



Establishing a Mango Orchard

PROCEDURES AND COSTS OF ESTABLISHMENT

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INTRODUCTION

Based on the information existing in literature as well as in the experience obtained by this consultant from different parts of the world, a detailed description of all the steps required to establish a mango orchard from obtaining appropriate mango plants from the nursery till planting on the field. The following topics are discussed and recommendations for them are also covered in this document.

- On-farm access
- Clearing the land
- Selection of plant material (rootstocks and cultivars)
- Planting design and row direction
- Designing and installing the irrigation system.
Preparing the drainage system
- Planting procedures.



Finally, a non-quantified budget sheet is included, with the different economic inputs needed that can be used to estimate costs under different country/locations.

GENERAL FACTS

Establishing a new mango orchard to be profitable in the future is a complex procedure. The **selection of an appropriate location** is crucial to obtain abundant and regular crops that guaranty the economic viability of the mango planting. But it is first to decide about which **cultivar/s and rootstock** are to be planted. The next important step is to decide on the **tree spacing** to determine how many trees you need and how productive the orchard will become. The selection of a proper location requires careful planning, and paying special attention to many technical details. These include **climatic aspects** (tropical or subtropical location), selection of a **suitable location based on topography and soil type, temperature and rainfall** conditions, good **access to the orchard, wind protection**, possible problems of **soil erosion**, and possibilities of establishing appropriate **water drainage**, if needed. **Buildings required for farm equipment, fertilizers and pesticides** and, if pertinent, also for **future packing**, should be planned and the first ones built in advance. For economic reasons flat terrains or with reduced slope located as close as possible to roads and other transport facilities to permit the quick sending of fruits to local or foreign markets should be preferred.

If the planting is going to be established in a subtropical area, frost free and warmer locations should be chosen, avoiding areas with temperatures lower than 15°C during the expected flowering season (end of winter, beginning of spring), especially in the case of cultivars very sensitive to embryo abortion. In tropical areas, locations with winter temperatures below 20°C should be preferred to obtain a better flower induction. In the case of planting in terraces the lower part of hillsides or valleys should be avoided, and preference should be given to slopes oriented to the South in the Northern Hemisphere or those oriented to the North in the Southern Hemisphere. This will avoid cold pockets and frost in subtropical areas and water flooding in the rainy tropical areas. In locations exposed to wind, windbreak trees should be established prior to planting at least 10 m away from the nearest

orchard line, choosing fast growing trees of deep and narrow root system like acacia, cypress or other trees well adapted to the local environment and they should be watered and fertilized properly to favor quick growth.

As a general rule, planting on steep slopes (>25%) should be avoided to prevent soil erosion problems. When plantings in terrains with a slope higher than 10% it is recommended to plant the trees in small mounds to facilitate labor and improve drainage following the level curves or better in terraces to hold soil, water, organic matter, fertilizers or soil amendments (Fig.1). The installation of drip systems for planting in slopes facilitates cultural practices.

Even in the cases of planting in flat areas, it is important to control erosion and water runoff for which is necessary;

- Build diversion banks before the planting of the orchard that can conduct excess water flowing from the exterior to watercourses, water reservoirs or established grassed waterways avoiding waterlogging of the planting.
- Build internal drains through the orchard to conduct direct runoff from the inside of the planting to stable waterways.
- Build, if needed, appropriate dams to safely store runoff water.

Soil analysis to determine nutrient requirements to be added for mango production should be done prior to land clearing and plowing. Soil samples should be taken from 0-20cm and 20-40cm of the soil profile. It is particularly important to determine soil pH to estimate the need for liming or gypsum application to obtain an

adequate soil pH for mango of 5.5-7.0. Both amendments (gypsum, Sulfur for $\text{pH} > 7$ or calcium carbonate and calcium phosphate for low pH soils), as well as organic matter should be incorporated ($>2\%$ organic matter soil content being desirable) before the deep plowing labor (see section **clearing the land**).



Fig.1. Plantation of mangos in terraces

ON-FARM ACCESS

It is very convenient that mango plantings are provided with an **all-weather access road from all directions** that allow access of heavy vehicles and machinery from the main road to the shed to facilitate treatment applications and harvest operations. Orchard access road should be as smooth as possible to minimize fruit damage.

CLEARING THE LAND

It is recommended to initiate this labor around 12 months before planting. If planting is going to be done in a virgin land, it is necessary to **remove the existing natural vegetation** always keeping into account the country's legislation for tree clearing. In case of previously cultivated lands, a deep cross ripping to a depth of at least 50cm should be done to **break the compact layers** which usually exist in practically all the cultivated soils and also to improve drainage and soil aeration. This work should be done when the soil is dry, ideally at the end of the dry season. After the deep cross ripping and prior to planting, it may be necessary a **tillage operation to eliminate the weeds** that may appear after the rainy season. On step soils, and especially when planting in terraces, only planting holes are made.

If the soil is not too compact the ripping can be limited to 25-35cm followed by disking to destroy soil lumps. After soil leveling, **planting holes should be marked** accordingly with the planting density and design chosen. With the exception of planting in terraces it is always desirable –and especially for modern high-density plantings- to **work the whole surface area instead of only the planting holes** to avoid soil erosion or displacement of the soil surface after irrigation that can conduct to a situation in which the grafting point can be below the soil surface. Manual opening of the holes is better than a mechanical opening to minimize soil displacement and compact problems in the hole walls that can negatively affect the root expansion. It is not essential but always desirable to plant a cover crop before the mango planting and during the first 3-4 years to protect the mango trees from wind and weed competition which also serves as a mulching source.

SELECTION OF PLANT MATERIAL (CULTIVARS AND ROOTSTOCKS)

The following recommendations must be followed:

- Choose the cultivar(s) in function of the market and season of cropping.
- Choose the polyembryonic rootstock more adapted to your environment (i.e., tolerant to salinity) and/ to your desired planting design (i.e. dwarfing).
- Buy grafted trees from a well reputed nursery.¹
- Chose healthy, disease free plants with mature leaves of green color (recent new growth may not be green).
- Choose plants with long internodes, avoiding those compact or with a rosette of small leaves at the apex.
- Check that there is a good graft union with a normal uniform appearance between rootstock and scion.

¹Although polyembryonic mango cultivars can be grown directly from seeds, because usually, they give rise to true to type homogenous plants coming from nucellar embryos, this method is not recommended even for them because of eventual variations that can appear due to the development of some sexual embryos, and not at all for monoembryonic cultivars due to their heterozygotic characteristic. Grafted trees on polyembryonic rootstocks guaranty homogeneity and, also, favor early bearing by the stress effect of the graft itself and because of this mango propagation by grafting is the method used for commercial production of mangoes. It has been indicated, in some cases- particularly to reduce the initial cost in high-density plantings or to reduce the time for reaching full productivity in the subtropics the convenience of direct field planting polyembryonic rootstocks or simply polyembryonic seeds for posterior in situ grafting, but the loss of homogeneity makes this practice not recommendable.

- Choose well hardened and well-developed plants but that have not remained a long time in the nursery (less than one year) to avoid root problems. Small plants usually do not grow well.
- Do not buy plants that have flowered in the nursery as this can be a symptom of stress (Fig. 2).



Fig. 2. A good (left) an a bad mango plant which has flowered in the nursery (right)

- Inspect, if possible, a few plants by opening the bag and removing the propagation media to expose the root system. The main root should be straight with no deformation on it (Fig.3). The root system should not be too compact as occurring when the plant has been a long time in the pot, and plenty of adventitious roots should be present. Because of this, it is preferable to choose plants grown in nursery bags of 40cm length in which roots had been grown without touching the bottom.



Fig. 3. Plant with apparent deformed root system (left) and without symptoms of deformation (right)

PLANTING DESIGN AND ROW DIRECTION

Before clearing the land, it is necessary to decide about the planting design which is essential to facilitate mechanization and obtaining the best economic benefit. Both **planting distances and planting design should be chosen considering the size that the adult mango will reach**. In principle, depends on cultivar, soil, climate and cultivation practices, particularly the decision about the type of pruning in height and laterally to keep reduced size trees, as in the case of modern high-density plantings, or let them grow more freely as well as from the mechanization possibilities.

Two general considerations should be taken into account:

- Planting density can be higher in the subtropics compared with the tropics due to the slow growth and early bearing. Planting at 7x4m is one of the most used density and design utilized in the tropics, keeping the plant through pruning to a maximum height of 4m. Planting in the subtropics may do at 6x2m or 3x4m for the small producers without mechanization. High-density plantings in the subtropics may be even planted at 3x1m.
- The slope of the soil, particularly when planting in terraces.

The most recommended system for small growers is the **triangular planting pattern** (Fig. 4) because this permits to maximize the number of trees per unit area. The **rectangular planting design** is, however, more appropriate for bigger plantations and especially for high-density plantings because this design facilitates mechanization (Fig.5). In any case, wide service roads should be established inside the plantation, being recommended to leave a minimum alley of 4m around the whole contour of the orchard.

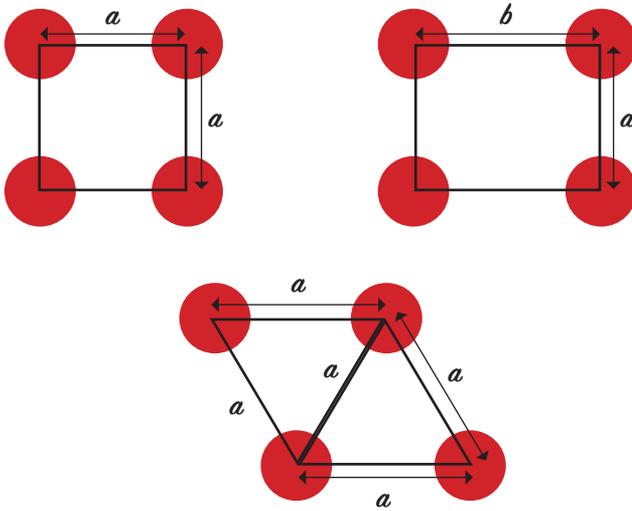


Fig 4. Different planting systems (square, rectangular and triangular)



Fig. 5 . The rectangular planting design facilitates mechanization

It is generally **preferably** and particularly in high-density plantings to **orientate rows in the North-South direction** to intercept as much sunlight as possible. However, sunburn damage may happen in very hot and sunny location in fruits exposed on the western side. Our final decision about row orientation should try to conjugate positively the different factor influencing it such as:

- In the case of wind locations, and particularly for the high-density plantings, rows should be orientated perpendicular to the dominant wind direction.
- The convenience that row orientation coincides with the maximum length of the parcel to facilitate machinery operations, fruit harvest and transport to the packing shed.
- Row orientation should also facilitate drainage.

DESIGNING AND INSTALLING THE IRRIGATION SYSTEM.

PREPARING THE DRAINAGE SYSTEM

The irrigation system must be designed in **function of the irrigation needs of the adult mango plant**, which can be estimated as 1000-1200l water/week but has a maximum demand of 1500-2000l during hot weather months.

Drip irrigation or micro sprinkler systems are the most recommended systems for modern well technically managed mango plantings since both permit the incorporation of fertilizers

through fertigation with the benefit of better nutrient uptake and economy of labor. In the case of using mini sprinklers the irrigation design could include a blocking micro spray feature to limit water throw during the first two years when only 100l/tree/week are sufficient. In the case of drip irrigation when using a ring of emitters around the tree, the number of emitters can be increased as the tree is growing or, if drip lines are used, another line can be added as the tree grows to place the two lines with the emitters one on each side of the tree.

A well-planned irrigation system in rainy areas must also consider **drainage needs** which should begin by designing and building **diversion banks** before the orchard is planted (see section **General Facts**) to avoid runoff water flowing inside and **conduct excess water** to an appropriate **water reservoir or grassed field**. They are usually covered with a creeping grass to avoid scouring. Suitable design and later building of **contour and v-drains inside the orchard** to conduct excess water into a stable watercourse or grassed waterway is also necessary for wet areas. They can also be grassed to avoid erosion.

The irrigation system should also include water reservoirs and should **be designed well in advance by a well-qualified irrigation designer** to avoid unnecessary mistakes that can spoil the future of the mango orchard.

PLANTING PROCEDURES

The planting operation consists of **marking and opening the holes, preparation and placing of the mango plants, filling of the hole, watering the plants and protecting them from wind, insolation or other climatic problems and undesirable wild fauna.**

Plants should be inspected before planting, eliminating any stunted plant or showing chlorosis or other unhealthy symptoms. Lateral branches should be removed to leave a single stem. They should be hardened enough to avoid shock problems at transplanting and get quick good growth. They should arrive at the planting hole well-watered to prevent a risk of breaking from the soil ball during transplanting (Fig. 6).



Fig. 6. Plant out of its container showing an intact root ball

It is important that the soil is in excellent condition and not frozen or excessively wet at the moment of planting the tree to allow opening the planting hole without compaction. Trees should be planted in the appropriate season to avoid frost, temperatures below 15°C, too hot summer temperatures, dry conditions or flooding. Because of this, trees should be planted in subtropical climates in spring, once the risk of low temperatures or frost is nil, provided that the soil is not too wet. If no adverse climatic conditions are expected and if irrigation is available mangoes can be planted in any time of the year. Generally, but particularly in hot areas, planting should be done early morning or late afternoon to reduce stress problems during transplanting.

The final position of the trees is decided accordingly to the chosen planting design. It can be marked with the stakes used later for training the trees. If the irrigation system has not been placed before this is the moment to do it.

The successive steps that should be done for planting are the following:

- 1** Water the tree site to a minimum depth of 30 cm 1-2 days before planting.
- 2** Dig a hole twice the size of the container (usually, trees come from the nursery in a plastic bag) with the tree you are planting. The dimension of planting holes typically range from 40-60 cm in depth and 30-40 cm in diameter in light texture soils but can be larger in heavy texture or clay soils (Fig. 7). The soil extracted from the hole should be divided into two portions, on one side the superficial half, generally more rich in organic matter, and in the other the rest of the soil.



Fig. 7. Manual opening of holes

3

Before planting, use about 300g of fertilizer containing phosphorus, potassium and trace elements or well-rotted animal manure but do not apply too much organic manure or peat moss below the tree to avoid inconvenient air pockets caused by the disintegration of the organic matter mixed with topsoil and place at the bottom of the planting hole.

4

Grafted mango plants coming from the nursery can be planted directly in the soil without defoliation, but it may be useful to slightly cut leaf tips to reduce the rate of water loss through transpiration and compensate root damage during transplanting. The plants should be wetted adequately before extracting from the nursery container to avoid splitting of the root ball during transplanting. When removing the tree from its container, it is imperative not to damage or disturb the roots, especially the tap root. Never pull the tree from the bag by the trunk because most often this causes irreversible shock to the young plant. Carefully cut the bottom of the bag, examine the root system cutting badly twisted roots, straight any large roots, loose a little the potting mix in the edges and at the bottom to expose some of the roots and place the tree with the remaining pot in the hole.

5

When placing the mango plant into the hole slowly fill the hole with soil, pressing with your hands, feet or hoe to contact the soil with the root ball and avoid the formation of air pockets. Fill the hole with water and let it drain before complete filling. Firm down the soil gently with your hands, leaving a small basin around the tree to hold water and water again. The tree should be at the same level that in the container, with the root-ball covered completely with soil and the grafting point 5-15 cm above the soil surface (Fig. 8 and 9).

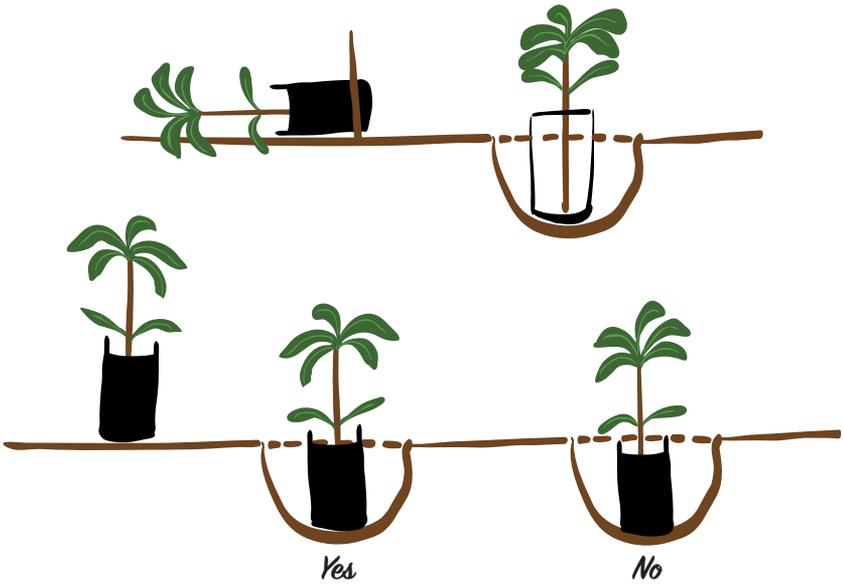


Fig. 8. Correct placement of the plant in the planting hole



Fig. 9. Mango recently planted with a supporting stake

6

If in an area of strong winds, place the plant with the graft orientated facing the dominant winds to prevent breaks and stake the plant by tying it to a strong stick with a strip of cloth, rubber or similar, making sure that it is loose enough to avoid restraining the tree as the trunk grows. If in an area with light frost risk, wrap the trunk with any insulating material and place plastic or protecting grass over the top of the tree during winter nights and early mornings. If in a region of extreme sun, protect your tree from sun damage by painting the tree with a diluted solution of white latex paint, white wash, protecting spray or an appropriate net (Fig. 10 and 11). If in an area with rabbits or other small rodents protect the trees with a plastic tube.



Fig. 10. Protection of plants from excessive sunburn



Fig. 11. Sprinkled plant with kaolinite to protect it from excessive sunburn

7

The area around the trunk on a radius of 1m should be kept without weeds. Because of this, it is convenient to spread coarse mulch, like leaf litter, hay, bagasse or similar around the base of the tree to preserve humidity and reduce weed competition as well as heat absorption in hot areas. Avoid the mulch touching the trunk to minimize disease risk. If plants are established on trickle irrigation, black polyethylene mulch will help reduce water requirements and control weeds.

8

It is convenient to give copious irrigation immediately after the planting and then continue watering the plants regularly until is well established and the roots are growing into the surrounded soil (Fig. 12). The timing of irrigation depends on the weather condition and soil type. It may be necessary to water at least twice a week during the first four weeks Do not overwater. Keeping the soil constantly wet is not necessary and can lead to roots rotting.



Fig. 12 Copious watering after planting

COST STUDY

Non-quantified budget sheet for the establishment of a mango orchard

1. Infrastructure

- Machinery and tools storage building
- Building for farm supplies storage (fertilizers, pesticides, etc.)
- Packing shed

2. Land preparation

- Soil analysis
- Fertilizer amendments
- Machinery hiring for land clearing and levelling

3. Planting materials

- Windbreak trees
- Mango plants

4. Fertigation system

- Design Project
- Fertilizer tanks
- Electric pump
- Pipes
- Sprinklers or drip emitters

5. Hand labor

- Clearing, levelling and weeding
- Planting Windbreak trees
- Building drainage channels
- Mark out tree plant sites
- Digging of holes
- Planting the trees

6. Other items

- Small farm tools
- Planting stakes
- Irrigation water
- Black polyethylene for mulching
- Protecting paint
- Protecting plastic tubes
- Unexpected items

BIBLIOGRAPHY REVIEWED

Anon. Undated. Modelo productivo de producción de mango bajo riego en el Estado de Colima. www.fifonafe.gob.mx/gerenciamiento/file_biblio/mango.doc

Anon. 1992. Estudio de factibilidad para producir y exportar mango fresco (*Mangifera indica*) a mercados selectos de la Comunidad Económica Europea <https://bdigital.zamorano.edu/bitstream/11036/4416/1/CPA-1992-T053.pdf>

Anon 1999. Mango Information Kit. Queensland department of primary Industries.

Anon. 2014. Mango. Estimated production costs in Miami-Dade country. agecon.centers.ufl.edu/documents/Budget/mangoes.pdf

Cambra Ruiz de Velasco, M. and Cambra Ruiz de Velasco, R. 2004 (1ª edición 1991). Diseños de plantación y formación de árboles frutales, Madrid: Consejo Superior de Investigaciones Científicas.

Crane, J.H., Bally, Y.S.E., Mosqueda Vázquez and E. Tomer. 1997. Crop Production. In: R.E. Litz (Ed.). The Mango, Botany, Production and Uses. CAB International. Wallingford. Oxon: 203-256.

Carmo Mouco, M. A. do, Albuquerque, J. A. S. de, Castro Neto, M. T. de and Rabelo Barbosa, F. 2002. Implantação do Pomar. En Carvalho Genú, P., J. de y Queiroz Pinto, A. C. de (eds.) A Cultura da Mangueira. Embrapa Informação Tecnológica

Diczbalis, Y., C. Wicks, C. and G. Owens, G: 2006 Mango Irrigation Management Guidelines Agnote No: D14 June 2006. Crops, Forestry and Horticulture, Darwin (Formerly DPIFM).

Galán Saúco, V. 2008. El cultivo del mango (2nd ed.). MundiPrensa. Madrid.

García Lozano, J., Abaunza González, C.A. and Rivera Velasco, J.E. 2017 Modelo productivo para el cultivo de mango en el valle del Alto Magdalena para el departamento del Tolima. Mosquera (Colombia): Corpoica.

Johnson, B. 1988. Updated by Mullins, F. 2007. Mango enterprise budget North Queensland

Hermoso González, J. M., Guirado Sánchez, E. and Farré Massip, J. M. 2018. Introducción al cultivo del mango en el Sur Peninsular. Caja Rural de Granada. Granada.

Mora Montero, J. Gamboa Porras, J. and Elizondo Murillo, R. 2002. Guía para el cultivo del mango. Sistema Unificado de Información Institucional (SUMI), Instituto Nacional de Innovación y Transferencia de Tecnología Agropecuaria (IBIA). San José. Costa Rica.

Rodríguez Hernández, L and Méndez Hernández, C. 2010. Manejo de plantaciones nuevas de mango. Cabildo de Tenerife.

Sandoval Esquivel, A. 2008. Manual para el establecimiento de plantaciones de mango C.V. Ataulfo con alta densidad de plantación. Folleto para productores N° 12. Instituto Nacional de Investigaciones Forestales Agrícolas y Pecuarias. Centro de Investigación Regional Pacífico Sur. Campo Experimental Rosario Izapa. Tuxtla Chico, Chiapas. México.



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