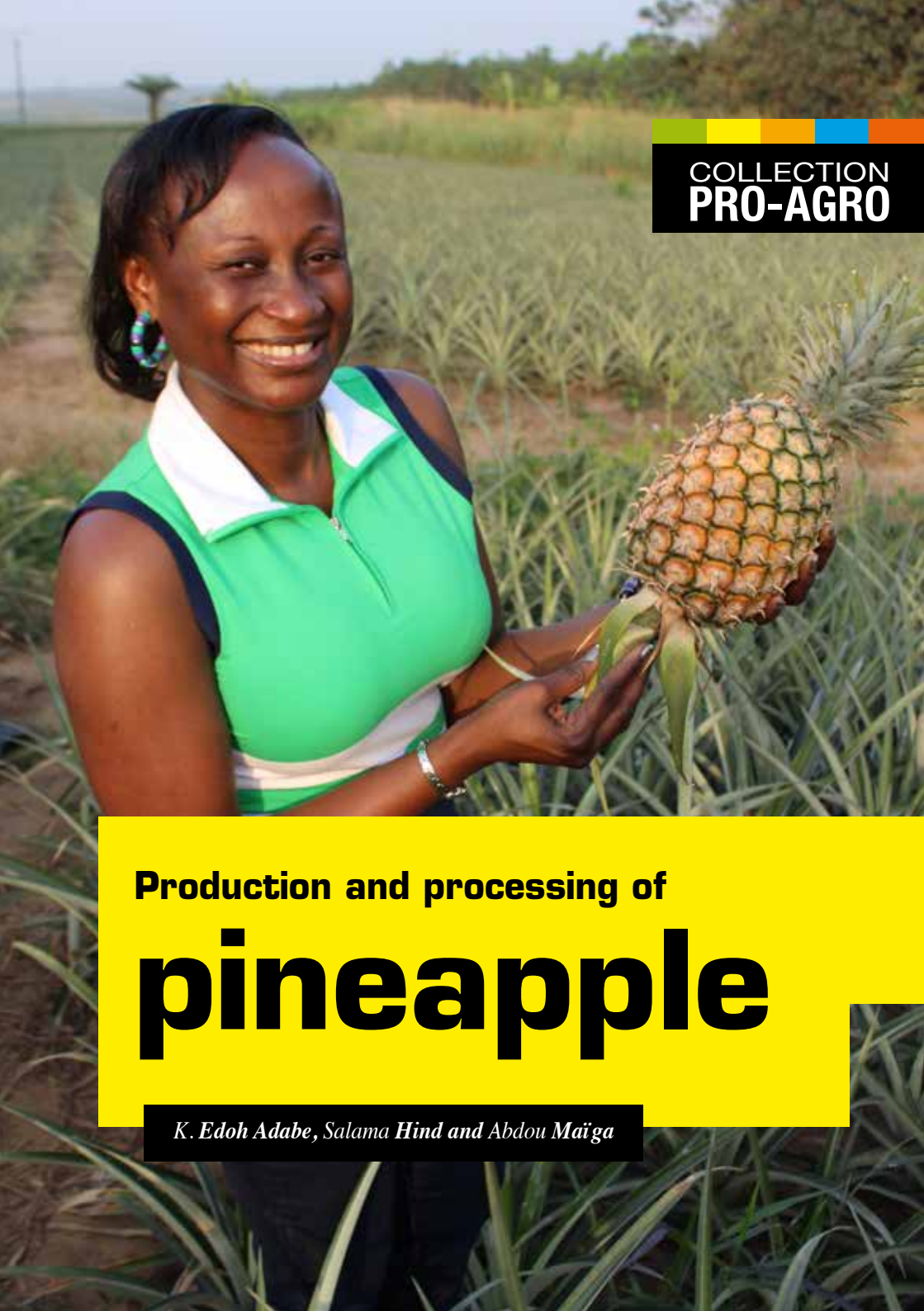

COLLECTION
PRO-AGRO

Production and processing of pineapple

*K. **Edoh Adabe**, Salama **Hind and** Abdou **Maïga***

Contributors

COORDINATOR

E. Lionelle Ngo-Samnick

AUTHORS

K. Edoh Adabe, Salama Hind and Abdou Maïga

PRINCIPAL REVIEWER

Michel Havard

CONTRIBUTIONS

Florent Nkouasseu, Aline Haeringer, Hélène Angot, Pascal Nondjock and Komlavi Il Adjegan

REVIEWERS

WREN*media* and Bianca Beks

ILLUSTRATIONS

Eric Mengaptche and Elena Peñalta

TRANSLATION

BLS

LAYOUT

Stéphanie Leroy

The Pro-Agro Collection is a joint publication by Engineers Without Borders, Cameroon (ISF Cameroun) and The Technical Centre for Agricultural and Rural Cooperation (CTA).
CTA – P.O. Box 380 – 6700 AJ Wageningen – The Netherlands – www.cta.int
EWB Cameroon – P.O. Box 12888 – Yaoundé – Cameroon – www.isf-cameroun.org
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Cover photo: © Ange Konan
ISBN (CTA): 978-92-9081-604-1

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General information

A herbaceous, perennial and heliophile plant, and a member of the Bromeliaceae family, the pineapple has significant nutritional, commercial and industrial potential. Mainly grown for its fruit, the pineapple can be consumed fresh, dried or processed into preserves, drinks or vinegar.

Citric acid is extracted from it and used in the manufacture of certain pharmaceutical products, particularly those related to bronchitis. Starch can also be extracted, as can a variety of organic acids, wax, sterols, etc. The leaves and crowns, or even the whole plant, can be crushed and incorporated into livestock feed. The pineapple stem is used for its anti-inflammatory properties. Bromelain is used to aid post-operative or post-injury recovery and to treat, among others, venous diseases, contusions, arthritis, and dysmenorrhea. The fibres of the leaves are used in the production of luxury fabrics, rope, bags and special types of paper.

In 2014, global pineapple production exceeded 24 million tons. Its world trade represents more than US$7 billion. Brazil, the Philippines and Thailand are the largest pineapple producers. In Africa, Nigeria and Kenya are the leading pineapple producers, while Côte d'Ivoire and Ghana are the largest African exporters.

This manual on the production and processing of pineapples is intended for small and medium sized pineapple producers and processors, as well as extension agents in this subsector. While taking account of the extensive agricultural, pedological and climatic diversity of the world's pineapple-growing regions, it is important to give a broad outline of the traditional pineapple production process, at the same time recommending some pesticides and fertilisers that can be used in the production process.

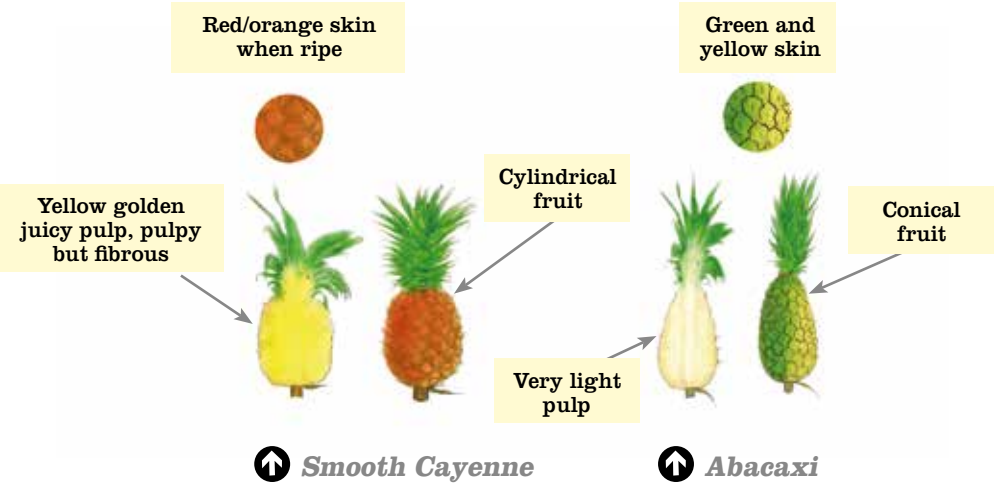
However, the decision to use a particular product or mineral fertiliser must be made, among others, on the basis of its effectiveness in reducing the impact of harmful elements of the plants, as well as its approval in both the country where it is grown and the country where it is sold, in the case of export.

1

DESCRIPTION OF THE PLANT

The pineapple is a perennial herbaceous plant with shallow roots. The stem carries thick and prickly trough-shaped leaves grouped in a rosette formation, from which the inflorescence emerges supported by a peduncle (stalk).

There are a number of pineapple species, including 'Comosus', which contains all the cultivars currently planted. The most popular variety is the 'Cayenne', whose leaves are much less thorny. The other varieties are: Queen, Spanish, Abacaxi and Perolera.

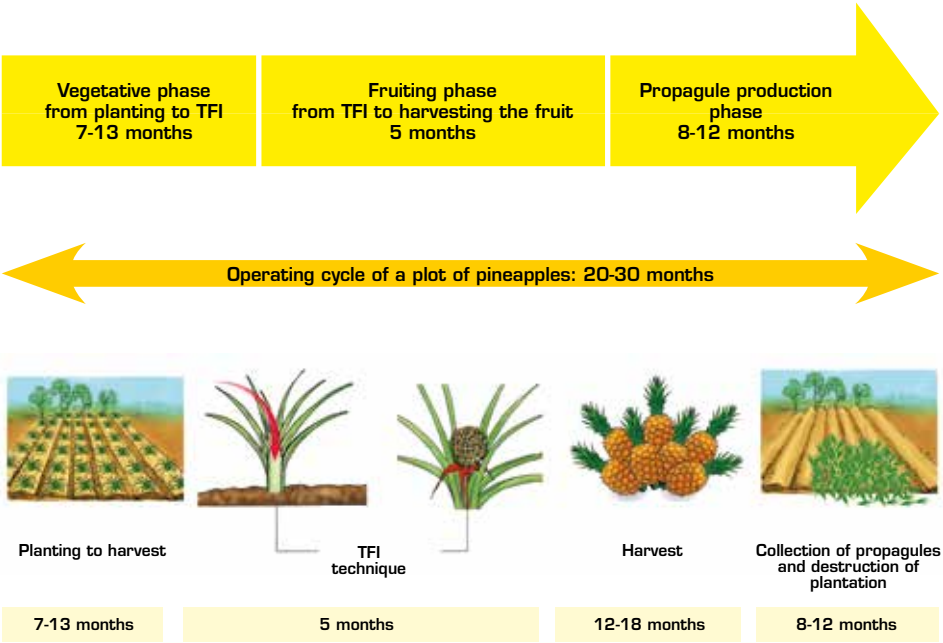


The cultivation of pineapple is unique due to the artificial induction of flowering by humans. The treatment for floral induction (TFI) enables the farmer to group the flowerings, and therefore the harvest of a plot. This can be done every year, which makes it possible to plan production cycles and harvests.

A plot is worked (from fruit production to propagule production) over a total period of no more than 20-30 months. The length of the production cycle (from planting to harvesting the fruit) is between 12 and 18 months.

This depends on the local climate, the amount of propagules planted, the input used and the crop management process implemented. After the fruit has been harvested, the propagule production usually takes 8-12 months, depending on the climate, the parasitological conditions and availability of nutritional minerals.

Operating cycle of a plot of pineapples



2

SOIL AND CLIMATE SUITABLE FOR PINEAPPLE DEVELOPMENT

Ideal characteristics of soil and climate

Soil	Climate
• Soil that is loose, light, well-aerated, permeable, and rich in humus • Slightly acidic soil, with a pH between 4.5 and 6 • On flat ground or a slight slope at low altitude	• Annual rainfall between 1,200 and 1,500 mm evenly spread throughout the year • Average temperature 25°C • Exposure to sunlight (minimum light): 1,500 hours. To achieve this, avoid the presence of large trees in the planting area

Influence of the climate on the quality of pineapple fruit

Problems	Probable causes
Fall in acidity and gradual decrease of the colouring of the skin of the fruit	Low temperature
Colour of the fruit goes from pale green to yellow, and then red	Prolonged lack of water
Dull fruit	Low sunlight

It is difficult to control the amount of sunlight and the temperature, but these factors are very important for the quality of the fruit.

- When they are low, this results in the fruit being more acidic, with low sugar content, having poor colouring, and slower growth of both fruit and plants.
- When they are too high, the fruit will be sunburnt and translucent, and there will be problems with the colour. Excessive translucence causes the fruit to become extremely fragile; in extremis this will lead to fermentation of the flesh, which may in turn result in foam being released.

Translucent fruit

Oval and hollow fruit is usually due to a water deficit when the fruit is formed.

3

PREPARATION OF THE LAND

Planning agricultural work is crucial for its success, and the indicative timetable below can be used as a guide to enable producers to prepare their organisational framework.

Example of agricultural timetable for pineapple production

Operations		Month																				
		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Preparation of the land: clearing, tilling, etc.																						
Preparation of the propagules: harvest/ purchase, trimming, etc.																						
Planting	Planting																					
	Replacement of missing plants																					
Maintenance	Weeding																					
	PT against nematodes																					
	PT against symphylans																					
	PT against phytophtora																					
	PT against cochineals/ants																					
	Mineral fertilisation																					
Treatment for floral induction (TFI)																						
Interventions between TFI and harvest	Counting the number of flowering young plants																					
	Reducing the crown																					
	Protecting against sunburn																					
	Degreening																					
Harvest																						
Propagule plots	Cut back leaves																					
	Weeding																					
	Phytosanitary treatment																					
	Mineral fertilisation																					
	Propagule harvest																					

PT. Phytosanitary treatment

Standard operations to be carried out

Operations to be carried out in case of visible attacks

The land preparation stage is essential for the harmonious development of the plant. The length of the preparation period depends on the nature of the land (forest, uncultivated land, former pineapple fields, etc.). The preparation of a forest area, for example, requires more preparation than a former pineapple field.

3.1 Clearance of vegetation cover

Thoroughly clear the site of all types of weed (any species other than that to be grown), stumps, shrubs, roots, etc.

This can be done manually, chemically, or using machinery.

Manual clearance

The following tools are commonly used: machete, files, chainsaw, knives, pickaxe, dabas, hoes, guiding line (200 m), fork and backpack sprayer, and then a cart or wheelbarrow for transport.

Some of the tools used for manual clearance

>>> Previously uncultivated land

Forest vegetation

In a forest (a wooded area comprising one or more stands of trees, bushes and saplings) eliminating the trees is necessary.

To do this:

A forest

- Clear the ground with a machete, then cut down the trees and bushes with an axe or chainsaw.
- Recover those trunks that can be recycled for planks, firewood and other uses.
- Use a pickaxe to remove the stumps.
- Burn the branches, foliage and other unusable elements on site and scatter the ashes to ensure the even development of the young plants.
- Remove all roots with a pickaxe and burn them as well.

Herbaceous vegetation

Herbaceous vegetation is an area mainly covered with grasses (non-woody plants) and containing very few trees or bushes.

In this case, use a machete or any other tool to cut and destroy the grass.

>>> Previous pineapple field

Destroying the plant residues from the previous crop is essential, as these probably carry pests. Clearance by hand requires a significant amount of labour, as a significant amount of plant material remains after harvesting the propagules (100-150 t/ha).

To destroy the remains by burning, first cause them to dry up by using a contact herbicide based on the following active substances: 200 g/l glufosinate-ammonium (Basta F1) or 720 g/l 2.4-D amine salt (Amistar 720 SL), at a ratio of 3 to 4 l of commercial product per ha. This practice will destroy most parasites. Then burn the plant remains and pull up any remaining roots or stems.

Caution must be exercised when using phytosanitary products for pineapple cultivation

Throughout this manual, active materials constituting phytosanitary products (herbicides, acaricides, insecticides, nematicides, fungicides, etc.) are suggested to eliminate pests attacking the pineapple crop. These active materials are dangerous and carry a risk of poisoning for farmers and the environment, and even for the health of consumers. Only use these active materials if they are approved in both the country of production and the country of destination. Certain active materials may be banned in some pineapple producing countries and not in others, which is also the case for destination countries. Other active materials that are authorised today may be banned in the near future.

You must:

• check that they are approved in your country and in the country to which your production is exported, before using phytosanitary products; and

• comply with the instructions and recommendations when handling and using the products. For responsible use, you must use the appropriate personal protective equipment (PPE), protect the environment and the health of consumers, and comply with the Maximum Residue Limits (MRL) and the Pre-harvest Interval (PHI) for the products. When using the pesticides, it is important to comply with the instructions on the labels, reading the useful information concerning they type of product (use), the user safety advice (PPE, storage), the instructions for use (dose, PHI, conservation of biodiversity and the environment), and the date of manufacture and expiry.

Chemical clearance

This method of elimination is used for herbaceous vegetation. The grass must not be more than knee-height. In this case, a total herbicide should be used. The following active materials are recommended:

- In the rainy season: glyphosate (Casse-tout), at a ratio of 1.5-3 l of commercial product per ha.
- In the dry season: triclopyr 480 g/l (Garlon 4E), at a ratio of 2-3 l of commercial product per ha.
- In the dry season on wet soil: triclopyr 480 g/l (Garlon 4E) and diuron (Action 80 DF), at a ratio of 1.7-2.2 l of commercial product per ha.

Glyphosate must be used a long way from water sources and beekeeping areas, and the operator must use PPE

The destroyed vegetable matter must then be ploughed and buried, after which the soil needs to be loosened to help the plants put down roots.

Mechanical clearing

The equipment for mechanical preparation of the land is as follows: a bulldozer to clear forest areas, a rotary mulcher to crush plant cover and fill a former pineapple plot and a pulveriser (or cover crop) for tillage work.

Heavy pulveriser and caterpillar tractor for tilling the soil

To clear a forest area (felling trees, windrowing plant remains, tilling the soil), there are a number of alternatives:

- Fell all the trees with a special bulldozer.
- Fell all the trees with a chain pulled by two bulldozers.
- Cut down those trees that can be used for other purposes, then use the bulldozer or the chain for the other operations (grubbing, windrowing).

Next, for mechanised clearance, place the trees in windrows (rows of trees cut into piles), taking account of the future position of the pineapple plots, and burn them in stages.

On uncultivated land or other herbaceous cover (previous pineapple plot, etc.), a rotary mulcher can be used to crush all plant cover, which will help with the burial of plant waste during the preparation of the soil.

Tractor and rotary mulcher

3.2 Burial and tilling

The tilling consists of burying the weeds and organic material, then loosening the soil to enable the plants to take root more effectively. This can be done by hand or by machine.

The equipment used for manual tilling comprises the daba, the fork and/or the hoe.

After cutting down large trees and undergrowth, mechanical tilling is often performed with the Rome Plow (the name given to the heavy pulveriser in Cameroon) for the initial preparation of the soil, before subsoiling (depending on the nature of the soil), which makes it possible to aerate the soil in depth.

It is possible to till only the growing lines (for planting the propagules) and then create ridges

The finishing work comes next, comprising the dispersal of soil aggregates (if the planting is followed by furrowing) or ridging.

A basal dressing of fertiliser and/or a pesticide to combat nematodes or symphylans (depending on the condition of the soil) could be incorporated into the soil during this stage.

Previously uncultivated land	Land previously used for pineapple cultivation
• Deep tilling to at least 30 cm • Burial of decomposed organic matter	• Deep tilling to at least 25-30 cm and burial of organic matter • Second tilling 25-30 cm, crossing the first

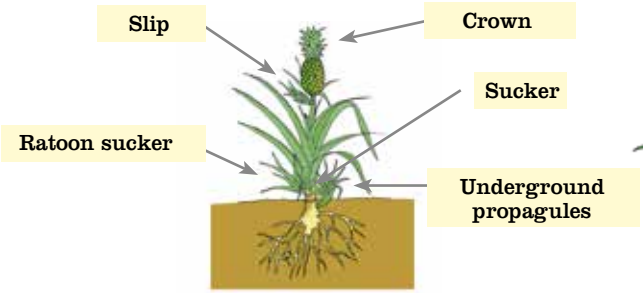
Single row disk harrow and tractor

Dry the organic matter for at least 2 weeks before burying.

3.3 Plant material

A pineapple plantation is created only by replanting the propagules. A propagule is an offshoot of the main stem of the mother plant. Depending on availability, choose the following propagules, in order of preference, as the planting material: ratoon suckers, suckers, slips and crowns.

- Ratoon suckers develop on the main stem: they are called underground propagules when they develop in contact with the soil.
- Suckers originate in the leaf axils.
- Slips grow from the fruit itself or along the stalk below the fruit; they are usually smaller.
- The crown is the leafy top of the fruit.



Different types of propagule

A ratoon sucker or stem propagule

All four types of propagule can be used as plant material. However, each of them has its own characteristics in terms of growth, needs, vulnerability to disease, etc. For a good plantation, suckers and ratoon suckers are recommended.

Techniques for multiplying the plant material

As the propagules constitute the future of a plantation, it is important to take particular care of this aspect, during their production (self-produced propagules) or their purchase (external acquisition).

Self-produced plant material

The supply of pineapple propagules is not always easy for someone wanting to grow pineapples on a large scale. If they can be found, they are often of variable quality. It is therefore necessary for the farmer to produce them himself, if he wants to get the best results.

There are a number of methods to increase the number of propagules. Here are two that can easily be achieved by small-scale farmers:

- Rapid multiplication of pineapple propagules
- Direct maintenance of the plants after the fruit has been harvested

Rapid multiplication of pineapple propagules

This method is used by producers concerned about the origin and quality of their plant materials and who are keen to obtain a large quantity of propagules early in their farming project. The operating method is as follows:

- 5-6 months after planting, carry out a treatment for floral induction (hormone treatment) on the developed plants, either with calcium carbide, at a ratio of 500 g in 150 l of water; then apply 50 ml/plant during the night, and repeat the treatment twice at 3-day intervals, or with ethephon (Callal 480 SL), at a ratio of 50 ml in 15 l of water, applying 50 ml of the mix per plant.
- 1-2 months after the hormone treatment, carry out the ablation on the inflorescence after it emerges.
- Immediately after the ablation of the flowers, trim the leaves.
- Propagules will develop 3-4 months after the ablation of the inflorescence; collect those with an acceptable weight (300-600 g) after 8-12 months.
- Continue to maintain the plot regularly throughout the propagule production period.

Direct maintenance of the plants after the fruit has been harvested

This method consists of maintaining the original plants after harvesting the fruit at 8-12 months. To do this:

- After the harvest, trim the leaves to reduce the plant's consumption of nutritious elements, which speeds up the production of propagules.
- Weed the plot regularly to aerate the plants and reduce the humidity of the soil.
- Every other month, spray an insecticide with a base of the active material chlorpyriphos-ethyl 480 g/l (Dursban 4E) at a rate of 1.5 l/ha.
- Apply urea and potassium chloride (KCl) on a monthly basis at a ratio of 1 g of urea and 1 g of KCl per plant.
- Harvest propagules with the desired weight (300-600 g) every month.

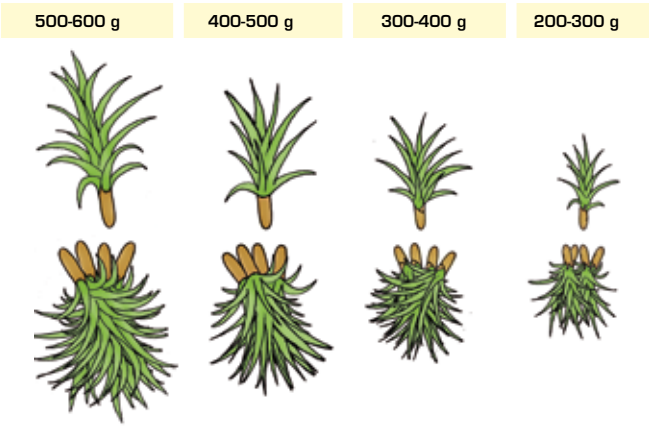
3.4 Quality of the plant material

Select the cultivar best-suited to the region by observing, if possible, what is happening in the area. The weight of the propagules to be planted in a single plot must be uniform and between 300-600 g. The size is irrelevant. The base of the propagules must be dry, with no trace of nematodes or rot, and the core must be clean and have no trace of insects.

To enable the young plants to develop harmoniously, facilitate maintenance operations (application of fertilisers) and schedule the cutting (selling the fruit in one batch) for a given plot. You are strongly advised to plant propagules of the same weight in the same place. On the other hand, to obtain staggered production of the fruits and sell them in stages, it is advisable to use propagules of different weights. This approach carries all the same risks in terms of the technical care of the plot (the rational use of fertilisers, development of disease and pests, particularly core rot, nematodes, symphylans, etc.) due to the extended length of the production cycle of low-weight propagules.

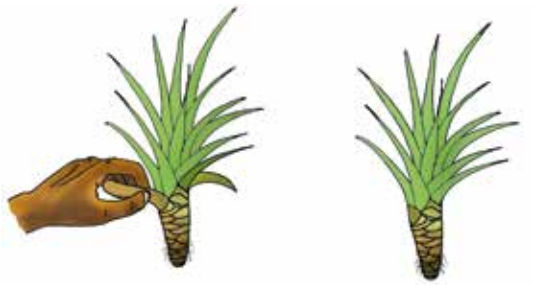
Preparation of the plant material

Calibration consists of grading the propagules in groups according to their size, weight and breadth. Whatever the origin of the propagules (self-produced or external purchase), they must be placed in bundles on the floor, head down, so that they can be easily handled during transport and counting, and to facilitate the closing over of the base to reduce the risk of rot caused by black root rot (thielaviopsis).



Calibration

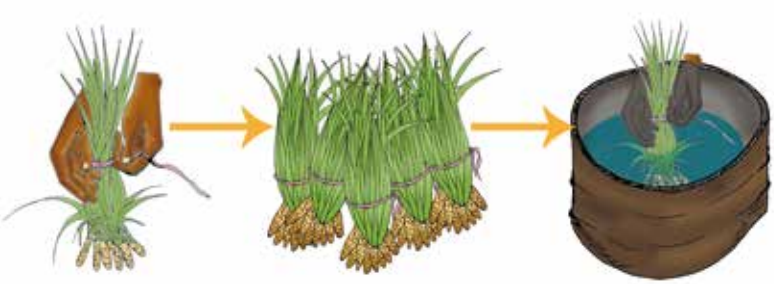
Trimming consists of removing the roots and flakes at the base of the propagule to reveal the eyes from which the new roots will grow.



Trimming

Soaking or disinfection is an operation that consists of disinfecting the plant material in a solution of fungicide and insecticide to prevent attacks by different insects (particularly cochineals) and Phytophtora diseases. After trimming, soak the propagules in water containing fungicide and/or insecticide (complying with the manufacturer's recommended doses and wearing protective gloves). Soaking can be done in a solution of fosetyl-aluminum (500 g of Aliette) and chlorpyrifos-ethyl (750 ml of Durban 4E) in 200 l of water for 20,000 propagules, making sure not to keep this solution for more than 24 hours. After this time, the solution becomes ineffective.

Place the treated propagules in a standing position for 12 hours to ensure that the product is evenly distributed.



Disinfection

3.5 Marking out and ridging

The ridges must be correctly aligned. If the work is conducted by hand, stake out the plot in advance by marking the ground to identify the places to make a hole for planting. On slightly sloping permeable ground, mark out the lines at a right angle to the steepest slope. On heavy land with a steep slope, follow the contour lines.

Planting pineapples following the contour lines

It is also possible to use a tractor-drawn ridging plough. In this case, marking out is not necessary

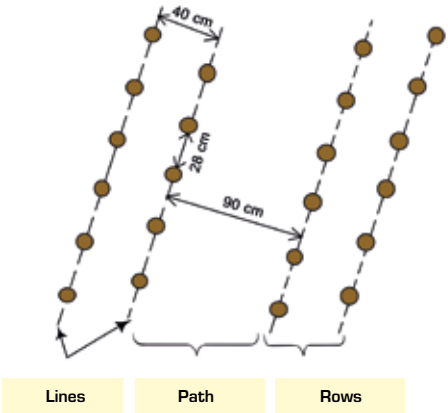
Planting systems and density

Planting density depends on the production goals, varieties, climate and technical skills of the producer. A variety of planting systems can be used:

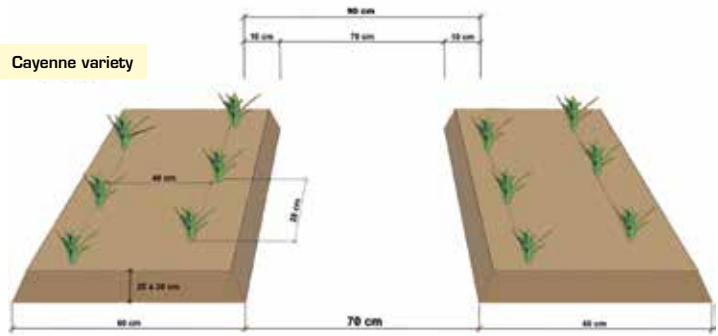
- A simple line on a ridge or border, in the case of a traditional crop in combination with other food crops grown in the locality.
- A twin line on a ridge or border with variable distances, depending on whether the producer is a professional farmer or a beginner.

The greater the planting density, the higher the risk of attacks (wilt, nematodes, symphylans, etc.), and the more complicated the technical aspect of the operation becomes (the rational use of fertilisers, managing pests). It is therefore preferable to begin pineapple production with a reasonable density of 45,000 plants/ha.

If this is a first-time operation, the lines of pineapples should be twinned so that the young plants are staggered. The planting density will be between 45,000 and 66,800 plants per ha for the smooth Cayenne variety.



Pineapple planting in two staggered twinned lines on a ridge (a border)



Adequate gaps ensure access to sunlight and give the young plants enough space to produce larger high-quality fruits

Gaps for the smooth Cayenne variety

Example of planting layouts currently used (smooth Cayenne variety)

Propagules will be planted on ridges or borders using the following gaps:

Layout	Gaps (cm)	Density (plants/ha)	Comments
Simple line	**100 x 100**	10,000	Traditional and combined cultivation
Twinned lines	**90 x 40 x 25** Between two ridges: 90 cm Between the lines on the ridge: 40 cm On the line between two plants: 25 cm	61,500	Recommended for experienced growers
	90 x 30 x 25 Between two ridges: 90 cm Between the lines on the ridge: 30 cm On the line between two plants: 25 cm	66,800	
	90 x 40 x 28 Between two ridges: 90 cm Between the lines on the ridge: 40 cm On the line between two plants: 28 cm	55,000	Inexperienced growers
	90 x 40 x 40 Between two ridges: 90 cm Between the lines on the ridge: 40 cm On the line between two plants: 40 cm	45,000	

4 PLANTING

4.1 Planting date

Pineapples may be planted at any time of the year. The cycle varies from 12-18 months. The desired harvest date is determined by the planting date and the weight of the propagules planted.

Harvest dates in accordance with the propagule weight and planting dates in the Moungo area of Cameroon

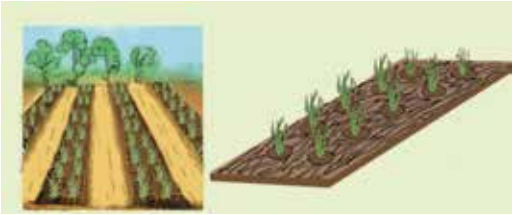
Desired harvest dates	Planting dates	Weight of propagules
October to December, year n+1	July to October, year n	300-400 g
	November to December, year n	400-500 g
March to May, year n+1	January to February, year n	300-400 g
	March to May, year n	400-500 g

4.2 Planting

Mulching adds organic matter to the soil

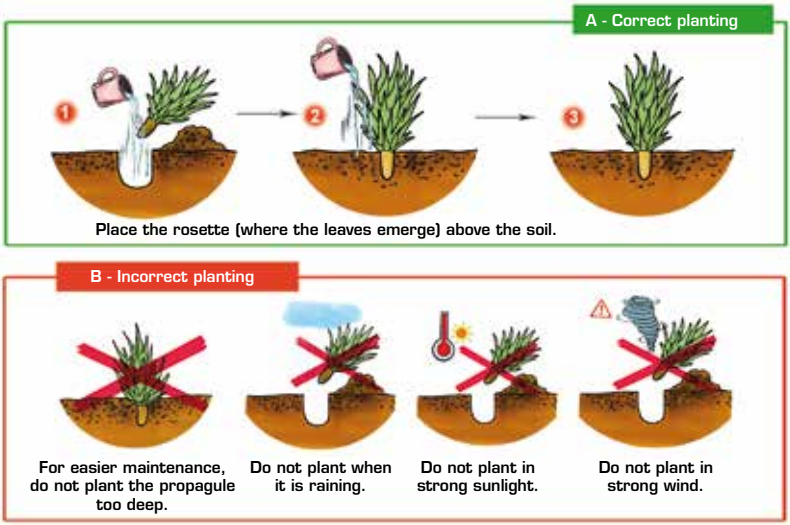
Before planting the propagules, mulching the ridges with rice straw or other grasses is recommended, and, when possible, also with straw obtained by clearing the plot. This helps to prevent weed growth, protect the soil from bad weather, reduce the risk of erosion, cut water losses from the soil, and speed up the growth of the propagules.

Mulching the ridges



For planting:

- Distribute the graded propagules on the plot.
- Make holes (8-10 cm deep) with a machete or dibber at the places indicated.
- Plant the propagules in slightly wet soil, fill in the hole, and then lightly tamp down the earth to ensure good contact between the stem and the soil.



5

MAINTENANCE AND PHYTOSANITARY PROTECTION

After planting, the plantation must be maintained and protected against parasites and diseases.

5.1 Counting and replacing plants

The plants are counted by category of propagule, making it possible to identify what has not been planted. One month after planting, the dead or dried up propagules are replaced by others that are heavier. The replacement must stop two months after planting.

5.2 Removing and preventing weeds

Pineapples are sensitive to weeds during the first 4 months after planting. Weed removal can be mechanical or chemical.

In the case of mechanical removal, weed by hand twice a month for the first 4 months, then once every 3 months for the rest of the cycle.

For chemical treatment, apply herbicides at three stages of the cycle:

- During the preparation of the soil: between two tillings, spray a contact herbicide with an active material (glyphosate, triclopyr, glufosinate-ammonium or diuron), using a backpack sprayer or a tractor-towed sprayer.

	Dose of active material in kg/ha	Volume of mixture in l/ha
Glyphosate	1,5-3	800-1,000
Triclopyr	2-3	800-1,000
Glufosinate-ammonium	3-4	800-1,000
Diuron	1,7-2,2	400-1,000

After the herbicide treatment, you must not walk in the plantation area, as this would cause the growth of weeds on the footsteps in the field

- During planting: Use residual herbicides (e.g. diuron), first treating the ridges before planting the propagules. Then treat the furrows after planting, walking backwards, as it is not permitted to walk on treated ground for two weeks. During this time limit, there is a risk of destroying the protective film of the product covering the soil and encouraging the growth of weeds on those parts. This treatment should be applied on moist soil.

	Dose of active material in kg/ha	Volume of mixture in l/ha
Diuron	1,7-2,2	400-1,000

The residual herbicides remaining on the soil after application prevent the regrowth of weeds

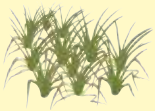
- After planting: For 3 months following the first treatment of residual herbicide during planting, do not use a hoe or other tools (dabas), as turning over soil could cause weed germination in those places or bring seeds to the surface that could then grow into weeds. It is better to weed by hand. The second herbicide treatment of the plot should not be carried out before the fourth month. The products used at this time will be contact herbicides (glyphosate, triclopyr and glufosinate-ammonium). This operation will be carried out between the line spacings or furrows. These products must not touch the pineapple plants, as they could burn the leaves. In the case of treatment of the entire surface area, including the planted parts, use diuron (selective herbicide for pineapple) on wet soil. A 15 l backpack sprayer can treat an area of 315 m² (ridge and line spacing: 315 m x 1 m).

Chemical weeding with a backpack sprayer

5.3 Phytosanitary treatment

A number of parasites and diseases affect pineapple crops.

Parasites/ diseases	Symptoms	Treatment/preventive methods
Pineapple roots infested by nematodes **Due to the high toxic levels of nematicides, it is recommended to carry out these treatments very early in the morning, before sunrise, a long way from water sources and residential areas. The operators must use PPE (gloves, glasses, cartridge respirators)**	**Nematodes** *(Rotylenchulus reniformis, Pratylenchus brachyurus, Meloidogyne javanica and incognita)* alter the root system and affect the growth of the plant. • The plant will be small. • The leaves will become red and dry.	**Preventive action:** • Use clean and healthy propagules. • Leave the land uncultivated for at least 6 months, then cultivate using the recommended doses of fertiliser (see section 5.4. Fertilisation). **Chemical treatment:** Application of nematicides: ***1st application before planting*** • During the rainy season, use solid formulations of terbufos 150 g/plant (Counter 15 FC), at a ratio of 45 kg/ha and oxamyl 10% (Furadent Super 10 G) at 55 kg/ha; dig into the ridges with a hoe. • In the dry season, use the liquid formulation of oxamyl 240 g/l (Vydate L), at a ratio of 3-4 l/ha applied with a sprayer onto the ground around the young plants. ***2nd application, 3-4 months after planting (treatment to be carried out in the event of attacks)*** • During the rainy season, use solid formulations of terbufos 150 g/plant (Counter 15 FC), at a ratio of 45 kg/ha and oxamyl 10% (Furadent Super 10 G) at 55 kg/ha, spreading it around the plants using gloves. • In the dry season, use the liquid formulation of oxamyl 240 g/l (Vydate L), at a ratio of 3-4 l/ha applied with a sprayer onto the ground around the young plants.
Fungus *(Thielaviopsis)* 	*Thielaviopsis* is a fungus that causes: • Soft rot of the fruits. • Black rot on the stem of the propagule. • Leaf rot.	**Precautions for the propagules:** Make sure that the base of the propagule is completely closed. **Precautions for the fruit:** Avoid impacts on the fruit during harvesting and packing. Ensure cleanliness of the harvesting and packing locations. **Precautions for the leaves:** Treatment carried out against Phytophtora with fosetyl-aluminium 80 g/kg (Aliette 80 WG) at a ratio of 7.5 kg/ha by spraying the mixture on all the leaves.

Parasites/ diseases	Symptoms	Treatment/preventive methods
Fungus *(Fusarium* sp.*)*	This fungus (*Fusarium* sp.) causes black spot disease on the fruits.	Sensitivity to black spot is increased by a wet period with little sunshine at the point when the inflorescence emerges, and by a sunny and dry period near to the harvest. Variations in the intensity of black spot are unpredictable and can be very severe. Bearing in mind the rapid development of black spot as the fruits ripen, bring the cutting forward to limit this problem. Regular observation of the fruits between the TFI interval and harvest make it possible to change the cutting date and preserve the quality of the taste of the fruit.
Phytophtora nicotianae	**Heart rot** (cryptogamic disease) caused by two fungi (*Phytophtora nicotianae* and *Phytophtora palmivora*) results in the yellowing of the young leaves of the heart of the plants; these young leaves fall off easily and display a rotten base which gives off an unpleasant smell.	**Use of fungicide at various stages of the plant's development:** • During the soaking of the propagules (see section 3.4. Quality of the plant material). • During vegetation: 2 days after planting, or 1 week after the TFI, plan a treatment using the active material fosetyl-aluminium 80 g/kg (Aliette 80 WG) at a ratio of 7.5 kg/ha by spraying the mixture onto the heart of the young plants.
Generalised symptoms 	**Wilt,** transmitted by the mealybug, is characterised by a violent, swift and usually irreversible withering, attacking isolated or neighbouring plants, and the curling of the edges of the leaves. Cochineal colonies located at the base of the fruit.	**Preventive actions:** • Burn and plough in the plant material of the previous crop. • Only harvest the propagules of healthy plants. • Destroy all plants showing symptoms of wilt. • Destroy plant with large colonies of cochineals or ants. **Chemical actions:** with insecticides containing chlorpyriphos-ethyl (Dursban 4E) at a ratio of 1-1.5 l/ha), cypermethrin 25 g/l (Cythrine 25 EC) at 2 l/ha, imidacloprid 20 g/l and cypermethrin 80 g/l (Cofresh P 100 EC) at 1.5 l/ha. • Treat the propagule plots regularly with insecticide using a backpack sprayer. • Soak the propagules in an insecticide solution. • Apply insecticide in the field every 2 months (particularly in the dry season). • If ethephon is used to improve the colour of the fruit, add an insecticide with a pyrethroid base (low endurance), for example cypermethrin 50 g/l (Cigogne 50 EC), to the ethephon, and then brush the fruit to prevent cochineals appearing at the base.

Parasites/ diseases	Symptoms	Treatment/preventive methods
Symphylans (myriapoda) **You must not eat, drink or smoke when using pesticides. Pesticides must be handled with caution. After using pesticides, wash your hands and face and the rest of the body thoroughly with soap and water**	Symphylans (*Hanseniella* spp.) are small 'centipedes' that live in the soil and feed on the roots of the pineapple. • You can see an even development in the vegetation, with strands of poor growth with a moth-eaten appearance alongside well-developed green plants. • A 'witch's broom' deformation appears in the roots.	Treatments against symphylans involve the same products as those against nematodes, but using a double dose. **Chemical treatment:** Application of symphylicides ***1st application before planting*** • During the rainy season, use solid formulations of terbufos 150 g/plant (Counter 15 FC), at a ratio of 90 kg/ha and oxamyl 10% (Furadent Super 10 G) at 110 kg/ha; dig into the ridges with a hoe. • In the dry season, use the liquid formulation of oxamyl 240 g/l (Vydate L), at a ratio of 6-8 l/ha applied with a sprayer onto the ground around the young plants, spreading evenly all around the plants while protecting the hands with gloves. ***2nd application, 3-4 months after planting (treatment to be carried out in the event of attacks)*** • During the rainy season, use solid formulations of terbufos 300 g/plant (Counter 15 FC), at a ratio of 90 kg/ha and oxamyl 10% (Furadent Super 10 G) at 110 kg/ha, spreading it around the plants. • In the dry season, use the liquid formulation of oxamyl 240 g/l (Vydate L), at a ratio of 6-8 l/ha applied with a sprayer onto the ground around the young plants.

5.4 Fertilisation and irrigation

The pineapple needs quite a lot of fertilising. The production of one fruit requires 4 g of nitrogen (N), 112 g of phosphorus (P) in the form of phosphorus pentoxide (P205), 2-3 g of magnesium (Mg) in the form of magnesium oxide (MgO), and 10 g of potassium (K) in the form of potassium oxide (K20): these are the theoretical needs for a pineapple planted using TFI.

Fertilisation must be calculated in accordance with soil analyses (mineral and PH content) and the local availability of fertilisers in formulation and form.

Basal dressing

The nutritional needs of the plants can be covered by basal dressing (the application of P- and Mg-based fertilisers before planting), complemented by maintenance fertilisation (the application of N- and K-based fertilisers) during vegetation, or by maintenance fertilisation only (the application of N, P, Mg and K during vegetation).

Basal fertilisers applied during the preparation of the soil can satisfy the P and Mg needs.

For example, for 20,000 plants, the following basal fertilisers can be applied in accordance with the plant's theoretical needs.

Type of fertiliser	Needs of the plant	Commercial product	Quantity (kg of commercial product for 40,000 plants)
P fertiliser	1-2 g	Dicalcium phosphate	100-200
		Super triple phosphate	92-180
Mg fertiliser	2-3 g	Dolomite	360-544
		Kieserite	296-444

If the soil quality is poor, the addition of nutritional elements is essential. For good fertilisation, ensure that the plants absorb the active elements supplied by the fertiliser as well as possible. The plant lends itself more effectively to application by spraying (dilution of urea and K in water) before application. As it develops, the plant's nutritional needs grow. There are two possible application techniques:

- monthly applications, on a set date, of increasing doses of fertiliser; and
- application of identical doses at gradually shorter intervals.

In addition to the basal dressing referred to above, fertilisation depends on the length of the cycle. The quantities of inputs can vary according to the cycle, bearing in mind the theoretical needs of the plant as defined above and the soil analysis. Keep in mind the ratio K:N = 2:2.5 (see the example of a fertilisation schedule in the table below). Apply by hand to the leaf axils at the base of the plant fertilisers in solid and granular form (urea and potassium sulphate, K_2SO_4) in the rainy season, and by spraying all the leaves in the dry season (dilution of urea and K_2SO_4 in water).

Example of a liquid fertilisation programme on the smooth Cayenne variety

Nature of fertiliser	Week	Input N (g)	Input P205 (g)	Input K20 (g)	Input Mg (g)	K_2O/N
3-6 g of phospal per plant 10-14 g of dolomite per plant	Before planting		1-2		2-3	
1.09 g of urea per plant 2.2 g of K2S04 per plant for each application period	4	0,5		1,1		2,2
	10	0,5		1,1		2,2
	15	0,5		1,1		2,2
	20	0,5		1,1		2,2
	24	0,5		1,1		2,2
	27	0,5		1,1		2,2
	30	0,5		1,1		2,2
	32	0,5		1,1		2,2
TIF	34	4	1-2	8,8	2-3	2,2

Source: Crop management process for Cayenne pineapple, PIP (2004)

Two consecutive applications of liquid fertiliser can be replaced by a single application of solid fertiliser, i.e. 2.18 g of urea and 4.4 g of K2S04 applied to the axil of the old leaves.

Example of a solid fertilisation programme on the smooth Cayenne variety

Nature of fertiliser	Week	Input N (g)	Input P205 (g)	Input K20 (g)	Input Mg (g)	K_2O/N
7.25 g per plant for each period with a special complete pineapple fertiliser (formulation type 11-5-27-5)	4-5	0,8	0,36	1,96	0,36	2,45
	9-11	0,8	0,36	1,96	0,36	2,45
	15-17	0,8	0,36	1,96	0,36	2,45
	20-22	0,8	0,36	1,96	0,36	2,45
	26-27	0,8	0,36	1,96	0,36	2,45
TIF	30	4	1,8	9,8	1,8	

Source: Crop management process for Cayenne pineapple, PIP (2004)

In a region where the rainfall is below 1,200 mm or unevenly distributed, an additional form of irrigation (2-4 mm per day) is required to increase the yield. A temporary lack of water is not harmful to the plant.

Nitrogen deficiency causes the leaves to turn yellow, slows growth, prevents the growth of slips and produces undersized plants. In the event of such a deficiency, improve the fertilisation by applying a N-rich fertiliser.

Potassium deficiency causes the leaves to turn yellow and remain short and narrow; discoloured patches will appear on the leaves. The fruits will be small and unscented. In the event of such a deficiency, improve the fertilisation by applying a K-rich fertiliser.

Magnesium deficiency causes the base of the leaves to turn blue and wilt. In the event of such a deficiency, improve the fertilisation by applying Mg.

Calcium (Ca) deficiency causes the appearance of blotches and discoloured areas on the limb of the leaves. The leaves blister and the extremities dry up. In the event of such a deficiency, improve the fertilisation by applying Ca.

Nitrogen deficiency

Potassium deficiency

Magnesium deficiency

Calcium deficiency

5.5 Treatment for floral induction (TFI)

Several TFI techniques can be used to group the production of fruits in a pineapple plot.

Acetylene and calcium carbide treatment

Acetylene is obtained by the reaction of water on calcium carbide (CaC_2). Add 500 g of CaC_2 (in small pieces) to a 200 l plastic drum 3/4 filled with water. A volume of air must always be left in the container. The drum is immediately sealed and shaken vigorously for 10 minutes to ensure the release of gas and good dissolution. The resulting mixture is then

Mechanising this technique is dangerous as there is a risk of explosion due to the contact between CaC2 and certain metals (copper) that may be contained in some application devices. A gradual degassing must also be carried out when the CaC2 is dissolved in water. This treatment should therefore be carried out manually

poured into the heart of each plant in a sufficient quantity to drown it, which requires at least 50 ml. This can be done using a plastic cup or a modified backpack sprayer, from which all metal parts contained in the tanks and the pressurised hose have been removed, enabling the mixture to run through a pipe attached to the tank using gravity. Two treatments must be carried out with an interval of 3-4 nights. This technique is the most commonly used.

Ethephon treatment

Synthetic products releasing ethylene are commonly used. The best known is ethephon. Ethephon treatments are easier than those referred to above: one application per day is sufficient and small backpack sprayers can be used. The treatment is even more effective when urea is added to the solution.

There is a risk of 'bottle fruits' being formed, which makes it difficult for the fruits to colour

Treatment with ethylene-enriched activated carbon powder

Treatment with ethylene-enriched activated carbon (C) powder is performed on young plants with an acceptable growth rate (size of the neck of the plant, leaf D: the largest leaf weighs between 50-70 g); growing stage between 7-13 months to bear fruits between 12-18 months. After planting, although it is necessary to wait for the plant to develop sufficiently, you must remain vigilant, as an over-developed plant will produce a small fruit.

The activated C treatment can be carried out using the wet or dry method.

>>> **Wet treatment**

- Place the ethylene-enriched activated C powder into the tank of a backpack sprayer. The activated C used in this case is preferably in 'powder' form (e.g. Pulsorb GW from Chemviron Carbon).
- Mix the ethylene-enriched activated C powder with water in the tank of a backpack sprayer. It is best to use cold water to help the ethylene to dissolve and thus obtain better results.
- Shake gently to ensure an even mixture.
- Spray the heart of the plants through the hose (nozzle removed in advance) with a dose of 250 mg/plant.

If the treatment is carried out correctly, the flowering rate could reach 100% after 8 weeks of treatment (250 mg/plant, repeated at 2-day intervals).

Activated C treatment is not always within the scope of the small producer due to the expense involved, the difficulty to acquire it and the complexity of the equipment required for its implementation. In addition, the enriched activated carbon is not available everywhere

>>> **Dry treatment**

Dry treatment is useful when access to water cannot be guaranteed. It is also less physically demanding than wet application.

- Acquire activated C granules (e.g. Filtrasorb 400 carbon from Chemviron Carbon).
- Place the granules in the doser (Hornady, Lock-n-load style).
- Set the doser to the required dose.
- Apply the activated C directly to the heart of the plant, observing the dose of 250 mg/plant.

Used correctly, this technique produces a flowering rate between 85-90% after 10 weeks of treatment.

Lock-n-load powder doser

Whatever treatment technique is used, respect the following principles:

- **For it to be effective, carry out the treatment at night, early in the morning or in the evening (preferably in good weather).**
- **Repeat the treatment twice at intervals of 3-4 days.**
- **If it rains within 3 hours of the treatment, the application is invalidated.**

5.6 Interventions between flowering and harvest

Counting the inflorescences is done 45-60 days after the TFI to ensure the success of the operation. Once it appears, the young pineapple flower must be protected against bees and other insects. A box of chilli powder diluted in a sprayer with 15 l of water can efficiently protect at least 500 flowers.

The reduction of the crown is a delicate operation that is carried out between 3.5-4 months after the TFI. It consists of excising the meristem of the growing crown with a tool called a '*gouge*':

- If the gouge is pushed too deep, the central cylinder of the fruit will rot.
- If the gouge is incorrectly reduced, the crown will lean to one side 2-3 weeks later.
- This must be done on 2-3 occasions at intervals of 2-3 weeks.

Main steps in reducing the pineapple crown

Degreening is necessary to obtain a uniform yellow colour in a plot using ethephon. Treatments are carried out 7-10 days before harvest. In localised application, a dose of 1.5 kg/ha of active material in a volume of 800 l of water, at a ratio of 15 ml/fruit (55,000 fruits treated), is applied 8 days before harvest.

Direct sunlight causes burns on the skin and underlying tissues, changing the shape of the fruit. To protect pineapple from the sun:

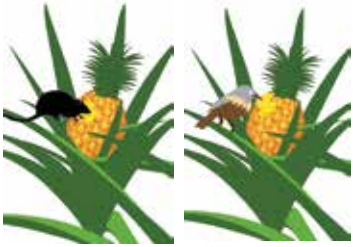
- Bind together a section of the leaves.
- Mulch the pineapple with dried grass.
- Maintain the leaves of the plants trained by lines.

Bind together a section of the leaves	Mulch the pineapple	Maintain the leaves of the plants using lines

Mulching – protection from the sun

Birds and rodents pierce and eat the fruits. The plot must be cleaned and traps laid.

Sunburn



Birds and rodents

Harvest

To preserve the nutritional elements and organoleptic qualities of the fruit, harvest when the fruit is sufficiently ripe.

The timing of the harvest is mainly dependent on climate conditions. It takes place approximately 160 days after the TFI, and between 145-174 days in extreme cases. The external colouring of the fruit is the most frequently used criterion to assess ripeness. The fruits are usually harvested at the stage of ripeness known as 'turning', which corresponds to the yellowing of the lower quarter of the fruit.

Fruiting pineapple | Turning ripeness | Ripeness of lower 2/4 | Ripeness of lower 3/4 | Completely ripe

Stages of ripeness of the fruits

- Cut the stalk with secateurs or a machete 10-15 cm from the base of the fruit.
- Cut the crown to make packing easier and recover the plant material. This practice must be approved in advance by the customer.
- Place the fruits on their sides in a staggered formation in the crate without piling them up.

Ripe pineapple

Harvesting pineapples

Harvested pineapples

An 'anti-impact' chain must be provided throughout harvesting and packing operations. The harvested fruits must be protected from sunlight in a cool and airy location. The packing of harvested fruit depends on a variety of subsectors: fresh fruit export, canning and the manufacture of sub-products (juice, dregs, etc.). Packing fruit for export requires skill and know-how. Weighing, calibrating, and assessing the size of the crown and the fruit are operations required to comply with international standards. The fruits are then labelled and placed in cardboard boxes.

The fruit can be preserved by moderate refrigeration (pineapples do not react well to temperatures below 7°C).

Internal browning of the fruit and bitter taste

During storage and transport, particularly by ship, the interruption of the cold chain, resulting in an average temperature that is too low, creates physiological accidents leading to the internal browning of the fruit, which only becomes apparent when reheated. The taste of the fruit then becomes bitter.

After harvesting the fruits, the farmer moves on to the production of propagules, as referred to in section 3.3

Ripe fruit with internal browning

6

FINANCIAL INFORMATION

In 2016, for the manual cultivation of one hectare of pineapples in Notse, in Southern Togo, over a period of 3.5 years, the propagules represent 22% of expenditure, maintenance and fertilisation products 19%, labour 44%, and tools and access to the land 16%. In total, expenses can amount to 3,437,406 CFA F (€5,240.29) for a 1 ha plantation.

The pineapple production cycle lasts from 20-30 months, so expenses and income below represent two production cycles

Operating income is related to the sale of the fruits (58%) and the propagules (42%). With an average yield of 50 t of fruits and 240,000 propagules per ha, income can amount to 8,593,000 CFA F (€13,230.80). The net profit from the cultivation of 1 ha of pineapples on an old plot would then be 5,155,593.80 CFA F (€7,859.70), or 1,473,026 CFA F (€2,245.60) per year.

Expenses				Income			
Designation	**Quantity**	**Unit cost (CFA F)**	**Total (CFA F)**	**Designation**	**Quantity**	**Unit cost (CFA F)**	**Total (CFA F)**
Propagules (number of plants)	50,000	14.95	747,500	Fruit revenues (in kg)	50,000	100.1	5,005,000
Fertilising and treatment products	Flat rate	_	645,261	Propagules revenues (number of plants)	240,000	14.95	3,588,000
Labour (hrs/day)	925	1,625	1,503,125				
Other expenses (rental of land, tools, etc.)	Flat rate	-	503,125				
Depreciation of equipment and provisions (*)	Flat rate	-					
Total expenses	**-**	**-**	**3,437,406**	**Total income**	**-**	**-**	**8 593 000**
				Net profit	**-**	**-**	**5 155 594**

** A cart for transport and a small storage facility*

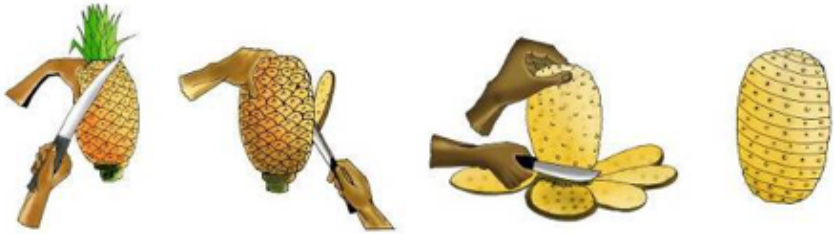
The pineapple production cycle lasts from 20-30 months, so expenses and income below represent two production cycles

7

PINEAPPLE CONSUMPTION AND PROCESSING METHODS

Fresh pineapple

- Cut off the crown and the lower part.
- Remove the rough external skin.
- Cut the pineapple from top to bottom and if necessary remove the spine.
- Slice the flesh for eating.
- Collect the juice.



Steps for peeling the fruit

Fresh pineapple juice

- Prepare a pineapple as shown above.
- Grate it or cut into cubes.
- Wrap the grated or cubed pineapple in a clean cloth, then press to extract the juice, which should be put into a clean container.
- Serve fresh.

The remaining pulp can be dried for use in the preparation of doughnuts, bread rolls or cakes, or to flavour meat and fish dishes.

Dried pineapple

- Select a fruit that is firm and not too ripe.
- Peel it and cut it into slices 1 cm thick.
- Remove the spine if it is too fibrous.
- Place the slices in the sun or in a solar drier until they are dry. This normally takes 3 days. If possible, cover the fruit with a fine net to keep away flies.
- If there is not enough sun, finish the drying in an oven at a very low heat.
- Store in clean jars and seal hermetically, or in plastic bags.

Dried pineapple can be used in meat and fish dishes or in desserts.

Peeling the pineapple

Round slices spread out on a pallet

Dried and packed pineapple

Pineapple syrup

Ingredients

- *1.50 kg of sugar*
- *1 l of pineapple juice obtained from four medium size pineapples*

Preparation

- Boil the sugar and pineapple juice in a wide-bottomed casserole dish.
- Once boiling, cook for a further 30 minutes.
- Stir constantly.
- When the syrup is cooked, pour it into dry bottles and place them in a water bath for about 30 minutes to allow them to cool.
- When they are cold, remove, seal and store the bottles in a horizontal position until they are used.

This product can be preserved at room temperature for at least 6 months. The syrup is served mixed with water.

8

RECIPES

Pineapple cake

Ingredients (for six people)

- *170 g of flour*
- *3 eggs*
- *1/2 sachet of baking powder*
- *3 teaspoons of refined oil*
- *5 spoons of pineapple juice*
- *5-6 pineapple slices*
- *60 g of sugar*
- *60 g of butter*

Preparation

- Mix the flour and the eggs. Add the oil, the melted butter, the sugar, the pineapple juice and the baking powder. Obtain a smooth and uniform paste. If the paste is too thick, add some pineapple juice.
- Pour the paste into a buttered baking dish.
- Cook for 10 minutes at 190°C (thermostat 6/7).
- Place the pineapple slices on the preparation.
- Cook for a further 20 minutes.

Pineapple-vanilla jam

Ingredients (four medium size jars)

- *3 pineapples*
- *540 g of sugar (30% of the weight of the fruit, or 20% if the pineapples are very ripe).*
- *1 vanilla pod*

Preparation

- Chop the pineapples into small pieces.
- Split the vanilla pod in two and scrape out the seeds.
- Place the pineapple, the pod and the vanilla seeds into a casserole dish (or a pressure cooker or a jam pan) and leave to rest for at least 1 hour, stirring regularly.
- Simmer on a low heat for 20-30 minutes. Stop cooking when a cooled preparation dripped onto a plate has the consistency of jam.
- Then remove the vanilla pod from the fruit and crush with a mixer, processor or blender.
- Boil the jars and lids, fill them with hot jam and store them the next day.

Once opened, the jam may be stored in a refrigerator for 15 days.

9

ADDITONAL INFORMATION

9.1 Bibliography

AGROCOM, 2000. *Guide de production et de protection de l'ananas.* Douala, Cameroon.

Colin J.P., 1987. Contribution à l'analyse de la petite production d'ananas en basse Côte d'Ivoire. ORSTOM, Fruits, 42 (4): 207-218.

FAO, 1980. *L'ananas, un fruit délicieux et rafraîchissant.* Fiche n° 10. Garnier C.L., 1997, Ananas : la Queen Tahiti. Ministère de l'Agriculture, de l'Élevage et des Forêts. Service du développement rural, note technique.

Lebeau F., Imele J.P., Teisson C. and Delhove G., 2009. *Efficacité de la technique d'induction florale d'Ananas comosus (L.) Merr. au moyen de charbon actif enrichi à l'éthylène (TIFBio).* Biotechnol. Agron. Soc. Environ. 13(3) : 395-400.

Opportunities Industrialization Center Togo, 2005. *Manuel de formation II - Production végétale.*

PIP/COLEACP. 2004. *Itinéraire technique Ananas Cayenne* (Ananas comosus). 62 p.

PIP/COLEACP. 2004. *Itinéraire technique Ananas MD2* (Ananas comosus). 62 p.

Py C., Lacoeuilhe J-J., Teisson C. 1984. *L'ananas, sa culture, ses produits.* Paris, France, Maisonneuve et Larose, collection Techniques agricoles et productions tropicales, n°33. 562 p.

TIFBio, 2008. *Traitement d'induction florale de l'ananas compatible avec l'agriculture biologique.*

Lebeau F., Imele J.P., Teisson C., Delhove G., 2009. *Efficacité de la technique d'induction florale d'ananas comosus (L.) Merr.* Au moyen de charbon actif enrichi à l'éthylène (TIFBio), Biotechnol. Agron. Soc. Environ. 13 (3), 395-400.

9.2 Useful contacts

RÉSEAU DES OPÉRATEURS DES FILIÈRES HORTICOLES DU CAMEROUN (RHORTICAM)
PO 4636 Douala
Cameroon
Tel.: (237) 699 81 59 11 / 677 75 03 95
Fax: (237) 233 42 83 17
E-mail: rhorticam@hotmail.com

OPPORTUNITIES INDUSTRIALIZATION CENTER (OIC-TOGO)
B.P. 106 Lomé
Togo
43, 155 rue des Rossignols – Kodjoviakopé
Tel.: (+228) 22.21.03.39 / (+228) 24.42.00.04
Fax: (+228) 22 21.03.42 / (+228) 24.42 01.94
E-mail: oic-togo@cafe.tg

ORGANISATION FAÎTIÈRE DE LA FILIÈRE ANANAS ET BANANE (OCAB)
16 BP 1908 Abidjan 16
Côte d'Ivoire
Tel.: (+225) 20.25.18.72/78
Fax: (+225) 20.25.18.82/87
E-mail: ocab.a@aviso.ci

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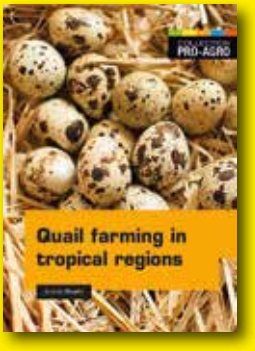

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Production and processing of pineapple

PRO-AGRO is a collection of practical, illustrated guides that are jointly published by CTA and EWB Cameroon. They are an ideal source of information for farmers, rural communities and extension workers in tropical and subtropical regions.
This manual presents the technical process for pineapple production. It also refers to the nutritional and economic benefits of this plant, providing practical information on processing and consumption. Financial information is also provided for possible investment.

- **The Technical Centre for Agricultural and Rural Cooperation (CTA)** is a joint international institution of the African, Caribbean and Pacific (ACP) Group of States and the European Union (EU). Its mission is to advance food and nutritional security, increase prosperity and encourage sound natural resource management in ACP countries. It provides access to information and knowledge, facilitates policy dialogue and strengthens the capacity of agricultural and rural development institutions and communities. CTA operates under the framework of the Cotonou Agreement and is funded by the EU.

- **Engineers without Borders (EWB)** is a network of professionals in more than 64 countries to promote human development through improved access to scientific and technical knowledge. In Cameroon, EWB works together with local people to improve their livelihoods and strengthen their technical capacity by sharing and diffusing information adapted to their needs.