soil by applying organic matter such as crop residues, compost, and manure to protect the soil physically from sun, rain, and wind and to feed soil biota. The potential for spreading of pests should be considered before implementing this practice;  
Consider adding lime to soil to compensate for acidification, caused by acid deposition and fertilizers, and to maintain stable pH levels;  
Assess sludge quality for contaminants (for example, heavy metals) prior to use for soil enhancement.

Pesticide Use

The primary aim of pest management should be not to eradicate all organisms, but to manage “pests and,” including insect pests, diseases, and weeds that may negatively affect production of plantation crops so that they remain at a level that is under levels beneath an economically and environmentally damaging threshold. Pesticides should be managed to avoid their migration into off-site land or water environments by establishing their use as part through a process of an integrated pest management (IPM) strategy documented in a Pesticide Management Plan (PMP). The following stages should be considered when designing and implementing an IPM strategy, giving preference to alternative pest management strategies, with the use of synthetic chemical pesticides as a last option, that combines chemical and non-chemical approaches to minimize pest impact, while also minimizing the impact of such measures on the environment. Pesticides should be used only to the extent necessary under an IPM and integrated vector management (IVM) approach, only after other pest management practices have either failed or

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11 See FAO (1992), chapter 4 of The Use of Saline Waters for Crop Production, for a discussion of the suitability of water for irrigation purposes.

12 IPM refers to a mix of farmer-driven, ecologically based pest control practices that seeks to reduce reliance on synthetic chemical pesticides. It involves: (a) managing pests (keeping them below economically damaging levels) rather than seeking to eradicate them; (b) relying, to the extent possible, on nonchemical measures to keep pest populations low; and (c) selecting and applying pesticides, when they have to be used, in a way that minimizes adverse effects on beneficial organisms, humans, and the environment.
proven inefficient. The following steps should be considered and documented in an integrated pest/vector management plan:

Alternatives to Pesticide Application

1. Where feasible, the following alternatives to pesticides should be considered:
   • Provide those responsible for deciding on pesticides application with training in pest identification, weed identification, and field scouting;
     • Identify the main pests affecting crops in the region, assess the risks to the operation, and determine whether a strategy and capacity is in place to control them.
     • Where possible, apply early-warning mechanisms for pests and diseases (i.e., pest and disease forecasting techniques).
     • Select resistant varieties, and use the cultural and biological control of pests, diseases, and weeds to minimize dependence on pesticide (chemical) control options. An effective IPM regime should:
       o Identify and assess pests, threshold levels, and control options (including those listed below).
   • Rotate crops to reduce the presence of pests and insects, disease, or weeds in the soil ecosystem;
     o Use pest-resistant or crop varieties.
   • Use mechanical weed control and/or thermal weeding;
   • Support and use beneficial bio-control organisms, such as insects, birds, mites, and microbial agents, to perform biological control of pests;
     o Protect natural enemies of pests, by providing a favorable habitat, such as bushes for nesting sites and other original vegetation that can house pest predators; and parasites.
     o Favor manual, mechanical weed control and/or selective weeding.
     o Use animals to graze areas and manage plant coverage;
     o Use mechanical controls, such as traps, barriers, light, and sound to kill, relocate, or repel pests.
     o Pesticide. Use pesticides to compliment these approaches, not replace them.

Prior to procuring any Application

2. If pesticide application is warranted according to, assess the PMP, users should take the following precautions to reduce the likelihood environmental impacts:
Train personnel to apply pesticides and ensure that personnel have received applicable certifications or equivalent training where such certifications are not required;\(^{13}\)

Review the manufacturer’s directions on maximum recommended dosage or treatment as well as published reports on using the reduced rate of pesticide application without loss of effect (such as DAAS 2000), and apply the minimum effective dose;

Apply pesticides based on criteria such as field observations, weather data, time of treatment, and dosage, and maintain a pesticide logbook to record such information;

Avoid the use of pesticides that fall under the World Health Organization Recommended Classification of Pesticides by Hazard Classes 1a and 1b.

Avoid the use of pesticides that fall under the World Health Organization Recommended Classification of Pesticides by Hazard Class II if the project host country lacks restrictions on distribution and use of these chemicals, or if they are likely to be accessible to personnel without proper training, equipment, and facilities to handle, store, apply, and dispose of these products properly;

Avoid the use of pesticides listed in Annexes A and B of the Stockholm Convention, except under the conditions noted in the convention;\(^{14}\)

Use only pesticides that are manufactured under license and registered and approved by the appropriate authority and in accordance with the Food and Agriculture Organization’s (FAO’s) International Code of Conduct on the Distribution and Use of Pesticides;\(^{15}\)

Use only pesticides that are labeled in accordance with international standards and norms, such as the FAO’s Revised Guidelines for Good Labeling Practice for Pesticides;\(^{16}\)

Select application technologies and practices designed to reduce unintentional drift or runoff only as indicated in an IPM program, and under controlled conditions;

Maintain and calibrate pesticide application equipment in accordance with manufacturer’s recommendations;

Establish untreated buffer zones or strips along water sources, rivers, streams, ponds, lakes, and ditches to help protect water resources;

Avoid use of pesticides that have been linked to localized environmental problems and threats.

\(^{13}\) Examples of certification schemes are provided by the US EPA (2006), which classifies pesticides as either “unclassified” or “restricted” and requires workers that apply unclassified pesticides to be trained according to the Worker Protection Standard (40 CFR Part 170) for Agricultural Pesticides. It further requires restricted pesticides to be applied by or in the presence of a certified pesticide applicator.


\(^{15}\) FAO (2002c)

\(^{16}\) FAO (2002c)
Pesticide Handling and Storage

3. To prevent, reduce, or control the potential contamination of soils, groundwater, or surface water resources, which may result from accidental spills during transfer, mixing, and storage, pesticides should be stored and handled in accordance with the recommendations for hazardous materials management in the General EHS Guidelines. Additional recommendations include the following:

- Store pesticides in their original packaging, in a dedicated, dry, cool, frost-free, and well aerated location that can be locked and properly identified with signs, with access limited to authorized people. No human or animal food may be stored in this location. The store room should also be designed with spill containment measures and sited in consideration of potential for contamination of soil and water resources;
- Mixing and transfer of pesticides should be undertaken by trained personnel in ventilated and well lit areas, using containers designed and dedicated for this purpose;
- Containers should not be used for any other purpose (e.g. drinking water). Contaminated containers should be handled as hazardous waste, and should be treated accordingly. Disposal of containers contaminated with pesticides should be done in a manner consistent with FAO guidelines and with manufacturer's directions;
- Purchase and store no more pesticide than needed and rotate stock using a "first-in, first-out" principle so that pesticides do not become obsolete. Additionally, the use of obsolete pesticides should be avoided under all circumstances; A management plan that includes measures for the containment, storage and ultimate destruction of all obsolete stocks should be prepared in accordance to guidelines by FAO and consistent with country commitments under the Stockholm, Rotterdam and Basel Conventions.
- Collect rinse water from equipment cleaning for reuse (such as for the dilution of identical pesticides to concentrations used for application);
- Ensure that protective clothing worn during pesticide application is either cleaned or disposed of in an environmentally responsible manner;
- Implement groundwater supply wellhead setbacks for pesticide application and storage;
- Maintain records of pesticide use and effectiveness.

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17 FAO (2002c)
19 See FAO (1996).
20 See the FAO publication on pesticide storage and stock control manual. FAO Pesticide Disposal Series No. 3 (1996).
Eutrophication of Aquatic Environments

4. Nutrient management strategies should aim to optimize crop yield while maintaining and improving the soil nutrient status without causing off-site environmental problems. These strategies should be implemented as part of an INM approach that aims to prevent, reduce, or control contamination of groundwater resources and eutrophication of surface water resources from runoff and leaching of excess crop nutrients. The periods of greatest risk for runoff and leaching may be during and immediately after spreading if the nutrients are not incorporated into the soil, and during heavy rains that cause rapid runoff.

5. The following steps should be considered when designing and implementing an INM strategy including evaluating the need for crop nutrient application, following a recommended crop nutrient and post-nutrient application plan, and handling and storage of crop nutrients.

Evaluating the Need for Crop Nutrient Application

6. Consider the following to evaluate the need for, and reduce the use of, crop nutrients:

- Balance nutrient application according to INM recommendations, including the use of reduced or no soil tillage techniques, nutrient recycling, one-pass soil preparation and sowing, taking into account the potential for increased pesticide consumption proposed use and the intended users.

- Use crop rotation methods to enable cultivation of leguminous plants with nitrogen fixation capabilities

- Use plants to cover the soil, especially during a fallow period and in wet regions, to reduce loss of nutrients;

- Incorporate organic waste materials into soils rather than burning

- Avoid excess fertilization by analyzing soil before the growing season to estimate how much additional plant nutrient will be needed for the crop to be produced. Evaluate the need for crop nutrient application through test plot observations

- Assess soil acidity, which is important for achieving maximum uptake of phosphates;

- Provide farm operators with training in INM following published principles and agricultural practice manuals.\textsuperscript{22}

\textsuperscript{21} Roy et al. (2006)
\textsuperscript{22} See FAO (2000).
Crop Nutrient Application

7. If the application of crop nutrients is warranted, the following recommended actions to reduce environmental impacts should be considered:

- Apply organic matter, such as manure, to replace chemical fertilizers to the extent practical;
- Incorporate manure into the soil or apply between growing crops to improve plant utilization of nutrients and thereby reduce nutrient loss and contamination. Do not apply solid or liquid manure directly onto grazing areas or edible crops. In areas with intensive livestock breeding, be aware that agricultural crop lands are often used to dispose of manure with the risk of over-fertilization
- Apply “fertigation” in horticulture, in which small amounts of fertilizer added to irrigation water may be applied. This requires detailed management and should be limited to plantations that have water management devices that can control the timing and volume of irrigation return flow
- Time the application of crop nutrients using meteorological information to avoid, where feasible, application during or close to precipitation events
- Use appropriate technical equipment for spraying manure;
- Establish buffer zones, strips, or other “no-treatment” areas along water sources, rivers, streams, ponds, lakes, and ditches to act as a filter to catch potential runoff from the land
- Implement INM planning and documentation, which may include the use of a fertilizer logbook to record the following information:
  - Dates of purchase, dates of use, amount of fertilizer used per field / hectare, purpose of use, and weather conditions during application
  - Rates of nutrient application for the crop growth stage
  - Maintenance schedule of application equipment to ensure efficient dosage

Pesticides use and management

Where pesticide use is warranted, in order to prevent, reduce, or control the potential contamination of soils, groundwater, or surface water resources caused by accidental spills during transfer, mixing, and storage, crop nutrients and application, pesticides should be stored and handled and applied in a manner consistent with the recommendations for hazardous materials management presented in the General EHS Guidelines. In addition, fertilizers

19. A pesticide management plan (PMP) that includes procedures for the selection, procurement, storage, handling, and ultimate destruction of all out-of-date stocks should be prepared in accordance with FAO
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2007 VERSION VS. 2015 DRAFT REVISED VERSION

guidelines and should be consistent with country commitments under the Stockholm, Rotterdam, and Basel Conventions. The PMP prescribes the type of pesticides to be used as well as the purpose of their use, and outlines best practice for the procurement and storage of all pesticides. Personnel must have appropriate training—including certification, where relevant—to handle and apply pesticides safely. In particular:

- Ensure that any pesticides used are manufactured, formulated, packaged, labeled, handled, stored, disposed of, and applied according to the FAO’s International Code of Conduct on Pesticide Management.
- Do not purchase, store, use, or trade pesticides that fall under the World Health Organization’s (WHO) Recommended Classification of Pesticides by Hazard Classes 1a (extremely hazardous) and 1b (highly hazardous), or Annexes A and B of the Stockholm Convention.
- Do not use pesticides listed in WHO Hazard Class II (moderately hazardous), unless the project has appropriate controls established with respect to the manufacture, procurement, or distribution and/or use of these chemicals. These chemicals should not be accessible to personnel without proper training, equipment, and facilities in which to handle, store, apply, and dispose of these products properly.
- Preferentially, use selective pesticides, where appropriate, rather than broad-spectrum products to minimize impacts on non-target species.
- Ensure that the product is not harmful to the crop.

Storage

- Store all pesticides in a lockable, bunded container or store that has sufficient space in which to capture any spills without contaminating the environment. Stores should be set away from water sources, residential and built-up areas, as well as livestock and food storage areas.
- Procure spill kits and institute suitable control measures in case of accidental spillage.
- Store all pesticides in their original, labeled containers, and ensure that storage instructions are followed.

23 http://chm.pops.int/
24 http://www.pic.int/
25 http://www.basel.int/
• Keep a register of all pesticides procured, recording when they were received, amounts used, and amount remaining in store.
• Keep MSDSs at appropriate locations in storage facilities.

Handling
• Operators must read, understand, and follow product label directions for mixing, safety, application, and disposal; use trained personnel for critical operations (e.g., mixing, transfers, filling tanks, application).
• Insist that correct PPE be worn at all times when handling and applying pesticides (e.g., gloves, overalls, eye protection).
• Mandate that any mixing and filling of pesticide tanks occur in a designated filling area.
  o This should be set away from watercourses and drains.
  o If on concrete, water should be collected into a separate sump and disposed of as a hazardous waste.
  o Ensure that spills are cleaned up immediately using appropriate spill kits; spills should not be washed away into watercourses or drains.

Application
• Give preference to the application method with the lowest EHS risk.
• Select pesticide application technologies and practices designed to minimize off-site movement or runoff (e.g., low-drift nozzles, using the largest droplet size and lowest pressure that are suitable for the product).
• Establish buffer zones around watercourses, residential and built-up neighborhoods, as well as livestock and food storage areas.
• For the aerial application of pesticides, the boundaries of target areas should be clearly demarcated and all possible nearby communities, livestock, and rivers should be identified in the flight plan. The aerial application of pesticides should not be conducted where there is potential for contamination of organic or otherwise certifiable production.
• Ensure that all equipment is in good condition and properly calibrated to apply the correct dosage.
• Insist that applications occur under suitable weather conditions; avoid wet weather and windy conditions.
Disposal

- Any unused dilute pesticide that cannot be applied to the crop, along with rinse water, and out-of-date or no-longer approved pesticides, should be disposed of as a hazardous waste, as per FAO guidelines.
- Empty pesticide containers, foil seals, and lids should be triple rinsed, and washings used in the pesticide tank should be sprayed back onto the field or disposed of as hazardous waste in a manner consistent with FAO guidelines and according to the manufacturer's directions. Containers should be stored safely and securely under cover prior to their safe disposal; they should not be used for other purposes.

Fertilizers

- Store fertilizers in their original packaging and in a dedicated location that can be locked and properly identified with signs, and with access to which is limited to authorized persons.
- Only purchase and store minimal fertilizer requirements, and use older fertilizers first.
- Keep fertilizer stores separate from pesticides and machinery (e.g., fuels, ignition, or heat sources).
- Know and understand each crop's fertilizer requirements and only apply what is required, when it is required, to minimize losses to the environment.
- Implement a suitable training program for personnel that are transporting, handling, loading, storing, and applying fertilizers.

Biodiversity Impacts

8. If not properly managed, modern, intensive, conventional cultivation methods may lead to adverse impacts on biodiversity. The main ecosystem threats that should be managed at the farm level may include the following:

Loss of Genetic Resources and Variability

9. Personnel in charge of plantation crop production operations should be aware of the biodiversity issues at the farm level (also termed agricultural biodiversity), as well as more general biodiversity issues in the area where the farm is located. The following actions should be taken to maintain farm-level agricultural biodiversity:

- Where possible, consider reuse of residue from the previous crop on the soil surface. The potential for spreading of pests should be considered before implementing this practice;
• Reduce soil preparation to maintain the structure of soil ecosystems (e.g., promote low-till and no-till strategies);
• Utilize field borders to provide wildlife corridors around fields used for plantation crop production;
• Provide buffer zones on farmland bordering wildland of specific environmental and research interest;
• Regularly monitor soil health, for example, by determining the population of soil macrofauna bioindicator species such as the earthworm population;
• Use certified crop seeds that do not contain seeds from invasive alien species and that comply with the information on the packaging regarding seed diameter and species;
• Ensure protection of the natural enemies of pests by providing favorable habitats, such as hedges, nesting sites, and original vegetation, to house pest predators; and
• Promote the use of organic agricultural practices to the extent feasible.  

10. The following actions should be taken to help maintain regional biodiversity:

• Before converting land to plantation crop production, survey the project area to identify, categorize, and delineate natural and modified habitat types and ascertain their biodiversity value at the regional or national level;
• Ensure that any natural or modified habitat to be converted to plantation crop production does not contain critical habitat, including known habitat of critically endangered or endangered species, or important wildlife breeding, feeding, and staging areas;
• Be aware of the presence of critically endangered or endangered species in the areas already used for plantation crop production and consider them during management processes;
• Provide for minimum disturbance to surrounding areas when harvesting or gathering crops.

Genetically Modified Organisms (GMOs)

20. Perennial crop production has the potential to have a direct and indirect impact on biodiversity. Key direct impacts relate to habitat conversion or degradation, water usage, pollution, introduction of invasive species, and inappropriate cultivation techniques. Indirect impacts relate to in-migration, displacement of communities, and induced access for hunting or collection. Impacts and associated mitigation activities related to biodiversity are primarily specific to the crops, techniques, and biodiversity context at any specific site.

29 For further guidance on organic agriculture, see IFOAM (2005).
21. Appropriate site selection, including expansion planning, is the single most important mitigation measure available to plantation crop production. Early screening can improve macro-level project site selection and scoping of priorities for further assessment, thus reducing unnecessary biodiversity impacts and costs in the future. Screening should be conducted so as to identify species and sites of importance for high biodiversity values within the broader region or landscape. Tools, such as the Integrated Biodiversity Assessment Tool (IBAT),\(^{31}\) can facilitate access to key international data sets. Sites of local, regional and international importance\(^ {32}\) may include: nationally and internationally protected areas, Important Bird Areas (IBA), Key Biodiversity Areas (KBAs), Alliance for Zero Extinction (AZE) areas, Ramsar Sites (Wetlands of International Importance), along with known congregatory sites and unique or threatened ecosystems.

22. Screening should consider any existing spatial data and landscape mapping as part of the literature review and desktop analysis. Key sources include Strategic Environmental Assessments (SEA), National Biodiversity Strategies and Action Plans (NBSAP),\(^ {33}\) relevant sector plans (including those that may be impacted, such as eco-tourism or fisheries), and conservation plans.

23. Conversion of existing natural or critical habitats into agriculture should be avoided, and planting on existing modified habitats or degraded lands should be promoted (i.e., a land-sparing approach\(^ {34}\)). This should be informed by an assessment of existing modified or degraded lands suitable for crop production within the landscape.\(^ {35}\) Efficient use of existing modified habitats or degraded lands can reduce risks and costs associated with biodiversity impacts.

24. The farm- or forest-level management plan should be informed by an assessment of biodiversity values of importance, including species, sites, and habitats. This should, at a minimum, consider the farm/forest management unit, but in cases of higher risk, expected landscape connectivity or wildlife movement issues should consider a broader landscape unit based on the specific needs of biodiversity values in question. Very large management units, particularly where conversion or planting will be managed in smaller sub-units (e.g., multiple compartments or a phased approach), may not find a single comprehensive assessment to be practically feasible. In such cases, a desktop assessment, including analysis of satellite data supported by targeted groundtruthing, can be used to scope areas of potentially modified, natural, and critical habitat, as well as to identify potential set-asides and restoration areas that

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\(^{31}\) [http://www.ibatforbusiness.org](http://www.ibatforbusiness.org)


could mitigate possible impacts on biodiversity values across the full management unit. Groundtruthing can be practically implemented at the level of smaller sub-units (e.g., refining existing set-asides or establishing new ones). It is important that the conversion or planting schedule for these sub-units allow sufficient time (1 to 2 years) to allow for assessment, analysis, and development of an appropriate management plan based on this information.

25. Some biodiversity values will require on-site management to maintain viability on-site and within the larger landscape. These include maintaining, establishing, or restoring corridors (e.g., riparian areas, movement corridors for wildlife), set-asides (e.g., important breeding or feeding sites), and buffer zones (e.g., to minimize off-site disturbance to neighboring riparian areas and wetlands, protected areas, and other important sites). The number, extent, and location of these areas should be informed by the assessment process and not simply by the prevalence of areas in which development is not feasible (e.g., steep slopes). Active management (e.g., access control, hunting reduction, and enrichment planting with indigenous species) and monitoring may be required in some situations to maintain required biodiversity values.

26. Developers should seek to avoid the introduction of invasive species, as well as control and reduce their further spread. This includes sourcing planting material (e.g., seeds, tube stock) from reliable suppliers who can provide evidence of purity.

27. Developers should use planting material that does not contain seeds from invasive alien species and that complies with local quarantine and hygiene regulations; and implement machinery cleaning programs when moving between fields to remove soil and seeds that may carry invasive or alien species.

Genetically-Modified Organisms (GMOs)

28. Environmental concerns related to the introduction of GMO crops may include transfer of introduced genes to other species (possibly weedy or invasive); their unanticipated impact on beneficial insects, as well as native fauna and flora; or increased pest resistance. Other concerns include the potential impact on the health of human consumers, along with the introduction of pests.

29. The introduction of GMO crops should be assessed for compliance with the existing host-country regulatory framework for such introductions. If such a regulatory framework does not exist in the host country, the potential impacts and risks related to a specific crop’s introduction should be assessed by a competent professional, paying specific attention to its invasive potential and the impact of fertilizers.
and pesticides required for invasive behavior, and its growth, while identifying any appropriate mitigation measures.

**Crop Residues and Other Solid Waste**

41. The largest volume of residues in crop production is crop residues themselves, although the waste with the most significant impact is often related to pesticide containers and obsolete, expired, pesticides. Prevention and control of potential impacts from the generation of these wastes include the following:

- Recycle crop residues and other organic materials by leaving the materials in the fields, plowing, or composting. The potential for spreading of pests should be considered before implementing this practice;
- Reuse crop residues as a thermal energy fuel in bioenergy facilities, as a substrate in fermentation facilities, and as feedstock in biorefineries;
- Clean (e.g., triple rinse technique) and dispose of (e.g., through crushing, shredding, or return to suppliers) pesticide packaging and containers to ensure that they are not subsequently used as containers for food or drinking water; Rinsing solutions should be recovered for reuse as diluting agents, or stored for eventually disposal, as per FAO Guideline;
- Manage expired and unwanted pesticides as hazardous wastes in accordance with the General EHS Guidelines and FAO Guidelines for the management of unwanted and expired pesticides.

**Atmospheric Emissions**

**Energy Use**

30. Energy is used in perennial crop production for site preparation, cultivation, management, irrigation, harvesting, transport, lighting, heating, cooling, and ventilation. Recommendations to reduce energy use and increase efficiency are presented in the General EHS Guidelines. Additional recommended strategies include:

- Select energy-efficient machinery and equipment (e.g., tractors, ventilation systems, drying and storage systems, cooling devices) and consider on-board fuel-use monitors.

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36 Introduction of GMOs should be considered using the principles outlined under the Convention on Biological Diversity available at http://www.biodiv.org/default.shtml.
37 See Footnote 8.
38 FAO (1999).
39 In case that disposal of pesticides involves overseas shipments, project must ensure compliance with country’s commitments under Stockholm, Rotterdam and Basel Conventions.
31. Irrigation energy use can be significant; the following techniques are recommended for efficient use of energy in irrigation systems:

- Develop an irrigation plan that is appropriate for climate, season, soil conditions, plant materials, and grading. This plan should include optimum scheduling, monitoring, and recording systems so that energy usage and efficiencies can be examined. An irrigation logbook or database should be maintained so that quantitative measures are recorded (e.g., kWh electricity/m³ applied, fuel usage as l/m³ applied).
- Regularly maintain the irrigation system and associated infrastructure, such as supply channels and water storage.
- Select efficient pumps
- Ensure properly matched pumps, systems, and power sources by keeping a good record of the amount of water pumped and the energy used to ensure suitability.

Air Quality

Atmospheric emissions are primarily associated with emissions of fuel-combustion by-products, including carbon dioxide (CO₂), sulfur dioxide (SO₂), nitrogen oxide (NOₓ), and particulate matter (PM), resulting from the operation of mechanized equipment or from combustion by-products from the disposal or destruction of crop residues. Dioxins and furans may be present in residues if crops have been treated with chlorinated pesticides. Greenhouse gas (GHG) emissions, including nitrous oxide (N₂O), methane (CH₄), and ammonia (NH₃), may result from the use of fertilizers or from soil conditions associated with certain crops such as rice. Ammonia and nitrous oxide are volatilized under high wind and elevated temperature conditions, or processing by-products. The impacts of these pollutants depend on the local context, including the proximity to communities, sensitivity of ecosystems, concentrations of the pollutant, topography, and meteorology. Air-quality issues, including management of mechanized farm equipment, should be managed according to recommendations in the General EHS Guidelines for mobile and stationary sources. Specific recommendations for perennial crop production to prevent and control air emissions are:

12. Recommended prevention and control measures include the following:

- Manage emissions from mechanized farm equipment according to recommendations in the General EHS Guidelines for mobile and stationary sources;
• Adopt reduced tillage options to increase the carbon storage capacity of soils;
• Where feasible, use biofuels instead of fossil energy to reduce net GHG emissions;
• Where feasible, favor solar drying techniques for crops that require drying;
• Reduce particulate matter emissions by avoiding burning straw and other organic material in the field and by maintaining organic matter to protect soil against wind erosion during and after soil preparation activities;
  • Avoid open burning for land preparation, pre- and post-harvest and evaluate controlled burning in energy production facilities to extract thermal energy for beneficial use. Where burning is unavoidable, potential impacts should be identified and weather conditions monitored to schedule burning with least-impact periods.
  • Prohibit burning of pesticide-treated agricultural wastes and by-products (e.g., pesticide containers) to avoid unintended emissions of persistent organic pollutants (POPs) which may arise from open burning of pesticide-treated agricultural wastes avoiding such practices.
• Reduce ammonia and nitrous oxide emissions by:\n  o Reducing ammonia and nitrate concentration in soil;
  o Applying denitrification inhibitors;
  o Enhancing soil aeration; and
  o Enhancing soil incorporation of ammonia and urea fertilizers and manure using techniques such as manure injection, placement of fertilizers at adequate depth beneath soil, use of supergranules in flooded rice fields etc.
  • Adopt IPM strategies to avoid and reduce use of pesticides and associated drift.
  • Monitor and minimize ammonia emissions resulting from nitrogen fertilizer and manure use. Note certain types of nitrogen fertilizer have higher ammonia emissions associated with their use than others. Consider incorporating fertilizer at planting to minimize ammonia emissions.
  • Reduce the risk of fire by reducing the build-up of potential groundcover fuel sources and controlling weeds and invasive species. Where controlled burns of residues are necessary, ensure optimal conditions for the low risk of spread and low impact on existing air quality.
  • Consider in-field systems and logistics that reduce the usage of high-emission equipment (e.g., the use of cable transport systems instead of tractors).
  • Evaluate the substitution of no- or low-emission energy sources for combustion methods.
• Ensure proper maintenance and operation of combustion equipment (irrigation engines, boilers, etc).

40 Roy et al. (2006)
tractor engines, heaters, etc.) and consider replacing old units or retrofitting air emission controls.

- Modify field operations where possible (e.g., reducing the number of in-field passes with machinery, reduced tillage operations, or improved logistics to minimize travel distances).
- Modify timing of operations, where possible, to coincide with favorable atmospheric conditions and reduced risk of air pollution.
- Establish cover crops where possible; retain residues and reduce tillage intensity to avoid dust and soil degradation due to wind erosion. Where water supplies are ample, water application to cropped areas and access roads may reduce the risk of airborne dust.
- Establish natural wind barriers—such as vegetative field borders, hedgerows, herbaceous wind barriers, and tree/shrub establishment—to intercept airborne particulate matter and droplets, which may also include contaminants.

Greenhouse Gas (GHG) Emissions

33. Perennial crop production produces GHG emissions, including methane, nitrous oxide, and carbon dioxide from different stages in the production cycle. Carbon is also stored in the crop's biomass above and below ground, as well as in the soil ecosystem. The primary sources of GHG emissions during site preparation for perennial crops will be carbon dioxide associated with land use change. During the production phase are nitrous oxide from fertilizer use and carbon dioxide from on-farm fuel and electricity use. Emissions from fertilizer come from both the manufacture of the product and from the application of the product to the crop, with both activities resulting in nitrous oxide emissions, which have a high global warming potential. These emissions should be managed through resource-efficient farming.

34. The following are recommended measures for minimizing GHG emissions from crop production:

- Identify sources of on-farm GHG emissions and establish a GHG management plan that includes methods of mitigating emissions and a monitoring program.
- Follow the nutrient management plan to ensure that the nutrient balance is right for maximum crop uptake, the quantity of nitrogen matches crop needs, and the timing of application coincides with active growth stages;
- Consider using a fertilizer recommendation system to help with planning.
- Where available, use abated nitrogen fertilizers, which have lower GHG emissions associated with their manufacture, or use nitrification or urease inhibitors, which reduce soil emissions.
- Reduce fossil energy use through adopting energy-efficient production and management practices.
• Where feasible, consider using renewable energy (e.g., solar, wind, biofuel) for crop drying or to power irrigation pumps.

35. The loss of stored carbon in the land occurs primarily during harvest and plantation establishment. Land use changes, such as converting grassland or forest to crop production areas, are responsible for the release of GHG emissions in the form of carbon dioxide. If the existing vegetation is burned as part of site preparation activities for the new land use, both methane and nitrous oxide will be emitted during the combustion process, in addition to carbon dioxide.

36. When converting land, the potential impact on GHG emissions should be assessed and measures implemented to reduce and mitigate this impact.

37. The following activities and strategies for the prevention and control of GHG emissions are as follows:

• Avoid conversion of high carbon stock areas, such as primary forest and peatlands/wetlands.
• Avoid open burning of biomass.
• Protect soils from the loss of organic matter by implementing good soil conservation management practices.
• Increase soil organic carbon stocks through land management techniques, such as no-till.
• Maintain and rehabilitate degraded areas and vegetative buffer zones to increase carbon stocks.
• Consider increasing the rate of sequestration with species/clone selection.

1.2 Occupational Health and Safety

38. In developing suitable plans for mitigating environmental, health, and safety risks associated with all plantation crops, the hierarchy of controls should be followed as a means to limit workplace risk. Occupational health and safety (OHS) issues associated with plantation crop production include the following:

- Physical hazards;
- Confined space entry;
- Chemical hazards;

- Physical hazards
- Confined space entry

41 http://www.cdc.gov/niosh/topics/cftrbanding/
### Environmental, Health, and Safety Guidelines

PERENNIAL PLANTATION CROP PRODUCTION

2007 VERSION VS. 2015 DRAFT REVISED VERSION

- Risk of fire and explosion
- Biological Hazards
- Chemical hazards

**Physical Hazards**

*Operational and workplace hazards*

39. Operational hazards include:

- Slips, trips, falls resulting in sprains, strains, and fractures;
- Lifting injuries due to incorrect techniques, or lifting excessive weights, or repetitive tasks;
- Injury from sharp objects in the workplace (e.g., foot injuries from thorns on oil palm fronds and fruit);
- Injury resulting from the incorrect operation of hand-held equipment, such as knives, chainsaws, workshop tools, and other equipment; and
- Over-exposure to noise, vibration, and extreme or adverse weather conditions.

40. Occupational safety and health impacts and controls relating to safe work practices during routine operations are discussed in the General EHS Guidelines. Potential risks within perennial crop production include exposure to vibration and noise from equipment operation, extreme/adverse weather, and manual handling. Being exposed to extremes of weather—including sustained exposure to the sun or cold—can be harmful, creating hypo- or hyper-thermia, resulting in dehydration or even death in some cases. These risks should be managed according to the General EHS Guidelines. Vibration from machinery may affect the whole body and can cause chronic backache or hip and knee pain and can additionally lead to spinal, gastro-intestinal, and urinary tract problems. Noise and vibration from hand-held equipment (such as chainsaws, brush cutters, or strimmers) can cause hand/arm vibration problems, such as Vibration White Finger.

**Machinery and Vehicles**

41. Accidents may occur in connection with the use of machines and vehicles, including worker transportation, farm tractors, harvesting and felling machinery, and a variety of other machines on the farm. In addition, operators may be at risk used on plantations and in forests. These may include vehicle collisions; vehicle and machinery roll-overs; uncontrolled movement resulting in personal injury (e.g., crushing by moving vehicles); damage or loss of impacts; injury, entrapment, or death due to faulty or unguarded equipment and machinery (e.g., moving parts and pinch points on machinery and vehicles); entrapment.

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42 ILO 2011.
due to unplanned starting, activation, or engagement of equipment (e.g., rollers); or injury during inspection or repair of vehicles (e.g., vehicle lift not secured while personnel working underneath).

### 14.42
Most fatal accidents are associated with crushing by vehicles or equipment. Where plantation crops are harvested by hand, many of the injuries are hand-tool related. By far the largest number of logging accidents occurring annually are associated with felling operations. Workers may also be exposed to associated risks, such as the noise of operating machines, especially in the more confined spaces of farm buildings, or exertion of work, which can be physically demanding and is often compounded by the presence of repetitive motion. Machines they operate. Occupational safety and health impacts and controls relating to equipment and vehicle operation and repair are discussed in the General EHS Guidelines. Physical hazard resulting from felling activities are discussed in the Forest Harvesting Operations EHS Guidelines.

#### Confined Spaces and Restricted Space Entry

### 15.43
Occupational health and safety hazards associated with confined and restricted spaces on farms and plantations (e.g., manure pits, processing bins and silos, grain product storage bins, water tanks, or inadequately ventilated buildings) include the risk of asphyxiation, primarily due to explosions due to gas, dust, or fumes (e.g., residual petroleum fumes); and entrapment or enclosure within the accumulation of methane. Entry to confined space. Serious injury or fatality can result from inadequate preparation when entering a confined space or in attempting a rescue from a confined space. Entry into all confined spaces should be restricted and should be subject to permitted supervision by properly trained persons, as described in the General EHS Guidelines. Restricted areas should be clearly marked and clearly conveyed to personnel and contractors.

### 44
Re-entry into plantation areas that have been treated with pesticides and fungicides should be guided by information provided by the chemical manufacturer, normally included in the MSDS.

#### Risk of Fire and Explosion

### 45
Fire safety management should be managed according to the General EHS Guidelines. Additional sector-specific risks include fires resulting from the combustion of stored oil or crop residues, which can lead to a loss of property or cause possible injury to or fatality of project workers. National or international safety standards should be used in the design, operation, and maintenance of facilities, where applicable.

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46. Management plans and operating procedures should include comprehensive strategies for the prevention, detection, and suppression of fires within plantation perimeters and adjacent properties, including:

- Description of primary detection methods, tools, and protocols;
- Ability to communicate with field staff, contractors, and communities;
- Measures for reducing fuel loading;
- Means to access and contain fires within plantation premises;
- Proper placement of appropriate fire suppression equipment; and
- Training of staff, contractors, and communities in fire prevention and suppression actions.

Biological Hazards

47. Occupational health and safety hazards associated with crop production may include contact with venomous animals such as insects, spiders, scorpions, snakes and certain wild mammals. Recommended mitigation measures include:

- Wear appropriate protective clothing such as a long-sleeved shirt, long pants, hat, gloves, and boots
- Inspect or shake out any clothing, shoes, or equipment (including PPE) before use.
- Use insect repellent
- On-site first aid equipment (including for example antivenom serum) and trained personnel should be available, as well as procedures for emergency evacuation.

Chemical Hazards

Exposure to Hazardous Products, including Pesticides and Herbicides

46-48. Occupational health and safety impacts associated with pesticides are similar to those for other hazardous substances, and their prevention and control are discussed in the General EHS Guidelines. Potential exposures to pesticides include dermal contact (e.g., in storage rooms or from leaking containers) and inhalation during their preparation and application. The effect of such impacts may be increased by climatic conditions, such as wind, which may increase the chance of unintended drift, or high temperatures, which may be a deterrent to the use of personal protective equipment (PPE) by the operator. Recommendations specific to plantation crop production include the following:

- Dermal contact (e.g., in storage rooms or from leaking containers or splashes/spillage);
- Inhalation during preparation, mixing, and application; and
- Ingestion by swallowing the pesticide or contaminated foodstuffs.
49. The effect of such impacts may increase due to climatic conditions, such as wind (which may increase the chance of contaminant drift), elevated temperatures, or high humidity (which may be a deterrent to the use of PPE by the operator, thereby increasing the risk of exposure). Recommendations to minimize risks associated with pesticides and chemicals include (in addition to those listed in Section 1.1):

- Use alternative products or methods with a lower OHS risk profile (such as using lower toxicity rated products, or using safer application methods, such as shielded sprayers, incorporation, or low-volume equipment).
- Train personnel on hazardous product management and storage. Include training on how to read labels and the Material Safety Data Sheet (MSDS) and to understand the risks associated with all hazardous products, including pesticides, fertilizers, and crop-processing products.
- Train operators and support personnel to apply pesticides and ensure that these personnel have received the necessary certifications, or equivalent training where such certifications are not required—so that they are competent.
- Monitor and proactively manage all stages of pesticide and chemical purchase, storage, mixing, usage, and disposal. Maintain accurate records and analyze the records for any evidence of undue exposure or misuse of hazardous products.
- Respect pre- and post-treatment intervals to avoid operator exposure during reentry to crops with residues of pesticides;
  - Respect preharvest (re-entry) intervals to avoid operator exposure to pesticide residues on products during harvesting in production areas and on roadside landings and logging decks.
  - Ensure that product withholding periods are observed to minimize the risk of chemicals or their by-products entering the value chain.
- Ensure hygiene practices are followed (in accordance to with FAO regulations and PMP the project pesticide management plan) to avoid exposure of personnel or family members to pesticides pesticide or chemical residues.

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44 The US EPA classifies pesticides as either “unclassified” or “restricted.” All workers that apply unclassified pesticides must be trained according to the Worker Protection Standard (40 CFR Part 170) for Agricultural Pesticides. Restricted pesticides must be applied by or in the presence of a certified pesticide applicator. For more information, see http://www.epa.gov/pesticides/health/worker.htm.  
45 FAO 2014.
1.3 Community Health and Safety

Community health and safety issues during the production of plantation crops may include the following:

Community health and safety issues during the production of plantation crops may arise due to land use changes or to the loss of natural buffer areas (such as wetlands, mangroves, and upland forests that mitigate the effects of natural hazards, such as flooding, landslides, and fire) that may result in increased vulnerability and community safety-related risks and impacts. The diminution or degradation of natural resources may result in health-related risks and impacts. Hazardous products, including pesticides, may affect community health in the same ways that they affect individual operators: through dermal contact, ingestion, or inhalation of harmful products or chemicals. Risk of exposure to hazardous products can be minimized by ensuring that the plantation group is following guidelines for the transportation, storage, handling, usage, and disposal of those products. Risks also arise from:

- Potential exposure to pesticides caused by spray drift, improper disposal and use of packaging and containers, and the presence of pesticides or by-products in potentially harmful concentrations in foodstuffs and postharvest products.
- Potential exposure to pathogens and obnoxious noxious odors associated with the use of manure.
- Potential exposure to air emissions from openfires, burning of crop waste, residues, or solid waste.

Pesticides may affect community health in the same ways that they affect individual operators, through dermal contact or through inhalation of such chemicals as a result of application. The potential for community exposure to pesticides in the environment may be considerably influenced by climatic conditions, such as wind velocity, while the potential for exposure to residual levels in post-harvest products may depend on adherence to pesticide use instructions. There may also be an increased risk of vehicle or machinery injuries on roads and access routes around the community caused by dermal contact with residues in containers, packaging, etc.

While odors from manure, especially during application, are not generally hazardous, they can be a serious source of discomfort to the community. Avoid burning of residual organic crop waste can and other wastes, which create harmful air emissions for that may adversely impact surrounding communities.

Specific recommendations to minimize risks to communities include:
- Monitor and record all potentially harmful products and activities and manage them to minimize the following risk to communities. Regularly audit and update operating procedures and ensure that personnel are suitably trained.

- Implement best practice guidelines for management of potentially harmful products, and follow the General EHS Guidelines.

- Avoid the aerial application of pesticides whenever feasible; and give priority to other management strategies, if possible.

- Do not apply pesticides, chemicals, or manure if meteorological conditions are likely to result in adverse impacts in surrounding communities.

- Use biological or safer lower-risk-profile products, whenever feasible; if available.

- Respect pre-harvest intervals and post-harvest withholding periods for products that have been treated with pesticides to avoid unacceptable levels of pesticide residues in products, further complying with any applicable pesticide tolerance requirements.46

- Do not store or transport pesticides and fertilizers with food (human or livestock foodstuffs) or beverages (including drinking water).

- Ensure that animals and unauthorized people are not present in the areas where pesticides or other potentially harmful products are handled, stored, or applied.

- Store manure and crop protection products as far away from dwellings as possible, and use measures, such as covering the manure, to reduce odors and atmospheric emissions.

- Do not apply manure to the fields if the wind direction is toward nearby dwellings.

- Clean (e.g., a triple rinse or pressure technique) and dispose of (e.g., through crushing, shredding, or return to suppliers) pesticide packaging and containers to ensure that they are not subsequently used as containers for food or drinking water.

- Open burning of residual, organic crop waste should be avoided. Crop waste should be returned to the fields to enhance the nutrient content of the soil. Opportunities for use of crop waste as a fuel for energy generation should be considered, where feasible, including composting to create biogas.

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46 Examples of potentially applicable pesticide tolerance requirements include the FAO/WHO (1962–2005) Codex Alimentarius’ Maximum Residue Limits in Foods and 40 CRF Part 180. Tolerances and Exemptions from Tolerances for Pesticide Chemicals in Food, the latter of which applies to crops sold in the United States.
2.0 Performance Indicators and Monitoring

2.1. Environment

14. The following environmental guidelines in Table 1 should be used in applying pesticides and nutrients in order to avoid or reduce leaching into groundwater or surface water, runoff into surface water, atmospheric emissions, and other losses outside of the crop production system. Guidance on quantitative parameters that can be used to establish a project's water consumption can be found in Annex B.

Environmental Monitoring

53. The indicators in Table 1 can be used to monitor the effectiveness of EHS measures applied to the unit of production. This list of indicators is not crop-specific and can be generally applied to most crop production systems.

54. The performance indicators in Table 1 do not have minimum threshold requirements, as these are difficult to establish at the global level. When consistently measured and monitored as part of the farm/forest management plan implementation, they can be used to determine the effectiveness of risk mitigation actions and to enable adaptive management, where necessary. In addition, some indicators of resource efficiency can be used to demonstrate gradual improvements in resource efficiency against a baseline. Baselines should be measured for individual projects.

<table>
<thead>
<tr>
<th>Table 1. Core Performance Indicators for Perennial Crop Production Systems</th>
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<tbody>
<tr>
<td><strong>Performance indicator</strong></td>
</tr>
<tr>
<td>Farm or forest management plan</td>
</tr>
<tr>
<td>Water quality (on-site and off-site water supplies)</td>
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<tr>
<td>Irrigation water – pesticides, nitrates,</td>
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</tbody>
</table>
### Soil and soil management

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Description</th>
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<tbody>
<tr>
<td>Soil erosion and soil erosion risk</td>
<td>tons per hectare per year</td>
<td>Projects should aim to reduce erosion hazard rating levels, which should be assessed annually based on topography and slope; ground cover; exposed and bare soil; evidence of sheet, gully, and/or all erosion; recent sedimentation; silt deposition in streams; and exposed plant roots.</td>
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</tbody>
</table>

### Nutrient application and management

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Descriptions</th>
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<tbody>
<tr>
<td>Nutrient application and management</td>
<td>kg nutrient per ha</td>
<td>✓ Soil maps appropriate to culture are available</td>
</tr>
<tr>
<td></td>
<td></td>
<td>✓ Soil analysis indicating nutrient deficiencies are available</td>
</tr>
<tr>
<td></td>
<td></td>
<td>✓ Fertility prescriptions are in place and supported</td>
</tr>
</tbody>
</table>

### Pesticide

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use and effectiveness of pesticides</td>
<td>Active ingredient usage per ton of market product and/or per hectare treated</td>
<td>System in place that allows effective identification of phytosanitary problems and effective treatment.</td>
</tr>
</tbody>
</table>

#### Pesticide residues on-site soil

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pesticide residues on-site soil</td>
<td>Active ingredient in g/ha</td>
<td>These parameters should be below applicable tolerance levels.</td>
</tr>
</tbody>
</table>

#### Pesticide residues on produce

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pesticide residues on produce</td>
<td>Active ingredient in µ/kg of product</td>
<td>These parameters should be below maximum residue levels.</td>
</tr>
</tbody>
</table>

### Air quality, air emissions, and energy use

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy use</td>
<td>MJ/t product, kWh consumed, kWh/ha crop, kW/t crop product</td>
<td>Projects should aim to show improvements in energy efficiency. Systems to monitor and report energy use and efficiency should be implemented.</td>
</tr>
</tbody>
</table>

### GHG emissions and carbon stocks

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>GHG emissions and carbon stocks</td>
<td>t carbon stocks, gCO2eq/t product</td>
<td>Projects should aim to install appropriate monitoring systems to record changes in GHG emissions (t carbon stocks, gCO2eq/t product), including those changes associated with above- and below-ground carbon stocks (e.g., as part of harvest planning in forest management plans) and soil carbon stocks.</td>
</tr>
</tbody>
</table>

### Notes:

48.55 Environmental monitoring programs for this sector should be implemented to address all activities that have been identified to have potentially significant impacts on the environment, during both normal operations and upset conditions. Environmental monitoring activities should be based on direct or indirect indicators of emissions, effluents, and resource use applicable to the particular project. They should include monitoring of community impacts, such as those from waste, discharges, and emissions from any processing activities, through a well-designed monitoring program.

19.56 Monitoring frequency should be sufficient to provide representative data for the parameter being monitored. Monitoring should be conducted by trained individuals following monitoring and record-keeping procedures and using equipment that is properly calibrated and maintained equipment. Monitoring data should be analyzed and reviewed at regular intervals and compared with the operating standards, so that any necessary corrective actions can be taken. Additional guidance on applicable sampling and analytical methods for emissions and effluents is provided in the General EHS Guidelines.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Media</th>
<th>Guideline Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pesticides, nitrates, coliform or other potential agricultural contaminants</td>
<td>Irrigation water</td>
<td>Concentrations should not exceed national irrigation water quality standards or, in their absence, internationally recognized guidelines (e.g. WHO Water Guidelines applicable to irrigation water quality).a</td>
</tr>
<tr>
<td>Pesticides, nitrates, coliform or other potential agricultural contaminants</td>
<td>On-site water supplies</td>
<td>Concentrations should not exceed national drinking water quality standards or, in their absence, internationally recognized guidelines (e.g. WHO Irrigation or Drinking Water Guidelines for compounds potentially present in on-site groundwater wells or surface waters).b</td>
</tr>
<tr>
<td>Nutrient balance</td>
<td>On-site soil</td>
<td>Nutrient surpluses should remain stable; nitrogen surplus should be preferably below 25 kg/ha/yr.c</td>
</tr>
<tr>
<td>Pesticides</td>
<td>On-site soil and produce</td>
<td>Below applicable tolerance levels.d</td>
</tr>
</tbody>
</table>

NOTES:
See also Roy et al. (2006) Plant nutrition for food security, a guide for integrated nutrient management.
d Examples of potentially applicable pesticide tolerance requirements include the Food and Agriculture Organization Codex Alimentarius’ Maximum Residue Limits in Foods and the US Code of Federal Regulations Title 40, Part 180 — Tolerances and Exemptions from Tolerances for Pesticide Chemicals in Food, the latter of which applies to crops sold in the United States.
2.2 Occupational Health and Safety

Occupational Health and Safety Guidelines

Occupational health and safety performance should be evaluated against internationally published exposure guidelines, examples of which include the Threshold Limit Value (TLV®) occupational exposure guidelines and Biological Exposure Indices (BEIs) published by the American Conference of Governmental Industrial Hygienists (ACGIH®), the Pocket Guide to Chemical Hazards, published by the United States National Institute for Occupational Health and Safety (NIOSH®), Permissible Exposure Limits (PELs) published by the Occupational Safety and Health Administration of the United States (OSHA®), Indicative Occupational Exposure Limit Values, published by European Union member states, or other similar sources.

Accident and Fatality Rates

Projects should try to reduce the number of accidents among project workers (whether directly employed or subcontracted) to a rate of zero, especially accidents that could result in lost work time, different levels of disability, or even fatalities. Facility rates may be benchmarked against the performance of facilities in this sector in developed countries through consultation with published sources (e.g., U.S. Bureau of Labor Statistics and U.K. Health and Safety Executive).

Occupational Health and Safety Monitoring

The working environment should be monitored for occupational hazards relevant to the specific project. Monitoring should be designed and implemented by accredited professionals as part of an occupational health and safety monitoring program. Facilities should also maintain a record of occupational accidents and diseases and dangerous occurrences and accidents. Additional guidance on occupational health and safety monitoring programs is provided in the General EHS Guidelines.

Where pesticides are used, the health conditions of the workers who handle pesticides should be monitored through periodic health exams that include clinical assessment and blood/urine testing of relevant bio-indicator parameters (e.g., for organo-phosphates, cholinesterase, and alkylphosphates).
3.0 References and Additional Sources


European Agency for Safety and Health at Work. 2006. Available at http://europe.osha.eu.int/OSHA


Environmental, Health, and Safety Guidelines
PERENNIAL PLANTATION CROP PRODUCTION

2007 VERSION VS. 2015 DRAFT REVISED VERSION


Environmental, Health, and Safety Guidelines
PERENNIAL PLANTATION CROP PRODUCTION

2007 VERSION VS. 2015 DRAFT REVISED VERSION


Forest Stewardship Council (FSC). 2012. FSC Principles and Criteria for Forest Stewardship FSC-STD-01-001 (V5-0) EN. https://ic.fsc.org/principles-and-criteria.34.htm


Sustainable Agriculture Alliance. 2010. Sustainable Agriculture Standard, version 2. www.sanstandards.org


UNDP and GEF (Sustainable Forestry Initiative. 2010 Section 2. SFI 2010-2014 STANDARD. http://www.sfiprogram.org/sfi-standard/sfi-standards/


Annex A: General Description of Industry Activities

45. The production of plantation perennial crops consists of planting useful crops and modifying the environment to provide them with optimum conditions for growth. The life cycle of a plantation is normally longer than one growing season. For example, olive trees may be productive for several hundred years, although some plantation crops such as modern oil palm, coconut, and rubber plantations are productive for 20 to 30 years; but sugar cane crops are only grown for one season. Most plantations are artificially created, although some may be based on natural growth, for example, mango production.

61. Plantations or two seasons. Perennial crops belong to many different plant classifications and families. Products from trees palms include palm oil, and coconuts; products from tree crops include citrus fruits, rubber, and cacao; products from bushes include coffee and tea; products from herbs include bananas; and sugar cane is derived from a member of the grass family. Tropical forestry plantations include species such as *Eucalyptus* and *Pinus*. Temperate and boreal plantations are varied and many include spruce, pine, and fir.

24. The optimal growing conditions, (including nutrient and water needs,) and threats, (including diseases and insects,) differ for each crop. This is also the case for the utilization of the crop, which varies from human consumption to industrial uses.

25. Cultivation of different plantation crops is characterized by a wide range of crops, soil types, and climatic conditions. Modification of the environment ranges from minimal to intensive depending on the particular crop, growing conditions (soil, climate, diseases, weeds, and insects), and management techniques. The land area used for plantation crops and the scale of the production output are a factor of the above considerations, in addition to the use of fertilizer, water, and pesticides. It is the management of these latter factors that is of particular concern for environmental protection and occupational and community health and safety, as well as for occupational and community health and safety. However, achieving sustainable intensification and increased productivity per unit of land may be the most important factor in both reducing the expansion of plantation crops into natural areas and ensuring the adequate provision of foodstuffs for communities.

26. As illustrated in the schematic diagram in Figure A-1, the agricultural operations for plantation crops are divided into soil preparation, planting, growth, and typically multiple harvesting phases, nursery (or planting material/seed production), planting, and tending before the crop starts to yield productively.
Soil Site Planning and Preparation

27.65 Soil Site preparation involves preparing and improving the soil and the surrounding borders specifically for plantation crops, including removal of undesired plants, enhancing water supply and drainage systems, adding nutrients to the soil and regulating pH, and establishing various mitigation measures for in view of potential threats from flooding, runoff, and erosion. Tractor-drawn harrows and bulldozers can be used to remove existing vegetation. The cleared vegetation may be left to form a mulch to help improve soil quality. Following clearing, a period of 6–8 weeks passes before This is the phase in
which land is sprayed with herbicides use is assessed, topographic and terrain models are established, natural vs modified habitats are mapped, species and the plantation crop is sown or planted, sites of high biodiversity value (including critical habitat and HCV areas) are identified, roads are planned, community receptors are identified, and watercourses are protected, etc.

**Figure A-1: Generalized Perennial Crop Production Cycle**
66. Tractor-drawn equipment and heavy machinery (e.g., bulldozers, excavators) are often used to remove existing vegetation. Cleared vegetation can be left to form a mulch to help improve soil quality, rather than burned.

67. Following clearing, a period of six to eight weeks passes before the land may be selectively sprayed with herbicides, to reduce vegetation, and the plantation crop is then sown or planted.

**Planting or Sowing**

68. Depending on the type of plantation crops and the soil conditions, the planting seedbed and planting rows are prepared to maximize early growth, to reduce soil exposure, and to optimize early yields from the crops. The choice of appropriate tools and equipment should be used to will ensure a successful crop, with minimum impact on the local environment. Sowing can be done by equipment and methods range from tractor-drawn tools and implements (e.g., sugar cane) to manual planting, is typically done manually by digging planting holes and inserting a juvenile (sapling) plant (sapling) (e.g., oil palm, coconut, cacao, rubber, forestry), or to partially or fully mechanized planting methods (e.g., sugar cane, forestry).

69. The inter-row areas should be planted with suitable cover plants (e.g., legumes, food, or fodder crops) to protect the exposed soil, cycle organic matter and nutrients, and maintain desirable soil structure and conditions.

**Weed Control**

70. Weed control is the botanical component of pest control, which attempts to stop weeds, especially noxious or injurious weeds, from competing with plantation crops. Weed control is normally conducted mechanically through harrowing or other forms of plowing, the use of mulch or plastic barriers, or the use of chemical herbicides.

**Immature (Growing) Phase and First Cropping**

71. In the plantation crop's first growthimmature phase, the land is planted rows and access paths are kept clear of undesired vegetation, although some ground cover and fire risk is desirable to managed to optimize early growth and prevent erosion-unplanned damage. Returning crop residues from harvesting, thinning, pruning, and processing to the inter-rows, and establishing vegetative cover crops in trees or palm and bush plantations, minimize soil and environmental impacts. Other activities in this phase to promote optimal growth include shaping the plantation crop canopy and structure (for example, cutting pruning branches to form the trees or bushes and to assist future harvesting), irrigation, and the application of pesticides and nutrients, as necessary.
Some plantations apply intercropping techniques to maximize harvest output. For example, olive tree plantations may also cultivate other crops, such as tomatoes and potatoes, between the rows of olive trees.

Harvesting, Transport, and Postharvest

Once the crop reaches the desired mature stage of growth, it is carefully harvested. Harvesting of plantation crops involves digging, cutting, picking, or other methods to remove the crops from the ground, stalks, vines, bushes, or trees. Small fruits and other food crops (for example, strawberries) are typically harvested by hand, although they may be harvested by machine (e.g., sugar cane, coffee), and some utilize both methods (e.g., forestry). For some crops, such as sugar cane, preharvest burning and forestry, prescribed fire may be conducted to improve access to the crop and reduce fuel loading, although this practice is declining worldwide as the value of crop residues and effective residue management methods are demonstrated and effective methods of residue management are developed.

After the harvest, the plantation crop is stored on site in a controlled environment and may undergo certain preprocessing activities, such as washing (to remove pesticide residues) and drying. Agricultural plantation crops destined for use as processed foods (such as olives, e.g., olives, palm oil) and products (e.g., forestry timbers) are likely to undergo extensive washing and processing at the processing plant, and this may require significant water use (e.g., washing of food crops such as olives). Crops such as coffee and cocoa require fermentation and drying on site before transport to the processing plant is possible. Crops such as oil palm and rubber undergo processing to extract the marketable fractions (e.g., palm oil, palm kernel, fiber) of the yield.

The processed plantation crop is then prepared for market transport using a wide variety of forms, including:

- **Consumer packaging:** the produce is packed using various materials, including corrugated cardboard, paper, and plastic fabric packaging materials, before being loaded for transport to protect it until it reaches the consumer (e.g., fresh bananas) or additional processing facilities (e.g., coffee beans being sent for roasting and grinding).
- **Small bulk containers:** bulk containers including large crates (e.g., copra from coconuts), small tanks (e.g., refined coconut oil) or large reinforced cardboard containers (e.g., citrus fruit destined for juicing plants).
• Break bulk systems: the products are packaged in lots that can be handled and these are then packed inside larger bulk handling in containers (e.g., bags of copra are packed inside shipping containers, or bundles of timber are packed inside shipping containers). These large consignments are then “broken down” to the smaller packages at the destination for transport and distribution.
• Bulk handling: typically, large tankers (e.g., palm oil, raw coconut oil), shipping containers (e.g., processed timber, bags of cacao or coffee), and freighters/ships (e.g., copra, timber).

31.77 The potential pollution outputs of harvesting and postharvesting activities include air emissions from harvesting equipment and crop residue burning, wastewater potentially contaminated with organic wastes and pesticides from crop washing, wastewater and waste product from processing, and damaged packaging materials.

Soil Preparation

The Replanting phase

78. Once the marketable component is harvested and/or the yield declines, a plantation is then prepared for the next cropping phase. Activities include:

- Review of the site and replanning for the next crop cycle (including community and EHS);
- Establishment of a nursery (e.g., oil palm, cacao, rubber, forestry) or seed crop (e.g., sugar cane) to provide planting material for the next rotation;
- Removal and mulching of the existing plants; applying nutrients; controlling harmful vegetation and insects crop in-situ;
- Site preparation, including lining of new planting rows in the inter-rows;
- Soil and nutrient management in preparation for the new crop;
- Managing pests and diseases, if needed;
- Replanting or propagating from rootstock; and restoring
- Restoration of infrastructure, such as irrigation systems, roads, bridges, and harvesting access paths.

32.79 When the plantation crop becomes the primary plant, its crown may be sufficient reaches maturity, the leaf area usually provides significant ground cover to limit weed growth, and weed control activities may not be necessary. A well-established canopy provides soil protection from raindrop impact and erosion. On slopes, the planting density should not be too dense to prevent light and rainfall penetration, which would limit protective inter-row vegetation establishment.
## Annex B: Water Consumption

80. Water consumption for plantation crops per crop can be calculated and compared with a theoretical standard value (water/yield). In practice, the requirements for irrigation water depend on crop species, soil type, and evaporation, and water conservation practices. The irrigation requirements are also based on available nutrients and the presence of harmful diseases, weeds, and insects. The Food and Agriculture Organization has (FAO) provides guidance materials on water management that explain how to calculate appropriate irrigation. Examples, and CropWatis a computer program for the calculation of crop water requirements of individual crops and irrigation requirements based on soil, climate and typical yields crop data that can help design and efficiencies are presented manage irrigation schemes.

81. Crop-specific evapotranspiration factors (crop coefficients—Kc) form the basis of crop water calculations. Table A shows the single-crop coefficients for selected crops. It is provided for illustrative purposes only and demonstrates that water requirements vary over the growing season, influencing the risks and impacts of a particular project. The length and time of the growing season must also be considered when estimating whether crop water requirements are in line with water availability.

82. The risks and impacts associated with water use should consider the status of the river basin within which the project is located.

### Table A: Indicative Single-Crop Coefficients (Kc) for Selected Crops

<table>
<thead>
<tr>
<th>Crop</th>
<th>Initial</th>
<th>Mid</th>
<th>End</th>
<th>Initial</th>
<th>Mid</th>
<th>End</th>
</tr>
</thead>
<tbody>
<tr>
<td>Herb</td>
<td>Water requirements vary between 200–220 mm</td>
<td>0.5–1.0</td>
<td>Good commercial yields of banana are in the range of 40 to 60 tons/ha (2)</td>
<td>1.1–1.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Citrus Tree</td>
<td>Sugarcane</td>
<td>1.25</td>
<td>0.75</td>
<td>1.0–1.15</td>
<td>1.1–1.15</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Crop</th>
<th>Initial</th>
<th>Mid</th>
<th>End</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tea</td>
<td>0.95–1.1</td>
<td>1.0–1.15</td>
<td>1.1–1.15</td>
</tr>
</tbody>
</table>


54 The effects of the integration over time represent an average wetting frequency for a “standard” crop under typical growing conditions in an irrigated setting.
60 tons per ha; lemons 30 to 45 tons per ha per year; mandarin – 20 to 30 tons per ha per year\(^{(2)}\)

<table>
<thead>
<tr>
<th>Crop Type</th>
<th>Water Requirements</th>
<th>Yield</th>
<th>Oil Content of Fresh Fruit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sugar-cane Grass</td>
<td>Water requirements vary between 1500 to 2500 mm per yr</td>
<td>Good yields in the humid tropics of a totally rain fed crop can be in the range of 70 to 100 ton/ha cane, and in the dry tropics and subtropics with irrigation, 110 to 150 ton/ha cane. Sugar content at harvest is usually between 10 and 12 percent of the cane fresh weight(^{(2)})</td>
<td></td>
</tr>
<tr>
<td>Olives Tree</td>
<td>Water requirements vary between 600 to 800 mm per yr</td>
<td>Good commercial yields under irrigation are 50 to 65 kg/tree of fruit with a possible maximum of 100 kg/tree of fruit. Oil content of the fresh fruit ranges from 20 to 25 percent(^{(2)})</td>
<td></td>
</tr>
<tr>
<td>Palm Oil Palm Tree</td>
<td>0.95</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Coffee Bush Cacao</td>
<td>Water requirements 1500 mm and 2600 mm per yr</td>
<td>Average of 1.1 kg/ha, with varieties producing 2.4 kg/ha under good growing conditions(^{(2)})</td>
<td></td>
</tr>
<tr>
<td>Cocoa Tree Coffee*</td>
<td>Water requirement 1500mm and 2000 mm</td>
<td>Average of 346 kg/ha, cacao with varieties producing over 2.000 kg/ha under good growing conditions(^{(4)})</td>
<td></td>
</tr>
<tr>
<td>0.95-1.10</td>
<td>Olives</td>
<td>0.65</td>
<td>0.7</td>
</tr>
</tbody>
</table>

\(^{(1)}\) Modern high-yielding varieties are capable of producing in excess of 20 tons of bunches/ha yr, with palm oil in bunch content of 25 percent\(^{(2)}\).

\(^{(2)}\) Water requirements vary between 1600–5000 mm/yr.

\(^{(3)}\) Average of 1100 kg/ha, with varieties producing 2400 kg/ha under good growing conditions.

\(^{(4)}\) Average of 346 kg/ha, cacao with varieties producing over 2.000 kg/ha under good growing conditions.

Notes: 1Crop coefficient during the initial crop development stage. These values are subject to the effects of large variations in wetting frequencies. 2Crop coefficient in the mid-season; 3Crop coefficient at the end of the season. ** - for rainfed crops with lower plant density. aLower values are bare ground, higher values are with weeds, b no ground cover 20-70% canopy, c with active ground cover or weeds