GOOD AGRICULTURAL PRACTICES

TRAINING MANUAL

FOR ORANGE FARMERS IN GHANA

german cooperation
DEUTSCHE ZUSAMMENARBEIT

1st Edition, 2013

Market-Oriented Agriculture Programme (MOAP)
of the Ministry of Food & Agriculture

Christoph Arndt
MOAP
MoFA (DAES)
Accra, Ghana
E-Mail: c.arndt@mail.ru

Isaac Fokuo Donkor
MOAP
MoFA (DAES)
Accra, Ghana
E-Mail: isaacfdonkor@gmail.com

Table of Content

This Training Manual on Good Agricultural Practices for Orange Farmers in Ghana has been developed in the frame of strengthening the links between smallholder orange producers in the Central Region of Ghana and two larger orange juice manufacturers. The Training Manual aims to increase the productivity of orange producers and in this way enhance the competitiveness of the entire orange juice value chain. The training on Good Agricultural Practices is considered just a first step. It needs to be followed by the Farmer Business School in which the producers are trained to understand the economics behind efforts towards Good Agricultural Practices.

This Training Manual was produced by Component 3 of the **Market Oriented Agriculture Programme (MOAP)** "Strengthening Public and Private Service Delivery in Agriculture", Ministry of Food and Agriculture of the Republic of Ghana, Directorate of Agricultural Extension Services.

MOAP is a Programme assisted by the German Government via the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ). Component 3 is implemented by AFC Consultants International GmbH.

Design: Christoph Arndt and Nat Appiah-Opong, "Unlimited Access", Accra Ghana

The authors would like to acknowledge the support of Dr. Godfred Budu, Mr. Holger Kahl, Mrs. Emelia Monney and Mr. Kofi Biney in contributing to the contents of the Training Manual and revising it.

For soft copies, please contact Christoph Arndt at c.arndt@mail.ru

First edition, September 2013

MODULE 1. SELECTING A GOOD SITE FOR PRODUCTION

A good citrus farmer selects a good site for citrus production because:

1. Citrus does well only on sites with a deep soil.
2. Citrus cannot stand water-logging.
3. Citrus needs above 1000 mm rainfall per year, if not irrigated
4. Citrus farms need to be easily accessible (this lowers costs of all farm operations including the costs of transporting the produce to the offtaker).

Practices that positively affect citrus production:

- Choice of suitable rootstock and scion
- Optimal nutrient management
- Effective pruning
- Effective weed management
- Effective pest and disease management

What is a good site?

Use a well accessible site on which cocoa would do well, too. Remember, citrus has a rather shallow root system. Only on a flat surface with no rocks the roots find sufficient nutrients. However, make sure there is no stagnant water on the site. Soil pH should be between 6.0 and 6.5 (see Module 7).

Good and poor orchard

Exercise 1: Selecting a good site

1. What is the importance of having the farm accessible by road?
2. Is your land well-drained or waterlogged?
3. Can cocoa grow on this soil?
4. Is the area hilly? Is the soil deep enough?

REMEMBER

Only use well-drained soils for your plantation.

MODULE 2. SELECTING GOOD PLANTING MATERIALS

Main types of citrus fruits

Orange

Tangerine

Lime

Common orange varieties and their uses:

Variety	Maturity time	Main uses	Sweetness	Fruit size
Ovaletto	Aug. - Oct.	processing, fresh	sweet	large
Sekkan	Aug. - Oct.	processing, fresh	sweet	medium
Obuasi	Oct. - Dec.	fresh	medium	small
Mediterranean	Oct. - Dec.	processing	medium	small
Pineapple	Oct. - Dec.	processing	sweet	small
Late Valencia	March or Sept.	processing, fresh	medium	large
Olinda Valencia	March or Sept.	processing, fresh	medium	large
Red Blood	Oct. - Dec.	fresh	low acid	medium

What to consider when buying young trees for planting

1. Check if nurseries have a valid certificate from Ghana Standards Authority (GSA) (District MoFA Offices will provide information of recommended nurseries)!
2. Make sure that your young tree has been properly grafted on a suitable rootstock (e.g. Rough Lemon, Cleopartra Mandarin, Rangpur Lime, Citrus Volkameriana, Swingle Citrumelo and Citranges; see Table on next page)!
3. Verify that mother plants of scions and rootstock are free from diseases!
4. You have a proper graft if i) rootstock and scion have about the same diameter; ii) the graft union has healed well; and iii) the graft union is 20 to 30 cm above the ground!
5. Do not mix different varieties in one orchard!

Common rootstocks in Ghana:

Rootstock	Advantages	Disadvantages
Rough Lemon	Roots go deep, suitable for soil with poor fertility Makes tree drought-tolerant Makes tree tolerant to Citrus Tristeza Virus (CTV) Good for oranges meant for processing **You get high yield, …**	Makes tree susceptible to blight and scab Makes tree very susceptible to gummosis Produces poor fruit quality **…but poor quality.**
Cleopatra Mandarin	Makes tree tolerant to CTV virus Makes tree grow well even in soils with high salinity and pH **Good for tangerines, …**	Reduces the number of buds **…but not for oranges.**
Rangpur Lime	Increases yields Produces sweet fruits with high brix **Yields & quality are high…**	Trees become susceptible to virus diseases such as CTV **…but risks are high, too.**
Citrus Volkameriana	Produces large vigorous trees Makes trees tolerant to CTV virus **Large yields, …**	Produces poor quality fruit Tree becomes susceptible to blight **…but poor quality fruits.**
Swingle Citrumelo	Makes tree tolerant to CTV virus and foot-rot **Sweet fruits with high brix, …**	Not suitable to lime-rich soils with a high pH **…but low yields.**
Citranges	Resistant to foot-rot and CTV virus **Reduces risks from diseases, …**	Only produces shallow roots Trees cannot tolerate severe droughts **…but requires irrigation.**

What you need to know about rootstocks

Different rootstocks give different quality, yield, canopy formation and disease tolerance to the plant.

Planting distances also depend on the type of rootstock. For example Rough Lemon rootstock gives a bigger canopy and will require wider planting distance between each tree.

In Ghana, Rough Lemon rootstock is preferred because it has a deep root system which makes the tree more drought-tolerant.

Examples of nurseries that sell certified young trees

- Asuansi Agriculture Station (AAK District, Central Region)
- Agriculture Research College Kade (Kwaebibirem District, Eastern Region)

Exercise 2: Selecting good planting materials

1. Why should you buy your young trees only from a recommended source?
2. Which variety of orange is doing well for juice making?
3. If you tend to have problems with gummosis and blight, which rootstock should you avoid?
4. If you need to increase sweetness of your fruits, which rootstock do you choose?

REMEMBER

Only buy young trees of which you know both, variety and rootstock!!

MODULE 3. PLANTING AND INTERCROPPING

A good citrus farmer avoids overcrowding of trees in his/her orchard.

The correct planting distance:

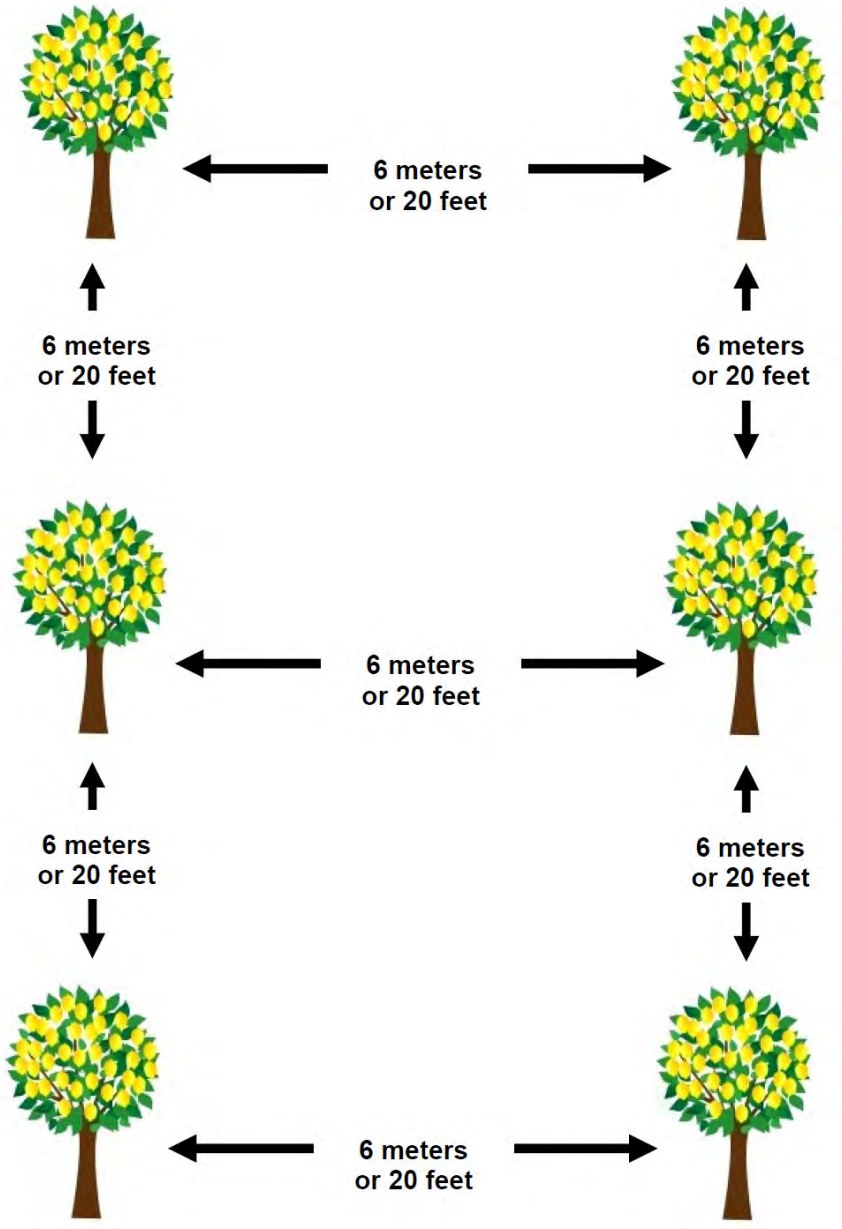
- Allows for good exposure of sunlight
- Allows the roots to spread properly
- Leads to good fruit quality with sweet fruits.

Best planting distances:

Rough Lemon rootstock:
6 meters x 6 meters
This makes about
110 trees per acre.

Swingle Citrumelo:
5 meters x 5 meters
This makes about
160 trees per acre.

Cleopatra Mandarin:
5.5 meters x 5.5 meters
This makes about
135 trees per acre.



Some farmers plant at a closer distance. When trees become large, they thin out weak trees. In this way they can harvest more in the early bearing periods.

Intercropping in young citrus orchards

Young citrus trees can be intercropped with a number of crops including:

Maize

Plantain

Pineapple

Cocoyam

The intercrop should be at least 1 m away from the citrus tree. But remember: These intercropped plants require additional fertiliser (see Module 7).

However, there are some important crops which a good citrus farmer should avoid intercropping with oranges because they may compete too much for nutrients (example cassava) or may become alternative hosts of pest and diseases (example chilli pepper).

Cassava

Chilli

Exercise 3: Planting and intercropping in citrus

1. Why is planting distance important?
2. What is the correct planting distance for citrus? How many trees per acre?
3. List crops you can intercrop with young citrus?
4. List crops you should not intercrop with citrus. Why?

Activity

Class learns how to measure, peg and line the correct planting distance for citrus.

REMEMBER

The correct planting distance for citrus (Rough Lemon rootstock) is 20 ft by 20 ft (6 meters x 6 meters).

MODULE 4. CONTROLLING WEED

A good citrus farmer weeds his/her orchard because:

1. Weeds compete at all stages of growth for nutrients and soil moisture.
2. Tall weeds inhibit the flow of air throughout the orchard and therefore create higher humidity and favourable conditions for diseases.
3. During the dry season, weeds may become sources of bush fires.
4. Severe weed pressure impedes harvesting operations.

Hand weed control (with a cutlass)

👍 Use slashed weeds as mulch.

👎 Hand weeding is time consuming and labour-intensive.

👎 It needs to be repeated every second month.

Chemical weed control (with a sprayer)

👍 Chemical weed control is easy to apply, and very effective if done properly.

👍 Chemical weeding can prevent the emergence of weeds (with pre-emergence weedicides)

👎 Chemical weeding is not suitable to kill mature weeds – as most of the post-emergence weedicides are only effective for **small weeds which are actively growing** (green).

👎 Chemical weed control may be very expensive, especially if weed is high.

👎 Herbicides have negative effects on the environment, on water bodies and on beneficial insects.

👎 Improper mixing and application of herbicides may lead to serious health consequences.

👎 In certified organic production, chemical weed control is no option.

Read instructions on container carefully before use

Motorised weed control (with a brush-cutter)

An example of this method is the use of the **brush-cutter** introduced by MOAP with Fruittiland.

👍 This method is fast, efficient and reliable.

👍 Mechanical weeding is only necessary 3 times per year, because weeds are cut at their base.

👎 The cost of brush-cutter may be too high for one farmer. It is advised therefore that farmers employ the services of trained weeding gangs in their districts.

A farmer in Central Region in full gear using the brush-cutter "Stihl FS 350" from C. Woermann (Accra)

Exercise 4: Controlling weeds

1. Why should your citrus orchard be free from weeds?
2. How many times should an orchard be weeded in a year?
3. What are the types of control available in your community?
4. List the disadvantages of the different methods.

Activity

1. Farmers undertake hand weeding for ¼ acre.
2. Farmers observe the use of brush-cutter machine to weed ¼ acre farm.
3. The class then compares the two methods based on these parameters:
   a) Time needed for ¼ acre
   b) Cost of labour / service for weeding gang for ¼ acre
   c) Cost per weeding one acre
   d) Cost per one person working one hour
4. The class decides which method is best suited for their orchards.

Method	**Size weeded**	**Start time**	**End time**	**Time needed**	**Costs**	**Costs per 1 acre**	**Cost per 1 person working 1 hour**
	acre	hours	hours	hours	GHC	GHC/acre	GHC/hour
Hand weeding 	1/4 acre						
Brush-cutter 	1/4 acre						

REMEMBER:

Do not allow your farm to be overgrown with weeds and control weeds in your farm regularly.

MODULE 5. CONTROLLING MAJOR PESTS AND DISEASES

A good citrus farmer prevents/controls pests and diseases by:

1. Regularly monitoring the farm in order to scout for pests and disease infections early enough.
2. Practicing orchard hygiene by weeding the farm frequently.
3. Pruning to increase aeration of the farm.
4. Removing pruned material from the farm to reduce disease pressure on the farm.
5. Removing and destroying infected plant parts in the farm to reduce disease pressure on the farm.
6. Using only recommended rootstock.

The Citrus Fruit Fly

The most invasive types in Ghana are the *Ceratitis capitata* (a fruit fly from the Mediterranean) and *Bactrocera invadens* (a new invasive fruit fly). The female fruit flies, which are about 1 cm in size, pierce the skin of the fruits and lay their eggs. The maggots hatch from the eggs and eat into the fruit. At the end, the fruit falls to the ground. A larva in a fruit is often sufficient to render it unsuitable for storage, sale or human consumption. Each female can lay about 700 eggs.

Fruits affected are citrus, mango, guava, papaya, avocado and cashew. Vegetables such as okra, chilli pepper, tomato and squash are also affected.

Female invasive fruit fly

Female piercing the skin and laying eggs

Controlling the Citrus Fruit Fly

This fruit fly is seriously threatening many crops in Ghana and thus the livelihood of thousands of farmers. We all need to do everything we can to break the life cycle of this livelihood-threatening pest.

Hygiene:

1. Collect all dropped fruits!
2. Destroy affected fruits in a way to prevent the maggots inside from developing and continuing the life cycle.
3. All affected fruits and vegetables should be collected three times a week.
4. Either **bury** collected fruits in soil (more than 30 cm deep), **burn** or put into a thick black plastic **bag** which is sealed and "cooked" in the sun for at least 3-5 days.
5. An alternative host to the fruit fly is chilli pepper; avoid planting chilli pepper as an intercrop in citrus orchards.

Collected infested fruits in securely fastened thick black polythene bags and exposed to the heat of the sun

Trapping: "Attract and Kill"

Trapping (baiting) attracts the male fruit fly and kills it. This prevents the males from mating with the females and eventually reduces the fruit fly population.

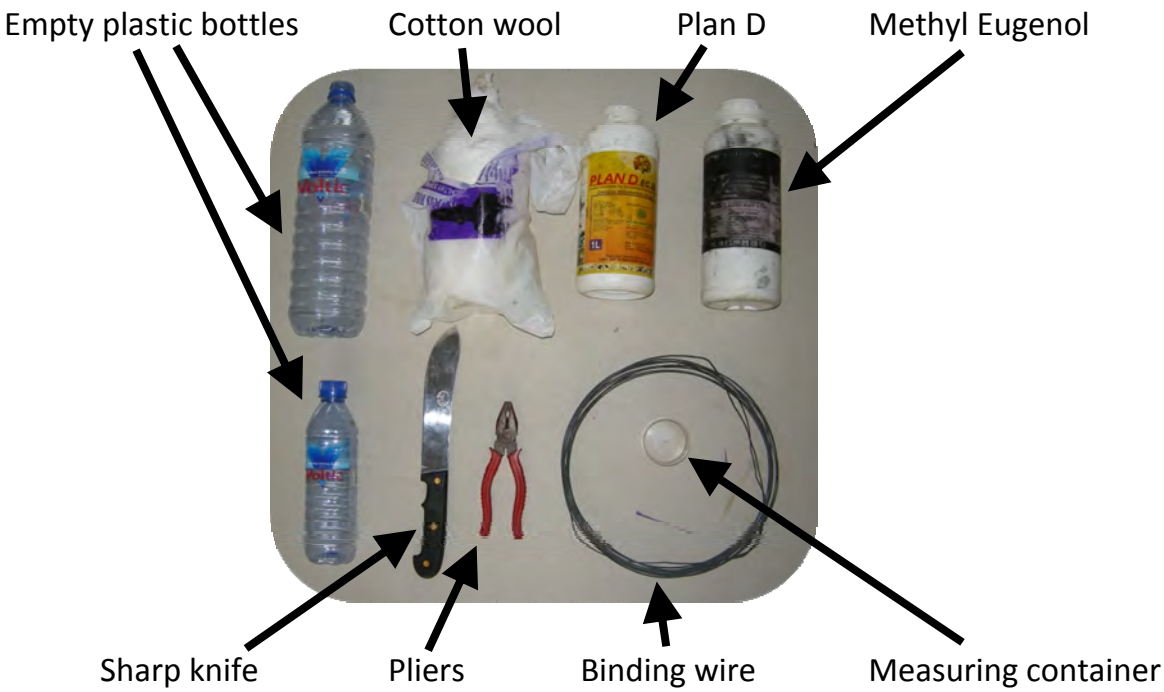
Place plastic jar traps baited with an attractant (sex hormone) and a killing agent (insecticide) in the affected trees/plants (see below on how to construct traps).

Usually about 5 traps per acre are needed and the materials inside the traps should be changed every 8 weeks.

Commercial & home-made plastic traps in a tree Dead fruit flies inside a trap

How to make your own fruit fly trap

What you need:



Cut off the neck of the bottle at the second ring or serration.

1

The cut-off neck will serve as an entry funnel into the rest of the bottle.

2

Cut a piece of wire, about 60 cm or 2 feet long!

3

Heat the tip of the wire that you will insert through the bottle.

4

Pierce through the bottom of the bottle, avoiding the low centre.

5

Pull the wire through the bottle with equal lengths sticking out at each side!

6

Pull out a piece of cotton wool, and roll it into a ball, the size of a 20 Pesewas coin.

7

Attach the ball to the wire at the open end of the bottle. But leave it still out.

8

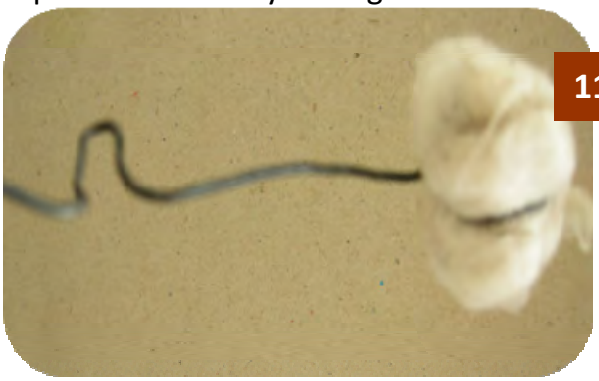
Mix 4 parts of Methyl Eugenol with 1 part of Plan D with the help of a measuring container.

9

Dip the cotton wool ball into the mix and let it soak up the liquid.

10

Bend the wire as below so it cannot be pulled all the way through the bottle.



Pull the wire through till the bend in the wire stops it.

Now insert the cut-off bottle neck piece into the base of the bottle!

Push the neck in tight so it sits firm in the base of the bottle.

The trap is ready now and can be placed in your citrus or mango tree.

Re-dip the cotton ball in the mix every 2-3 weeks!

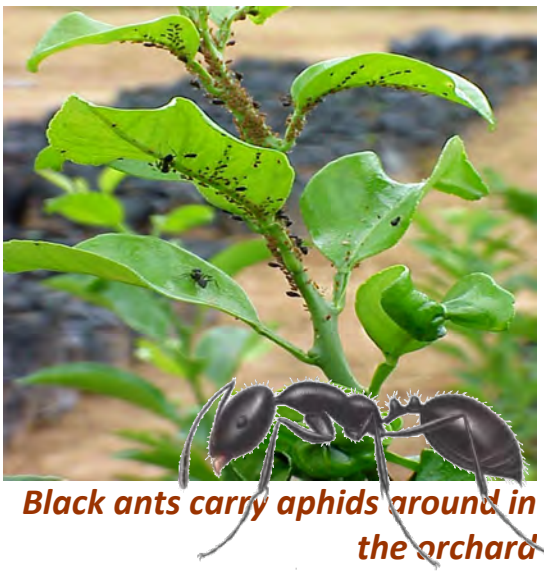
Avoid getting any of the liquids on your skin. Wash hands thoroughly after you have finished building your trap.

Other pests of citrus: Aphids, Whiteflies, Mites

Aphids feed by sucking on new blossoms causing severe curling and deformation of young leaves and stunted growth of leaves and twigs. Aphids excrete large amounts of honeydew, leading to the growth of black sooty mould on leaves and fruits. They also transmit Citrus Tristeza Virus (CTV).

Control **black ants** by spraying neem oil, but make sure you do not target the weaver ant nests.

Promote weaver ants in your orchard which feed on fruit fly maggots.



Black ants carry aphids around in the orchard

Weaver ants feeding on fruit fly maggots

Whiteflies feed on citrus leaves and excrete honeydew. Whiteflies also carry harmful viruses such as Citrus Tristeza Virus (CTV).

Spray trees with **neem oil**. Use synthetic insecticides only if neem oil has not shown any effect. ***Neem oil made-in-Ghana can be bought at Green-Gro Ltd. (www. green-grogh.com).***

Whiteflies on a citrus leaf

Citrus Bud Mites cause malformed twigs, leaves and fruits.

Mites can be best controlled by spraying **Agric Oil** (e.g. Eco Oil Spray from Dizengoff in Accra).

Rusty oranges caused by mites

Major citrus diseases

Disease	Caused by	Symptom	Control	Picture
Citrus Canker	Bacteria	Leaves and fruit drop prematurely	Preventive copper-based sprays.	
Black Spot	Fungi	Spots with black margin on fruits	Preventive copper-based sprays; remove dead twigs; apply urea to accelerate litter breakdown.	
CTV	Virus	Death of the entire citrus tree	Control brown citrus aphid; use appropriate rootstock (see Module 2).	
Pseudo-Cercospora	Fungi	Starts as a brownish spot that expands as fruit matures	Pruning and removal of infected leaves. Frequent fungicide sprays (e.g. Mancozeb or Carbendazim) always together with copper fungicides (such as Nordox) – every 4 weeks or more often.	
Gummosis	Fungi	Sticky fluid from the bark of the tree	Destroy ant hills around orchards as termites injure the bark of the tree. Remove affected bark and apply Ridomil mixture every 3 months until wound completely healed.	
Sooty Mould	Fungi	Black powdery substance on fruit starting from the top	Control aphids, whiteflies, mites and scales producing honeydew on which Sooty Mould develops.	

Spraying your orchard:

- ✓ Use professional motorised mist blower (no knapsack sprayer!) for greater atomisation of the spray droplets and longer distance that droplets are able to cover
- ✓ For good plant penetration, look at the CFM-value of the mist blower (Cubic Feet per Minute of air going through the machine). The CFM-value should be more than 700 (i.e. more than 1,200 m^3/hr)
- ✓ Protect yourself when spraying your orchard: Wear an overall, rubber boots, long proper gloves and a face mask

Use a mist blower to reach the entire tree

Exercise 5: Controlling pests and diseases in the citrus orchard

1. List the local names of important pests in your citrus farm.
2. List the local names of important diseases in your citrus farm.
3. Select the most important pest and the most important disease and describe how you control them on your orchard!
4. List all preventive measures to avoid pests and diseases in your orchard!

Activity

1. Collect dropped fruits and put into a thick black plastic bag to be "cooked" in the sun for 3-5 days.
2. Build your own fruit fly trap and place 5 of them in a 1-acre orchard.
3. Spray a preventive copper fungicide (such as Nordox).

REMEMBER

Remove pruned materials to avoid the spread of diseases.

Prevent breeding of pest by removing and destroying all fallen fruits.

Destroy such fruits by burning, by burying more than 30 cm deep or by "cooking" in thick black plastic bags (i.e. generating heat to kill pathogens).

Control fruit flies with 5 pheromone traps per acre.

MODULE 6. PRUNING

A good farmer prunes his/her citrus orchard because:

- Pruning removes diseased and unproductive wood.
- Pruning encourages lateral branches on which more fruit buds develop.
- It also improves light and air flow through the canopy therefore reducing pests and disease.

An ideal citrus tree looks like this

A bad citrus tree looks like this

Tools needed for pruning

Secateurs

Pruning saw

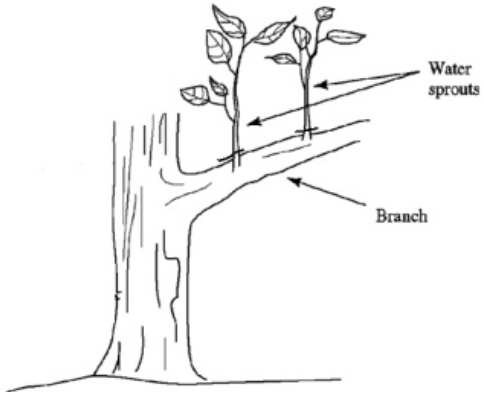
Disinfectant

Loppers for branches thicker than 1.2 cm

Cotton bag to collect pruned twigs

Tripod stand

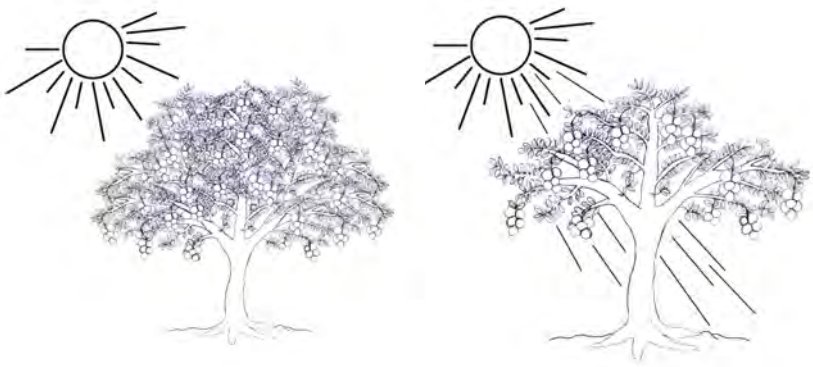
Types of pruning



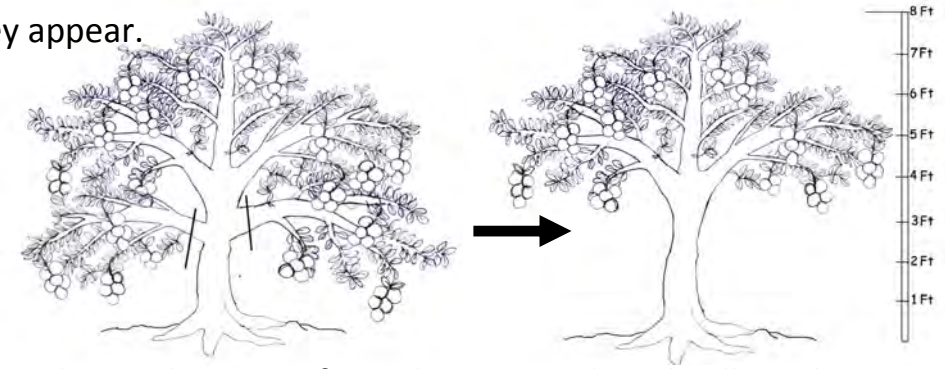
1. General Maintenance Pruning: This is done to remove **dead, damaged and diseased** branches or wood from the tree. Remove also all **water sprouts**.

2. Heading back: Trees maintained under 8 feet (2.5 meters) in height facilitate pruning, spraying and harvesting. This keeps costs down. Cut back your citrus tree so that it does not become too tall. Look at the ideal picture of a citrus tree: You want to have 3-4 main branches which grow up in a 45 degree angle (V-shape) and produce a wide canopy. Remove those branches which **grow vertically up** towards the sunlight. Also remove branches that **grow inside** into the centre of the tree (instead of growing outside)

3. Canopy Thinning: Citrus needs sunlight to develop flavours and juice. Dense canopies may not allow enough sunlight to reach fruit, so thinning is needed at least once every two years. A good way to judge canopy density is whether or not you can see dappled sunlight on the ground beneath the tree. We don't want dense canopies with fruits only growing at the top where there is enough sunlight.



4. Skirting out: "Skirts" are pendulous branches that hang to the ground. They provide pathways for termites and black ants to the trees. **Skirts** should be removed whenever they appear.

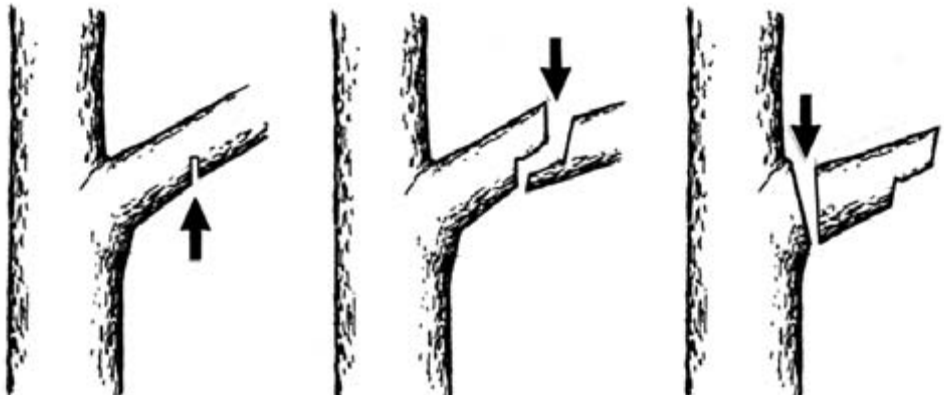


5. Suckering: Suckers are shoots that grow from the rootstock and will not be productive. **Suckers** should be removed as soon as they appear.

Best pruning practices

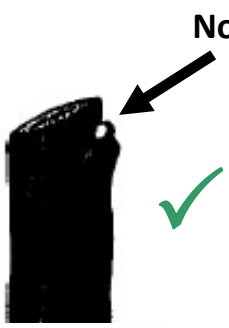
✓ Pruning should be done before flowering!

✓ Cut thick branches in a way that prevents bark from stripping down the trunk!



Step 1 **Step 2** **Step 3**

✓ Always cut just above a node or a leaf stalk – to avoid die-back! Cut at a slight angle.



Node

Correct!
Leave the outward facing bud. It will produce a new twig.

Node

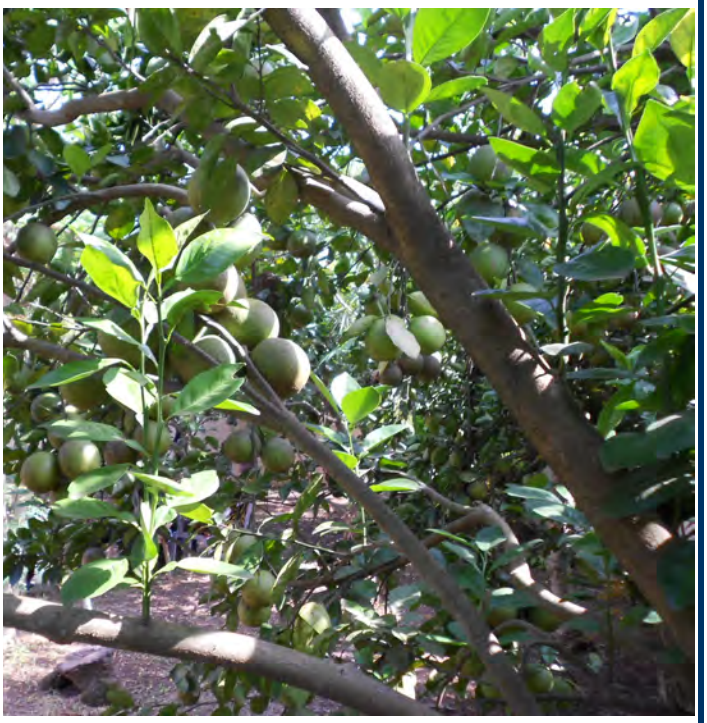
Wrong!
Stub may rot.

✓ All pruning tools should be sharp and clean. Sterilise tools after pruning of each tree with alcohol-based disinfectant. Otherwise you carry viruses such as CTV (Citrus Tristeza Virus) from tree to tree!

✓ Don't leave pruned twigs in the orchard, but collect them in a bag!

Exercise 6: Maintaining a well-pruned citrus orchard

1. How often should you prune your orchard farm?
2. What is the correct tree height for citrus and how do you maintain this?
3. How should you cut thick branches preventing bark from stripping down the trunk?
4. Look at the two pictures and decide where to place the pruning cut.



Activity

Class practices a “heading back” and a general maintenance pruning in a selected orchard.

REMEMBER

Diseased, dead, and damaged (3 D’s) parts should always be pruned out.

Always cut just above a node or a leaf stalk – to avoid die-back.

Maintain a tree height of not more than 8 feet in your orchard.

Remove and destroy pruned material after every pruning operation.

MODULE 7. MANAGING SOIL FERTILITY

A good citrus farmer maintains the fertility of his/her orchard because:

1. Nutrients that leave the orchard with the harvest need to be replaced.
2. The most deficient nutrient determines the overall yield.
3. Nutrients influence fruit size: Phosphorus (P) and Potassium (K).
4. Nutrients influence the taste of the fruit: Potassium (K) produces the fruit acids needed for the right flavour, while Nitrogen (N) and Magnesium (Mg) make the fruit sweet.

Replace what you remove with the harvest!

Every ton (1000 kg) of harvest removes also:

9 kg of Nitrogen (N)

3 kg of Phosphorous (P_2O_5)

15 kg of Potassium (K_2O)

2 kg of Magnesium (MgO)

From the above, we see that especially **potassium** needs to be replaced! Much of it can be given via organic fertilisers. **Empty fruit bunches** of oil palm, for example, contain 1 kg of K_2O in 100 kg. The bunch ash contains about 40% K_2O.

Important plant nutrients:

Nitrogen (N)

Good for:
- Proper growth and development
- Green leaves

Deficiency symptoms:
- ***Older leaves*** become yellow
- Small fruits

Apply:
- Potassium nitrate or urea
- Organic materials (compost, manure)

Phosphorus (P)

Good for:

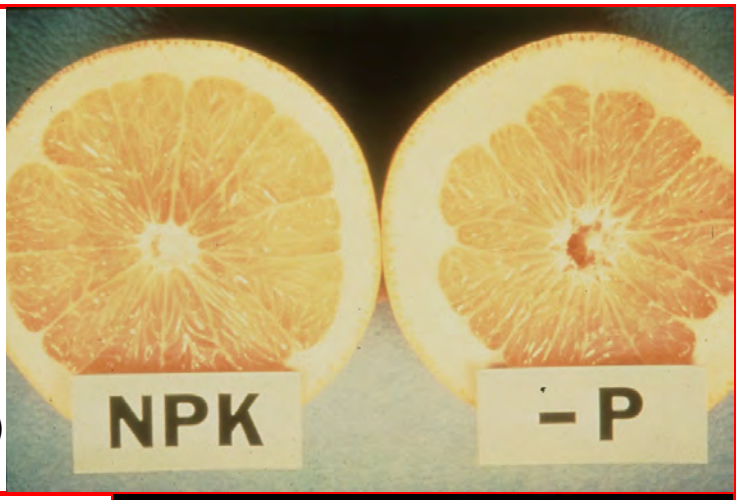
- Flowering and fruit formation.
- Development of small rootlets

Deficiency symptoms:

- ***Older leaves*** turn dark, almost bluish
- Delayed maturity and small fruits

Apply:

- Rock Phosphate (approved for organic)
- Animal manure (from chicken and pig)



Potassium (K)

Good for:

- Good taste of the fruits
- Thick peel
- Resistance of the tree to drought

Deficiency symptoms

- ***Older leaves***: Tips, edges die
- Fruits are small with low acidity

Apply:

- Potassium sulphate: Best for fruit crops
- Patentkali (K and Mg, approved for organic)

Magnesium (Mg)

Good for:

- Taste
- Colouration of fruits

Deficiency symptoms

- ***Older leaves***: Veins green, but yellow between veins
- Fruits without flavour (low acidity & sugar)

Corrective measures

- Calcareous dolomites
- Magnesium sulphate: Foliar spray

Micronutrients

Deficiency symptoms

- Always on ***younger leaves***

Apply

- Foliar spray
- Animal manure

Soil acidity

In Module 1 we said that soil pH for citrus should be between 6.0 and 6.5. The soil pH values how acid your soil is. If your soil becomes too acid (below 5.5), the citrus tree will find it very difficult to take up the most important nutrients: Nitrogen (N), Phosphorus (P), Potassium (K) and Magnesium (Mg)

This means: When your soil is extremely acidic (below 5.0), it is of no use to apply mineral fertilisers. They will not be taken up by the citrus tree. In this case you first have to increase your soil pH first! The fastest way to neutralise acidity is by adding lime (Calcium carbonate), dolomite (Calcium-magnesium carbonate), wood ashes or compost.

Use Merck pH indicator strips to test you soil pH.

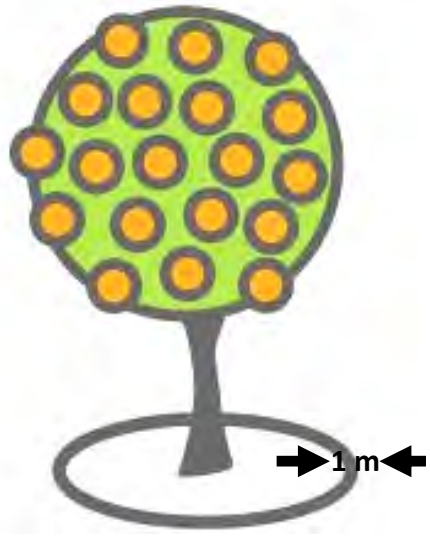
A quick method of measuring soil pH in field is using inexpensive **pH indicator strips**. In Ghana they are available from:

PKF Scientific Ltd.
Appiawah House, Spintex Road, Accra, Ghana
Contact Mr. Kofi Afunya, Sales Manager under 0244 796007 or 0303 404452

To raise your soil pH by approximately 1 unit, apply about 5 kg of lime in a circle around each tree under the drip line (4 kg for sandy soils and 6 kg for clayey soils). Lime costs about 20 to 25 GHC per bag of 50 kg ("Golden Stork"). Do not use hydrated or burned lime.

Golden Stork, Louis Dreyfus Commodities in Tema
Contact Mr. Stephen Tour under 0245 44 30
or 0303 206060

All fertilisers should be applied on the drip line around the tree in a 1-m wide circular band. If there is no rain, dig the fertiliser into the soil.



Apply all fertilisers on the drip line around the tree in a 1-m wide band.

Some nitrogen fertilisers make the soil more acid. They include ammonium nitrate, ammonium sulphate and urea. Do not use them if your soil is already at risk of being too acidic.

Soil testing

Soil labs in Cape Coast, Kumasi and Accra determine the levels of nutrients in your soil. Take soil samples from the layer 15-30 cm, remove un-decomposed plant materials and air-dry the soil sample, before you bring it into the soil lab. These are two soil labs which can analyse your soil at low costs:

CSIR Soil Research Institute, Kwadaso, Kumasi (Web: www.csir-sri-org)
Dr. Francis Tetteh, Mobile: +233 244622124, +233 24450353, Tel.: +233 322050275

Basic soil analysis: 25 GHC, Complete soil analysis: 40 GHC

University of Cape Coast, Cape Coast
Mr. Kwabena Osei-Agyeman, Mobile: +233 243512614 or +233 268674502

N, K: 20 GHC each; P: 25 GHC; Organic Matter: 30 GHC; pH: 5 GHC; Texture: 30 GHC;

Exercise 7: Understanding nutrient management

1. Which nutrients are responsible for a good taste of your fruits?
2. Why is it important to distinguish whether the nutrient deficiency symptom appears on older leaves or on young leaves?
3. Why is it important to know your soil pH?
4. How do you apply mineral fertiliser for tree crops?

Activity 1: Identifying nutrient deficiency symptoms in the orchard

1. Pairs of two are looking for unusual leaves in the orchard.
2. The class then discusses whether the leaves show symptoms of i) pest attack, ii) disease attack, iii) physical damage, or iv) nutrient deficiencies

Activity 2: Measuring soil pH

1. Small groups of 5 are using the soil pH indicator strips to measure the soil pH in different parts of the orchard (cups and water needed!)
2. The class then compares results and calculates how much lime is needed to get the soil back to pH 6.0.
3. Volunteers in the group apply lime around some of the trees where the pH has been measured and recorded. These trees are marked with coloured cloth.
4. Four weeks after some rains the soil pH level is measured again under these trees to see whether the soil has neutralised.

REMEMBER

Replace the nutrients which you are taking away with the harvest! However, only if the pH is over 5.0, the plant is able to uptake the nutrients which you apply. Therefore you need to know your pH and maintain it at 6.0!

MODULE 8. WATER MANAGEMENT

A good citrus farmer looks at water supply to his/her citrus trees because:

1. Water is essential for good growth and can improve yields greatly.
2. Nutrients are taken up together with water. No water in the soil – no nutrient uptake!
3. Moisture in the soil is needed for the biological activity of all types of soil organisms which decompose organic matter and produce humus.

Citrus is best produced in areas with annual rainfall above **1000 mm**.

Investments into irrigation are useful where annual rainfall is much lower.

Drip irrigation used together with manure and mulch

Mulching to conserve soil moisture

1. Use dry non-seeded grass (from weeding).
2. **Empty fruit bunches** from oil palm is another good mulch – it also gets potassium into the soil.
3. Just as in pineapple production, plastic under the tree can be used to conserve soil moisture.

Facts about irrigation

1. Avoid sprinklers as they create a conducive environment for diseases
2. Drip irrigation is expensive, but saves much water and is most efficient
3. Furrow irrigation is the cheaper option, but uses a lot of water
4. Irrigate if rainfall ceases for 10 continuous days:

New transplants:	30 litres per tree every week
2 year old trees:	100 litres per tree every week
3 year old trees:	300 litres per tree every two weeks
Bearing trees:	500 litres per tree every two weeks

Exercise 8: How can water be conserved in the soil?

Activity: Mulching of a citrus orchard with empty fruit bunches of oil palm.

REMEMBER

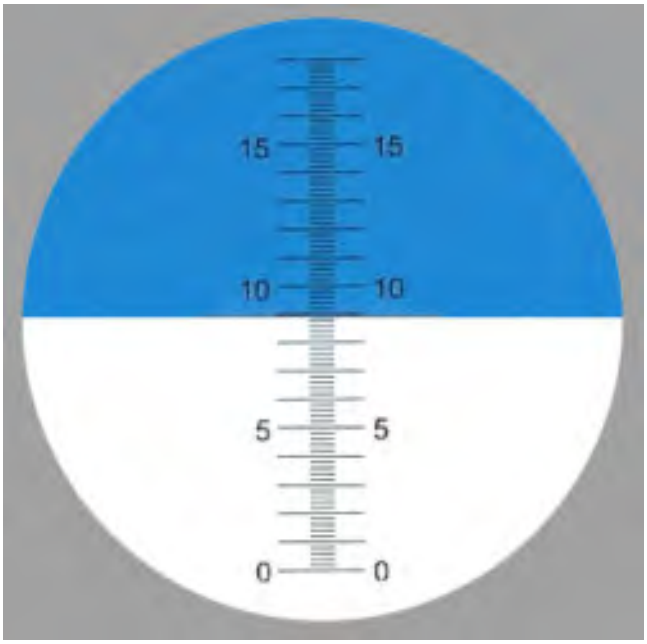
Mulching with empty fruit bunches helps to conserve soil moisture, reduce run-off water and add potassium to the soil.

MODULE 9. REDUCING POST-HARVEST LOSSES

A good farmer makes a rational decision about when to harvest

1. He/she harvests not too early, but when fruits are juicy and weigh heavy.
2. In addition, fruits should taste sweet (not too acid). A brix level of 9-10 is fine. A brix level of 6-7 is too low!
3. He/she harvests when the weather is dry and it is not likely to rain. Moist weather affects the quality of the fruit juice.
4. Two days before harvest, a good farmer collects all dropped fruits to minimize contamination of good fruits with bad ones.

Use a refractometer to determine ripeness



Use a refractometer to determine sweetness and whether the fruits are ripe for harvest. A brix level of 9 and above is fine. Don't pick acid fruits with a brix level below 9. The processor has no use for them.

Equipment for careful harvesting

Harvesting bags

Tripod stand

Secateurs

Crates

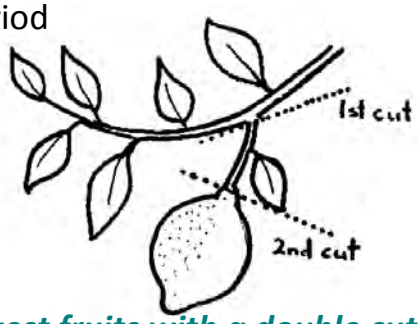
Reducing post-harvest losses

Postharvest losses in citrus can be important. These are the main causes:

- Over-maturity at harvest
- Damage to the peel, if fruits are pulled off the tree
- Damage from dropping into crates or bowls or onto the floor
- Water loss, if fruits are left in the sun over long period

Careful picking:

Don't pull the fruits from the tree, but clip them (**with secateurs**). The "button" of the fruit should be retained on the fruit. "Buttons" left on the tree are an entry point for diseases.



Harvest fruits with a double cut!

Harvest fruits into a harvesting bag hanging in front of your belly. Don't let the fruits fall from more than 1 ft when emptying the bags to reduce physical damage.

Use a harvesting bag to avoid that fruits damage from falling from a height

Careful handling

Spread out the fruits for proper aeration and keep them under shade to minimize loss of vitamins. Spread them out on a tarpaulin and prevent contact with soil.

Grade based on quality parameters such as sweetness, size, colour and defects of skin to satisfy the different quality requirements of the different traders and processors. Remove bad fruits and twigs from harvested fruits.

Careful transporting

Losses may also occur during the transport of fruits. A good farmer prevents such losses by:

- Pre-arranging for transport a day or two in advance
- Selecting KIA trucks or similar (don't use passenger vehicles)
- Only loading the truck 3 ft high with oranges
- Providing aeration and shading during transport
- Getting the fruits to the factory and markets immediately after loading

Exercise 8: Careful harvesting

1. What is the level of brix that your offtaker needs?
2. How do you ensure that fruits do not spoil during harvest and transport?
3. Where should the "button" be, on the fruit or on the tree?

Activity:

1. With the help of a refractometer, please determine the brix level of: i) water; ii) orange, non-mature; iii) orange, mature; iv) orange, non-mature with sugar; v) palm wine; vi) soft drink
2. Exercise the "double cut" of fruits for harvesting
3. Get a harvesting bag sewed. Plan together now what you need and make one until next training session.

REMEMBER

The brix level of the orange juice should be at least 9 at harvest. Otherwise it is not sweet enough, and you should wait with harvesting.

MODULE 10. END OF SEASON EVALUATION

A good citrus farmer keeps records of farm operations because

1. Records are the basis for costing and pricing.
2. Records help to recollect past activities.
3. Records help to compare planned and actual yields, costs and operations.
4. Records help to improve the planning for the next season.
5. Records help to develop a realistic, and therefore bankable, business plan.

A good citrus farmer therefore uses the Orange Planning and Record Book

This is how it works to use the Orange Planning and Record Book:

You use a separate book for each of your farms!

Step 1: You fill in some basic information about your farm:

Information of the plot

Plot name:	Plot 2	Total number of plants in this plot:	100
GPS Coordinates:	-	Plot size (acres):	1
Variety:	Late Valencia	Number of plants per acre:	100
Planting date:	March 2001	Planting distance:	6.5 m x 6.5 m

Step 2: You plan your yield and the revenue from your yield:

Planning: Harvesting Dates, Volumes and Gross Revenue Calculation of Plot: .....Plot...2.....

Harvesting Date	Buyer (name + specify: market women, processor, exporter)	Unit (kg, sack, fruit...)	Quantity of units sold	Price per unit (GH¢)	Amount (GH¢) = Quantity of units sold x Price per unit	Conversion factor into kg (weight in kg of 1 unit)	Quantity sold (kg)
15.08.2014	Fruittiland	Sack	600	4.20	2 520	28	16 800
20.01.2015	Fruittiland	Sack	800	4.20	3 360	28	22 400
			Planned Gross Revenue (GH¢):		5 880	Total Quantity Sold(kg):	39 200

Step 3: You plan your operations and costs:

Planning: Farm Activities, Costs of Inputs and Labour

Farm Activity		Date(s)	Costs of inputs					Family and hired labour				
No.	Description		Input, active ingredients and target(s)	Unit	Quantity	Price per unit (GH¢)	Amount (GH¢)		Unit	Quantity	Value per unit (GH¢)	Amount (GH¢)
1	Scouting	All over the year	As often as possible!					Hired Labour or Services				
								Family Labour	Person-days	10	6	60
2	Pruning	01 April 2013						Hired Labour or Services	PD	10	6	60
								Family Labour	Person-days			
3	Apply organic fertiliser	20 April 2013	Chicken manure / compost (dug into the soil around the tree's drip line)	Bag of 20kg	20	10	200	Hired Labour or Services	PD	4	6	24
								Family Labour	Person-days			
4	Hang fruit fly traps	25 April 2013	Fruit fly traps	Trap	5	8	40	Hired Labour or Services				
								Family Labour	Person-days	1	6	6
5	1st weeding	01 June 2013						Hired Labour or Services	Contract	1	40	40
								Family Labour	Person-days			
6	Collection of dropped fruits	10 June 2013						Hired Labour or Services	PD	2	6	12
								Family Labour	Person-days			
17	3rd weeding	10 Feb. 2014						Hired Labour or Services	Contract	1	40	40
								Family Labour	Person-days			
18	Cutting Gum-mosis trees	15 Feb. 2014						Hired Labour or Services				
								Family Labour	Person-days	3	6	18
						Total Inputs (GH¢):	272	Hired Labour or Services	Total (PD):	-	Total (GH¢):	528
								Family Labour	Total (PD):	15	Total (GH¢):	90

1 PD (Person-day)
= 5 hours of work

Step 4: You calculate your planned gross margin:

Gross Margin Calculation of plot... PLOT 2...
representing ...1..... acre(s)

PLANNED GROSS REVENUE	
A. Planned Gross Revenue (GH¢)= (from page XX)	5 880
PLANNED VARIABLE COSTS	
B. Total Planned Costs of Inputs (GH¢)=	272
C. Total Planned Costs of Hired Labour or Services (GH¢)=	528
D. Total Planned Value of Family Labour (GH¢) =	90
E. Total Planned Variable Costs (GH¢)= B + C + D =	890
PLANNED GROSS MARGIN	
F. Planned Gross Margin (GH¢)= A – E=	4 990
G. Planned Gross Margin per Acre (GH¢) = F / size of plot=	4 990

Step 5: Now you record your real operations. For each operation you fill in the date, the description and costs of inputs, the costs of services as well as the value of the family labour.

Step 6: At the end of the season you compare your planned gross margin with your real gross margin.

Exercise 9: Calculate your costs and profit

Activity 1: Try to recall all your revenue from citrus during last year (between today 2012 and today 2013). Fill in below table.

Record-Keeping: Harvesting Dates, Volumes and Gross Revenue Calculation of Plot: ………………………………

Harvesting Date	Buyer (Name); Specify: Market Women, Processor…	Unit (kg, sack, fruit…)	Quantity of Units Sold	Price per Unit (GH¢)	Amount (GH¢) = Quantity of Units Sold x Price per Unit	Conversion Factor (CF): What is the Weight (kg) of one Unit?	Quantity Sold (kg) = Quantity of Units Sold x CF
			Actual Gross Revenue (GH¢):			Total Quantity Sold (kg):	

Activity 2: Now try to recall all your costs that you had during last year (between today 2012 and today 2013). Fill in below table.

Record-Keeping: Farm Activities, Costs of Inputs and Labour

Farm Activity		Date(s)	Costs of Inputs					Family and Hired Labour				
No.	Description and Operator		Input Active Ingredient and Pest/Disease Targeted	Unit	Quantity	Price per Unit (GH¢)	Amount (GH¢)		Unit	Quantity	Value per Unit (GH¢)	Amount (GH¢)
								Hired Labour or Services				
								Family Labour	Person-days			
								Hired Labour or Services				
								Family Labour	Person-days			
								Hired Labour or Services				
								Family Labour	Person-days			
								Hired Labour or Services				
								Family Labour	Person-days			
								Hired Labour or Services				
								Family Labour	Person-days			
								Hired Labour or Services				
								Family Labour	Person-days			
								Hired Labour or Services				
								Family Labour	Person-days			
						Total Inputs (GH¢):		Hired Labour or Services	Total (PD):		Total (GH¢):	
			1 PD (Person-day) = 5 hours of work					Family Labour	Total (PD):		Total (GH¢):	

Activity 3: When you finished, calculate your gross margin (last year's revenue minus last year's cost)

Gross Margin Calculation of Plot ... representing ... acre(s)

Actual Gross Margin

ACTUAL GROSS REVENUE	
A. Actual Gross Revenue (GH¢) = (from page 5)	
ACTUAL VARIABLE COSTS	
B. Total Actual Costs of Inputs (GH¢) =	
C. Total Actual Costs of Hired Labour or Services (GH¢) =	
D. Total Actual Value of Family Labour (GH¢) =	
E. Total Actual Variable Costs (GH¢) = B + C + D =	
ACTUAL GROSS MARGIN	
F. Actual Gross Margin (GH¢) = A – E =	
G. Actual Gross Margin **per Acre** (GH¢) = F / size of plot =	
H. Actual Gross Margin **per Own Working Day** (GH¢) = (A – B – C) / PD Family Labour	

Activity 4: Divide this gross margin by the number of acres you have, and you will get the gross margin per 1 acre. Now compare with your friends and neighbours. Who has got a higher gross margin per 1 acre? And why? Who has got a lower gross margin per 1 acre? And why?

REMEMBER

Record every operation which you carry out in your citrus farm. Note down at least the date, the inputs and the cost.

For your notes:

Calendar of Organic Orange Farm Activities *(best practice; variations might occur according to local conditions and varieties)*

Farm Activities	April	May	June	July	August	September	October	November	December	January	February	March	Remarks
Scouting	■	■	■	■	■	■	■	■	■	■	■	■	As often as possible!
Pruning	■												
Manure application	■												
1st fungicide spraying	■												Organic: e.g. neem + soap
Hang fruit fly trap	■												Check and empty every week
Collect dropped fruits		■	■	■	■	■							Bury the fruits!
1st insecticide spraying		■											Organic: e.g. neem + soap
2nd fungicide spraying		■											Organic: e.g. neem + soap
2nd insecticide spraying		■											Organic: e.g. neem + soap
1st weeding			■										
Harvesting (minor season)				■	■	■							
Collection and transport				■	■	■							
3rd fungicide spraying						■							Organic: e.g. neem + soap
Hang fruit fly traps							■						Check and empty every week
Collect dropped fruits						■	■	■	■	■	■	■	Bury the fruits!
2nd weeding							■						
3rd insecticide spraying							■						Organic: e.g. neem + soap
4th fungicide spraying							■						Organic: e.g. neem + soap
4th insecticide spraying							■						Organic: e.g. neem + soap
Fire belts							■						
Harvesting (major season)								■	■				
Collection and transport								■	■				
3rd weeding										■			
Cutting of Gummosis trees	■	■	■	■	■	■	■	■	■	■	■	■	Cut and burn the tree!

Good Life of Orange

Bad Life Practice ✗

1. Site selection

✗ Bad road access

✗ Water logged area

2. Planting materials

✗ Uncertified source

✗ Planting without knowing the variety

✗ Diseased planting materials

3. Planting

✗ Planting too close

✗ Intercropping with cassava or pepper

✗ Planting when there is little rain (e.g. Oct. - March)

4. Weed control

✗ Weeding only once a year

✗ Continuous use of herbicide every year

5. Pruning

✗ No pruning

Off-shoot from the rootstock

✗ Pruning with a cutlass

You may wound the main stem

✗ Pruning close to the main stem

Disease can enter from the wound

6. Pest and disease control

✗ Weedy field (Termites can easily climb up the trees)

✗ Wounding the trees

Gummosis

Fruit spot

USAID FROM THE AMERICAN PEOPLE

PINORA

Good Life Practice ✓

1. Site selection

✓ Good road access

✓ Well drained soil

✓ Area where cocoa can grow

2. Planting materials

✓ Certified source

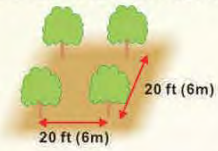
✓ Knowing the variety of the planting materials

For processing → Late valencia, Obuasi

For fresh fruits → Late valencia, Mediterranean sweet, Red blood

3. Planting

✓ Plant at 20 feet X 20 feet interval



✓ Intercrop with maize or plantain

✓ Plant at the beginning of the major rainy season (e.g. May - Aug.)

4. Weed control

✓ Weed at least twice a year

✓ Combine manual weeding and herbicide application (for conventional farms)

5. Pruning

✓ Prune off-shoots from the rootstock (for the first 3 years)

Leave 4 cm from the main stem so that disease will not enter

✓ Use a secateur or a hand saw

✓ Remove mistletoe

✓ Remove dead or diseased twigs

6. Pest and disease control

✓ Remove the infested bark and paint with Ridomil

✓ Weeding (so that termites cannot climb up the tree)

✓ No wounding of the trees

✓ If you are selling to fresh fruit market, spray fungicide 2 months after flowering onwards

Bad Life Practice ✗

✗ Leaving dropped fruits

Fruit fly

Aphids

Good Life Practice ✓

✓ Collect and bury dropped fruits

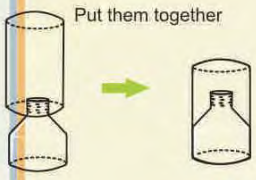
✓ Spray recommended insecticide

Fruit fly monitoring and control

1. Bottle trap

Cut a bottle in half

Put them together



Put 50ml of bait inside
(Bait can be made with
800g sugar/ 10L of water)

Hang it on a tree

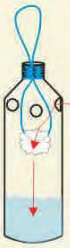
Refill the bait
every week

Flies can enter but
cannot come out

2. Pheromone trap

Make small holes

Soak a cotton ball
with a little pheromone



Flies will be attracted by
the smell of the pheromone,
and enter from the holes

They fall into the
water and die

To control fruit fly, hang 1 bottle trap/ tree

If you can obtain pheromone,
hang 1 pheromone trap/ 2 trees
(Phermone trap is more effective)

7. Fertilizer application

✗ No fertilizer application

7. Fertilizer application

✓ Apply well decomposed chicken manure
(20kg / tree) and cocoa pod husks
every 5 years

8. Harvesting

When?

✗ Green fruits

✗ Harvesting when raining, early morning
or at dawn (when the fruits are wet)

How?

✗ Leaving dropped fruits

✗ Hitting the fruits
with a stick

✗ Shaking the trees

✗ Twigs and bad fruits are mixed
with good fruits

✗ Heaping the fruits
higher than 1m
under the sun

Transport

✗ Overloading

8. Harvesting

When?

✓ Yellow fruits

✓ Fruits are juicy

✓ Fruits weigh heavy

✓ It tastes sweet
and not too acidic

✓ Harvest when the weather is dry (e.g. Feb. - March)

How?

✓ Collect dropped fruits
before harvesting

✓ Harvest with a sack and a basket

✓ Supervise the workers

✓ Remove twigs and bad fruits

✓ Spread out the fruits
under a shade

Transport

✓ Pre-arrange for transport

✓ Adequate loading

500 baskets/ acre

(Yield at 10th year of production; 1 basket =110 fruits on average)

1,100 baskets/ acre

(Yield at 10th year of production; 1 basket =110 fruits on average)

USAID FROM THE AMERICAN PEOPLE

PINORA

Above poster was produced by USAID TIPCEE in 2008. The authors of the poster are responsible for its contents.