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"REDUCING PESTICIDES RUNOFF TO THE CARIBBEAN SEA"

Good Agricultural Practices on BANANA FARMS in the MAGDALENA REGION

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CONTENTS

FOREWORD

One of the main pillars of the Colombian Association of Banana Producers is the promotion and development of projects that promote the improvement of productivity and competitiveness of the sector. For this, the group has boosted different programmes and research which, in partnership with other entities, have allowed producers to improve their agricultural practices and compete in today's marketplace.

Nowadays, the concept of product quality includes the way in which said product has been produced and this process must be in accordance with national and international regulations of environmental respect, and environment-related market demands.

The partnership between the United Nations Environment Programme – UNEP and the Association of Banana Producers of Colombia, AUGURA, was born in the framework of the REPCar Project: Reducing Pesticide Runoff into the Caribbean Sea. Funded by the Global Environment Fund (GEF), the project is coordinated by UNEP's Caribbean Regional Coordinatngn Unit , with the participation of Colombia, Costa Rica and Nicaragua.

Demonstration projects and training efforts headed by AUGURA within the REPCar Project framework seek to build awareness among growers on how their activities influence natural resource conservation, including marine ecosystems. These ecosystems are fundamental for tourism and fisheries activities in the region, thus contributing to the economy of coastal zones and the well-being of their inhabitants. Likewise, the Project seeks to provide tools for growers to strengthen their productive systems, increasing the competitiveness of the banana and plantain sector.

In this sense, AUGURA, with support of UNEP, is pleased to share the following educational materials:

- *Compendium of Good Agricultural Practices for Banana in the Magdalena Region*
- *Compendium of Good Agricultural Practices for Plantain in the Urabá Region*
- *Integrated Pest Management for Banana and Plantain Crops*
- *Handbook for Pesticide Handling*

We are sure these consultation materials will be helpful to growers, marketers, researchers and all stakeholders of this agro-industrial sector interested in implementing best practices to reduce the risk of pollution and foster safe food, as well as strengthen positions in international markets and sustainable development in the region.

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INTRODUCTION

The food safety issue in fruits

Food safety refers to the production of healthy or clean foods from a microbiological point of view, without overlooking aspects of physical and chemical pollution. Concern about these safety aspects in fresh foods has various origins. In first place, the increase in international trade of fruits and vegetables has made their worldwide market presence possible throughout the year. These fruits and vegetables come from different production systems that involve diverse agricultural practices. In second place, consumption of vegetables and fruits has increased notoriously in developed countries due to medical recommendations that highlight the need to eat more vegetables to prevent serious diseases like colon cancer and to improve overall health conditions. These recommendations have led to a substantial change in consumption patterns. And thirdly, vegetables are no longer grown by the people who consume them.

It is estimated that in the United States each year 76 million disease cases and 9 thousand deaths occur due to intake of contaminated food. Bacteria found on infected people are Campylobacter jejuni, Salmonella spp., Shigella spp. and E. coli 0157:H7. This problem has resulted in the definition of good agricultural practices that guarantee the production of safe foods from a microbial point of view to reduce the risk of contamination. (RODRÍGUEZ, A ., FORTIS, M)

Food safety has become a priority and a primordial factor of quality and competitiveness both for national and export markets.

Food Safety Assurance

To guarantee food safety, the various countries grouped under the CODEX ALIMENTARIUS promote the application of Good Manufacturing and Agricultural Practices and the principles of the Hazard Analysis and Critical Control Points (HACCP), with a chain focused on all components of the food sector, including fish, poultry, milk and dairy products, as well as fruits and fresh vegetables. (Good Agricultural Practice Guide).

1. GOOD AGRICULTURAL PRACTICES (GAP) GOOD MANUFACTURING PRACTICES (GMP)

Concept of GAP Good Agricultural Practices

GAP is a series of principles, rules and technical recommendations, applicable to the various production stages, with the aim of providing a safe product for direct consumption or industrial processing. The goal of their application is to offer high quality safe products to the market. GAP aims at continuous improvement to achieve sustainable agriculture and rural development. (FAQ, 2004)

Concept of GMP Good Manufacturing Practices

The risk of contaminating a product after harvest is high, since handling is frequent, and products have bruises and areas directly exposed to the attack of microorganisms. Also, conditions in the packaging area and inputs used in the process may be risk factors. Good Manufacturing Practices are basic to obtain products that are safe for human consumption, focused on hygiene and safe handling during packaging, storage, transport and processing, as necessary.

2. RAW MATERIALS AND AGRICULTURAL INPUTS

2.1. WATER

This is a basic resource for production, and its availability is crucial to ensure quality and productivity in regions with a low rainfall index. Among its multiple purposes we can highlight plantation irrigation using various systems (sprinkler, gravity and drop), washing fruit, preparation of agrochemical mixes, washing tools, personal hygiene and cleaning facilities related to the operation.

It is important to note that chemical and microbiological pollution is barely perceptible in color or odor or water. Water that appears to be clean is not necessarily suitable for consumption or other cultural tasks, which is why continuous microbiological analyses are so important.

Additionally, for all other harvest, post-harvest, cleaning, disinfection and other tasks, potable water is necessary to avoid the contamination of bananas with pathogenic microorganisms, mainly those of fecal origin or undesirable chemical substances such as soaps, detergents, heavy metals or agrochemical residues.

Figure 1. *Use of water for irrigation*

Figure 2. *Collecting water for fruit washing and irrigation by gravity.*

Good Water Management Practices

. *Water for agricultural use must meet certain minimum purity standards, not only when used for washing or other post harvest treatments, but also when used for crop irrigation, with special attention to ensure it does not carry pathogenic bacteria. (See Figure 1).*

- *Verify the source of the water and where it flows through, in order to evaluate possible contamination from fecal matter, agrochemical residues from other crops upstream, traces of chemical products used on other industrial activities and soaps from washing clothes in rivers or streams. (See Figure 2).*
- *It is important to use potable water during all steps of the agrifood chain, in order to ensure quality. This covers washing fruit, worker´s hands and daily irrigation.*

- *Water must be controlled by farm representatives. Microbiological, chemical and physical studies must be performed to ensure the water in use is clean, whether coming from a river, spring, local aqueduct or irrigation district.*
- *Keep water tanks or reservoirs clean, avoiding contamination.*
- *Always wash tools used in the farm with clean water, if possible potable water.*
- *Storage tanks with sufficient capacity to meet at least one day of processing needs are required. These tanks or reservoirs must be completely isolated from the environment to prevent contamination with foreign matter.*
- *To prevent water from stagnating in tanks and becoming contaminated by microorganisms and algae, it is necessary to change it constantly, which can be achieved by two different means. First: do not leave water still in the tank. The water network must allow treated water or aqueduct water to enter the tank first and from there move on to the rest of the process. Second: place the intake and exit pipes at different levels in the tank.*
- *Water tanks must me emptied and thoroughly cleaned at least twice a year, or more often if the quality of the water stored makes it necessary.*
- *Chlorination is the most frequent method to ensure bacteriological quality of water, making it necessary to control the levels of residual chlorine in the tanks and various parts of the system especially where water is collected for processing or for cleaning and disinfection. Sometimes simple chlorination systems may be needed to guarantee adequate residual chlorine levels.*
- *To increase probability of permanent availability, perform conservation activities at the sources.*

Hazards and Controls

Hazard	Control
Occasional chemical or microbiological contamination of surface water sources.	*Perform microbiological, chemical and physical monitoring to ensure that clean and safe water is being used.*
Possibility of cross contamination with dirty tools or when taking water from a reservoir or tank.	*Keep water handling tools and devices clean and, when possible, disinfected, including water storage tanks.*

Hazard	Control Measures	Corrective Actions
Microbiological contamination of water due to lack of residual chlorine.	*Residual chlorine for potable water ranges between 0.3 and 0.5 ppm. It is advisable to keep concentration above 0.1 ppm at all points of setup. Residual chlorine can be monitored using swimming pool kits.*	*If a decrease is residual chlorine levels is detected, check the system to verify if faulty piping is contaminating the water or if tanks should be cleaned more often.*

Water Regulations in Colombia

Decree 475 from 1998 Ministry of Health, technical standards for potable water quality

NTC – ISO 5667-1, water quality and sampling instructions

NTC – ISO 5667-2, general sampling techniques

NTC – ISO 5667-5, handbook for sampling potable water and water for food and drinks

NTC – ISO 5667 – 6, handbook on river and stream water sampling

NTC – ISO 5667 – 11, handbook on groundwater sampling

GTC 31, handbook for performing toxicity tests.

2.2. SOILS

Soils suitable to grow bananas are sandy loam, clay loam, sandy clay loam, and silt loam. They must also have good internal drainage and high fertility, with a depth ranging from 1.2 to 1.5 meters.

Good water retention is an important quality. Soils with 40% clay content are not recommended for bananas. Soil acidity should be 6.5, and a pH between 5.5 and 7.5.

Conservation practices are essential to maintain these soil properties.

Source: AUGURA research

Source: AUGURA research

Figures 3 and 4. *Sample extraction for soil analysis*

Good Soil Management Practices:

- *Use soils that are free of pests that affect banana.*
- *For soils previously used for banana where Moko disease was present and later eradicated, quarantine periods must be observed before planting again.*
- *Soils for banana must be loose, deep, and well-drained, with good organic matter content and good moisture retention.*

- *Nutritional and fertilization recommendations must be based on soil analysis and the correct interpretation of a technical assistant, in order to avoid excessive or insufficient inputs. (See figures 3 and 4)*
- *Floods are negative for the crop, as they destroy a high percentage of functional roots. Good site selection is necessary, as well as adequate drainage to allow evacuating surface and groundwater.*
- *Special treatment is required for soils with high pH as result of high salt concentrations from excessive chemical fertilization in previous crops, or movement of salt wedges from the oceans.*
- *Use friendly ground covers and dead covers (mulch) to avoid losing soil from runoff.*

▪ Hazards and Controls

Hazard	Control
Possibility of the soil not having conditions necessary for development of the crop.	*Perform soil studies when selecting the site.*
Inadequate use of machinery during soil preparation, increasing erosion, loss of fertility and production capacity of the site.	*Soil preparation must be adequately done, using agricultural equipment that does not alter soil structure like chisel plows and subsoilers. Drains must be built late in the rainy season and early in the dry season to avoid the loss of dug soil and runoff of rain water.*

2.3. AGROCHEMICALS

For banana cultivation it is important to pay special attention to agrochemicals used for insect, disease and weed control, ensuring they do not affect the health of farm workers.

Figure 5. *Use of fungicides (Sigatoka control)*

Good Agrochemicals Practices

- *Only use products that have been registered by ICA and endorsed by the seller for use on bananas. These products must always be in their original containers. Labels must remain intact and legible, in order to avoid mistakes at the time of using.*
- *Product banned in Colombia must be eliminated from stock and removed from the pesticide warehouse.*
- *Agrochemicals must be stored at a distance from where bananas are taken when recently harvested, classified, prepared for shipment or stored.*
- *Pesticide storage facilities must always remain closed and locked, and access of unauthorized persons must be restricted (see figure 6).*
- *Stored products must have a high turnover to avoid expiration. Expiration dates must always be verified when purchasing products.*
- *Agrochemicals must only be transported in vehicles for that task.*
- *Agrochemical substances must be used rationally, protecting water sources, wildlife and the health of people involved in the activity.*
- *Dose recommendations on labels must be observed; application equipment must be in good conditions and periodically calibrated, thus achieving greater efficiency.*
- *Pesticide appliers should receive training in good pesticide use at least once a year.*
- *Always have a first aid kit containing equipment needed to treat intoxications or burns caused by pesticides or other dangerous substances.*

Figure 6. *Warehouse for storing pesticides used on bananas*

Figure 7 and 8. *Pesticide application equipment and personal protection equipment*

- *Use gloves that offer adequate protection against the chemical product in use.*

- *Use face or breathing masks that filter vapors of certain toxic substances, if stated on product label (see figure 5 page 9).*
- *Have all necessary protection equipment available to workers (overalls, boots, face shield or goggles and hood).*

Figure 9. *Agrochemical storage room*

Figure 10. *Fertilizer storage*

- **Hazards and Controls**

Hazard	Control	Corrective Actions
Water comes to farm carrying chemical, physical and microbiologic contamination.	*Treat water before washing the fruit.*	*Look for alternative water sources in case contamination is found.*
Possibility of incorrect dosage for an application (overdose or under dose)	*Dosage must be handled by personnel with adequate knowledge in the subject. Refer to label recommendations or obtain technical assistance.*	*Check and adjust dosage regularly. Calibrate gear and use nozzles according to the type of product used.*
Expiration dates not observed due to prolonged product storage.	*Keep a record of products entering and exiting warehouses.*	*Discard expired products according to current legislation and authorities´ instructions.*
Chemical contamination may occur due to inadequate use of pesticides in the production chain.	*Use and handle pesticides correctly throughout the banana production cycle.*	*Discard contaminated bananas accordingly.*

Banana samples are taken to test for specific pesticides, when a given lot required unscheduled applications, when customers expressly request so, or when bananas are purchased from several different producers, especially those whose growing conditions are less than optimal.

Given the cost of sampling and specific pesticide analysis, it is necessary to optimize this activity, reason why it is convenient to ensure that:

- *The sample is representative of the plot.*
- *Samples are not contaminated when collected and transported to the analysis lab, either by contaminated worker hands, tools, containers, vehicles or areas.*
- *Samples are adequately identified and labeled to prevent confusion.*
- *Delivery to the lab takes place in the shortest time possible.*

2.4. ORGANIC FERTILIZERS

Banana growers use organic fertilizers such as chicken manure, worm culture, compost, cow manure or green fertilizers such as leguminous plants. It is important to note that these products must be traceable, and fertilizers must not contain heavy metals or other chemical products which affect banana safety.

To reduce microbial contamination the following practices must be taken into account:


Figures 11 - 12. *Compost production and management practices*

Good Organic Fertilizer Practices:

- *Use correct procedures to treat organic fertilizers, in order to reduce the amount of pathogenic organisms. These procedures include composting, pasteurizing or heat drying.*
- *Increase the time between the application of organic fertilizers and harvest in order to reduce the risk of contaminating the fruit.*
- *At the moment of purchase verify that all fertilizers have the mandatory ICA register.*
- *Farmers who buy natural fertilizers treated to reduce the level of pathogenic organisms and chemical compounds must get proof from the manufacturer specifying origin, disinfection methods, and results showing the condition of the product when it arrives for use.*
- *Be wary of leaching coming from other farms. In the event of runoff, propose procedures to prevent contamination.*
- *Fruit storage must be far from water and production areas, to avoid cross-contamination.*
- *Thoroughly wash hands and clothing after handling organic fertilizers and before moving on to any other crop activity.*
- *The clinical history or certificate is necessary when using animal manure.*

Hazards and Controls

Hazards	Controls
Natural fertilizers are not in optimal conditions	*Providers must provide evidence of treatment and use.*
Cross contamination during product storage. .	*A special site must be available for organic fertilizer storage.*

3. FARM AND POST-HARVEST FACILITIES

Banana production activities occur in nurseries, input storage rooms, tool and pesticide storage rooms, packaging plants and sanitary facilities.

Figure 13. *Sanitary facilities*

Figure 14. *Post-harvest area*

3.1. CRITERIA FOR DESIGN AND CONSTRUCTION OF FACILITIES IN FARMS

▪Good Facilities Practices

- *When processing bananas it is essential to have a large structure for bunch selection. This area must have a specific spot where bunches are suspended upon arrival from the field, with a height that prevents contact with the floor, and also allow for good ergonomic characteristics to reduce worker fatigue (not too low or too high).*
- *Rinse tanks must have the size and capacity to wash the daily production volume. This structure must be easy to clean, built with materials that resist wear and tear, and furnished with drain plugs in the lower part to allow for easy draining (see figure 15).*
- *The drying area must be after the washing tank, and at an optimum height to reduce worker´ fatigue. Full boxes must be stored indoors to prevent sunlight from directly reaching the boxes and to prevent excess heat. Floors must be flat and easy to wash after every work shift.*
- *Sanitary facilities must have toilets, urinals, sinks and showers for farm workers, allowing them to quickly return to their tasks and discouraging them from using the plantation as restroom (see figure 16).*
- *Store garbage in specific places that allow for the correct and easy handling and disposal of all wastes generated in the farm.*
- *Facilities must be far from possible contamination sources, like industrial complexes, landfills and places where staff or products are exposed to contaminants, diseases or pests.*

Figure 15. *Fruit rinsing tanks*

Figure 16. *Sanitary facilities*

4. EQUIPMENT AND TOOLS

General Considerations

The tools, gear and equipment used in banana plantations are the most common and care must be taken when cleaning and disinfecting them to avoid cross contamination, either chemical or microbiological.

Cleansing plans specifically apply to equipment that is in direct contact with fruit, such as gouges, trays, and others, used to transport and handle product. Propagation of diseases that might affect consumers or the bananas themselves is a possibility, deteriorating the fruit quality. This recommendation is particularly important when handling contaminated product, to avoid using the same tools and equipment to handle safe and contaminated products.

Figure 17. *Closet for gear and tools*

Good Practices for Equipment and Tools

- *Daily tool cleaning and disinfection programmes must be recorded on paper, indicating frequency, substance type and concentration, tools or equipment needed, name of person that performed the task and name of person who does the final check.*
- *For pieces requiring calibration (like thermometers, altimeters, spraying nozzles, etc.), a special programme must be in place to verify they work correctly. This programme allows strict control of the working conditions and maintenance of equipment and tools as required in the records.*
- *A whole diversity of tools can be part of the operation. These include hoes, boring shovels, mowers, machetes, knives, water pumps, spray pumps, scales, carts, tractors and accessories, gouges for special cuts and many others. These tools must be made of resistant materials and must not affect product quality and safety or worker health.*
- *All tools must be washed and disinfected after use to ensure they are clean for the following workday.*
- *Materials and devices must be suitable for the task. For instance, do not store water or other products in metallic containers, as these may rust and contaminate plants and fruits. Use plastic containers instead.*

- *Tools used to collect and handle waste material (especially organic waste, infected flowers, fruit rejected due to sanitary problems and other wastes that might be a source of contamination) must be clearly identified and labeled, and periodically subject to thorough cleaning and disinfection, to avoid accidental product contamination.*
- *All tools and equipment must be used within the timeframe stipulated by the manufacturer, also known as service life.*

Maintenance and Calibration

Maintenance and periodical calibration of equipment ensures correct conditions throughout the operation. Hence, the normal fluctuation of essential variables (temperature, relative humidity, and when necessary air flow or others) must be well understood. Machinery such as mowers and pesticide spray pumps or equipment like packers, scales and tools like cutting gouges, pliers and others needed in the process must be adequately maintained and calibrated.

Equipment must be calibrated following the relevant technical specifications and product tolerances to different variables like temperature, relative humidity or air flow, as they impact product quality and safety.

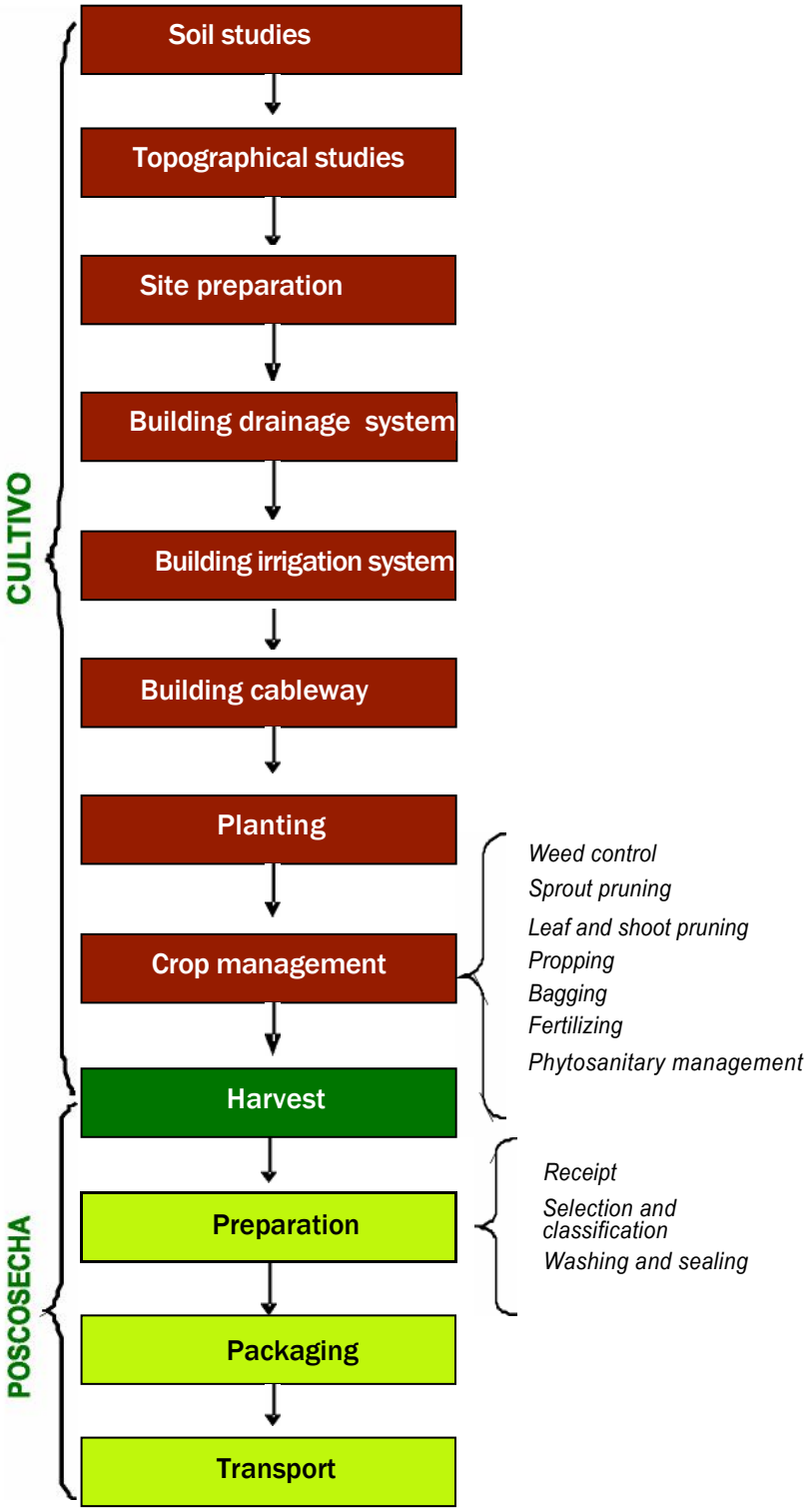
On the other hand, any gear or equipment used to handle wastes like fruit that does not meet hygiene or sanitary requirements (overripe or rotting product) and/or toxic substances used to control pests and diseases should be clearly identified to avoid accidental product contamination.

Hazards and Controls

Hazard	Controls
Tools or equipment contaminate bananas	*Wash and disinfect all tools and equipment after finishing daily operation.*
Incorrect reading of instruments	*Periodically calibrate all instruments and equipment.*

Good Agricultural Practices applicable to the banana production chain are described in the following diagram.

BANANA PRODUCTION FLOW CHART



BANANA PRODUCTION PROCESS

5.1. SOILS STUDIES

▪ General Considerations

Physical, chemical and microbiological properties are determined through a series of soil analyses as well as a series of criteria to evaluate optimal crop management and sustainability.

5.2. TOPOGRAPHICAL STUDY

▪ General Considerations

A set of operations represented in a topographic contour mapping of the area intended for planting, representing level sets approximately every 50 meters. A good graphic representation is required, covering both altimetry and planimetric properties.

5.3 SELECTION AND SITE PREPARATION

▪ General Considerations

Preparing the soil conditions as a basic component is aimed at offering up the best possible conditions for the development of the banana crops. Planting can be done starting from forests, shrublands, pastures or simply renovating old plantations that are no longer productive. Most of these crops are permanent, so soils must be carefully prepared. (See figure 20)

This process involves phases like cleaning, tillage and leveling.

As a conservation practice, when conditions so dictate, zero tillage may apply. Rigid or vibrating chisel plows must be used when soils are highly compacted, in some cases between 70 and 90 cm.

Figure 20. *Soil preparation*

Good Site Preparation Practices:

- *High acidity soils must be avoided, as they limit development and predispose the crop to certain diseases. Shrublands must be cleared and pasturelands may be overgrazed prior to preparation and use.*
- *Site preparation varies among growers, and can range from minimal tilling with tractors to using manual tools. Heavy or clayey soils require special care in their preparation, more so than loamy or very loose soils.*
- *After marking the site layout, seedlings are scattered in previously designated spots, and holes are dug according to soil structure and the vegetative material to be used.*

5.4 DRAINAGE NETWORK CONSTRUCTION

General Considerations

Since banana is a Musa species from the tropics, demanding significant water and soil permeability to allow for adequate root development, a water regulation system is required to reach and maintain optimal moisture levels. This is achieved with a drainage network consisting of a deep channel, and primary, secondary and tertiary ditches. (See figures 21, 22 and 23).

Figure 21. *Tertiary ditch*

Figure 22 - 23. *Main drainage channels*

5.5 IRRIGATION SYSTEM CONSTRUCTION

▪General Considerations

Subtropical regions with different rain patterns and dry periods, like Uraba and the Magdalena are, present seasonal periods with less rainfall than required, causing a crop water deficit. According to these conditions, site preparation includes the design and construction of irrigation such as: under leaf or overleaf sprinklers, gravity, and drip irrigation. Choice depends on the resources available and access to technology. Effectiveness relies on moisture retention, basic infiltration, potential evaporation and water balance. (See figures 24 and 25).

Figure 24. *Irrigation system design*

Figure 25. *Irrigation sprinkler*

▪ Good Irrigation and Drainage Practices:

- *Use irrigation according to the infiltration index, as well as physical soil characteristics.*
- *Indicators result from drawing moisture retention curves, according to water storage capacity and availability for the plantation. (See figure 26).*
- *Canopy evapo-transpiration levels are related to different methods such as penan, Thonrnthwaite and evaporation tank. (See figure 27).*

Figure 26. *Sampling irrigation water*

Figure 27. *Evapotranspiration bucket*

5.6 CABLEWAY CONSTRUCTION

▪ General Considerations

This transport system allows moving bunches from the plantation to the packing or processing facilities.

As a network of cables, it consists of one main and several secondary cables set up before planting. Depending on the drainage channel layout, secondary cables are perpendicular to the main cable. (See figures 28 and 29).

Figures 28 - 29. *Cableway design*

Good Cableway Practices:

- *This system must be designed in a way that allows easy movement of workers and bunches.*
- *Cable must be placed approximately 2.10 m above the surface, and must be held in place by galvanized tubes or treated wood arches, spaced between 8 and 10 meters for optimized strength and durability.*
- *The cable itself must consist of a metal rod approximately 7/16 inch in diameter, with a strength of 100 kg/mm to avoid the risk of breaking, dropping bunches to the ground.*

5.7 SEEDLING SELECTION

General Considerations

Several types of vegetative material include rhizomes, commonly referred to as corms in adult plants, pups or suckers in young plants, and also seedlings from in vitro reproduction.

To ensure a healthy and vigorous farm, the vegetative material must be of a known and guaranteed source, either plantations in the area or technified nurseries with license which supply certified material. This will guarantee better fruits and profits for the growers. (See figures 30 and 31).

Figures 30 - 31. *Seed stock nurseries*

Good Seed Selection Practices:

- *The origin of plant material must be considered at the time of seed selection, choosing good growth characteristics and young vigorous plants.*
- *Discard material from terraced, carefully extracting suckers using a sharp tool (spade) to avoid damage, cuts and wounds.*
- *Plant material must have three or more sword-shaped functional leaves.*
- *Corms or rhizomes should not be divided to obtain more seedlings, as this weakens their reserves and exposes them to parasitic attacks.*

- *Cut the roots and part of the pseudostem of selected corms, leaving about 15 to 20 cm, thus eliminating portions attacked by nematodes o weevils.*

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- *Use plant material that can be certified as healthy and well handled. Use food-industry grade disinfectant to treat seedlings.*

- *The presence of pests and diseases will greatly decrease with these preparation practices. However, their total elimination is not guaranteed so it is advisable to soak seedlings in hot water for some time and apply fungicides and insecticides.*

Hazards and Controls

Hazards	Controls
Seedling does not meet the basic quality characteristics listed above.	*Vegetative material must be sourced from reliable suppliers that handle it appropriately. This material should be certified and transported under the control of competent authorities.*
Vegetative material or corms become contaminated with chemical substances during preparation due to contaminated or incorrectly washed tools.	*Ensure all tools are clean before working with propagation material to avoid contaminating seedlings. Tools must also be washed and disinfected when moving from one seedling to another in order to block the transmission of diseases.*

5.8 PLANTING

General Considerations

Once the site has been prepared and facilities have been built, the plantation layout can be defined. The most widely used patterns are triangle, square and twin furrow. (See figures 32 and 33). Organic fertilizers are added when the seedlings are placed in their respective holes. Good microbiological quality of these fertilizers is vital in this stage.

Figure 32. *Plantation layout*

Figure 33. Triangular layout

▪ Good Planting Practices:

- *Plant corms ensuring that the first axilliary buds are some 10 cm below the ground and pseudo stem cut is 5 cm below the surface. If the plantation is intended exclusively to produce commercial seedlings, axilla buds must be planted closer to the surface in order to use the bud exposition method.*
- *Apply food-industry grade disinfectant on the root area when planting if seedlings have not been previously subject to disinfection.*
- *Cover corms with earth and gently compact with foot to prevent air pockets or cavities that might favor decay from waterlogging. Dig the hole according to the corm size, with approximate dimensions of 40 x 40 x 40cm, or the seedling size.*
- *Get advice from a technician when defining the crop spacing, considering the topographic conditions and the characteristics of the plant variety selected.*

▪ Hazards and Controls

Hazards	Controls
Large populations with short spacing hinder plantation management by workers and favors fungi proliferation.	*Plan minimum planting distances before sowing.*
Incorrect crop planning affects final production.	*Inspection planned plantation site to check preparation and readiness before sowing.*

5.9 CROP MANAGEMENT

▪ General Considerations

Execute tasks that favor good plantation development, good productivity and appropriate handling by workers. At this stage serious biologic and chemical contamination risks are present.

▪ Good Crop Management Practices:

Weed Control

Planted areas must be kept free of other plants that might compete for space, nutrients, light and water, and sometimes act as hosts for diseases and pests.

New sustainable production technologies allow implementing integrated weed control to limit the development and infestation of plants that may gradually interfere with crop plants, affecting productivity. This method consists of a combination of traditional control methods: manual, mechanical and chemical. Noble ground covers can complement these methods, with significant economic and environmental benefits.

- *Keep the site as clean as possible during the first year of the plantation, when smaller plants are more widely spaced and weed competition is at its highest. Grasses are very harmful to banana, so all weeds around the planting spot must be removed to avoid wounding the corm, damaging the roots, and furrowing the corm.*
- *This control can be done in a 1 meter radius around the pseudostem. After clearing the circle around the plant, cut weeds in the alleys down to 5 cm, and avoid exposing the soil completely, as it would be susceptible to erosion or biological deterioration.*
- *In flat or slightly undulated terrain, herbicides are often used for weed control. The quantities of herbicide per surface area must be controlled closely, following manufacturer recommendations.*
- *Herbicides must be applied only after justifying their use through technical evaluations.*

Thinning or Population Regulation

This population management practice consists of maintaining an adequate density that allows penetration of light and generational balance, regulation of nutrient absorption and movement of personnel around the area. The task itself consists of removing unnecessary sucklings since they affect the mother plant. This can be done with a hoe or ditch spade, eliminating only the shoot only, without affecting the root system or plant base. Alternatively a machete can be used, extracting the shoot from the plant. Both practices must be performed with the objective of achieving a good yield of the banana production plots.

Recommendations

- *Use direction and vigor criteria when replanting plantations.*

- *Use adequate tools, with sharp cutting edges and their respective safety gear (machete with cross brace and gloves)*
- *When renewing generations, follow the mother-daughter-granddaughter sequence.*

Pruning

This practice consists not only of removing dry and bent leaves, but also those that are too low, thus favoring the circulation of air and the penetration of sunlight, and preventing the attack of certain pests and diseases. Partially or totally eliminate those leaves with advanced incidence of black Sigatoka (presence of necrosis) to reduce new outbreak sources in the plantation. Additionally, leaves that are in direct contact or might come in contact with the bunch must be partially or completely removed. (See figure 34).

Figure 34. *Pruning activity*

Recommendations

- *Use adequate tools (pruning blade), sharpened correctly to optimize the job. (See figure 34)*
- *Do not leave stumps (petiole parts) that might become the origin of pathogenic contamination.*
- *Do not throw waste materials in ditches, channels or fertilization areas.*
- *Avoid unnecessary cuts to take maximum care of leaf area.*

Whorl removal

It consists of removing the whorls. This task must be performed by hand, starting from the bottom of the plant upwards, without tools. Whorl removal helps manage pests and diseases that might use decomposing sheaths as outbreak sites. Both whorl removal and pruning allow light and air to penetrate the lower part of the plants, helping to regulate plantation humidity.

Stem removal

This consists of eliminating the pseudostem after harvest. This task can be performed gradually, to favor sucker anchoring. Most pseudo stems are left above 1.5 m so suckers can anchor properly and ensure that nutrients flow to them.

Propping

The weight itself of the banana bunches makes the plant vulnerable to strong winds and to weak anchoring in the rainy season. When soils are saturated with water, plants must be tied down or anchored, using either bamboo props or nylon ropes. Tie down materials as well as any tools used to perforate holes in the plants for propping must have good hygiene conditions, clean and disinfected, to avoid microbial contamination of the plant. There are two types of propping: aerial and ground.

Recommendations

- *Always place opposite to plant tilt.*
- *Tie knot in upper part of pseudo stem, at the petiole base, between the third and fourth leaf, forming an angle of no less than 45°.*
- *Do not tie several trees to one same anchoring point, nor tie them to towers, wires, bridges or signs.*
- *Do not cut functional leaves; if leaves obstruct propping, change prop position.*

Fertilization and Nutrition

Banana plantations extract large amounts of both major and minor nutrients from the soil, which are important for plant physiology. This demands optimal dosage of these elements, depending on crop demands. Applications require prior soil analyses and must be made during the plantation development phase, and avoiding overdose that could leave undesirable residues on the final product. The decision to fertilize depends on the critical nutrient levels detected. (See figures 35 and 36)

These nutrient levels are determined through leaf analyses.

Figures 35 - 36. Fertilization methods

Recommendations

- *Do not apply to wastes or plant material.*
- *Do not apply fertilizers in extreme rainy or dry conditions.*
- *Add organic matter to plantation annually or bi-annually.*
- *Avoid applying in excess; use correct measure to guarantee recommended dose.*
- *Apply product as appropriate for components to the most effective method based on its components.*
- *Use all elements of personal fearl*

Bagging

Bagging bunches brings significant advantages to control insect pests, birds, rodents, and even adverse weather (excessive sun radiation, sudden temperature changes). Bagging contributes to increase the length, girth and weight of the bunch, as well as reduces the flowering-to-harvest interval, as it regulates bunch temperature. However, it is not free of safety risks and, additionally, bag handling represents an environmental problem. (See figures 37 and 38).

Figure 37 - 38. Bagging process

- *Ensure that bags have been treated using only authorized agrochemicals.*
- *When bagging, use work clothing and specific personal protection gear.*
- *Dispose of used bags properly and in conjunction with authorized companies.*
- *Bag as recommended by marketer (premature or present)*

Phytosanitary Management

- *When possible, resort to Integrated Pest Management, as this preventive method minimizes the use of chemicals through other techniques, like biologic and mechanical control.*
- *Certain practices like weed control, defoliation, stem cutting, fruit chopping and fertilization, performed in an appropriate and timely manner, contribute to Integrated Pest Management.*
- *The use of traps and manual chrysalis collection significantly reduce the use of pesticides.*
- *For Integrated Pest Management, organisms and biological substances must be correctly chosen to enhance their action and avoid losing control.*
- *Have adequate sanitary facilities for workers to wash and care for personal hygiene.*
- *Protect fruits from bird and bat attacks using protective nets. These animals can transmit pathogenic microorganisms or viral diseases to consumers.*
- *Apply pesticides in a targeted way, controlling volumes and exposure times to prevent overexposure of plants and future contamination problems due to toxic substances in the fruits or workers.*
- *Diagnose the problem correctly, evaluating the level of infestation and damage, to avoid the excessive use of pesticides (fungicides, nematicides, insecticides, etc.).*
- *Apply these substances properly; make sure the wind carries them away from workers and from product storage sites.*
- *Do not apply pesticides in unfavorable weather conditions (high temperatures, winds over 10 km/h or imminent rainfall), which may drift the product towards workers or products.*
- *Calibrate spraying gear correctly to avoid excessive application, uneven distribution or inadequate cover, favoring the action of microorganisms.*
- *Provide appropriate permanent training to ensure workers understand the pest and disease control products and how to apply them. Thus, each person involved in the process knows and has the ability to minimize the risk of contamination or intoxication.*
- *Constantly check national and international regulations to avoid using banned products.*
- *Use pesticide rotation to ensure applications achieve the expected results.*
- *Residues from the operations of washing containers or cleaning equipment must preferably be applied to the crop being treated, taking special care to avoid water contamination.*
- *Use current triple rinse operations, container perforation and disposal techniques.*
- *Avoid reusing original pesticide containers to store other agrochemicals or substances that could be in contact with people or fruits.*

Hazards and Controls

Hazards	Controls
Contamination when preparing seedlings	*Disinfect tools after cutting plants or preparing seedling with approved substances like iodine.*
Contamination during cultural practices like pruning or others. Biological contamination could result from blood of peoples suffering cuts while working.	*Use all personal protection gear when working in the field.*
Bananas contaminated with unacceptable levels of chemicals when fertilization is done indiscriminately.	*Keep records of fertilizer applications and follow the technical recommendations to avoid residual contamination.*

5.10 HARVEST

▪ General Considerations

This process begins when the bunch is cut from the plant and until it is taken to the packing station. Several further steps preserve the essential fruit characteristics until consumption. Incorrect harvesting results in failure to comply with export specifications.

Figure 39. Harvesting

▪ Good Harvest Practices

- *Strapping helps ensure a good harvest, as it allows determining the age of bunches, and schedule harvest accordingly. It consists of hanging a strap of a given color each week to the bag or pseudostem and letting it hang to easily identify bunch by age. It is also used as a planning and control tool.*
- *In the banana trade, harvesting means separating all bunches from the mother plant once they reach the commercial ripeness index or fulfill market requirements.*
- *Cutting begins when workers identify the bunches that are ready to harvest. They make a "V" shaped cut to the plant to bend it. (See figure 39).*
- *The cut must be made on the upper third of the plant, so when it bends down the bunch does not hit the ground or the plan pseudostem. This task must be performed with sharp tools (machete or lance point)*
- *Another worker must catch the bunch once the tree bends over. The receiver can place the bunch in a cradle or pillow and then transport it to the packing plant, either using the cableway or the cradle itself.*

Hazards and Controls

Hazards	Controls
Contamination may also result from bad hygiene practices both within and outside the planted areas.	*During harvest, workers must wash their hands, up to the elbows, before and after using the bathroom or performing any task that might imply contamination. All personal protection equipment must be perfectly clean.*
Premature ripeness of the fruit during transportation to its destination may cause economic losses and penalties to growers and marketers.	*Do not harvest bunches with ripe, overripe or overage fingers, bunches from fallen plants, plants with fewer than 5 functional leaves, or showing symptoms of disease.*
Field scars or bruises and bad appearance of the fruit may result in rejected production.	*Prevent rubbing bunches with nylon to avoid physical damage to fruit, and avoid prolonged exposure of bunches to sunlight, both in the field and in the packing station.*

6. POST HARVEST PROCESS

6.1. PREPARATION

General Considerations

Post harvest activities in banana refer to preparing the fruit for shipment, requiring good handling and hygiene practices in order to export high quality, safe product.

Figure 40. Rinsing fruit

Good Preparation Practices

The preparation of bananas begins with a detailed inspection in the packing plant, looking at the caliper, length, presence of bruises from the field, and verification of bunch age. After this, hands are cut and separated in clusters according to market specifications, and the fruit is weighed according to the type of box. It is important to note that all of these tasks are only done after trained workers have washed the fruit in tanks with very good hygiene conditions and a solution of water, alum and flocculant to prevent latex from adhering to the fruit. (See figures 40 to 45)

Figure 41 - 44. Selection process

Bananas are treated with a fungicide solution that acts as a healing agent in parts of the crown and prevents the formation of fungi during transport and storage. Thiabendazole is the product most widely used for this.

Figure 45. Selection and weighing

Figure 46. Crown treatment

- **Hazards and Controls**

Hazards	Controls
Bunches damaged during rinsing or transportation as result of incorrect handling	*Avoid damaged fruit from improper handling or cross-contamination. Provide training in correct bunch handling methods.*
Alterations of rinsing tanks due to incorrect dosage	*Dose correctly using accurate weight and volume measures to ensure a good wash without the risk of chemical contamination.*
Ineffective procedure if minimum immersion time is not correctly controlled	*Control immersion time for each batch to ensure exposure to products in solution for the required time.*

6.2. PACKING

General Considerations

Without doubt, packing is one of the most decisive procedures in fruit quality and acceptance. This task is based on a packing pattern decided by the marketer, according to the type of market where the fruit will be shipped. (See figures 47 and 48).

Figure 47 - 48. Packing process

Figure 49 - 50. Box coding or identification

Good Packing Practices:

- *Materials must meet the quality and technical specifications to avoid the risk of contamination and proliferation of microorganisms.*
- *Bag porosity must be correct to prevent the development and growth of pathogenic microorganisms.*
- *Packing materials or boxes must be easy to stack and keep safe during transportation and handling operations (see figure 49).*
- *Packaging materials must be in perfect conditions and storage must meet regulatory requirements.*
- *Clusters must be evenly distributed, trying always to follow the packing pattern and thus avoid mishandling.*
- *Ongoing training will ensure the staff in charge of this process has in-depth knowledge about product threats, as well as how to minimize the risk of contamination.*
- *Worksite inspectors must be healthy and follow good hygiene practices on the job.*
- *Efficient waste disposal systems will prevent the proliferation and development of microorganisms inside packing facilities.*

Hazards and Controls

Hazards	Controls
Product with organoleptic alterations	*Pack according to specifications to avoid alterations*
Product contamination from worker handling.	*Produce regulations and hygiene and cleanliness programmes for food product handlers indicating the correct way to perform cleaning and disinfection tasks*
Microbiologic contamination packing materials	*Refrain from using cardboard from rejected boxes.*
End product quality affected by incorrect packing.	*Always have packing instructions that show the correct way of performing this task, to prevent damage.*

6.3. TRANSPORT

General Considerations

Transport implies moving the packed product to distribution center or ports for shipping to its final destination (see figure 51).

Figure 51. *Transporting fruit at the port*

Good Transportation Practices

- *Fruit transportation vehicles must be used exclusively for this product. Under no circumstance must fruit be moved together with chemicals or animal products, rotting food, or other foods that may contaminate the product.*
- *Vehicle must be adequately covered to prevent boxes from getting wet or contaminated with foreign matter.*

- *Vehicles used to transport fruit must be periodically washed.*
- *Driver and helper must be aware of the level of care needed to perform this job, and must also attend a food handling training course at least once a year.*
- *The vehicle must receive thorough maintenance to prevent mechanical problems, and must be in good sanitary conditions.*

Hazards and Controls

Hazards	Controls
Product subject to chemical and microbiologic contamination during transportation	*Wash and disinfect vehicle as necessary; do not mix fruit with other food products during transport.*
Product alteration due to incorrect handling during loading	*Drivers and helpers must attend a food handling training course at least once a year, where they will be reminded of the importance of the products they transport.*

7 ENVIRONMENTAL MANAGEMENT

IN BANANA FARMS

General Considerations

Any type of productive activity uses resources provided by the environment, which in turn is impacted partially or totally. Agricultural production uses a great amount of resources, and sustainability over time will depend on its optimization.

Based on the major challenges it has traced for the survival of the planet - and hence its own - and having analyzed the current environmental crisis, man has developed strategies for natural environment recovery, compensation and mitigation, with input from all sectors of the economy. In the case of agriculture, this starts today with the implementation of programmes, regulations and legislation framed in the concept of sustainable development. Since bananas are so widely spread throughout the tropics, the use of environmental management must be a priority in product traceability.

An environmental management plan is implemented enforcing environmental guidelines provided in legal frameworks.

Components

- *Generalities in planning and environmental management*
- *Description of the production process*
- *Identification of impacts and management measures*
- *Evaluation, monitoring and follow up*
- *Procedures with the environmental community*

8. SUPPORT PROCESS

8.1. SANITATION PLAN

General Considerations

The establishment of, and efficient compliance with, clear hygiene regulations favors the development of a health culture that will guarantee high quality safe products well received in markets worldwide.

However, compliance with regulations and health programmes requires a sanitary design, a minimal supply of personal protection gear, and other elements necessary for field and post harvest operations, as well as basic training for workers to perform these tasks. Consequently, it is the owner´s or manager´s responsibility to ensure the material conditions for the implementation of good practices throughout the operation.

All workers or persons that might come in direct or indirect contact with the product must strictly observe these regulations, in aspects such as clothing, personal behavior and hygiene, health regulations, correct use of sanitary facilities, etc. Cleanliness, hygiene and disinfection programmes should be designed so they cover any and all production facilities (plantations free of waste materials or rotting fruit or, fruit attacked by fungi or contaminated with animal feces, product storage rooms, input and agrochemical warehouses, packing plants and other product handling facilities), sanitary facilities, offices, equipment, tools, etc.

Cleaning plans should consider the use of products that do not pose a risk of contamination for the fruit. Additionally, the microbiological and chemical quality of the water, as well as its correct use, is essential to maintain safe production areas and products.

The major contamination risks of each phase is the process should be analyzed and special attention must be paid to those where the product is exposed (from harvest onwards) to environment conditions and various sources of contamination. Therefore, utmost care must be taken to ensure the hygiene of cardboard boxes and other utensils used in this stage, as well as clothing and personal hygiene of workers, and the conditions of vehicles used to transport product.

A description of how, why and with what to clean and disinfect all tools, equipments, countertops, rinsing tanks, floors, and restrooms and others related to banana production operations must be provided in writing.

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Definitions that allow clarifying certain differences

Cleaning: *Process of eliminating leftover food or other foreign or undesirable matter*

Disinfection: *Reduction of the amount of microorganisms through physical or chemical means at levels that do not represent a risk for the safety of the food product*

Disinfecting agents: *Used to destroy microorganisms, for example: chlorine, Tego, Timsen and Delvocil*

Cleaning agents: *Used to remove dirt, most commonly soaps and detergents*

Daily cleaning: *Process performed daily, once a shift is over, or as needed, to clean a given area.*

General cleaning: *Cleaning of company facilities, including tools and utensils, at maximum intervals of one week.*

▪Good Cleaning and Disinfection Practices:

- *Once the cleaning and disinfection plans have been developed, company workers must be sensitized about the importance of following the recommendations made by the farm manager.*
- *All actions leading to the supply of safe food products, like washing hands after any action other than handling product, or keeping overalls or other clothing completely clean, must be followed every day. It is also important to enforce these good customs, and teach them to people who live with the workers that implement these hygiene rules.*
- *For clean facilities, plantation workers must know the cleaning and disinfection requirements for all food handling areas; for instance banana preparation surfaces and facilities and storage facilities must be rigorously cleaned and disinfected daily, thus keeping contamination levels low and preventing risks.*
- *All operating personnel must clearly understand their assigned task. This way the execution of these tasks will be more productive and appropriately supervised, with no task left unattended. The person in charge must also keep records indicating when and how the tasks were performed, keeping strict control of duties on the farm, who authorized and whether the goal was met.*

▪Cleaning and Disinfection Plans

It is important to plan the correct way to follow these procedures, so some examples are given as to how these actions must be done:

- **Tools and Utensils**

It is vital to be particularly careful with farm tools, as they may contaminate or trigger microbial outbreaks in the fruit at any time in any stage, causing significant economic losses to the growers. After finishing the daily chores, all tools and utensils must be cleaned and disinfected. To remove thicker filth, soak device in detergent water, scrub with a fiber or metallic sponge, and rinse with enough water to remove the detergent. Proceed to disinfect tools and utensils with disinfectant products depending on the type of microorganism targeted, like bacteria or viruses. The products most widely used due to their disinfectant power are those based on iodine and chlorine. Follow use and dilution prescriptions to prevent uncontrolled concentrations.

- **Washtubs or Tanks**

Widely used in banana farms, rinse tanks exist in pairs: one to cut banana hands, and the other to remove faulty fingers. Tank sizes are determined by the production capacity of the farm. Since produce is washed and prepared here upon arrival from the field, tanks must be kept very clean to prevent microbiological and chemical cross-contamination.

Cleaning must be done daily, emptying tanks after each batch and adding a detergent to remove visible filth, then rinsing with sufficient water and adding a disinfectant to eliminate any possible remaining microbes. (See figure 52).

Figure 52. *Fruit rinsing tanks*

Floors

Floors in the sorting areas and around the washing tanks must be cleared, scrubbed with detergent and rinsed with abundant water, then left to drain and dry. (See figure 53)

Figure 53. *Packing plant floors*

Hazards and Controls

Hazards	Controls
Contamination at the end of the production chain	*Follow all previously mentioned control measures throughout the complete production process to prevent contamination.*

8.2. PEST CONTROL

General Considerations

The presence of pests affects the safety and shelf life of food products and is a serious threat not only because of the damage caused but also the possibility of contamination, causing lower quality and greater increased disease transmission. Therefore, efficient controls are required to eradicate these pests. The main pests that affect banana plantations are: ceramidia, banana green worm, saddle worm, colaspis, mealybugs and trigona bee, among others.

Good Pest Control Practices:

- *Execution of timely and correct cultural practices is the best control method.*
- *Use of certified and healthy seedlings also constitutes a control measure.*
- *Mechanical controls like collecting and destroying pupas hanging from dry leaves are an effective method.*

Other pests, although not specific to the crop, can affect the facilities where produce is prepared or stored. These are: rodents, cockroaches, bats, ants and flies (see figure 54)

Figure 54. Domestic cockroach, *Periplaneta americana (Linnaeus)*

- *Rodents are one of the most problematic pests. They must be closely monitored in facilities and places where inputs, raw materials and finished products are stored. Traps or rat poison can be placed around the premises. For pests that fly, such as birds, bats, wasps and mosquitoes, mesh screens must be placed to prevent their entry into the aforementioned areas. (See figure 55).*
- *To prevent rodents from entering through drainpipes, install smaller mesh size.*
- *Special measures must be applied to roofs, to prevent pests from entering through tunnels or ventilation openings.*
- *These or any other mechanisms to prevent the entry of pests without polluting the environment can be used.*

Figure 55. Domestic mouse, *Mus domesticus*

8.3. RECORD MANAGEMENT

General Considerations

When implementing systems to guarantee the quality of banana production systems, it is necessary to develop methods to prove that the phystosanitary management actions are generating results. At this point it will be necessary to create a series of records that help control how the tasks are performed, showing the following data:

Company name

Record name

Record number

Date

Record-specific information (to determine what part of the process the record covers, such as cleaning and disinfection, operations control, tool cleaning, equipment maintenance, pest control, etc.)

Name of person in charge of keeping the record

Name of person in charge of verification

Respective signatures

8.4. IDENTIFICATION, TRACEABILITY AND RECALL PROCEDURES

General Considerations

Identification is mandatory when dealing with quality control and international market requirements. This helps to ensure that the final product meets the standards specified by export markets and guarantees the safety of the food product at the time of consumption, since it allows to fully identify the product that has been delivered (see figures 56 and 57).

Identification

This can be achieved through a detailed description of the product, finished or packed, ready for shipping. Banana boxes are identified with a manufacturing date (indicating the day the produce was packed for storage), a batch number (a given number of boxes processed one same day), and labeling that is required by customers for fruits and fresh produce. Boxes must display the following information;

Figure 56 - 57. *Fruit traceability.*

- *Country of origin.*
- *Nature of product: The common name of the species must appear on the box, unless the fruit is visible from the outside. Also, the cultivar is mandatory for certain products and optional for others.*
- *Commercial specifications like: class, size (may be expressed in weight, using the national scale as regulated, or an actual mean), and use of preservatives, if applicable.*
- *Identification, name, address, and official brand code.*
- *Each package must be clearly marked with the appropriate information, waterproof, and visible on the outside of the package. All information must be located on the same side of the package.*

An example of a label is shown below:

Name and address of the company and/or forwarder, Logo or commercial identification
Country of origin, name of city, town and district
Nature of product, if contents are not visible
Net weight / Size / Quantity / Class

Traceability

It can be described as the possibility of tracing a given product back and forth in the production chain, distribution and consumption according to its production batch. Product traceability is based on two key factors: the correct coding of production batches, and the appropriate filing of production and control quality records for each batch.

Regarding the first factor, production batches must be accurately defined. Thus, a production batch might relate to a specific production day, a given work shift or even a load. In practical terms, batch definition will also depend on the actual possibilities of maintaining a separation between them during the production process.

In the case of production and quality control records, these must register the information in a way that allows identifying and linking the record to the corresponding production batch.

A good traceability system allows the company to determine the conditions under which a batch was processed, including the characteristics of the raw materials used. In this way, and in case of a claim, the traceability system allows to check with full confidence the production and quality conditions and determine whether the damage was caused by situations attributable to the process or, on the contrary, by customer handling.

Additionally, in case of a problem with a given batch, the traceability system allows to identify the destination of each batch, according to the wholesale distribution, to give clear instructions to the carriers and wholesalers concerning the management and handling of this particular batch.

Recall Procedures

The recall of products already in the market is an important aspect for all companies to plan, as it helps the buyer of a given product support to return product due to damages or defects.

Thus, post-harvest offices must have a recall programme that ensures, if necessary, that all products in poor conditions return to their point of origin, or one way or another are eliminated at some point of the food distribution chain.

Contact with wholesalers and banana traders must be permanent to monitor product conditions upon arrival, and detect where possible problems may arise, in order to quickly and efficiently solve them. Also, the manager should also have plans to recall damaged or mishandled products, which could include all the way from discarding produce the moment an alteration is detected, to returning the product to the farm to decide its fate.

9. STAFF-RELATED CONSIDERATIONS

9.1. HYGIENE PRACTICES

General Considerations

Product handlers are people directly linked with the crop and preparation of produce, and have such an impact on the quality of both finished and unfinished products that it could be stated that quality depends on them. If the procedures are correct, so will be the safety of the products.

For this reason produce handlers must observe strict personal hygiene and cleanliness, and follow good hygiene practices while on the job, preventing the contamination of food products and the surfaces they are in contact with it.

Good Hygiene Practices

- *Use work gear that meets the company minimum requirements. For instance, gear should be light colored to easily check cleanliness, no zippers or buttons that might fall on the product or contact surfaces like boxes or bags. Sufficient gear must be in stock so workers can change clothing on a daily or weekly basis, depending on the task performed.*
- *Fruit handlers must wash their hands with soap and water before starting their work, each time they leave or come back to their designated work area, after touching objects or materials that might contaminate the food product, and after using the restrooms designated for handlers or farm workers.*
- *Hair must be kept tied up and totally covered with a net or hat at all times. The use of face masks is mandatory. Beard, mustaches and large sideburns are not advisable and, in any case, must be fully covered.*
- *Special attention must be paid to fingernails, which should be kept short, clean and free of nail polish.*
- *Closed, durable, easy to clean footwear must be used, e.g. boots.*
- *When gloves are necessary, these must be clean, with no tears or defects. The material must be suitable to the task performed. The use of gloves does not exempt hand washing.*
- *Rings, earrings or other accessories are not allowed while packing produce. No eating, drinking or chewing of products or objects is allowed. Smoking or spitting is forbidden in production areas or other places prone to product contamination.*

Figure 58. Incorrect fruit handling, lack of correct clothing and gear

- *All visitors to different product plantations and preparation areas must comply with minimal protection measures such as: smock or overalls, hat, boots, and face masks, as necessary. The operation manager supplies this gear.*

Figure 59. Incorrect practice, eating or drinking in fruit processing area

- **Health**

Workers that handle produce must pass medical examinations before performing their assigned tasks. Medical checkups are also required when necessary due to clinical or epidemiological reasons, especially after a worker has been absent due to illness or infection. All farm or operation workers must undergo a yearly medical examination.

The company must take the necessary measures to prevent direct or indirect contamination of food products from a person suffering a disease that can be transmitted to or through food products, a carrier of such a disease, a person with and infected wound, skin irritation or diarrhea. Product handlers that present such a risk or that know of others with these symptoms must inform the company representative to prevent their access to production and storage areas.

- **Training**

Workers must participate in training programmes to ensure they perform their tasks following the good practice recommendations. Training must be continuous, following adult education guidelines, and delivering the necessary and specific information to enhance working skills applicable to each specific task. After the training sessions, permanent monitoring is required in the work areas to ensure that the concepts learned are applied.

A good agricultural practices training programme may include the following topics, among others: basic food contamination principles, physicochemical and microbiological fruit characterization, identification of potential risks and risk levels throughout the process, hygiene practices, cleaning, disinfection and pest control.

Worker training is the responsibility of the management and its commitment is a key factor for success.

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Contents

Training programmes must be ongoing and must focus on areas such as hygiene and sanitary practices to handle fresh fruits for consumption, and use and handle chemical products. The following topics are a priority:

Hygiene and sanitary practices

- *Importance of correct use of restrooms to reduce potential contamination of fields, products, fellow workers and water sources.*
- *Potential of fruits in general and bananas in particular to favor the development of pathogenic microorganisms under certain environmental conditions.*
- *Concepts and application of hygiene practices throughout the production process.*
- *Importance of hygiene for personal health and food safety.*
- *Specific training on correct procedures and threats to fruit safety, as well as hygienic handling of food products.*
- *Hand washing methods to guarantee fruit safety.*
- *Fruit and fresh produce packing practices, including possible contamination and microorganism development.*
- *Recommended fruit and fresh vegetable storage conditions.*

Handling agrochemicals

- *Types of recommended and banned chemicals for bananas*
- *Recommended doses*
- *Toxicity*
- *Residuals*
- *Training drivers or loaders on handling chemicals.*
- *Training in Integrated Pest Management. (IPM)*

Technical aspects

- *Training: recommended plant spacing, installation of propping systems, basic principles of post harvest handling.*
- *Training: gradual implementation of organic agriculture.*
- *Training: efficient and clean management of water resources.*
- *Training: preparation and handling of organic fertilizers, especially chicken and bovine manure, used as fertilizer in the banana production process.*
- *Techniques and agricultural inputs used in primary production, including factual probabilities of microbial contamination.*
- *Basic biology for correct fruit handling.*

Post Harvest

Constant and well-planned training can create an environment favorable for the development of good practices among product handling personnel. Training in these stages must cover the following subjects, among others:

- *Hygiene and health practices to handle fruits and vegetables for fresh consumption*
- *Correct handling of toxic substances in the production process*
- *Training in efficient and clean water management, as well as continuous water chemistry monitoring to ensure timely detection of eventual water contamination (due to errors in the production process or errors in nearby farms)*
- *Techniques and inputs for banana handling, including the actual potential of related microbial and chemical contamination*
- *Basic fruit biology to ensure correct handling*
- *Specific job training and safe handling of fruits and vegetables*
- *Understanding and compliance with good hygiene practices*
- *Training programmes should include feedback methods to measure effectiveness and take corrective actions to focus on good hygiene practices among workers.*

Environmental Management

Learning and implementing practices related to applicable regulations and environmental improvement of all farm areas, optimization and preservation of natural resources: fauna, flora, water, and soils.

Continuous training regarding knowledge and development of good practices related to occupational health and industrial safety.

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