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SOP18:

Standard Operating Procedure (SOP) for Land Preparation and Planting Banana and Plantain

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Authors & Contributors

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1. Introduction

Banana and plantain (*Musa* spp.), referred to as bananas, are staple crops widely cultivated in tropical and subtropical regions, serving as a vital source of food, income, and nutrition for millions of people (Lescot, 2020). They are mainly distinguished by (1) their form of consumption, (2) their inflorescence type, (3) the height of their pseudostem and (4) their genome composition (Swennen, 1990; Swennen & Ortiz, 1997). Successful cultivation of bananas depends on proper land preparation and planting techniques, which are critical for optimizing yield, minimizing pest and disease incidence, and enhancing plant vigor (Swennen, 1990). In addition, well-prepared land creates a favorable environment for root development, improves water retention and drainage, and facilitates nutrient uptake, all of which contribute to healthy crop growth (Simmonds, 1966; Vuylsteke et al., 2013). Poor land preparation can negatively impact seedling establishment, increase weed competition, elevate pest and disease risks, interfere with mechanized field operations and reduce the sustainability of production. This Standard Operating Procedure (SOP) provides a comprehensive guide to best practices for land preparation and planting of banana and plantain fields. It aligns with international agricultural standards and guidelines to support sustainable production. By following these procedures, farmers and researchers can enhance productivity while promoting environmentally responsible farming practices.

2. Purpose

The purpose of this SOP is to provide guidelines for the proper preparation of land for banana cultivation to enhance soil fertility, optimize yield, reduce pest and disease incidence, and ensure sustainable crop production.

3. Scope

This SOP covers the following: site selection; land clearing, tilling and soil preparation, bed preparation, plant spacing and planting, and management during growth.

4. Definition of terms

Land clearing: The process of removing vegetation, trees, and other obstacles from the land before planting.

Tilling: The act of preparing the soil for planting by breaking up and loosening the ground.

Plant spacing: The arrangement of banana plants in the field, which is crucial for optimal growth and to avoid overcrowding and to encourage better maintenance.

Water control: The management of water supply for banana plants, ensuring they receive adequate moisture without the risk of waterlogging, which can lead to root rot and leaching.

5. Roles and Responsibilities

Research Technicians for experiment execution, supervision of land preparation and planting.

Field Assistants are responsible for land preparation, planting and field management.

Scientists/breeders are responsible for experiment planning, site selection and layout approval.

6. Procedure/Protocols

The steps for banana land preparation and planting involve several key processes to ensure healthy plant growth and optimal fruit production. Here is a breakdown of these steps:

Step 1. Site selection

The site selection should be based on the farming objectives, the type of planting materials, the agro-ecology/climate and rainfall distribution. Major factors to be considered are:

- **Climate**: Bananas thrive in tropical and subtropical climates with temperatures between 26°C to 30°C (79°F to 86°F).
- **Soil**: Choose well-drained, deep, fertile soils, rich in organic matter. A pH of 5.5 to 7.0 is ideal.

A new field should never be planted on a site where there was previously banana or plantain cultivated except if there was a 2–3-year fallow. Before validating the site selection, soil sampling for nematodes is highly recommended to avoid setting the field on a nematode hotspot that will harm the effort for production. The samples should be submitted to a qualified nematology laboratory to check the presence and density of the major plantain and banana nematode pests.

Step 2. Land clearing and field preparation before planting

Bananas fields are prepared with minimum disturbance to soil. Therefore, manual clearing is preferred over mechanical activities (Swennen, 1990). If one starts with a fallowed field, the land clearing consists of slashing grasses and cutting of shrubs. In the case of a forest trees need to be cut with chain saw. Never use a bulldozer as this will damage the topsoil (Fig. 1). Big trunks can be removed for wood while the small to medium size branches are left to decompose to increase litter/organic matter. Major steps in the land clearing include:

- **Tree removal**: In the case of an established forest, trees are cut with the help of saw chains.
- **Tree stumps**: If there are large tree stumps, leave them to decompose.

- **Removal of weeds and vegetation**: Remove weeds, grass, and any other vegetation. This can be done manually or by using herbicides.

Figure 1. Opening forest for plantain planting

In a case where the topsoil of the site is not deep enough, disc harrow may be applied making it easier for bananas roots to freely penetrate the soil while growing. This will also improve soil aeration. During the process, organic matter (compost, manure, or other organic material) can be incorporated into the soil to increase fertility and moisture retention. Depending on soil tests, specific fertilizers (e.g., nitrogen, phosphorus, potassium) should be applied to balance nutrient levels.

Additional land preparation may include:

- Preparing trenches: In areas with heavy rainfall, trenches may be dug for drainage to prevent water stagnation around the banana roots, which can lead to rot.
- Water control through (1) watering to address bananas water needs by setting irrigation facilities (drip irrigation or furrow irrigation works well) and (2) monitor moisture to ensure the soil is moist but not waterlogged. Bananas require consistent moisture for healthy growth.

Step 4. Plant spacing and layout

Banana roots and leaves grow up to 2 to 3 m in length and radius. Thus, for optimal field occupation and minimal overshading and competition, plant density depends on the variety (2 x 2 m, 2 x 2.5 m, 2.5 x 5 m and 2 x 3 m). Plants are usually planted in a rectangular pattern, except on hillsides, where planting is done along contours (to decrease erosion). Further, row orientation is also critical. These should be aligned in a north-south direction to maximize sunlight exposure. Immediately after cutting the fallow/trees, the pegging (Fig. 2), should follow the assigned spacing and adopted and approved layout.

Figure 2. Pegging the field before plantain and banana planting

Step 5. Time of planting

Bananas can be planted throughout the whole rainy season, but for a maximal harvest the moment is picked so that plantlets can grow 3 - 4 months without water stress. Most farmers plant thus at the start of the rainy season, but the harvest peak is than very high about one year later with consequent low prices. However, if one plants when the rainy season is already 2 months old, better prices will be obtained during harvest. With irrigation, planting can be done anytime, even during the dry season.

Step 6. Planting

The planting period and the planting materials will depend on the trial objective. The planting materials could be suckers (Fig. 3A), tissue culture materials or plants derived from seeds (Fig. 3B). The pseudostem of identified suckers from healthy plants for planting is cut off a few centimeters above the corm to reduce bulkiness while the corm is peeled (paring) to reduce the soilborne diseases (fungi, bacteria, weevil, nematodes) pressure. Hot water treatment may be applied after paring to further clean suckers from the soil-born posts and diseases. Within a week, suckers must be planted. Suckers that are stored for more than two weeks will have a detrimental impact on their future yields (Hauser & Coyne, 2010; Swennen, 1990).

Immediately after pegging, proceed to digging holes (50 x 50 x 50 cm) whereby the topsoil is separated from the rest of the soil. The planting material (sucker, plantlets, …) is placed upright in the hole (Fig. 4A). The side of the corm which used to be connected with the mother corm is placed towards the wall of the plant hole (Fig. 4A), for opposite to this side the axial sucker will appear. This axial sucker is the best sucker for the next cycle, because it is the one which develops first and is the deepest. As such, the axial sucker gets a lot of space in the plant hole. The plant hole is then filled up, first with topsoil, later with the rest of the soil (Fig. 4B). Thus, roots sprout in the most fertile part of the soil. In a recently planted field,

planted material is hardly visible. The first growth above ground is visible after 3-4 weeks. Then checks are performed for replanting.

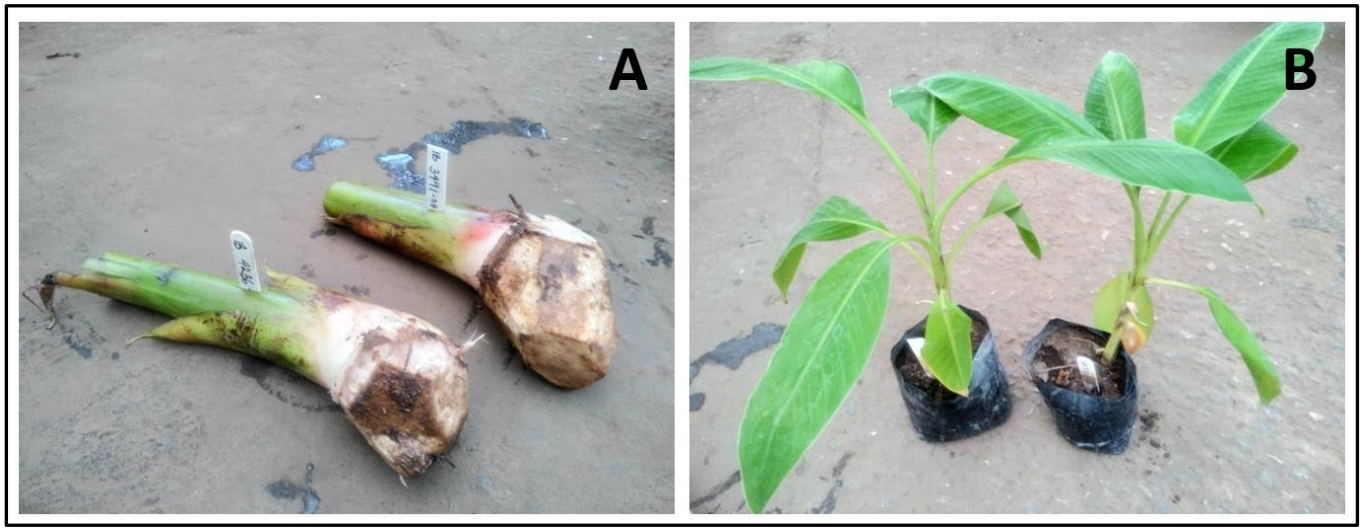

Figure 3. Banana planting materials: Suckers (A) and in vitro derived plantlets (B)

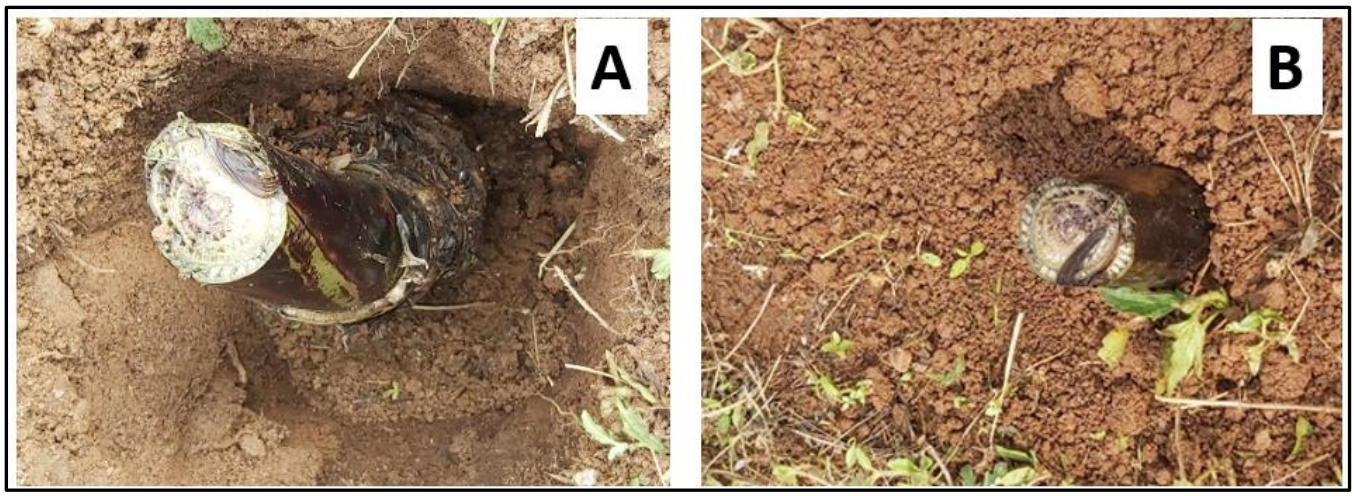

Figure 4. Plantain sucker in the hole (A) and after planting (B)

Step 7. Plant labeling

After planting is completed, prepare a detailed label/tag according to the field plan, using a combination of barcode/QR code and text information for each plant (Akech, 2023). This can be designed using MusaBase platform (https://musabase.org/) (Fig. 5).

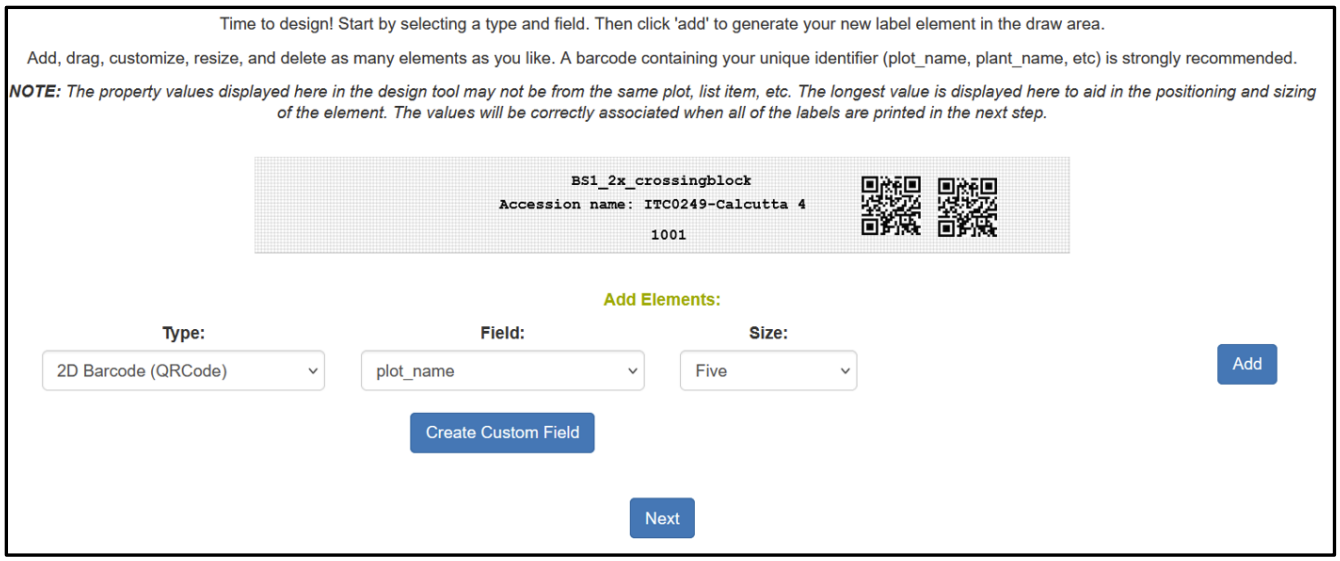

Figure 5. Screen capture of QR code designing using MusaBase

Labels are printed using OL125LP - Weatherproof Polyester Laser - 4" x 2" and fastened on plastic pegs placed about 10 cm from the plant in the field (Fig. 6).

Figure 6. Plantain with the QR code tag at the base of the plant with the plant unique identifier

Step 8. Plant management

These should include (1) fertilization application and weed control, (2) protection from wind/propping and (3) pests and diseases control

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