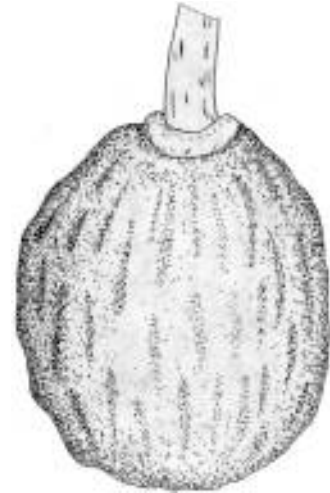


Growing the major

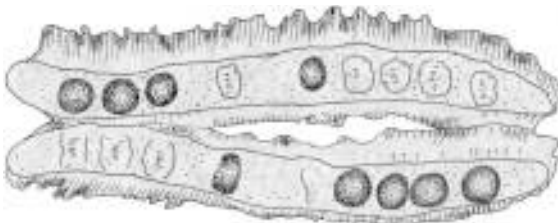
food plants

of



Papua New Guinea

**A description of the crops,
how and where they are grown,
and some of the problems
with their production.**



Bruce R French

What is this book about?

Papua New Guinea has a beautiful range of plants that can be used for food. It is still true that many of these have not been written about properly. Many of the highly nutritious edible greens are simply called “kumu” and in many places are not highly regarded. Often these plants are grown throughout the tropics and are of worldwide importance. But because they lack a name in English they also often don't have one in Tok Pisin and few books discuss them.

This book is going to talk about growing food in Papua New Guinea. Not everybody in the country grows and eats the same foods. Neither do they grow them or use them in the same way. Many of the more traditional food plants have lots of different names in different Tok Ples languages. It is hoped the drawings and descriptions will be enough to help you to work out the plant that is being described. Scientists give every plant a name in the Latin language. This is included so that we can know exactly which plant is being talked about. This name stays the same whatever country or whatever language is being used. So these names look hard but they are very useful. Sometimes Tok Pisin or Tok Ples names are included.

Most of the food plants people grow and use are very good food plants. They are something about which people should be proud. They are something about which we all should take a special interest.

This book is dedicated to those who still seek to fulfil what God asked in Genesis 2:15.

*"The LORD God took the man
and put him in the Garden of Eden
to work it and take care of it."*

INDEX for GROWING Food Plants

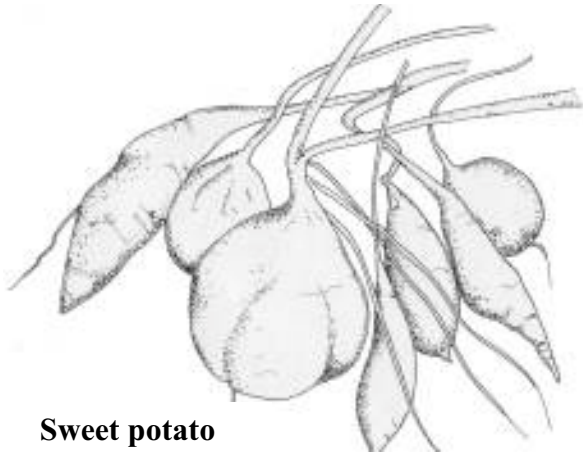
Main staple foods	Page
Bananas	7
Cassava	20
Potatoes	26
Sago	31
Solomon's sago	40
Sweet potato	42
Taro family	54
Chinese taro	59
Elephant foot yam	61
Giant taro	63
Swamp taro	65
Taro	74
Winged bean	82
Yams	84
Greater yam	88
Lesser yam	89
Potato yam	96
Five leaflet yam	98
Other root crops.	99
Polynesian arrowroot	
Queensland arrowroot	
<i>Ipomoea macrantha</i>	
Edible greens	101
Aibika	104
Amaranth	110
Blackberried nightshade	118
Ferns	121
Climbing swamp fern	122
Tree ferns	123
Diplazium	124
Kumugras	124
Waterfern	127
Fig leaves	128
<i>Ficus pungens</i>	129
<i>Ficus copiosa</i>	131
Kangkong	132
Kalava (<i>Ormocarpum</i>)	134
Rungia	135
<i>Dicliptera papuana</i>	137
Valanguar	142
Tu-lip	143
Watercress	145
Rorippa	147
Water dropwort (<i>Oenanthe</i>)	
Waterleaf	
Vegetables	149
Bamboo - small and large	150
Beans	153
Common bean	153
Long or snake bean	154
Cowpea	

	Lima bean	155
	Lablab bean	156
Cabbage family	Cabbage	167
	Chinese cabbage	168
	<i>Nasturtium schlechteri</i>	143
Capsicum		172
Chilli		174
Corn		176
Ginger		184
Job's tears		186
Peanut		187
Pitpits	Coastal or long pitpit	193
	Highlands or short pitpit	196
Pumpkin family		201
	Bottle gourd	204
	Choko	206
	Cucumbers	209
	Pumpkins	210
	Angled loofah	211
	Smooth loofah	212
	Bitter cucumber	213
	Wax gourd	214
	<i>Trichosanthes pulleana</i>	
Onions	Leeks	218
	Spring onions	218

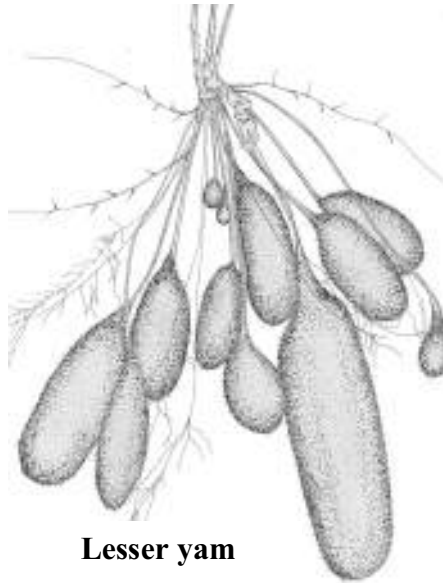
Fruit		219
Avocado		220
Bukubuk		223
Citrus		225
Custard apple family		230
	Bullock's heart	233
	Cherimoya	235
	Soursop	237
	Sweetsop	239
Five corner		241
Golden apple		243
Guava & cherry guava		245
Indian mulberry		248
Laulaus (<i>Syzygium spp.</i>)		250
	Malay apple	252
	Rose apple	255
	Surinam cherry	254
	Watery rose apple	253
Lovilovi family		256
Mango		257
Marita		260
Mon (<i>Dracontomelon</i>)		264
Mulberry		266
Mundroi (<i>Corynocarpus</i>)		268
Myristica		
Naranjilla		270
Tree tomato		272

Passionfruits & Granadilla	274
Pawpaw	278
Pineapple	283
Sugarcane	286
Ton (<i>Pometia pinnata</i>)	295
Watermelon	297
Nuts	299
Aila	301
Breadfruit family	304
Breadfruit	305
Jackfruit	309
Pakal	311
Candlenut	313
Castanopsis chestnuts	315
Coconut	317
Galip nuts	323
Finschia nuts	327
Karuka family	329
Karuka	330
Wild karuka	337
<i>Pandanus antaresensis</i>	340
Okari, talis, Java almond	342
Pao nuts	349
Index	
Scientific names	354
Common name	357

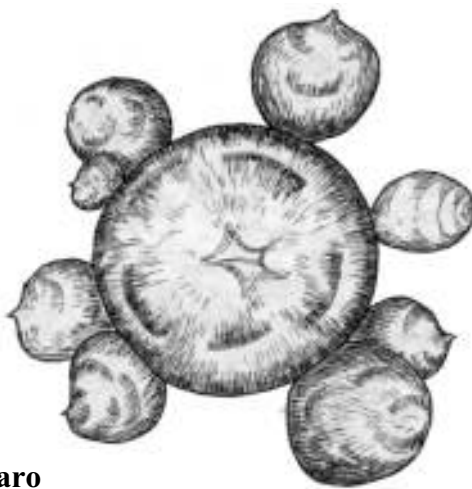
Main staple foods



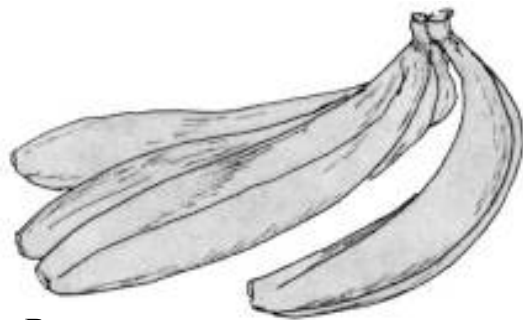
Sweet potato



Lesser yam



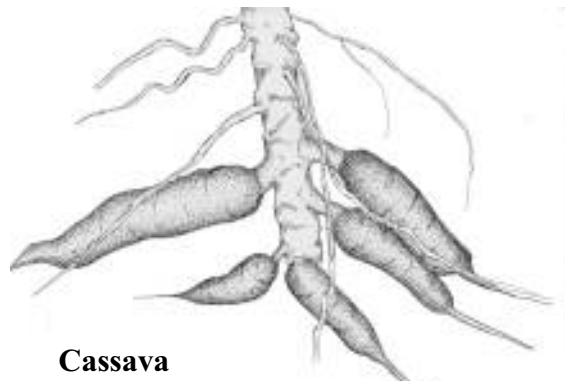
Taro



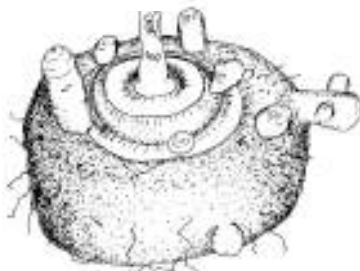
Banana



Greater yam



Cassava



Elephant foot yam



Chinese taro

Banana

Scientific name: *Musa sp. (A&/or B genome)*

Bananas

Most areas of Papua New Guinea have bananas. Some people have them as their main staple food while in other areas they are just a snack food. There is a very large amount of variation within the banana varieties in Papua New Guinea. It is important to understand something about these types of bananas.

Within some of these groups, Papua New Guinea has more varieties than any other country in the world. Within the banana group of plants there are several wild ones. In Bougainville the rainforest has many wild inedible bananas. But this article is about the main group of edible kinds of bananas.

The banana story

Although this story of the history of bananas is a little complicated it is important because it is most likely that all these kinds of bananas probably originally developed in Papua New Guinea. It is also important for banana growers to recognise some of the important differences between the groups.

Originally there were small traditional bananas like some of the edible kinds but the fruit were full of seeds. One of these became a parent of present bananas and by scientists is represented by AA meaning both its sets of chromosomes came from an original plant (*Musa acuminata* [Syn. *Musa banksi*]). This plant occurs as a wild seeded plant in many areas along the north coast of mainland Papua New Guinea. This plant when it is without seeds gives an important group of local edible bananas called diploids. Varieties in the Gazelle with names like kekiau, gulum, pitu, gorop and katual belong to this group. But another wild seeded parent is also another parent of some of the present bananas. This plant is called “BB” by scientists, because it has two sets of chromosomes from an original plant (*Musa balbisiana*). This plant occurs in the Gazelle Peninsula and is called Okaoko. A similar banana plant in the Gazelle Peninsula is called Auko and is an edible cultivated banana without seeds.



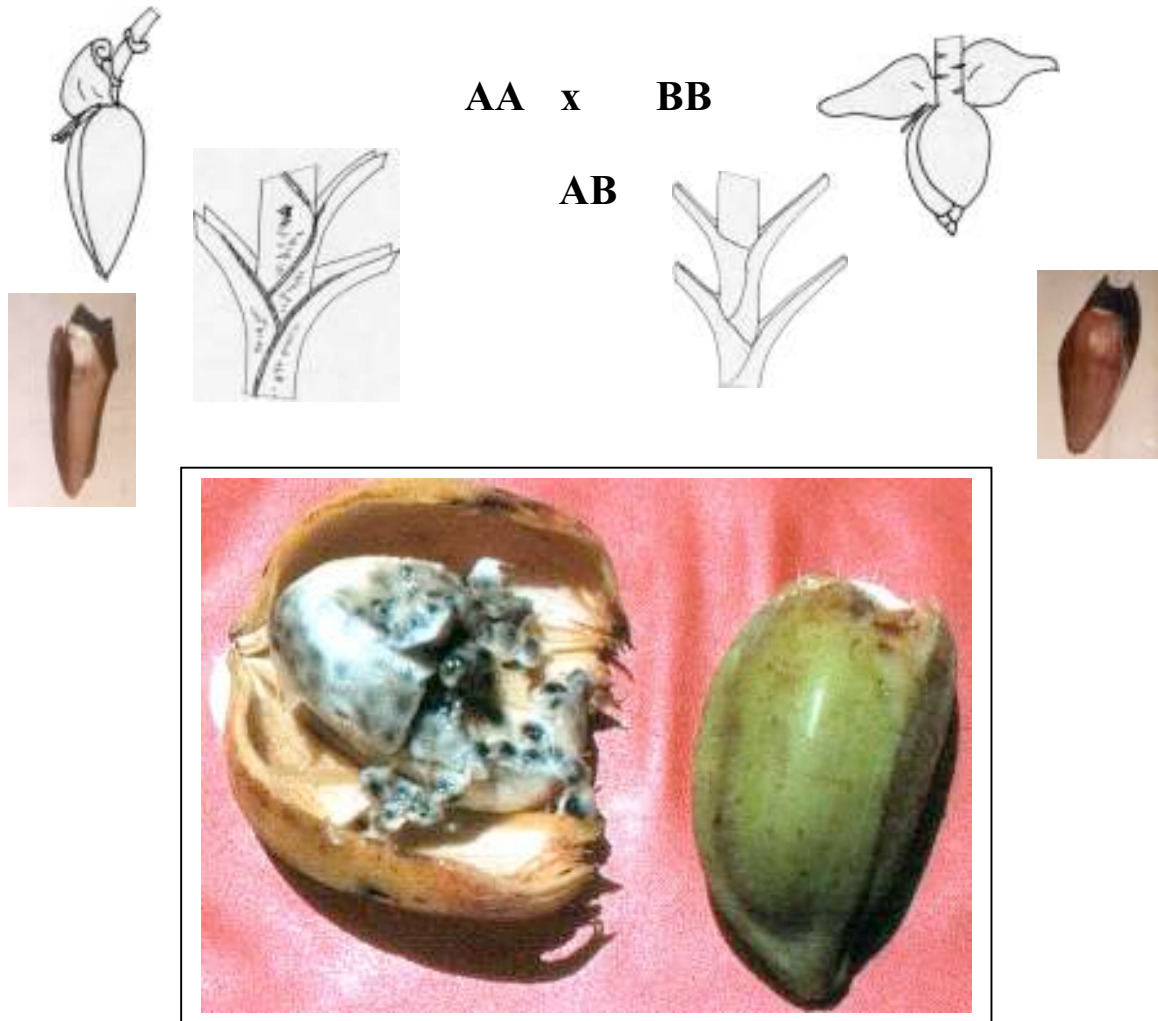
The wild seeded AA banana



The wild seeded BB banana

As well as both the wild seeded parents of bananas occurring in Papua New Guinea, they also occur as non-seeded edible bananas.

So the start of the banana story is that these two wild seeded parents have crossed.



A banana fruit full of seeds

But another thing can occur with bananas and this is where they develop more than two sets of chromosomes (the threads that contain the messages that control breeds and breeding). So there can also be plants represented as:

AAA
AAB
ABB
AAAA
AABB
ABBB

Occasionally plants can cross with some of the other wild bananas in Papua New Guinea (*Musa schizocarpa*) and give ones such as AS which is called Kalakala variety in Morobe district or ABBS.

So the picture of the main group of bananas in Papua New Guinea starts to look something like this: (Using Tolai variety names)

Diploids	AA	eg Mami, kekiau, gulum, gorop etc.
	BB	eg Auko.
Triploids	AAA	eg Siaina, (Cavendish), marau,
	AAB	eg avundumong, maramba, akambia,
		(Some very large fruited kinds within this group are called “Horn Plantains” and “French Plantains” in other countries. These kinds can be seen in Sepik areas in PNG.)
	ABB	eg Jawa, Kalapua, Akambia
Tetraploids		
	AAAB	eg Atan
	AABB	eg Kalamasol (North Solomons)
	ABBB	Jawa2
Others	AS	eg Kalakala (Morobe district)



Diploid banana



Colouring of AB group stems



Colouring of A group stems



B group bracts



Colouring of B group stems



Bunch and bracts A group

This drawing is of a diploid (kekiau) banana. With these the leaves point upwards and they are a smaller plant with less suckers.



These traditional diploid bananas usually have only a few suckers and smaller bunches. They grow quickly but need to be relocated and transplanted on a regular basis. They cannot tolerate poor soils and do not keep growing as bunches near houses but are put in new gardens.

The next drawing is of a triploid banana. The leaves hang over and the plant is more robust with more suckers.



Drawing by Celia Bridle

There are a range of triploid bananas. They tend to be large and can have chromosomes from both A and B parents. Some of these varieties produced large clumps of bananas and suckers. They can often grow for a long time near houses.



**A diploid banana or
one with 2 sets of
chromosomes**



**A triploid banana
or one with 3 sets
of chromosome**



**A tetraploid banana
or one with 3 sets of
chromosomes**



A seeded banana



**Seedling bananas grown
from seed**

Why is understanding the banana story important?

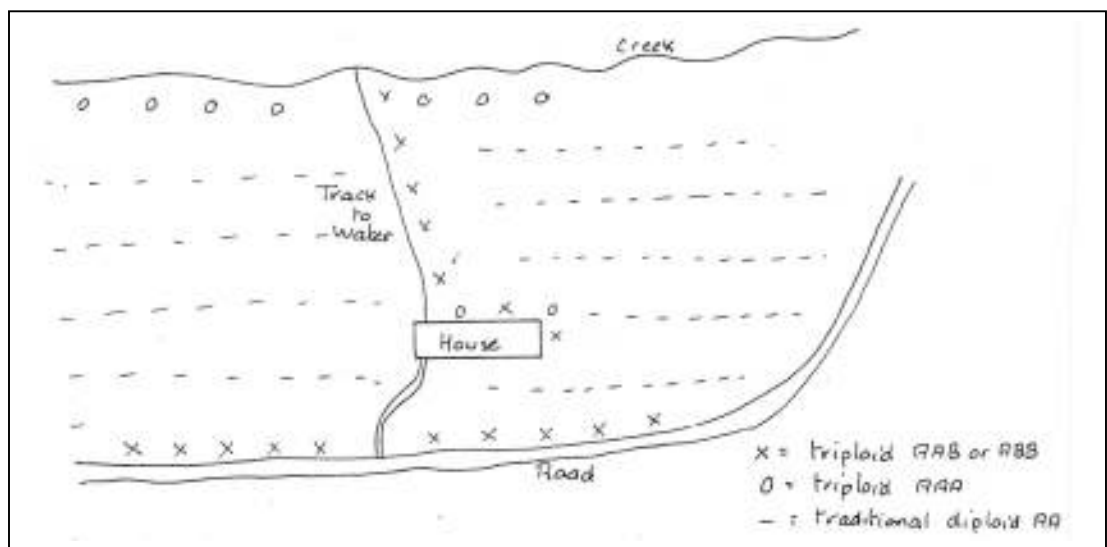
With bananas it is important to put the right kind of banana in the right place. The different groups of bananas have some things in common. Often "A" means the banana can't stand shade, cannot tolerate drought, needs fertile soil, and gets certain diseases. Similarly "B" means these plants can grow with more shade in drier soils and with lower soil fertility. As well, diploids (2 sets of chromosomes) are mostly smaller plants with fewer fruit and they produce less suckers. They need to be replanted after each crop of bananas. Some triploids such as ABB (Java) can often grow for many years in the one place and with poor soil. Some tetraploids such as (ABBB) are extremely large plants.

An understanding of these types can be seen in the way some Tolais lay out their gardens.

AA types are used as temporary shade for cacao.

AAA types are put in fertile areas near creeks.

AAB and ABB types are put around houses and along tracks leading to water etc where they will be left to grow for many years.



Growing bananas

After choosing the type of banana it is important to grow it well.

A healthy sucker needs to be cleaned to be sure that insects or nematodes or fungal diseases are not carried from one garden to the new garden. Choose a straight sword-like sucker not one that has leaves hanging out wide as soon as it comes through the ground.

The sucker needs to be put in freshly cleared ground where the soil is fertile, or the soil needs to be built up by putting compost and plant material in the planting hole. A hole 30 cm x 30 cm is suitable for most varieties.

The spacing of the plant will depend on variety and whether it is being intercropped with other plants. Diploid plants can be 1.5 m apart and larger kinds need to be 2 m or more apart. Thought needs to be given to whether it is a kind that will be replanted within a year or left to grow as a large clump for several years.

Soils must be well drained and most bananas require a fairly fertile soil. For larger bunches of fruit, some suckers need to be removed on the kinds that sucker freely.

Banana insect pests

<i>Apiraculus cornutus</i> (Pascoe)	Horned weevil	Curculionidae	(COL)
<i>Cosmopolites sordidus</i> (Germar)	Banana weevil	Curculionidae	(COL)
<i>Bactrocera bryoniae</i> (Try)	Fruit fly	Tephritidae	(DIPT)
<i>Bactrocera musae</i> (Try)	Banana fruit fly	Tephritidae	(DIPT)
<i>Dermolepida nigrum</i> (Nonf)	Chafer beetle	Scarabaeidae	(COL)
<i>Diacrisia papuana</i> Roths		Arctiidae	(LEP)
<i>Eumossula gracilis</i>	Coconut treehopper	Tettigoniidae	(ORTH)
<i>Heliothis armiger</i> Hubner	Corn earworm	Noctuidae	(LEP)
<i>Lema papuana</i> Jac.		Chrysomelidae	(COL)
<i>Locusta migratoria</i> (Linnaeus)	Migratory locust	Acrididae	(ORTH)
<i>Myospila argentata</i> Walker		Muscidae	(DIPT)
<i>Nacoleia octasema</i> (Meyrick)	Banana scab moth	Pyalidae	(LEP)
<i>Opagone</i> sp.		Hieroxestidae	(LEP.)
<i>Oribius cruciatus</i> Fst.	Shot hole weevil	Curculionidae	(COL.)
<i>Oribius inimicus</i> Mshl		Curculionidae	(COL.)
<i>Oryctes rhinoceros</i> (L)	Rhinoceros beetle	Scarabaeidae	(COL.)
<i>Othreis fullonica</i> (Cl)		Noctuidae	(LEP.)
<i>Papuana huebneri</i> Fairm.	Taro beetle	Scarabaeidae	(COL.)
<i>Papuana laevipennis</i> Arrow	Taro beetle	Scarabaeidae	(COL.)
<i>Papuana jappenensis</i> Arrow	Taro beetle	Scarabaeidae	(COL.)
<i>Papuana semistriata</i>	Taro beetle	Scarabaeidae	(COL.)
<i>Papuana woodlarkiana</i> (Montr.)	Taro beetle	Scarabaeidae	(COL.)
<i>Pentalonia nigronervosa</i> Coq	Banana aphid	Aphididae	(HOM.)
<i>Scapanes australis australis</i> Boisd.	Australian Rhinoceros beetle	Scarabaeidae	(COL.)
<i>Scapanes australis grossepunctatus</i>	New Guinea rhinoceros beetle	Scarabaeidae	(COL.)
<i>Scopelodes nitens</i> B.Bak		Limocodidae	(LEP.)
<i>Segestidea defoliata</i> Uvarov		Tettigoniidae	(ORTH.)
<i>Segestidea novaeguineae</i> F.Willemse		Tettigoniidae	(ORTH.)
<i>Taenaris dimona</i> Hew		Amathusiidae	(LEP.)
<i>Taenaris myops kirschi</i> Stgr.	Banana butterfly	Amathusiidae	(LEP.)

Banana insect pests

Banana aphid (*Pentalonia nigronervosa*)

This small sap-sucking aphid is potentially very important because it can spread virus disease around. These virus diseases have not been confirmed as present in Papua New Guinea yet.



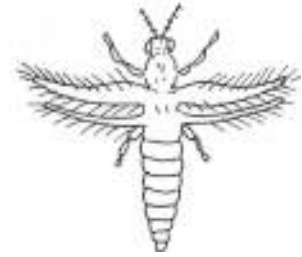
Banana fruit fly (*Bactrocera musae*)

Ripe fruit can easily be attacked and spoiled by this (and other) fruit flies. Fruit need to be harvested and stored carefully.



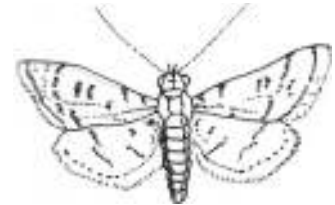
Banana rust thrips (*Chaetanothrips orchidii* & *C. signipennis*)

These small sucking insects cause rusty red discolouration between the fingers of the fruit. The skin becomes rough and can crack. It only spoils the appearance of the fruit. In some countries putting bags over the fruit is used. Traditional wrapping of fruit bunches may help.



Banana scab moth (*Nacoleia octasema*)

This very small moth hides under dead leaves during the day lays eggs on the flowers and the caterpillars. It badly damages the fruit in New Britain. Removing dead banana leaves near the trunk, cutting off the male flower and using varieties with widely spaced fingers reduces risk of damage a little.



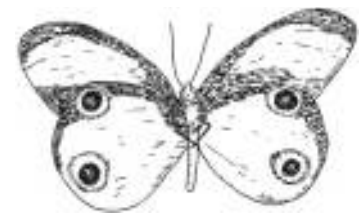
Banana weevil (*Cosmopolites sordidus*)

This long nosed weevil only occurs in some coastal areas but can damage banana plants by burrowing into the stems and causing them to fall over. "B" group bananas get less damaged. It is also important to use clean suckers for planting.



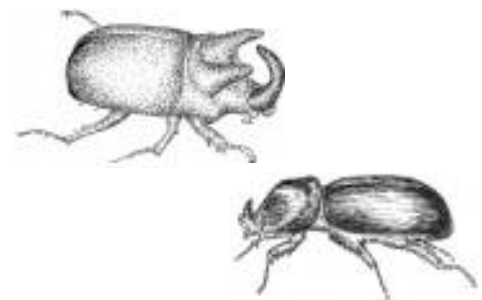
Banana butterfly (*Taenaris myops kirschi*)

The larvae of this moth can group together and eat the leaves of bananas causing extensive damage. The caterpillars are 5 cm long, greyish yellow with three lines along the side and 2 bunches of hairs on the back of each segment.



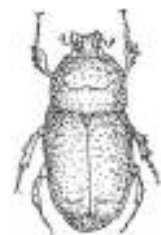
Rhinoceros beetles (*Scapanes australis*) & (*Oryctes rhinoceros*)

These beetles can burrow into the false stem of bananas causing plants to fall over and to put their bunches out the side of the stem. The beetles breed in rubbish heaps so removing these from gardens helps control. Also stripping off old leaves to form smooth banana stems makes it harder for the beetles to find somewhere to start digging into the stem.



Taro beetles (*Papuana spp.*)

These small brown and black beetles can dig very efficiently and damage the underground parts of banana plants as well as other root crops. They are hard to control.





Bananas scab moth damage



Banana Black cross



Diamond leaf spot



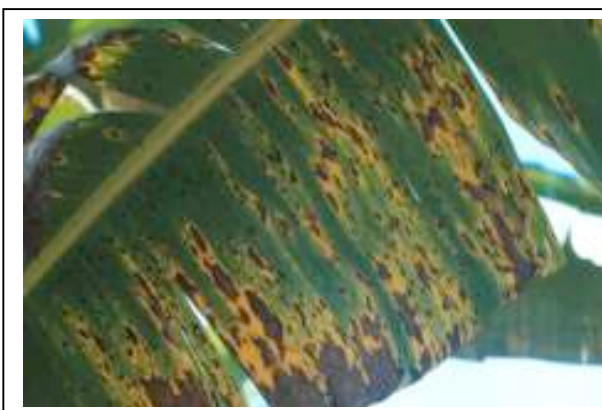
Black spot



Cucumber mosaic virus



Banana rust



Black Sigatoka

Banana diseases

Armillaria corm rot	Fungus	<i>Armillaria mellea</i>
Leaf spot	Fungus	<i>Cladosporium musae</i>
Anthrachnose fruit	Fungus	<i>Colletotrichum musae</i>
Diamond leaf spot	Fungus	<i>Cordana musae</i>
Black spot	Fungus	<i>Deightonella torulosa</i>
Leaf spot	Fungus	<i>Haplobasidium musae</i>
Leaf spot	Fungus	<i>Phyllosticta sp.</i>
Black leaf streak	Fungus	<i>Mycosphaerella fijiensis</i>
Sigatoka leaf spot	Fungus	<i>Mycosphaerella musicola</i>
Black cross	Fungus	<i>Phyllachora musicola</i>
Freckle	Fungus	<i>Guignardia musae</i>
Speckle	Fungus	<i>Ramichloridium musae</i>
Banana rust	Fungus	<i>Uredo musae</i>
Root rot	Fungi	<i>Pythium splendens</i>
	and	<i>Pythium vexans etc</i>
Stem end rot fruit	Fungus	<i>Botryodiplodia theobromae</i>
Algal leaf spot	Alga	<i>Cephaleuros virescens</i>
Infectious chlorosis	Virus	Cucumber mosaic virus
Root knot	Nematode	<i>Meloidogyne incognita</i>
Burrowing nematode	Nematode	<i>Radopholus similis</i>
Nematode	Nematode	<i>Helicotylenchus multicinctus</i>
		<i>Pratylenchus sp.</i>
		<i>Rotylenchus sp.</i>
Bacterial corm rot	Bacteria	<i>Erwinia chrysanthemi</i>
Stalk rot	Bacteria	<i>Erwinia carotovora carotovora</i>

Banana diseases

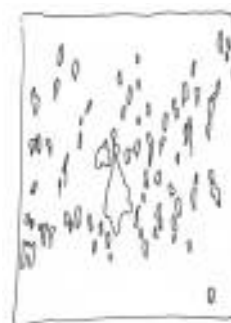
Sigatoka leaf spot (*Mycosphaerella musicola*)

A yellowish green speck on the leaf turns into a streak and turns brown. The brown centre has a yellow ring around it. It is caused by a fungus and gets worse on "A" type bananas and in wet weather. Leaves can die off early.

Black Sigatoka (*Mycosphaerella fijiensis*)

This fungus leaf spot similar to Sigatoka has caused severe problems in banana plants many other countries.

ABB clones seem to get this disease less.



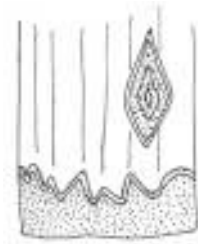
Black cross (*Phyllachora musicola*)

A fungus grows on the leaf in the shape of a black cross. It seems to cause little damage but may let other fungal diseases get started.



Diamond leaf spot (*Cordana musae*)

The spots are yellow and oval shaped. Often rings can be seen inside the spots. The edge of the leaf has an uneven bright zigzag yellow band. The disease is caused by a fungus. The fungus normally starts its attack after other fungi have damaged the leaf.



Banana rust (*Uromyces musae*)

This fungus which causing brown marks which look like rust only occurs occasionally on some varieties eg Pitu. It does not appear to be a very serious problem.



Freckle (*Guignardia musae*)

Small black speckled stripes develop on the leaves. They are mostly on the upper side of old leaves and go from the midrib towards the leaf edge. ABB bananas seem to get it most.



Speckle (*Veronaea musae*)

Soft grey covered spots develop on the lower surfaces of old leaves in humid areas. It tends to be worse on AAA type bananas.

Anthrachnose of bananas

The fungus causes black spots on ripening fruit. The spots get larger and cover the whole fruit. They get worse in wet weather.



Armillaria root rot

The leaves turn yellow and die from the base upwards. The plant can be pushed over or breaks off at ground level. The corm becomes brown and dead and has white threads growing through it. It occurs above 1,000m altitude in cooler areas.



Banana pests

Burrowing nematode (*Radopholus similis*)

This very small worm burrows into the roots of bananas in lowland areas and causes plants to reduce in vigour. Because of this it is necessary to move plants each couple of years. It is also important to clean the suckers and roots to avoid taking the nematodes to new gardens.

Bananas as food

The large number of varieties of bananas in Papua New Guinea means there are kinds of bananas for many different purposes.

Some are sweet and soft and eaten fresh as a snack and baby food eg Cavendish.

Others are dry and starchy and need to be moistened in a soup.

Some eg kekiau are quickly roasted in garden fires and eaten as snacks.

Others are boiled or baked and eaten as a main starchy staple eg Kalapua



Cassava

Tok Pisin: Tapiok

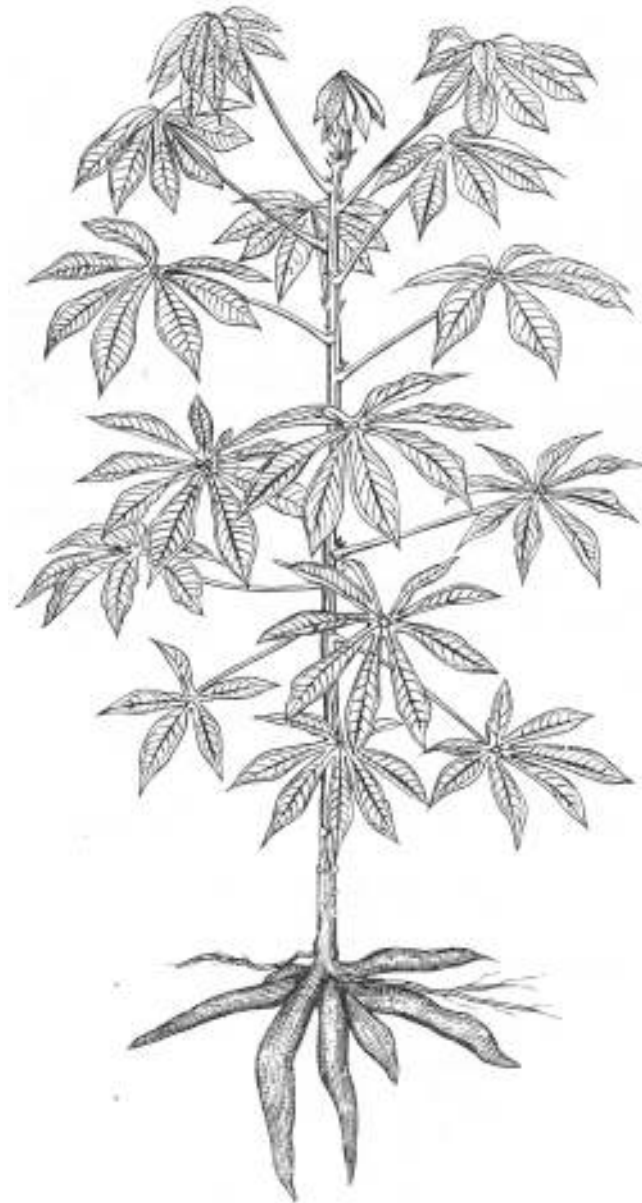
Scientific name: *Manihot esculenta*

The cassava plant

Cassava has been introduced to Papua New Guinea and has become widespread because it is easily grown and requires little weeding, and will grow on a range of soils and in a range of climates. It also suffers little from pest and disease damage at present in Papua New Guinea.

Cassava has a long woody stalk with leaves that are divided like the fingers of your hand. The width and shape of these leaflets varies between the different varieties. The leaf is on a long leaf stalk that can be coloured red or green. Where the leaf falls off there is a raised leaf scar on the stem.

Below the ground several long fattened roots form. These continue to increase in size and store starch as the plant matures.



Drawing by Celia Bridle

Planting cassava

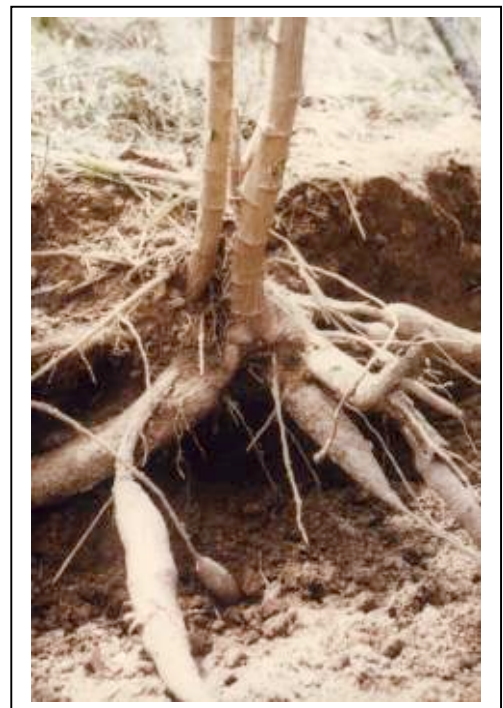
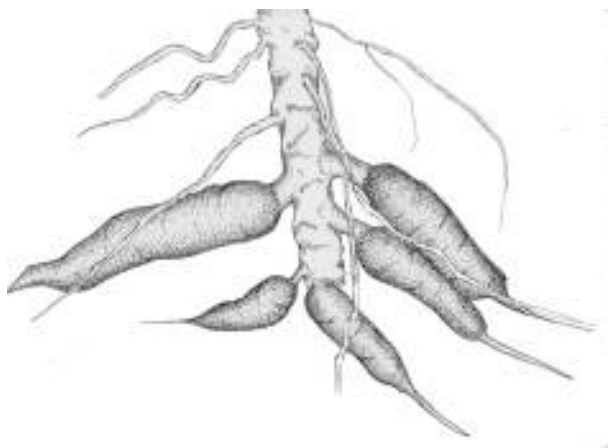
Cassava is planted from sections of the stalk. Sections about 15-20 cm long of the more mature woody stem are cut and stuck into the ground. They can be completely buried or put at almost any angle and it affects the growth little. Soon roots form and leaves start to sprout from the stalk.

It is not necessary to dig a hole to plant cassava and on many soils where the soil is loose it can be planted without digging the soil first. Cassava does not suit waterlogged soils and preferably they should not be too shallow or stony.

Cassava grows best in the tropical lowlands but will grow up to about 1800 metres above sea level. Once the cassava plant is established it can withstand fairly long periods of drought so is useful to have in seasonally dry areas such as the Markhum Valley and the Central Province.

Cassava can be planted at any time of the year but to get started it needs moisture so is often planted near the beginning of the wet season. Because cassava can still grow satisfactorily in poorer soils it is often put last in a rotation after others crops have already been grown on the piece of land.

Cassava takes about 10 to 12 months to produce mature tubers in the lowlands although some varieties produce a smaller yield earlier. The plants can be left growing and the tubers stored in the soil for considerable time. Once the tubers have been dug they do not keep for more than a few days.



Cassava as food

Cassava, like a number of other tropical crops contains large amounts of a poisonous chemical called hydrogen cyanide. It is because of this poison that commonly in coastal areas wild unused cassava plants can be seen growing along roadsides and riverbanks. These kinds are too bitter to use. All cassava contains this chemical but some kinds contain larger amounts. It is because of this chemical that it is important to cook cassava well. The chemical gets destroyed on strong heating.

Cassava tubers are a starchy energy food but are lower in protein than some other root crops. The leaves however are very high in protein so the young leaves are good quality food providing they are well cooked.

Cassava tubers can just be baked in the ashes or boiled in water. Often people grate the tuber and make cassava cakes mixed with some coconut milk.



These pale yellow young leaves are a deficiency in cassava that is growing on coral soils with a high pH



Thankfully this serious virus disease is not yet in PNG but occurs in Africa



Insect pests

<i>Acalolepta holotephra</i>	Cerambycidae (COL)	Boring into Ficus and cassava stems
<i>Amblypelta spp.</i>	Coreidae (HEM)	Spotting bugs or tip wilt bugs
<i>Apiocalus cornutus</i>	Curculionidae (COL)	Horned weevil
<i>Aulacophora spp.</i>	Chrysomelidae (COL)	Pumpkin beetles
<i>Brysis exigua</i>	Pentatomidae (HEM)	
<i>Ectropis bhurmitra</i>	Geometridae (LEP)	Cacao looper
<i>Ferrisia virgata</i>	Pseudococcidae (HEM)	Mealybug
<i>Hypotactus ruralis</i>	Curculionidae (COL)	Weevil
<i>Leptoglossus australis</i>	Coreidae (HEM)	Passionvine bug
<i>Oribius cruciatus</i>	Curculionidae (COL)	Shot hole weevil
<i>Protaetia papuana</i>	Scarabaeidae (COL)	
<i>Pseudaulacaspis pentagona</i>	Diaspididae (HEM)	Cassava scale
<i>Parasaissetia nigra</i>	Coccidae (HEM)	Nigra scale
<i>Tetranychus sp.</i>	Tetranychidae (ACAR)	Red spider mite
<i>Tiracola plagiata</i>	Noctuidae (LEP)	Banana fruit caterpillar

Insects

Tip wilt bugs (*Amblypelta spp.*)

The adults are about 20 mm long. They are a greenish brown with smoky wings. The colour varies with species. They fly short distances in warm times of day. In cassava they have been reported as killing the growing tips. This is particularly for *Amblypelta lutescens papuensis* and it occurs at low altitudes on the south side of PNG. These insects live in the bush and can be worse near there. They can be controlled by Kukuram ants.



Cacao looper (*Ectropis bhurmitra*)

The larvae of this moth move by forming a loop. They can build up into large numbers given the right conditions. They damage young leaves by eating them. They also damage other plants. They have other insects that control them naturally.



Black leaf-footed bug (*Leptoglossus australis*)

This bug is about 20 mm long and smoky black in colour. The body has several orange to red spots. The hind legs are long and flattened and toothed along the edge. The antennae have black and pale orange zones along their length. They damage a number of plants. The insect occurs in most districts of PNG at most temperatures and localities, wet and dry, grassland and forest up to 1750 m altitude. It tends to be common but not serious. Control is not normally necessary.



Shot hole weevil (*Oribius cruciatus*)

These are small hard long nosed weevils that are common on many plants. They chew small irregular holes. They get worse in weedy gardens. The weevils can be hand



picked into a tin of water with a layer of kerosene on the surface.

Diseases of cassava

Brown leaf spot	Fungus	<i>Cercosporidium henningsii</i>
Leaf spot	Fungus	<i>Cercospora vicosae</i>
Leaf spot	Fungus	<i>Phyllosticta sp.</i>
Blight leaf spot or (Tip die back)	Fungus	<i>Colletotrichum capsici</i>
	and	<i>Glomerella cingulata</i>
Pink disease	Fungus	<i>Corticium salmonicolor</i>
Associated with root rot	Fungus	<i>Dictyosporium toriloides</i>
Collar rot	Fungus	<i>Fusarium sp.</i>
Root rot	Fungus	<i>Helicobasidium purpureum</i>
	and	<i>Proboscispora manihotis</i>
	and	<i>Rigidoporus lignosus</i>
Storage rots		

At present in Papua New Guinea diseases do not cause a major problem with cassava growing. There are some serious diseases in other countries that make cassava growing difficult so it is important that people do not bring cassava cuttings into Papua New Guinea without careful control by Agricultural and quarantine specialists.

Leaf spots

Leaf spots on cassava can be caused by several different fungi and therefore are given different names.

Brown leaf spot

This disease is caused by a fungus called *Cercosporidium henningsii*, but also called *Mycosphaerella henningsii*. This depends on whether the sexual or the asexual life cycle of the fungus is being described. Brown spots occur on the older leaves of cassava. These start as small yellow spots and become brown and angular. Often the spots are darker around the edge then form a yellow ring. The disease gets worse in warm wet weather and when plants are over 5 months old. When this disease occurs leaves tend to fall off earlier so less food is stored in the roots. The amount of disease can be reduced by using wider plant spacing, removing old infected plants and using crop rotations.



Diffuse leaf spot of cassava

This disease is caused by a fungus called *Cercospora vicosae*. The spots are large and brown without definite borders. Each spot can cover one fifth of the leaflet. Under the leaf, the spots have a grey centre. It occurs on older leaves and in warm areas during the wet season. It does not appear to do

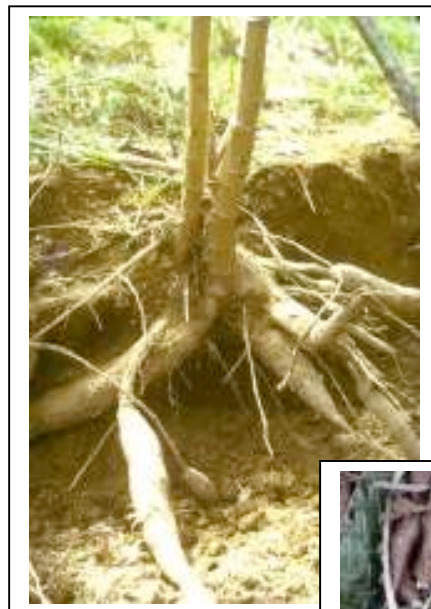
a lot of damage and control is probably not necessary.

Phyllosticta leaf spots

These leaf spots tend to be brown and the centre of the dead spot falls out leaving a hole in the leaf. They are due to fungi called *Phyllosticta sp.* Mostly they are not a serious problem.

Anthraxnose (Also called wither tip and blight leaf spot)

This disease is caused by a fungus with the scientific name of *Glomerella cingulata*. (Also called *Colletotrichum gloeosporoides*). This is a very common fungus and attacks many different plants. With cassava, the edges of the leaves die and leaves can develop spots and become twisted. Normally this disease gets worse where temperatures are about 25°C and the humidity is high. It spreads when there are heavy rains. This disease gets worse where the plants are growing in soil with low fertility and where plants are crowded and little air can blow between plants. It gets worse when plants are growing in shaded places. The disease gets started more easily where plants are damaged. Normally the best control of this disease is to improve the growing conditions.



Potatoes

Tok Pisin: Peteta

Scientific name: *Solanum tuberosum*

The potato plant

This is a short bushy plant that grows up to about one metre tall. It is branched and has wings on the stems. The leaves are made up of several leaflets of different size and shape.

Under the ground it produces a cluster of tubers. These tubers have buds or "eyes" around them and these are grouped more towards one end. New stalks can grow from these buds.

Many kinds of potatoes produce flowers at the top. They are normally white or light blue. These flowers are replaced by round green berries that contain the seeds. Normally these seeds are only used for breeding new kinds of potatoes.



Where are potatoes grown?

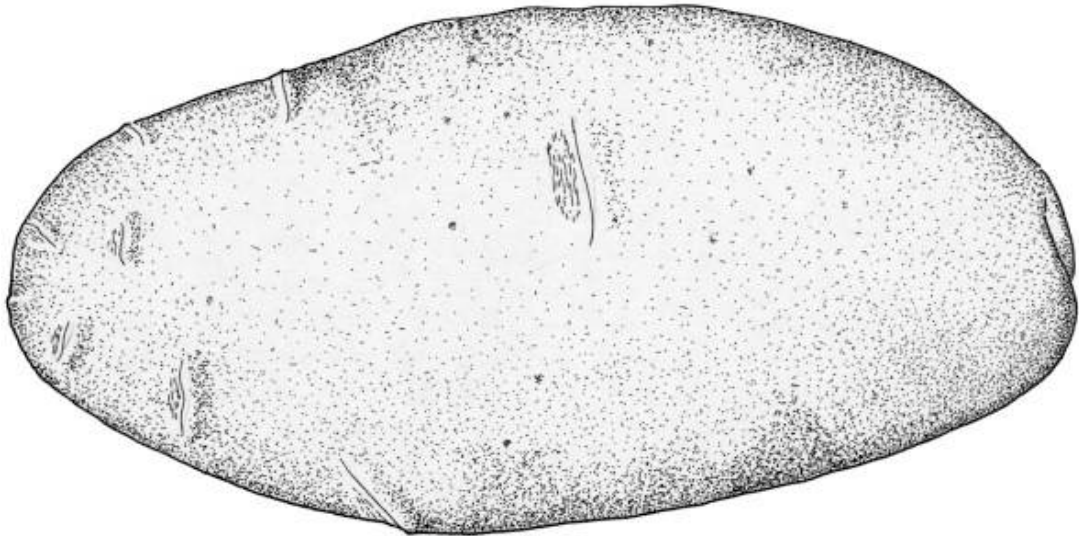
Potatoes can be grown from about 1200 metres altitude up to at least 2750 metres altitude. They only start to become important in subsistence above about 2000 metres and over 2400 metres are becoming the staple food crop. People past Margarima towards Tari, and people in Upper Mendi towards Tambul grow potatoes as one of their main crops. This also occurs in some areas of Enga Province. In these areas potatoes and wild karuka can be seen growing together.

Potatoes have a shorter time to maturity than sweet potato especially at the higher altitudes. Therefore it has advantages as a root crop. Above 2700 metres sweet potato often won't develop tubers but potatoes grow well. Below 1200 metres potatoes often won't develop tubers. Erave which is lower than this altitude, is colder than other places at the same altitude so potatoes can still be grown there.

Potatoes tend to need higher soil fertility than sweet potato. Potatoes will only grow very poorly in old sweet potato gardens. For good production they need to be planted in newer gardens cleared in the bush or in places where the soil fertility has been built up.

Growing potatoes

Potatoes are grown by planting a tuber, or a piece of a tuber. This is called a "sett". If you look at a potato you will see it has several buds or "eyes" around it in a spiral and getting closer together towards the end. Each of these "eyes" can produce a new shoot and therefore a new plant but if the whole tuber is planted mostly the buds near the end grow and produce a plant with only a few shoots. If the potato tuber is cut so that each piece contains an "eye" or bud, each piece can grow into a new plant.



Some choices about disease need to be made when planting potatoes. If small whole tubers are planted, it could be that they are small because of virus diseases and these therefore will produce a poorer crop. But if large tubers are cut, rots can develop more quickly on the cut surface and as well bacterial rot can be spread between plants on the cutting knife. So choices have to be made whether to plant small whole tubers or to plant pieces of larger cut tubers. As a grower gets to know his disease problems he can make this choice wisely.

Potatoes in subsistence should be planted intercropped with other plants and not in rows. This is because bacterial wilt disease can spread between plants and along rows if potato plants are close together or touching each other. When plants are widely spaced amongst other plants they do not get this disease because it cannot blow in the wind but must spread by washing in water or touching.



Bacterial wilt spreads in sap when tubers are cut before planting or when plants rub together

How do potatoes grow?

Potatoes grow a top first of all, then later they start to develop tubers under the ground. The tubers normally keep increasing in size as the top matures and also as the top then dries off. So normally potatoes are left growing until the tops have almost died off, then the potatoes are harvested.

As potato tubers grow and enlarge, the tubers can come up out of the ground. It is important to keep the soil mounded up around the potato plant to prevent them being exposed to the sunlight. This is important, because potato tubers turn green with sunlight, and are then poisonous and so are no use (except for replanting).

Potatoes suffer seriously from a few diseases.

Potato diseases

Target spot	Fungus	<i>Alternaria solani</i>
Collar rot & wilt	Fungus	<i>Athelia rolfsii</i>
Dry rot & wilt	Fungus	<i>Fusarium oxysporium</i>
Storage rot	Fungus	<i>Fusarium solani</i>
Leaf spot	Fungus	<i>Leptosphaerulina trifolii</i>
Leaf spot	Fungus	<i>Phyllosticta sp.</i>
Late blight	Fungus	<i>Phytophthora infestans</i>
Powdery scab	Fungus	<i>Spongospora subterranea</i>
Common scab	Fungus	<i>Streptomyces scabies</i>
Black scurf	Fungus	<i>Thanatephorus cucumeris</i>
Black leg	Bacteria	<i>Erwinia carotovora</i> sub sp. <i>atroseptica</i>
Soft rot	Bacteria	<i>Erwinia carotovora</i> sub sp. <i>carotovora</i>
Bacterial wilt	Bacteria	<i>Erwinia chrysanthemi</i>
Bacterial wilt	Bacteria	<i>Pseudomonas solanacearum</i>
Leaf roll	Virus	Leaf roll virus
Interveinal mottling	Virus	Potato virus x
Mosaic & dying leaves	Virus	Potato virus y
Root knot	Nematode	<i>Meloidogyne javanica</i>

PESTS AND DISEASES

Bacterial wilt

One of the most serious disease damaging potatoes in Papua New Guinea is a disease called bacterial wilt. With this disease the leaves and top of the plant start to wilt and collapse. The whole plant finally collapses and the tubers rot. So no food is harvested. If plants that are starting to wilt are quickly harvested the tubers can be eaten. But they should not be replanted because the disease bacteria will spread in the potato. If one of these tubers is cut in half and then squeezed drops of milky liquid that contain bacteria can be seen in a ring around the tuber.



Target spot

This disease is easy to see. It is produced by a fungus. This causes black dead spots to develop on the leaves. These spots often have a pattern of rings in them and this is why it is called Target Spot. Sometimes it is also called Early Blight because the leaves can die around the edge. When plants get this disease, the leaves die off early. Tubers are therefore smaller. It gets worse in wet cool places.



Common scab

On the skin of the tuber small brown spots can develop near the "breathing pores". These can then turn into a corky scab. This is due to a fungus. It gets worse in low fertility soil. It only spoils the appearance of the tuber.



Potato blight

Spots start to develop on the stems and leaves. They are not distinct round spots (like target spot) but irregular dark soft spots. The disease spreads fastest when temperatures are 18° to 22°C and the humidity is high. It needs moisture on the leaves for several hours.

Potato insect pests

Aphids these suck sap and spread viruses

Potato aphid	Aphididae (HEM)	<i>Macrosiphum euphorbiae</i> (Thomson)
Foxglove aphid	Aphididae (HEM)	<i>Aulacorthum solani</i> Kaltenbach
Green peach aphid	Aphididae (HEM)	<i>Myzus persicae</i> Sulzer
Melon aphid	Aphididae (HEM)	<i>Aphis gossypii</i> Glover
	Aphididae (HEM)	<i>Acyrtosiphon solani</i> Kaltenbach
	Aphididae (HEM)	<i>Myzus ornatus</i> Laing Common in highlands on potato

Leaf sucking

<i>Nysius villicus</i> Van Duzee	Lygaeidae (HEM)	Reported sucking on potato and sweet potato. They are inconspicuous greyish brown bugs 3-4mm long. The damage is normally unimportant. They normally live on weeds.
Sugarcane bug	Colobathristidae/Pyrrocoridae (HEM)	<i>Phaenacantha</i> spp. Probably <i>P. australiae</i> . Sucks sap.

Leaf eating

Leaf eating ladybird	<i>Henosepilachna signatipennis</i> Boisd.
and	<i>Henosepilachna haemorrhoea</i> (Biel)
<i>Monolepta semiviolacea</i> Fauvel	Chrysomelidae (COL.)

Small tortoise beetles	<i>Cassida diomma</i> Boisduval
	<i>Cassida papuana</i> Spaeth
	<i>Cassida sexguttata</i> Boisduval
<i>Cicadella sp.</i>	Cicadellidae (HEM)
<i>Conoderus mucronatus</i> Candeze	Elateridae (COL)
<i>Dasychira mendosa</i> Hubn.	Lymantriidae (LEP) Leaf eating caterpillar Also known to damage potato. Larvae small and brightly coloured. The head and legs are red. A tuft of white hairs occurs on the fourth segment, and a black one on the fifth. There is a white band around the body surrounded by a red spot. They are 30-40 mm long. They eat many shrubs and trees. Some now renamed <i>Psalis</i> .
<i>Homeoxipha fuscipennis</i>	Gryllidae (ORTH.)
<i>Idopsis coerulea</i> Faust.	Curculionidae (COL) Causing minor shot hole damage

Tuber damaging

Potato tuber moth	<i>Phthorimaea operculella</i> (Zell.)
Black cutworm	<i>Agrotis ipsilon</i> (Hufnagel)
Taro beetles	<i>Papuana aninodalis</i> Prell
<i>Apachynus beccarii</i> Dubrony	Apachyidae (DERM)



Foxglove aphid



Green peach aphid



Melon aphid



Phaenacantha sp.



Henosepilachna haemorrhoea



Henosepilachna signatipennis



Cassida diomma



Cassida sexguttata



Dasychira mendosa



Idopsis coerulea



Potato tuber moth



Black cutworm



Taro beetles

Sago

Tok Pisin: Saksak

Scientific name: *Metroxylon sagu* Rottb.

Sago palms

There are 2 species in Papua New Guinea. The other one occurs in North Solomons Province and in the Solomon Islands. Its scientific name is *Metroxylon salomonense*.

The sago palm plant

The sago palm grows up to 10 or 25 m tall and is nearly a metre across the trunk. It produces suckers around the base. After about 15 years the main trunk produces a very large flower at the top and then the trunk dies.

The centre of the trunk is filled with starch. The plant also produces useful building materials. The fronds are very good house roofing material.



Drawing by Celia Bridle

Where does it grow?

The sago palm common in Papua New Guinea also grows in Indonesia and Malaysia.

Sago palms grow in the lower areas, up to about 1200 m.

It is very important in the Sepik and Fly River areas, in the transFly and many coastal areas such as along the Papuan coast and Gulf region.

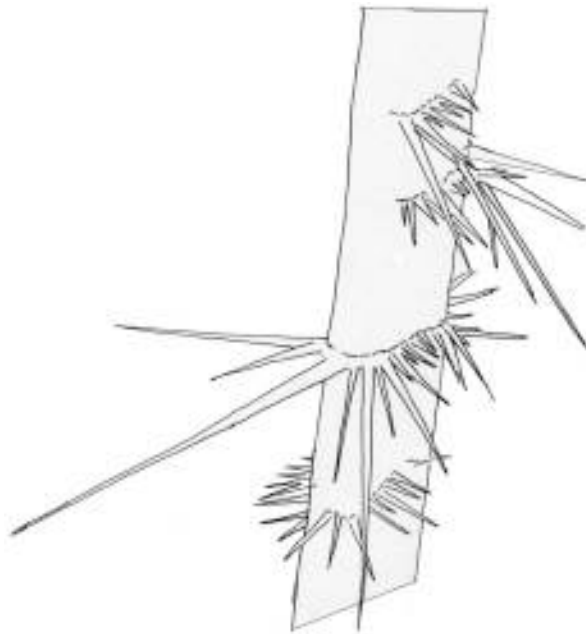
In the Southern Highlands in the Kutubu area (Foi and Fasu) sago is the staple food. In other lowland areas it forms an important supplementary staple but not the main food.

But sago isn't planted just anywhere in these places, it is planted in special sago sites. Often these are along the banks of creeks, like in the Kaluli area, or in the bottoms of valleys such as the Kerabi Valley near Erave. At Kutubu, the sago groves fill up large swamps. People establish and care for sago groves and these are often at some distance from the villages, as people prefer to live in drier places.

Sago doesn't like to be in a very wet swamp and doesn't like to be in a dry place. Often sago sites are just slightly too wet for gardening.

Varieties of sago

People in Hegiso village near Kutubu recognise and have names for at least 34 varieties of sago. These vary from having no thorns, up to ones with very long thorns on the bases of the fronds. The height, shape, toughness of the bark, and length of the fronds varies. Some palms mature quickly, some have many suckers and the taste and colour of the starch varies.



Sago thorns

In other areas the people only recognise a few kinds of sago.

Sago grows from suckers to a flowering plant over about 15 years.



Sago grubs are an important supplement to the diet and also important for management of palms including thinning out of suckers.



Planting sago

In the Southern Highlands practically all sago is planted. One or two varieties will grow fairly easily from seed, but most kinds are planted from suckers.

To plant sago, the planting site near a creek or in a damp place, is first cleared of trees and rubbish. Then a sucker of a suitable variety is chosen from an old sago clump. Often the fronds of the sucker are up to 3 m high. It is first checked to see if the sucker is old enough. Suckers ready for planting have a tough woody connection to the base of the old palm. This is chopped through with an axe. The sucker is then simply taken to a new site and planted in a shallow hole. If several palms are being planted, they should be about 7 m apart. The only other attention the new palm needs is an occasional weeding to cut back rubbish when it gets too thick.

Growth of sago palms

It takes 12 to 15 years for a sago palm to grow big enough to cut down. Palms in poor soil grow more slowly.

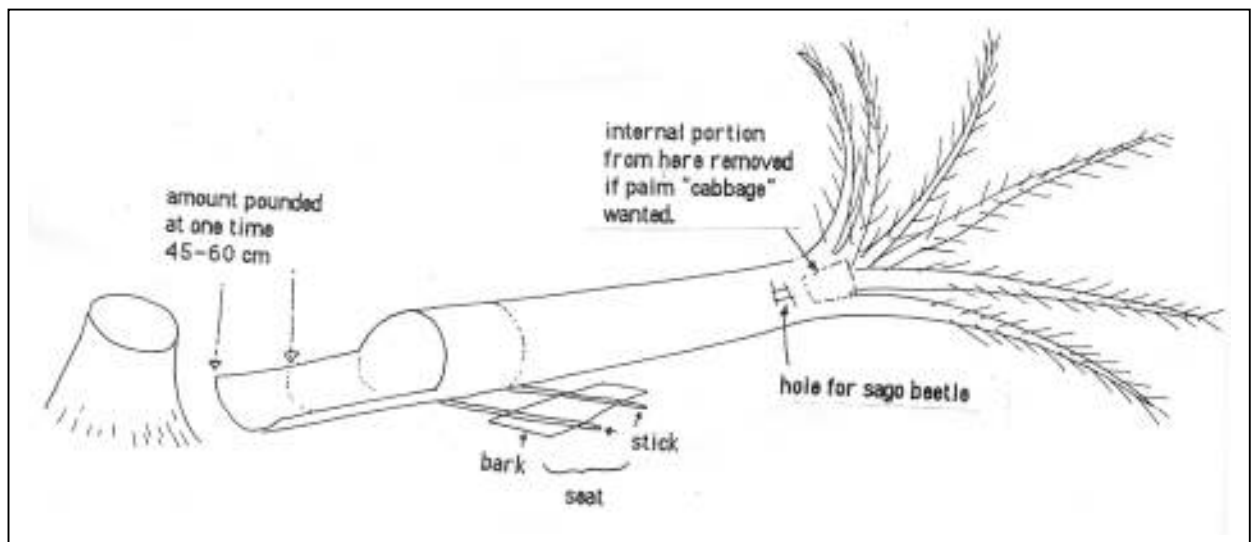
Normally, one main trunk grows up, but several small suckers may shoot up around the base. Sometimes these suckers spread out and the space between the palms becomes crowded. Too much competition between clumps slows down the growth of the main palm, so the grove needs to be thinned out. This is very easily done. A small hole (10 cm x 10 cm) is cut with an axe into the top of the trunk of a sucker that is not wanted. This hole lets the sago beetle in and the sago grubs that develop quickly kill out the sucker. They don't get into the main palm or other suckers unless a hole is made. After a few months when the sucker is seen to be dead it can be split open to provide a feed of sago grubs.

There is no simple way of telling when a palm is ready to harvest. By experience people learn to recognise how big each variety should be before it is ready to harvest. If the palm were left too long it would produce a very large flower at the top and then die. This flower would use up all the starch in the trunk so that there would be nothing to harvest. As long as the flower has only started to grow and the seeds haven't yet formed on it, the palm is still suitable for harvesting. Sometimes when people are in a hurry to use a palm that isn't quite ready, they cut a hole to check how much starch is stored inside. But sago grubs must not be allowed to get in.

After the palm has been cut and harvested another sucker grows more quickly than the others and becomes the new main trunk. It still takes about the same time to get mature.

Harvesting sago starch

First the sago palm is cut down. Mostly this is men's work. Then the bark is split off the trunk for about one metre along its length. Normally this bark is carefully laid out at the sides propped up by logs so that it both makes a seat for the person to sit on and a mat for the shredded pith of the trunk to fall onto.

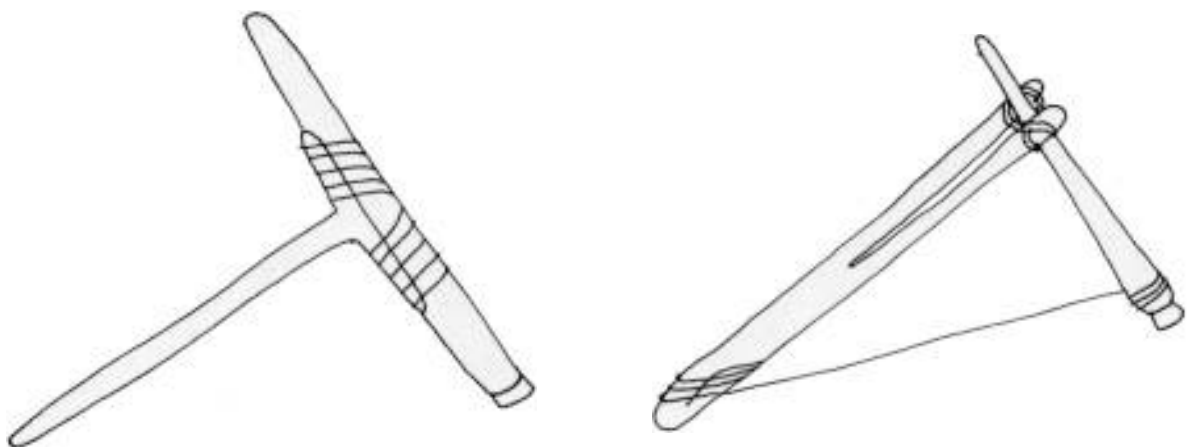


Sago harvesting process

Sago in the trunk of the palm is all mixed up with the fibres of the plant. So this pith has to be shredded up into small pieces and the starch is then washed out. Special tools are made for pounding up the trunk. They need to be light, strong and with a hard stone (or metal) head.

In areas where sago is the main food, sago is women's work. The woman sing special songs while they work. In areas where sago is not the main food, both men and women pound sago.

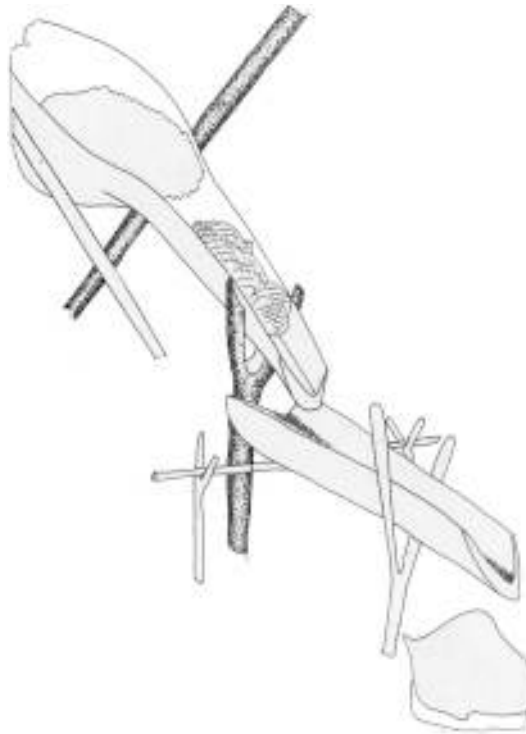
The normal method of pounding sago is to sit at the side of the trunk, hold the sago pounder in both hands and lift it above your head, then chop it down so that it just scrapes a thin layer off the edge of the trunk. When a pile of shredded-up trunk has been made, this is carried away to be washed. If a lump of the pith breaks off it is often chopped up with a bush knife or axe.



sago pounders

Sago washing

A framework is set up for washing sago. It needs to be near water. If no convenient creek is nearby, a hole can be dug in the ground as this quickly fills with water in most sago places. The water needs to be clean or the starch gets a bad colour and taste.



Sago washing apparatus

The washing framework is mostly built using the bottom section of the midrib of the sago fronds.

The shredded pith of the palm is put into the bowl made by the fronds and the starch is washed out by banging it with a stick, and pouring water over it. The filtered starch is allowed to settle out in a bowl. It is then dried and taken home.

Sago storage

Some people store sago for long periods. The sago to be stored is wrapped up in a tight bundle using leaves and bark. It is then buried in the mud. It will keep for one or two years. Sago that has been stored has a slightly different taste, but it is still quite good to eat. The unprocessed sago logs can be stored in water for considerable time. This is common along the Sepik river.

Sago cooking

In some areas people simply fill up a bamboo tube with sago starch and bake it near the fire. Sometimes sago is cooked wrapped in leaves. The bamboo tube is then split open and the sago eaten, along with greens and other foods. Occasionally people add leaves such as "tu-lip" leaves, or okari nuts. Sago pancakes are made by spreading sago out in a hot curved frying pan then placing another hot pan over it. Sago is often made into a porridge by dropping sago into hot water. There are lots of other interesting ways sago can be cooked and used, but people in some areas don't seem to use these.



**Sago
processing**

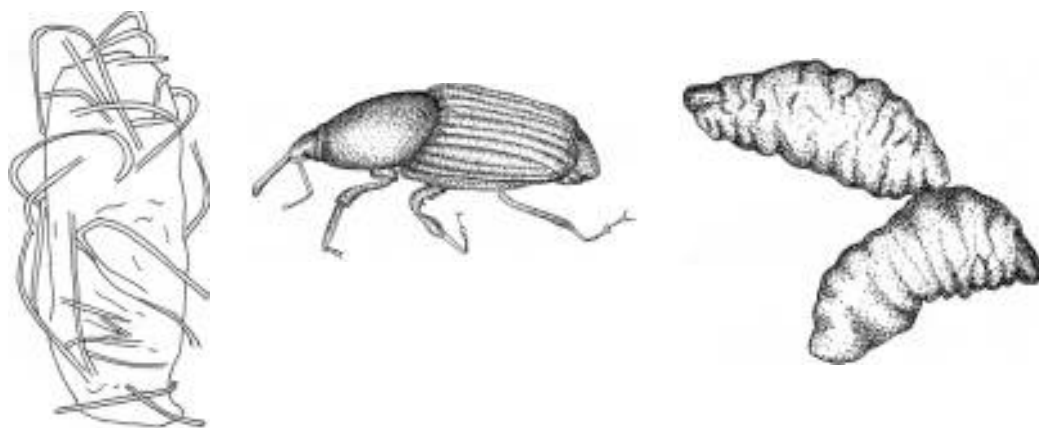


Extra food from sago

At the top of the trunk of a sago palm there is a bundle of young tender undeveloped leaves. This is often called the palm "cabbage". It can be cut out and cooked and eaten. It is good food.

Sago grubs, and sago starch go together. Sago grubs are grown in several different ways in sago areas. Normally the top and bottom sections of the trunk are left for sago grubs to grow in as these sections have less starch and more fibre and are therefore harder to work. As already described, sago grubs are grown in suckers that are being killed. If too many palms are ready at one time, the extra ones are cut down for grubs to grow in. Sometimes a poor tasting or very fibrous palm is left for grubs to grow in. Particularly near Bosavi, sago grubs are also cultivated in another palm called the fishtail palm (waiyo). It takes about 2 months for a harvest of grubs from the time the beetles are first let into the palm.

Sago grubs are the larvae of a beetle. (*Rhyncophorus spp.*) They are good food being both enjoyable and good food value.



Sago grubs – pupae, adult, larvae

Sago as food

Sago is a very good energy food. But it has very little of the growth food (protein) or health food (vitamins and minerals). Therefore in sago areas it is particularly important to pay special attention to the other foods that make up the diet.

The food value of 100 g of the food eaten is:-

	Moisture %	Energy cals	Protein g	Calcium mg	Iron mg	proVitA µg	provitC mg
starch	20-45	285	0.2	30	0.7		
grubs	70.5	181	6.1	461	4.3		
cabbage							

Yield and work required

One sago palm may last an average family (6 people) for 4 weeks. It is worked in sections of 60 cm to 100 cm of the trunk and 6 to 8 of these sections can be taken from one palm. A typical routine would be for a woman to spend 3-4 hours pounding and washing one section and this would produce about 20-25 kg of starch that would last the family for about 3 days.

Pest and Disease

Sago diseases

Sooty mould	Fungus	<i>Borinquenia sp.</i>
Black mould on leaves	Fungi	<i>Melanographium sp</i>
	and	<i>Tripospermum sp</i>
	and	<i>Zygosporium gibbum</i>
Parallel sided leaf spot	Fungus	<i>Sphaerulina sp.</i>
Leaf spot	Fungus	

(Also several fungi isolated from processed sago)

Sago insect pests

Asiatic rhinoceros beetle	<i>Oryctes rhinoceros</i> (L.)
Cane weevil borer	<i>Rhabdoscelus obscurus</i> Boisdual
Coconut leaf miner	<i>Promecotheca papuana</i> Csiki
Palm weevils	<i>Rhynchophorus bilineatus</i> (Montr.)
	<i>Rhynchophorus ferrugineous</i> (Oliv.)
and	<i>Rhynchophorus papuanus</i> Kirsch
Taro beetles	<i>Papuana spp.</i>
<i>Agapophyta bipunctata</i> Boisd.	Pentatomidae (HEM) - a bug reported on coconut and sago.
<i>Trochorhopalus strangulatus</i> Gyllenhal	Curculionidae (COL) - a weevil reported from dead sago palm. Adults and larvae boring into lower 40 cm of false stem of bananas causing heavy damage over limited area in central province.
<i>Leptococcus metroxylis</i> Reyne	Pseudococcidae (HEM) On sago, pineapple, coconut



Leaf spot on sago

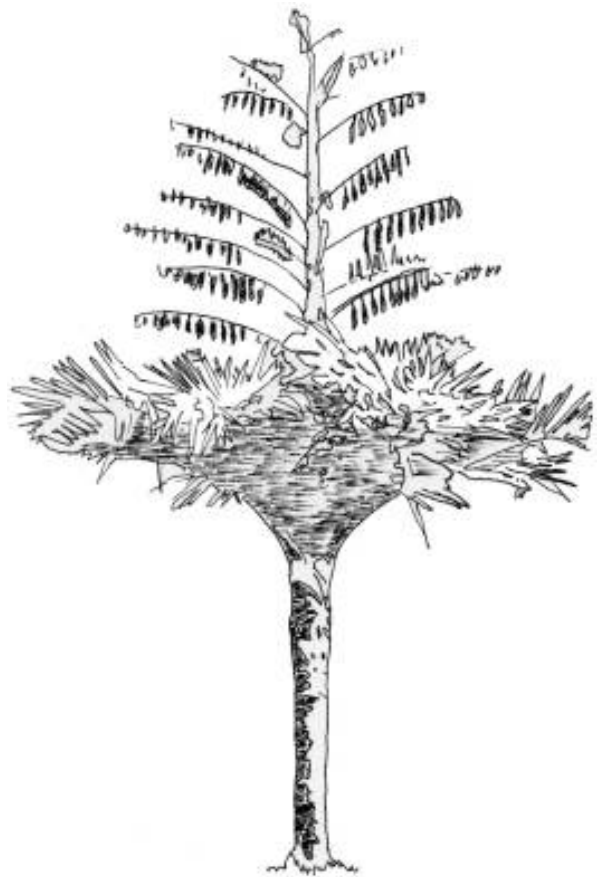
Solomon's sago

Scientific name: *Metroxylon salomonense*

How is this sago different?

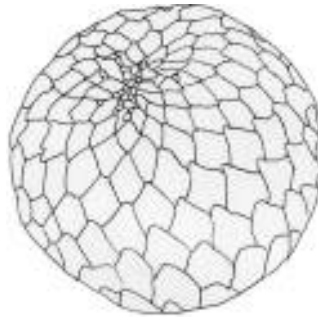
The sago palm that occurs in the North Solomons province and in the Solomon Islands is quite different from the sago that grows in other areas of Papua New Guinea. It has a different scientific name. The scientific name is *Metroxylon salomonense*. Originally, the sago in North Solomons Province was called *Metroxylon bougainvillense* but now that name has been shown to be not correct as the plant is the same as the one in the Solomon Islands.

How is it different? The leaves or fronds of this sago palm are much larger than those of the other Papua New Guinea sago palm. As well the seeds are much larger and this sago does not produce suckers. The stem of the Solomon's sago is also larger and the flower at the top of the palm is very large.



Growing Solomon island sago.

This sago is grown from seeds and it does not produce suckers. The seeds are large - up to 6 cm or more across.



Solomon's sago seed - 6 cm across

This sago normally grows in drier sites than for the normal sago in Papua New Guinea. The seeds are often planted on a bank or along a ridge away from a creek or swamp. It still grows quite well in these sites.

How is it used?

This sago is harvested, pounded, washed and the starch collected in much the same way as for other sago. In Bougainville, people normally only use it during times of food shortage or when they wish to hold a feast and need large amounts of food.



Sweet potato

Tok Pisin: kaukau

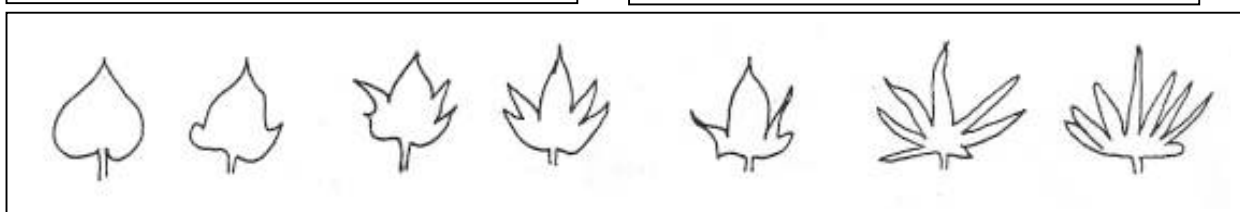
Scientific name: *Ipomoea batatas*

The sweet potato plant

In Papua New Guinea the sweet potato plant is a very variable plant. It has leaves borne singly along the vine and produces thickened tubers under the ground. But leaf shape, vine length, tuber size shape colour and taste are some of the many things that vary to give the large number of varieties seen throughout Papua New Guinea.



The fact that sweet potato easily flowers and sets seeds in Papua New Guinea and these seeds grow and produce new seedling plants is probably the reason that Papua New Guinea has developed so many different varieties of sweet potato. One of the obvious differences is in leaf shape but many other things vary between varieties as well.



Different leaf shapes

People are continually selecting kinds that suit their purposes. Some varieties mature very quickly. Kinds called "wan mun" have a small amount of food after 6 - 8 weeks in coastal areas. People are also picking out kinds that give some yield under lower fertility conditions as their garden sites get older.

For preference people tend to like a sweet dry variety that gives plenty of energy. Often the larger softer kinds are fed to pigs.

Growing Sweet Potato

Sweet potato is grown from the tips of vines. In some areas people put three runners in together. People often argue a lot about how many tops should be planted together. It does not greatly affect the amount of sweet potato produced whether plants are put closely together or more widely apart but the size of the tubers varies.

Sweet potato cannot stand water-logging. For tubers to form, there must be lots of air in the soil. If the soil becomes too wet the sweet potato will grow lots of vines and leaves and produce very few tubers under the ground. So probably the individual practices that different sweet potato growers have developed in different areas of the country are methods they have learned by experience to suit their soil and rainfall patterns. Where the soil is heavy with lots of clay it is more important to build mounds or ridges. In some places in Papua New Guinea where people have sandy soils they simply plant sweet potato on flat ground or sometimes with very small mounds. This works well enough for those soils as long as there is not a lot of rain causing the soil to be waterlogged. Once sweet potatoes have passed the particular time in their growth when the tubers are formed, they will not later produce tubers so only tops grow and the few tubers that have formed grow large.

Sweet potato also has another problem. Sometimes they grow too much top and produce little food under the ground. This occurs where the soil is very rich in nitrogen as this favours top growth but not storage of starch in tubers. Often when people see this occurring, especially in coastal areas they go through the garden and remove some of the top growth either by breaking it off or banging it with sticks. If a second crop of sweet potatoes is produced in the same garden it normally doesn't happen a second time as nitrogen quickly gets used up by plants or washed away in the rain. This problem is most common in new bush gardens.

In most areas of Papua New Guinea people go through their gardens several times harvesting the tubers. They take the large ones, then allow the smaller ones to continue growing before they are harvested later. In many areas after the third harvest pigs are allowed to forage in the gardens and eat the vines and tubers. This is one efficient way to clean up gardens but it is possibly for pigs to spread some diseases from one sweet potato crop to other areas if not careful. eg Sweet potato black rot.

DISEASES

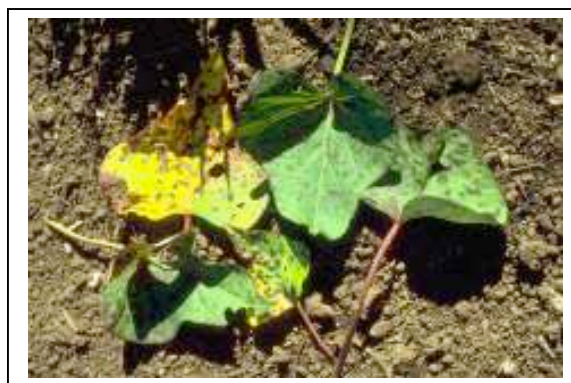
Leaf spot	Fungus	<i>Ascochyta convolvuli</i>
Collar rot	Fungus	<i>Athelia rolfsii</i>
Leaf spot	Fungus	<i>Cercospora bataticola</i>
Black rot	Fungus	<i>Ceratocystis fimbriata</i>
Leaf spot	Fungus	<i>Didymella sp.</i>
Scab	Fungus	<i>Elsinoe batatas</i>
Scurf	Fungus	<i>Moniliochaetes infuscans</i>
Leaf spot	Fungus	<i>Phoma sorghina</i>
Stems with internal browning	Fungus	<i>Phomopsis ipomoea-batatas</i>
Leaf spot	Fungus	<i>Phyllosticta sp.</i>
Leaf spot	Fungus	<i>Pseudocercospora timorensis</i>
Soft rot	Fungus	<i>Rhizopus stolonifer</i>
Tuber rot	Fungus	<i>Botrydiplodia theobromae</i>
	Bacteria	<i>Erwinia sp.</i>
	Bacteria	<i>Erwinia chrysanthemi</i>
	Fungus	<i>Fusarium sp.</i>
Fusarium wilt & tuber rot	Fungus	<i>Fusarium oxysporium</i>
Storage rot	Fungus	<i>Aspergillus sp.</i>
	and	<i>Choanephora sp.</i>
	and	<i>Mucor sp.</i>
Blue mould rot	Fungus	<i>Penicillium sp.</i>
Charcoal rot	Fungus	<i>Macrophomina phaseolina</i>
Little leaf & vein clearing	Mycoplasma like organism	
Potyvirus leaf curling	Virus	
Root knot	Nematode	<i>Meloidogyne sp.</i>

Leaf spot (*Pseudocercospora timorensis*)

Small angular brown spots develop on the leaves of sweet potato. They are due to a fungus.

The spots are mostly on the older leaves and they become more common in old garden sites where soil fertility is getting low. They are also worse in the wet season.

Leaves fall off slightly early but the disease appears to do little damage.



Scab (Elsinoe batatas)

Brown scabby spots can often be seen on the veins of the leaf and along the vine of the sweet potato plants. The leaves become twisted and often the tips of the branches stick upright.

Some varieties of sweet potato get the disease less than others. Most varieties of sweet potato in Papua New Guinea seem to have a sufficiently high level of resistance to this disease for it to not get too bad. The yields are reduced.



Fusarium wilt

In the Upper Mendi and Upper Karint areas sweet potato tubers are rotting and plants are growing leaves only. The stalk which joins the tuber to the plant has rotted off. If the tuber is cut in half or if the stem is cut open a dark brown ring can be seen. This ring is because a fungus has got into the plant and blocked the conducting cells where food and water pass up and down the plant. Normally it is root knot nematode which first damages the skin and lets the fungus get inside. The very small worm like nematodes normally twist roots into knots but when this fungus gets inside the roots do not form these galls.



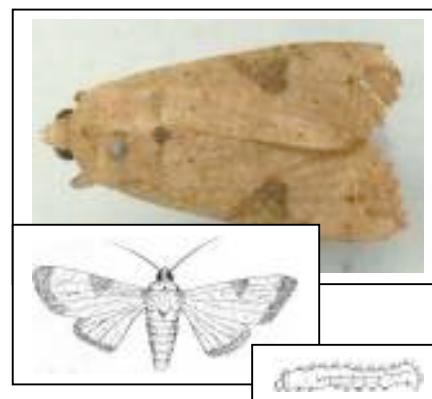
Insect damage

Some of the leaf-chewing insects on sweet potato do not do serious damage as sweet potato often grows an excess of leaves especially in fertile gardens and in coastal areas.

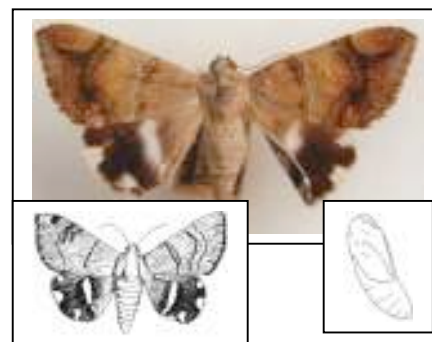
Insects

Sweet potato hawkmoth	Sphingidae (LEP)	<i>Agrius convolvuli</i> (L.)
Sweet potato leaf miner	Lyonetiidae (LEP)	<i>Bedellia somnulentella</i> (Zeller)
Sweet potato weevil	Curculionidae (COL)	<i>Cylas formicarius elegantulus</i> (Summers)
	Acrididae (ORTH)	<i>Atractomorpha crenaticeps</i> Blanch
Cacao armyworm	Noctuidae (LEP)	<i>Tiracola plagiata</i> Walk.
Cacao false looper	Noctuidae (LEP)	<i>Achaea janata</i> (Linnaeus)
Cacao looper	Geometridae (LEP)	<i>Ectropis bhurmitra</i> Walker
Cacao mirid	Coreidae (HEM)	<i>Helopeltis clavifer</i> (Walker)
Grass bug	Miridae (HEM)	<i>Halticus tibialis</i> Reut
Horned weevil	Curculionidae (COL)	<i>Apirocalus cornutus</i> (Pascoe)
Grasshopper	Tettigoniidae (ORTH)	<i>Phaneroptera brevis</i> Serv
Pumpkin beetles	Chrysomelidae (COL)	<i>Aulacophora</i> spp.
Sugarcane aphid	Aphididae (HEM)	<i>Aphis sacchari</i> Zehntner
Taro hawkmoth	Sphingidae (LEP)	<i>Hippotion celerio</i> (L.)
Tobacco whitefly	Aleyrodidae (HEM)	<i>Bemisia tabaci</i> (Guen.)
	Arctiidae (LEP)	<i>Argina cribraria</i> (Clerck)
Leaf eating beetle	Coccinellidae (COL)	<i>Epilachna signatipennis</i> Boisd.
Sweet potato stem borer	Pyralidae (COL)	<i>Omphis</i> spp.

Cacao armyworm *Tiracola plagiata* Walk is a Noctuid moth or an armyworm that attacks many different plants. It is a semi looper that means it has less than the usual 5 pairs of legs on the abdomen of the caterpillar. The moth is a light grey moth with a "V" mark on the front wings. Caterpillars feed on leaves at night. They gather together in groups and are therefore called armyworms. The larvae eat young soft growing parts of the plants and can also eat weeds and other bush trees. The insect tends to build up on trees like leucaena shade or other large areas of one crop then spread in plague numbers into surrounding gardens. Mixed cropping helps keep a balance of insects and their predators. Outbreaks can be predicted by trapping moths in light traps. Some predators and parasites operate but they do not exert enough control to stop a strong outbreak. Carbaryl insecticide will control them.



Cacao false looper *Achaea janata* (Linnaeus) is the larva of a moth. The mature larvae are grey with a spotted head and a coloured stripe along the side. It is 60 mm long. A life cycle egg to egg takes 32-38 days. The larvae eat a range of young soft leaves especially castor but also damage sweet potato, peanuts, citrus, cacao, rubber, pumpkins etc. They occur up to 1900 m altitude.



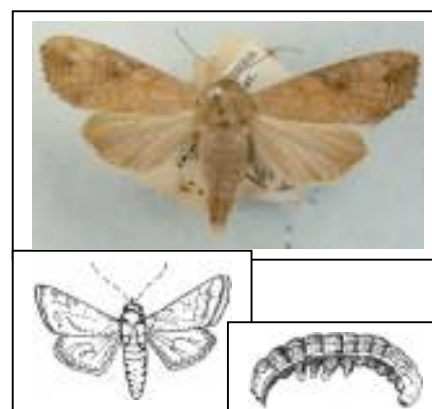
Cacao looper *Ectropis sabulosa* Warr. The larvae of this moth move by forming a loop. They can build up into large numbers given the right conditions. That is where the two common names come from. It eats the young leaves during the flush of growth of cacao. It also damages sweet potato, cassava, taro, peanuts and coffee by eating the leaves. Large outbreaks of these insects normally die out naturally due to predators.



Cluster caterpillar *Spodoptera litura* (Fab). The adult moth is 18 mm long with a brown body. The wingspan is about 40 mm. The front wings have silvery marks and the hind wings are silvery white and you can almost see through them. This moth is attracted to lights at night. The larvae are dark brown above and green beneath with a light band along the side. Larvae are 45 mm long and cluster together. They damage a range of crops. Quite often the damage is only slight but in some seasons they can do extensive damage. They move between crops and the numbers depend on the climatic conditions. Sometimes, control can be achieved by removing and destroying leaves that have large numbers of caterpillars on them. On taro, the young caterpillars can be collected in a paper bag and burned. Control can be achieved with contact insecticides such as carbaryl.

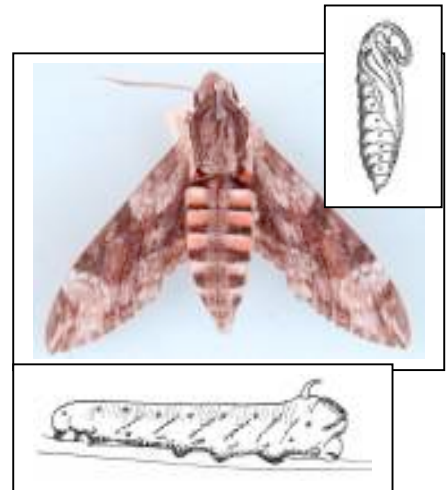


Corn earworm *Heliothis armigera* (Huebner). The moths vary in colour but are generally brown to grey with dark irregular markings across the front wings. They are darker towards the tip with a pale band near the edge and with a dark spot almost near the centre. Adult moths have a wingspan of 35 mm. They fly at night. Moths lay up to 1550 eggs. The larvae feed on leaves and fruit. They damage a range of plants. They can cause serious damage to corn cobs and tomato fruit. Rain helps the pupae develop and warm moist weather makes the pest worse. In the highlands the occurrence is probably seasonal with a lull early in the year then in Aug/Sept. The insects have a number of parasites and predators therefore for these to build up and be able to control the insect, it is important to restrict spraying as much as possible. A fungus disease grows on the insects in the highlands and is favoured by wet conditions. The larvae become dark and move slowly. White fungal

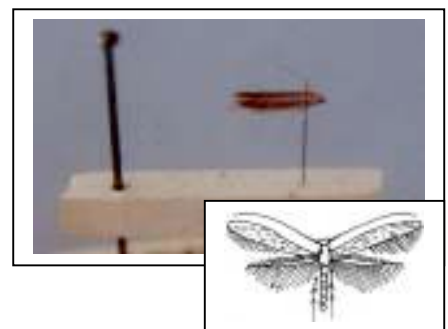


threads turn green and become powdery. The larvae can also be shaken off the plants and then killed.

Sweet potato hawkmoth *Agrius convolvuli* L. The adult is a large hawkmoth with grey wings and pink and black banded body. The wingspan is 75-120 mm and the body 45 mm long. The wings have irregular light and dark patterns. The adults fly near sunset. They are strongly attracted to lights. Adults can fly long distances. (Thousands of kilometres.) The adults can suck nectar from flowers by hovering near sunset. They larvae eat the leaves of sweet potato and also damage taro. The larvae feed on the underside of the leaves. It is more serious in coastal areas and is mainly below 1500 m. It is also worse in dry weather. There are natural parasites and predators that help control. Digging the ground to expose pupae reduces the number. The larvae can be picked off leaves by hand. Plants can be sprayed with carbaryl insecticide. (But this should rarely be used as people eat both taro and sweet potato leaves. The young larvae that need to be sprayed are on young leaves that people eat.)



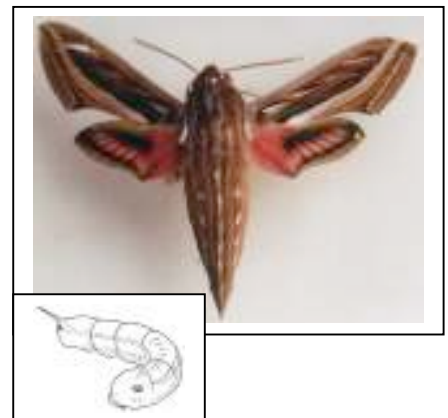
Sweet potato leaf miner *Bedellia somnulentella* (Zeller). The larvae of this very small moth burrow into sweet potato leaves. The larvae are small green caterpillars. Adult moths are 3 mm long and brown to grey in colour. A life cycle takes 3-4 weeks, so pest numbers can build up quickly. The larvae or caterpillars can be up to 7 mm long and at first make straight mines in the leaves but later they mine out blotches of tissue. Only occasionally do large outbreaks of these caterpillars occur. Mostly they are controlled by parasites and predators. Care with chemicals is important as it can upset the balance of predators and parasites. If it is necessary to spray, a range of chemicals will kill the larvae but not the pupae. Therefore it is necessary to spray twice about a week apart.



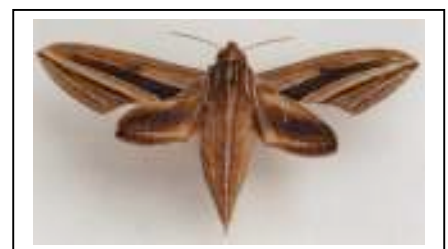
Sweet potato vine borer *Omphisa anastomosalis* Guenee. Larvae are yellowish with brown hard plates. Up to 3 cm long. Adult lays about 300 eggs on underside of leaves and pupae form in the tuber. Larvae burrow into leaf stalks then burrow downwards. A life cycle takes about 55 days. When larvae bore into vines it is claimed that the tubers are reduced in size. Infested sweet potato start to wilt in dry weather. For control crop rotation is important.



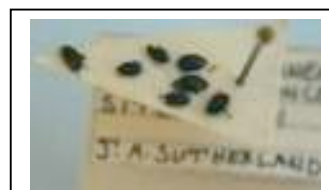
Taro hawkmoth *Hippotion celerio* (L.). The adult moths have small silvery markings on light brown torpedo-shaped bodies. They fly at night with a whirring sound. The front wings are brown with a silvery stripe and the rear wings are brown with a black central patch and bright pink near the body. The larvae are up to 60 mm long. They are green or brown with a large eyespot on the fourth body segment and a small yellow eyespot on the fifth segment. The horn on the rear end is straight and black. The larvae eat the leaves and can do serious damage. They are normally under the leaf and eat the edges of the leaf. They eat taro and sweet potato leaves and grapevine leaves. The loss of some of the leaves does not necessarily reduce the yield. It is possible to pick the caterpillars off by hand. Carbaryl insecticide can be used. It has some parasites and predators that help control.



Vine hawkmoth *Theretra oldenlandiae* Fabricius. These moths are similar to sweet potato hawkmoth but have no pink areas on the hind wings. The moth has a wingspan of 60 to 75 mm. The larvae feed on grapevines, sweet potato, taro etc.



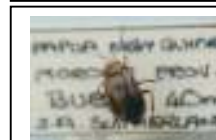
Black flea beetle *Arsipoda tenimberensis* Jacoby. This insect damages sweet potato leaves, corn, common bean and soybean and probably some other plants. The insect causes characteristic damage. It is widespread but the damage is normally not important.



Horned weevil *Apirocalus cornutus* (Pascoe). They occur up to about 1600 m altitude and damage a range of plants. The insect mainly attacks growing points and soft shoots. It chews the leaves eating holes and this is often called shot hole damage. Other insects do similar damage. The damage is often not serious. The weevils can be picked off plants and drowned in a tin of water that has a little kerosene on the surface. Chemical control is not easy.



Monolepta beetles *Monolepta* spp. are similar to pumpkin beetles. They damage leaves and flowers of cassava, corn, mungbeans, pumpkins, cucumber, and sweet potato. They feed on young shoots.



Pumpkin beetles *Aulacophora* spp. The adults feed on flowers and leaves. They eat the leaves. The larvae tunnel in stems and attack roots. They can be stopped with a dust such as Derris dust. An insecticide such as Malathion can be used.



Small tortoise beetles *Cassida* spp. Feed on sweet potato leaves as well as lettuce and potato. Damage is normally minor.



Sweet potato weevil *Cylas formicarius elegantulus* (Summers). This is a small shiny blue/black ant-like insect. The adult rarely flies but they can fly up to 1.5 km and they are very poor at burrowing in the soil. It is about 5-6 mm long. Adults feed on leaves and stems. They can live for several months. Eggs are laid in holes in vines or tubers and hatch in 1 week. Pupae are in the tuber or stem and last for one week. Larvae are white and legless 7-8 mm long and burrow into vines and tubers. 14 days. A life cycle takes about one month. There can be 8 generations per year. They can cause serious damage in cracking soils and in old gardens. When they burrow into sweet potato stems and tubers, tubers get a bitter taste and bad smell. Damage is worse in dry weather. The insect thrives under warm moist conditions. Insects can also live on other sweet potato family plants. Crop rotations prevent large numbers building up. A one-year break between crops and one kilometre between gardens is needed. Mounding soil around sweet potatoes especially in places with cracking soils. Be careful not to take weevils to new gardens in planting material. Deep rooting kinds and fast maturing kinds of sweet potato get less damage. Get rid of old sweet potato vines after the crop is harvested. Pigs or other animals can be used to clean the gardens. Insects can also breed in sweet potato family weeds eg morning glory. Harvest the crop as soon as it matures. Damage can occur after harvest. Plant kinds of sweet potato that get less damage. Planting material can be dipped in Malathion insecticide.



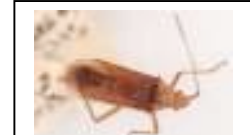
Taro beetles *Papuana* spp. The adult beetles are brown to black and with strong legs for digging. The insects are 15-25 mm long and the wing covers do not quite reach the end of the abdomen. There are one or more small horns on top of the abdomen. They fly at night. Adults can live for 150 days. Eggs are laid in the soil near grasses etc 50-150 mm deep. Larvae are white curl grubs and feed on plant roots. Pupa can be 200 mm to 1 m in the soil. Control is very difficult. Garden location influences the amount of damage. Barrier crops around the edges of gardens possibly helps control. Some varieties get less damage.



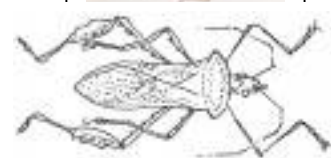
Tortoise beetles *Aspidomorpha* spp. The adults are round insects often with bright colours. A life cycle may take 4-6 weeks. The adults and larvae eat holes in sweet potato leaves and eventually all the leaf between the veins can be eaten away. They also eat aibika. They are normally not a major pest. Old sweet potato plants and other plants in the same family can act as places for the insects to breed so these should be removed. Spraying with carbaryl insecticide works (0.2% solution). Often control is not necessary.



Amblypelta bugs *Amblypelta* spp. They suck sap and secrete a toxic saliva. A few insects can cause extensive damage. They attack a range of other plants. They can cause plants to wilt and fruit to drop off.



Black leaf-footed bug *Leptoglossus australis* (Fab.) This bug damages at least 26 different species of plants. The insect occurs in most districts of PNG at most temperatures and localities, wet and dry, grassland and forest up to 1750 m altitude. The young stages and adults suck the sap, causing plants to wilt. It is common but not very serious. Control measures are not normally required.



Cacao mirid *Helopeltis clavifer* (Walker). They have piercing mouthparts that secrete a toxic substance that produces a dead spot on the plant. They can cause the death of the terminal bud and growing shoot of plants. One insect can make 50 feeding punctures a day. Young fruits can die and older fruits can be deformed. They have been recorded damaging 25 species of plants in PNG. The insects occur from sea level up to 1670 m altitude. Infestation is often only to a section of the crop or tree.



Grass bug is also called sweet potato mirid. *Alticus tibialis* Reut. This bug is about 20 mm long and black. It jumps. It is widespread on sweet potato and reputed to be vector of "little leaf".



Tobacco whitefly *Bemisia tabaci* (Guen.). These are very small white whiteflies. Adults are about 1 mm long. Larvae do not move much. The whitefly is mostly found on the lower leaf surface. If the leaves are shaken a cloud of small moth-like insects flutter out but resettle. The young insects suck sap, causing leaves to turn yellow, wilt and die if there are large numbers of insects. They spread viruses. They also secrete honeydew causing sooty mould fungi to grow. Damage is more common during the dry season and they disappear when rain starts. Control is not normally needed.



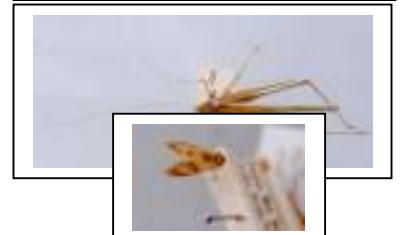
Atractormorpha crenaticeps Blanch. This grasshopper is uniformly green or light brown with pale pink hind wings. This grasshopper damages the leaves and tends to do damage in moist places.



Mole crickets *Gryllotalpa africana* Pal. The adult is a brown cricket about 25 mm long with a velvety appearance. The front legs are specially adapted for digging. Males are heard chirping in the evening. The eggs are oval brown and 1.5 mm long. It attacks many crops at the seedling stage. Roots are damaged and plants wilt. It is worse at lower altitudes and in moist soil. It can burrow deeply into the soil. Most of the damage is to seedlings as the insects burrow just below the surface. They can feed on sweet potato below the ground.



Phaneroptera brevis Aud.-Serv, is a long horned grasshopper common in the highlands. It is fairly narrow. Antennae are 3-4 times the length of the body. Females lay up to 60 eggs over 3 months. It attacks sweet potato by eating the leaves. It is often found in shady places. Control is usually not necessary.



Other minor pests

Adoxophyes sp. Tortricidae (LEP.) -leaf roller
Reported damaging sweet potato.

Aedia sericea Butler Noctuidae (LEP.)
Frequent in small numbers in sweet potato in highlands.

Antestiopsis chambereti Le Guillon Pentatomidae (HEM.)
on sweet potato

Aphthona bicolorata Jacoby Chrysomelidae (COL.)
Doing minor damage feeding on the leaf epidermis of sweet potato.

Argina cribraria (Clerck) Arctiidae (LEP.)
On sweet potato and Crotalaria. An orange spotted moth. There are white edged spots on the front wings and darker spots on the rear wings. Larvae feed within the seedpods of crotalaria. Caterpillar is black with yellow rings across the body and with long black and white hairs. There is a row of orange spots along the side. They are up to 25 mm long.

Asura crocota Hampson Arctiidae (LEP.)
Larvae reported boring superficial channels in stored sweet potato tubers in the highlands.

Atysa sp. Chrysomelidae (COL.)
Reported on leaves of sweet potato and also pollinating plant.

Cassida spp. small tortoise beetles reported feeding on sweet potato leaves in small numbers and doing minor damage.

Cicadella wallacei Distant Cicadellidae [Jassidae](HEM.) On
sweet potato in highlands.

Clysterius angustus Arrow Scarabaeidae (COL.) In sweet
potato

Colasposoma regulare Jacoby Chrysomelidae (COL.)
On leaves and stems of sweet potato. Makes small round holes in sweet potato.

Dendrothripoides ipomoeae Bagn. Thripidae (THYS.)
Feeding on sweet potato leaves causing yellow freckling.

Epilachna signatipennis Boisd. Coccinellidae (COL.) leaf eating
beetle reported damaging sweet potato.

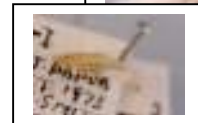
Idopsis excellens Faust. Curculionidae (COL.)
Reported damaging sweet potato leaves.

Kolla sp. Cicadellidae (HEM.)
Reported damaging sweet potato leaves causing brown spotting.

Nysius villicus Van Duzee Lygaeidae (HEM.)
Reported sucking on sweet potato. They are inconspicuous greyish brown bugs 3-4mm long. The damage is normally unimportant. They normally live on weeds.

Onchyrotica concursa Walker Pterophoridae
Larvae on sweet potato. Larvae fold and web leaves.

Solephyma papuana Galerucidae (COL.) Reported
damaging sweet potato



Tabidia insuralis Snell

Pyalidae (LEP.)

Reported causing extensive windowing of sweet potato leaves in lowlands. They tie leaves together and chew the leaves.

Teleogryllus commodus Wlk.
potato.

Gryllidae-field cricket. In sweet

Zygina medioborealis Ghauri
sweet potato in highlands.

Cicadellidae (HEM) Common on



Sweet potato weevil damage



Armyworm damage

Taro family plants

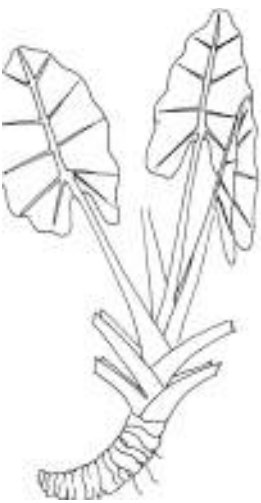


Taro tru
Colocasia esculenta



Chinese taro
Xanthosoma sagittifolium

Taro plants



Giant taro
Alocasia macrorrhiza



Swamp taro
Cyrtosperma merkusii



Elephant foot yam
Amorphophallus paeoniifolius



Taro tru *Colocasia esculenta*



Chinese taro *Xanthosoma sagittifolium*



Swamp taro *Cytosperma merkusii*



Giant taro *Alocasia macrorrhiza*



Elephant foot yam *Amorphophallus paenifolius*

Chinese taro

Tok Pisin: Singapo; taro kongkong

Scientific name: *Xanthosoma sagittifolium*

The Chinese taro plant

This plant looks a bit like taro tru but the leaves are bigger. The leaf is also divided near where the leaf stalk and blade join and there is a distinct vein around the edge of the leaf.

Under the ground the plant produces a ring of small corms around a large central stem or corm. It is these that are eaten.



These taro plants can grow up to 2 metres tall although an average plant is probably only a metre tall.

Where does Chinese taro grow?

Chinese taro will grow well from sea level up to about 1600 metres above sea level. Sometimes it is seen growing at higher places than that, but it doesn't produce very well.

Chinese taro is one of the newer taros to Papua New Guinea and it is still being introduced to some areas of the country. In the Southern Highlands it was brought in by the first people that landed by plane at Lake Kutubu.

People in mid altitude areas use Chinese taro very commonly. At Kutubu, and similar lowland areas it is one of the most commonly used root crops. In the Gazelle peninsula where people are very short of land they grow Chinese taro under cacao and coconuts.

Chinese taro is suited to high rainfall areas.

How is Chinese taro planted?

Chinese taro is normally planted by using the top piece of the main central corm or stem. It can also be grown by using the small side corms; or pieces of the corm can be used as long as they have some buds on them.

They can be planted at any time of the year but in dry areas the middle of the dry season should be avoided. Plants are spaced at varying distances but there is often about 0.9 m x 1.5 m between plants.



What conditions does Chinese taro like?

Chinese taro grows better in good soils especially ones with plenty of nitrogen. But it can be grown in relatively poor soils and still give a satisfactory amount of food. Where the soil is hard and compact, much less food is produced.

This taro like most other taro family plants can also be grown in light shade. It is often grown near bananas and other taller plants.

The places where it has become a major crop mostly have a deep soil that has been washed there by water (alluvial) and a well-distributed rainfall. In these places it is a very easy crop to grow and requires very little maintenance or re-planting. It does not do well in waterlogged soils. The soil water level must be at least 45 cm below the soil surface for Chinese taro to produce properly.

When is the food ready and how is it harvested?

Sometimes a crop of corms can be harvested after 7 or 8 months but often plants take up to one year to grow a good crop. Where plants are on hillsides the corms are often harvested without actually digging out the whole plant. The soil is carefully dug away from the plant and the small corms are broken off the parent plant. The main stem is then covered to produce a new crop.

Chinese taro gardens often stay in the same place for many years and corms are just harvested with only occasional or irregular re-planting.



The corms will store reasonably well under dry, cool, well-ventilated conditions. The corms will also remain in good condition if they are left growing in the ground and just harvested when needed.

Chinese taro as food

Mostly only the young corms are eaten. The main stem or corm can be eaten but often it contains oxalate crystals so that it burns the throat.

The young leaves can be boiled and eaten as an edible green or kumu.

Some idea of the amount of different nutrients that are contained in a 100 gram portion of the part that is eaten are given in this table.

	Moisture %	Energy cals	Protein g	Calcium mg	Iron mg	proVitA µg	provitC mg
Corms	70-77		1.3-3.7				
Leaves			2.4-4.1				

The corms are mostly peeled then boiled or roasted. Many people do not like Chinese taro as much as some of the other root crops but they grow and use it because it is easy.

Pest and Disease

Chinese taro suffers little from serious pest or disease problems. Sometimes the corms are damaged by taro beetles or rats. Sometimes the leaves are attacked by small sucking insects, like coconut scale and cotton aphid.

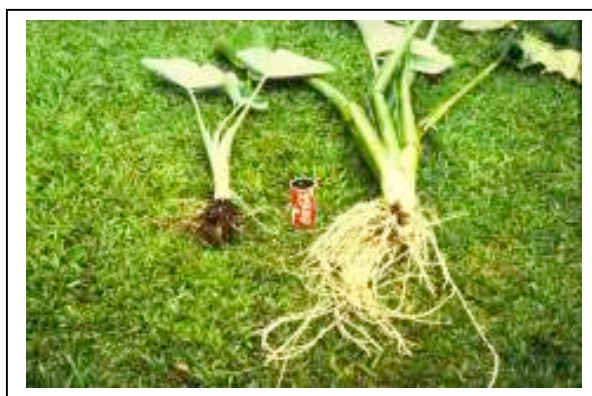
Corm rots, especially during storage, can be a problem if corms are damaged or poorly stored.

Chinese taro does not get the taro blight disease that is causing so much trouble with taro tru. But it can get some fungal leaf spots.

But because at present Chinese taro does not suffer serious pest and disease problems it should not be assumed that problems cannot occur. Root rot problems have occurred both in Ghana and East New Britain. These problems arose where soil fertility was low, plants were continuously replanted in the same area and a fungus such as *Corticium rolfsii* attacked the roots and virus like symptoms showed up on the leaves. Plants died.



Chinese taro leaf spot



Chinese taro root rot

Chinese taro diseases

Root rot	Fungus	<i>Phytophthora citricola</i>
	Fungus	<i>Phytophthora nicotianae</i>
	Fungus	<i>Pythium arrhenomanes</i>
	Fungus	<i>Pythium vexans</i>
Leaf spot		

Chinese taro insect pests

Taro beetles	Scarabaeidae (COL)	<i>Papuana spp.</i>
Coconut scale	Diaspididae (HEM)	<i>Aspidiotus destructor</i> Signoret
Armoured scale	Diaspididae (HEM)	<i>Chrysomphalus dictyospermi</i> (Morgan)
Armoured scale	Diaspididae (HEM)	<i>Hemiberlesia palmae</i> (Cockerell)
Soft scales	Margarodidae (HEM)	<i>Icerya seychellarum</i> (Westwood)
Yam mealy bug	Pseudococcidae (HEM)	<i>Planococcus dioscoreae</i> Williams. On Chinese taro in storage
Mealy bug	Pseudococcidae (HEM)	<i>Planococcus pacificus</i> Cox
Longtailed mealybug	Pseudococcidae (HEM)	<i>Pseudococcus longispinus</i> (Targioni)

Nutrient deficiencies

What signs does a plant show when it is short of soil nutrients?

When nitrogen is in short supply plants are small with pale green leaves and short leaf stalks. Growth is slow.

Phosphorus shortage also makes plants small and growth slow but the leaves remain dark green.

Magnesium shortage results in a bright orange colour developing between the veins. The leaf dies.

Calcium shortage causes old leaves to be thick and leathery but young leaves are small and twisted with dead and pale patches.



Elephant foot yam

Scientific name: *Amorphophallus paeoniifolius*

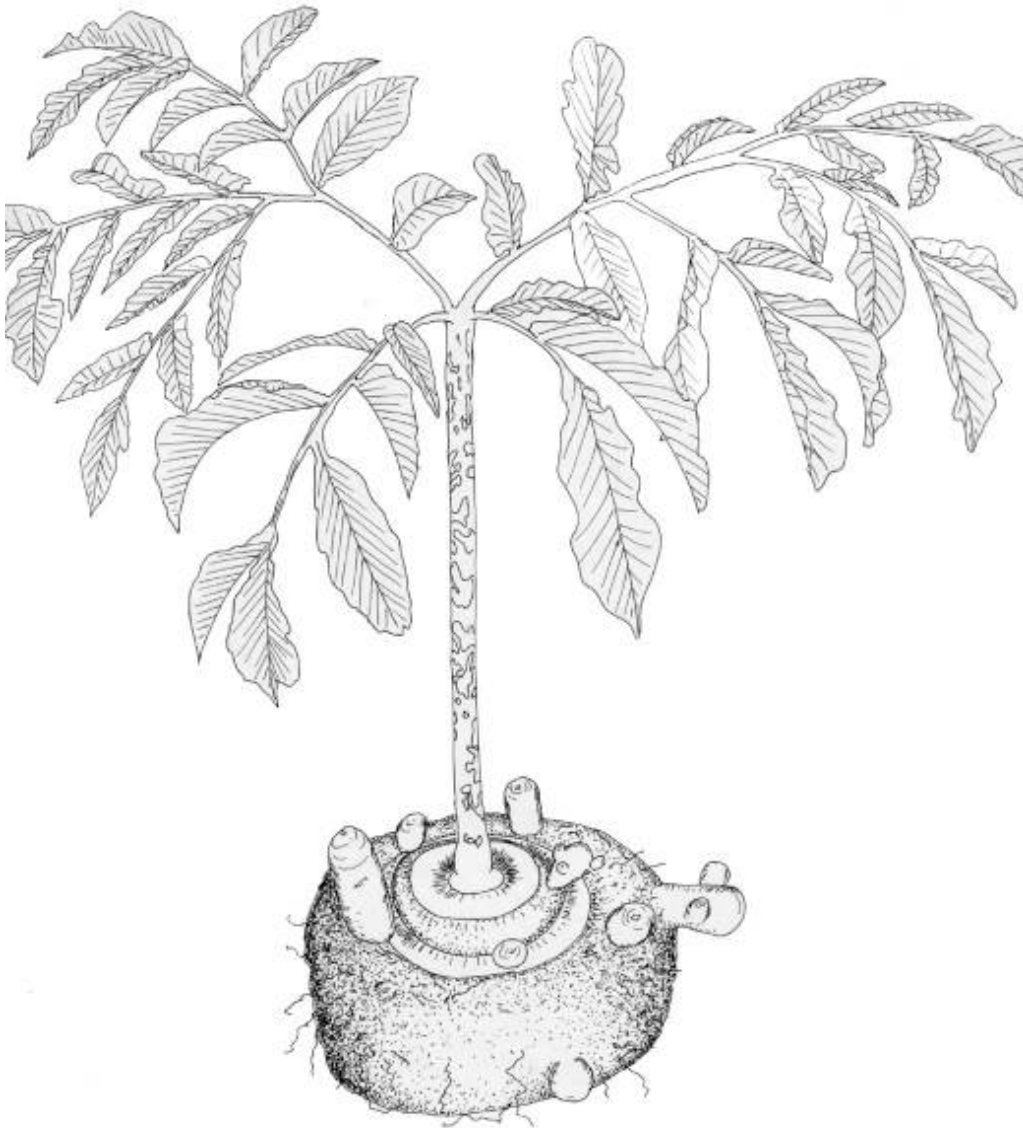
What is the plant like?

The plant has one straight leaf stalk and then a very divided and irregular leaf at the top.

People in villages know a wild form of this plant. The stalk or leaf petiole is very rough. This kind is never eaten because it contains large amounts of a poison called oxalate that burns the throat and irritates the skin. The kind that is grown and eaten has a smooth leaf stalk.

The large round underground corm produces small corms around the side. These are usually used for planting.

After the leaf dies back, a very large lily type flower is produced. This flower has a strong smell, like rotting meat, which attracts flies to pollinate the plant.



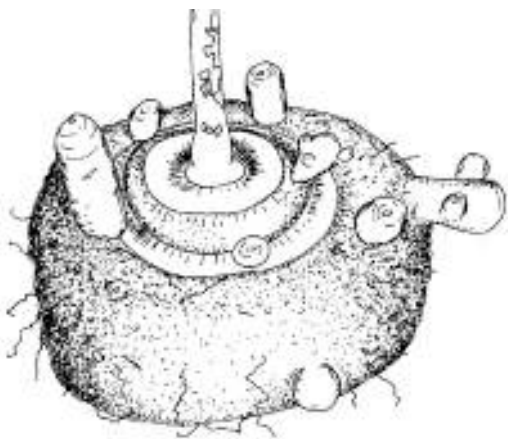
Names

This plant produces a large round underground corm. That is how it got its name "elephant foot". But it is not a yam, as the flower and the taste of the plant show it really belongs to the taro family.

Scientists have recently changed the names of these plants. The old name was *Amorphophallus campanulatus* but now the correct name is *Amorphophallus paeoniifolius*. There are two varieties: var. *hortensis* which is the cultivated kind with smooth leaf stalks, and var. *sylvestris* which is the wild kind with rough green leaf stalks.

How does the plant grow?

Small corms from around the side are the normal part planted. If a very small corm is planted, the plant may need to grow for several seasons to produce a large yield. After harvest, the corm needs to be kept for a few months before it is ready to produce a new shoot and re-grow. When it is planted a single leaf stalk is produced and the irregular shaped leaf is produced at the top of the stalk. Eventually the corm under the ground increases in size then the leaf dies back. The corm could be harvested and stored, or eaten at this stage. If it is just left, a very large flower is produced. After a while this flower produces a strong smell like rotting meat.



This type of growth pattern where the plant grows leaves and produces a corm or tuber that then can be stored and needs to be kept before it re-grows, is the type of growth that suits areas with a distinct wet and dry season. It has the advantage that the corm will store well after harvest and can be eaten in the dry season when food is short.

Where does this plant grow?

In Papua New Guinea this plant is grown occasionally in several coastal areas. It can be seen in Sepik gardens and in Milne Bay. It is also grown in several other tropical countries. It is common in some areas of India and is grown and used in Fiji, the Philippines and Indonesia.

Giant taro

Tok ples: Paragum (Kuanua)

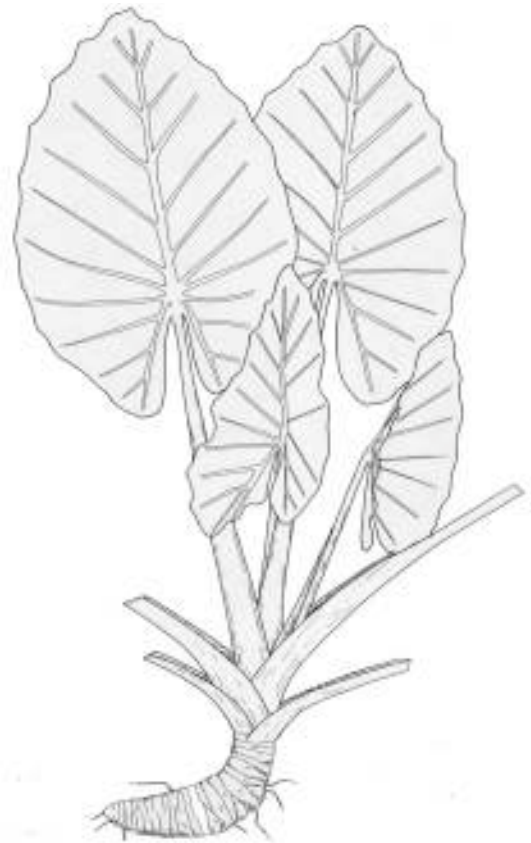
Scientific name: *Alocasia macrorrhiza*

What is the giant taro plant like?

This is a taro family plant. It grows as a large upright plant that can be up to 3 metres tall. The tuber or rhizome grows above the ground and is the part eaten. It is only eaten in some varieties and is not commonly used except in a few places in Papua New Guinea.

The leaves are large and upright. The leaf blade continues straight on at the same angle as the stalk and is not bent back at right angles. The leaf is shiny and often the edge of the leaf is wavy. The bottom lobes of the leaf are rounded.

The stem or rhizome is thick (10-15 cm) and often extends along the ground or curves upwards at an angle. Brown trailing fibres of the leaf bases often hang from the stem. Small round side shoots grow from this stem.



Giant taro

Where do giant taros grow?

In Papua New Guinea Giant Taro or Paragum can be seen growing wild near creeks and in the bush in many parts of the country. They grow from sea level up to about 2700 metres altitude. But in most places these plants are wild and not eaten for food. They are very bitter.

In a few areas this taro is grown in food gardens as a food. At Namatanai in New Ireland Province, and amongst some of the Tolais near Rabaul it is commonly grown and used.

The same plant has been recorded as an occasional food plant in a number of Pacific countries, the Philippines and in Indonesia and Malaysia, Taiwan and India.

How are Giant Taros grown?

Small shoots or corms develop along the sides of the stem of the main plant. These can be removed and planted. But growth from them is very slow.

It is better to use the top piece of an old stem once the plant has been harvested. Pieces of the stem can be used. Plants need to be 1 to 1.5 m apart.

Because the giant taro takes more than a year to be ready to harvest, it often ends up left growing in an old garden site after the other plants have been replanted in a new garden. The giant taro is simply left to grow without much care or weeding, until the owner wants to harvest it.

Preparing and cooking giant taro

Giant taro contains small needle-like crystals in the tissues. These are due to a chemical called calcium oxalate. It is necessary to remove these during the preparation and cooking. The method of peeling is important. Normally some ladies who are especially experienced at peeling do this job. Also the taro corm is often left to wilt for a week after it is harvested and before it is used.

Also to help remove some of the crystals, the stem is baked for a long time, or boiled in several changes of water.

It is also important to use the right variety of giant taro because the kinds grown in gardens have less of the chemical than wild ones.

What conditions does giant taro require?

Giant taro is a tropical plant and will not grow well below 10°C. It requires a well-distributed rainfall and does not tolerate drought. Even though it grows along creek banks it cannot tolerate waterlogged soil.



Swamp taro

Scientific name: *Cyrtosperma merkusii*

The plant

This taro family plant can be picked out from other commonly grown taro plants by the pointed ends to the leaf lobes. The leaves are arrow shaped and point upwards. But other aspects of the plant can vary. Some kinds are more spiny on the leaf stalks than others.

The plants can grow up to 4 metres tall. Under the ground there is a large fattened rhizome or corm. This is shaped liked a cylinder and can be up to 70 kg in size.

The plant produces a lily type flower that then produces a group of seeds that are orange in colour.

The plant produces suckers. The number of suckers varies with varieties. Some countries have up to 15 varieties of this taro.



Drawing Celia Bridle

Naming of the plant

In the past scientists have often called this plant *Cyrtosperma chamissonis* and sometimes *Cyrtosperma edule* but these names have now been changed to *Cyrtosperma merkusii*. This type of confusion sometimes occurs when a plant varies as much as this one and scientists think the one in another country is a different plant. A scientist who worked in Papua New Guinea took 3 years to sort out the correct naming of this group of plants.

Where does the plant occur?

As a food plant in Papua New Guinea this swamp taro is mainly grown and eaten on Manus Island, The Trobriands, the Mortlock Islands and in some areas of Bougainville and Buka Island.

In Kiribati, a Pacific Island nation, this plant has been one of their main traditional foods. It was grown in pits dug into the coral atolls. It is also grown and used in Malaysia, Indonesia and the Philippines as well as some other Pacific Island countries.



Taro

Tok Pisin: taro tru

Scientific name: *Colocasia esculenta*

The taro plant

The taro tru plant is an upright plant with large leaves carried on a long, often striped, petiole.

The petiole joins this large leaf blade away from the edge towards the centre of the leaf.

At the ground level it has a large fattened base to the stem that is called a corm. Around this corm small buds produce a circle of suckers or small side plants.

As plants get older, particularly if a dry period occurs, the taro plant will produce a lily type flower in the centre. When this is pollinated it produces a green fruit that turns orange. Inside this there are some thousands of small seeds.



Kinds of taro

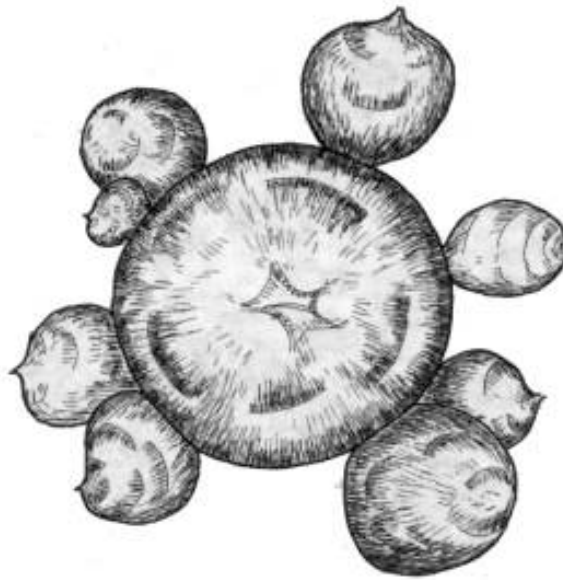
Scientists recognise two different kinds of taro tru.

They give them slightly different scientific names.

And *Colocasia esculenta* var. *esculenta*
Colocasia esculenta var. *antiquorum*

The first one is for the taro that is grown in most areas of Papua New Guinea that has a ring of small leafy suckers and new plants are grown from the tops of main plants or young leafy suckers. The other plant actually has all the leaves dry off and it has a period when the plant can be stored. The suckers are larger. This plant mainly occurs in very dry areas such as the Western District.

A plant looks like this after the leaves have dried off. The leaves and plant when growing look much the same as the ordinary taro.



Dasheen type of taro

The main type of taro tru comes in many different varieties. These can be picked out by the colour of the leaf stalk and by looking at many other details of the plant. The differences between all these kinds are important to taro growers.

Where does taro grow?

Taro will grow from sea level up to about 2300 metres altitude. It needs an average daily temperature above 21°C. This means that most gardeners in Papua New Guinea have the chance to grow taro if they want to. In fact most families grow at least some taro. It is a crop that particularly suits hot humid places like coastal areas of Papua New Guinea. In the past it has been very important but some diseases such as taro blight and virus diseases means that it is now less grown in areas like Bougainville, the Gazelle peninsula and Manus. It also needs a fertile soil and other crops such as sweet potato and cassava will grow on poorer soils.

Taro needs some special conditions to grow well. It needs to have a fertile soil, and it needs plenty of water. So in most places taro is put first in a rotation after land is cleared from bush. Otherwise it is put on fertile soils near rivers.

Because taro can also stand a reasonable amount of shade, it is particularly suitable for growing in newly cleared rainforest in places with high rainfall. Near Mt Bosavi, the Kaluli people have these conditions and they have also developed a special gardening technique. They clear the undergrowth, plant their taros and bananas, then cut the trees down over the top of the crop. The taros and bananas grow up through the fallen leaves and branches. Just because taro will grow reasonably well in shade it normally still grows better in full sunlight. Taro tru needs more sunlight than Chinese taro.

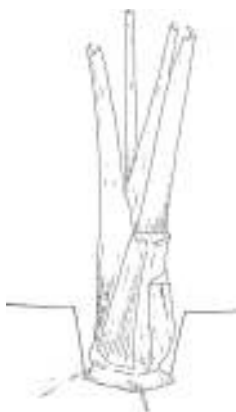
The Huli people near Tari often grow taro along the edges of the drains that they are so specialised at digging. Here the taro can get moisture and good fertile soil. In other areas people find the right conditions for taro either at the bottom of a deep limestone sink-hole such as on the Nembi plateau or at Erave; or beside a creek or river or at the bottom of a small valley. Often taros are put near houses where the soil fertility can be built up with household scraps and rubbish.

In some areas of Papua New Guinea people grow taro as a flooded crop where they make a shallow pond and then grow the taro in the water. Normally water is provided for the pond by as system of irrigation so that the water doesn't become stagnant and cause the taros to rot. This method is also used in some other Pacific countries. (Some other taros such as swamp taro are also grown in water.)

How can you grow taro?

Taro is grown from the top piece of a corm, or from side suckers. When tops are used, leaf stalks about 20 cm long are left attached to a piece of the corm about 1 cm thick. As a general rule, larger tops grow faster and give larger corms. Often when side suckers are used they are stored in a nursery beside a creek until needed. It is possible to get taro buds on taro roots to grow and produce several new plants if the growing tip is removed. This is a way to increase the amount of planting material.

The top or sucker is planted in a hole. The hole should be 10-20 cm deep. Normally it is made with a digging stick or a spade. Putting taro in pits or holes gives better taros than by planting on flat ground or raised beds. A normal spacing for taro is to put one plant on each square metre of ground.

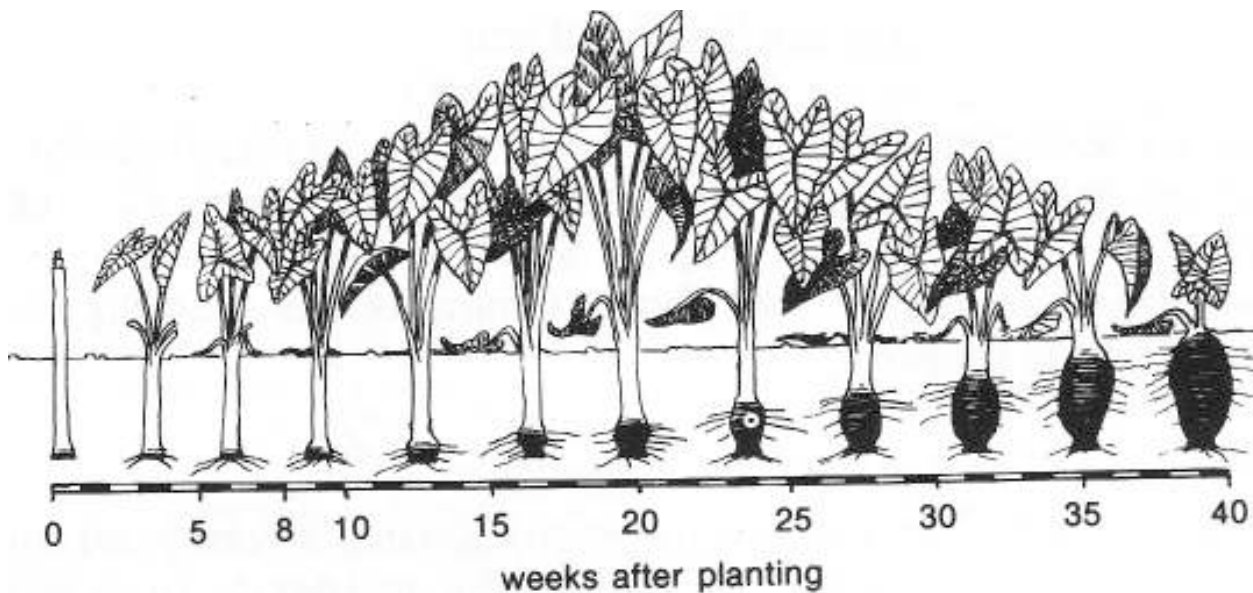


A taro top in a planting hole



Taro can be planted at any time of the year but it is often fitted into a seasonal pattern to suit the rainfall and other gardening conditions. It does not grow well in dry periods so planting is often arranged to avoid these in coastal areas.

Dr Sutherland in his book, Introduction to Tropical Agriculture shows the growth of a taro crop and the taro plant looking like this.



Initially there are lots of leaves and these increase in size, then the corm forms and the leaves get smaller and fewer. Although weeds growing in a taro crop affect the size of taro the effect is worst when weeds are left growing at an early stage of the crop when the taro leaves are small and it cannot compete as well. During the growth of a normal taro crop between 7 and 9 weedings may be needed. Allowing weeds to keep growing reduces the size of the taros and as well the number of suckers produced. As with most crops, weed control is less of a problem in the highlands.

Putting mulch around taro plants normally gives a higher yield. This is probably because it helps weed control and well as keeping moisture in the soil.

On the coast taro is often ready for harvest after about 5 or 6 months but in the highlands it is often 10 or 12 months before corms are large enough for harvest.

Often people in taro growing areas insist that taro should either be grown on its own or with only certain other plants intercropped with it. This is probably a practice that has developed with experience as it has been shown that taro can restrict the growth of some other crops such as beans.

Taro as food

Taro corms can vary in how much water they contain. This can vary between 58% and 75%. Papua New Guinea farmers normally prefer drier types as these give more energy for work. Large softer kinds are given to pigs in some areas.



Some taro varieties burn the throat due to chemicals called oxalates and possibly some other chemicals. This means that in all kinds of taros there are also wild kinds that grow along creeks etc and these are often not used. In gardens the amount of these oxalates is influenced by the amounts of fertiliser used. Adding extra potassium and nitrogen can increase the amounts of oxalates.

Taro starch grains are very small and this makes it a very easily digested food.

Taro leaves are very good quality food. Young taro leaves are commonly cooked and eaten and one taro leaf per day is enough to meet the vitamin A needs of three small children.

The leaf stalks of taro can be cooked and eaten.

Protein is an important part of food for health and growth. Taro corms contain between 1.7% and 4 % on a dry weight basis. This varies with variety and also the fertility of the soil. The protein content also gets less as corms get older.

/ 100 g edible portion

	Moisture %	Energy KJ	Protein g	proVit A µg	proVitC mg	Iron mg	Zinc mg
Corm	66.8	1231	1.96	3	5	0.7	3.2
Leaves	85.0	210	5.0	424	90	0.6	0.7
Leaf stalks	93.0	101	0.5	180	13	0.9	

Diseases

Taro

Leaf spot	Fungus	<i>Cercospora sp.</i>
Blossom blight	Fungus	<i>Choanephora cucurbitarum</i>
Brown leaf spot	Fungus	<i>Cladosporium colocasiae</i>
Leaf spot	Fungus	<i>Colletotrichum sp.</i>
Mitimiti disease	Unknown	<i>Hirschmanniella miticausa</i>
Leaf spot	Fungus	<i>Leptosphaerulina trifolii</i>
Leaf spot	Fungus	<i>Neojohnstonia colocasiae</i>
Shot hole	Fungus	<i>Phyllosticta sp.</i>
Blight	Fungus	<i>Phytophthora colocasiae</i>
Leaf blight	Fungus	<i>Thanatephorus cucumeris</i>
Root rot	Fungus	<i>Pythium spp.</i>
Mosaic	Virus	Dasheen mosaic virus
Dwarfed plants	Viruses	Alomae & Bobone viruses
Root rot	Fungus	<i>Fusarium solani</i>
	and	<i>Periconia sp.</i>
Root knot	Nematode	<i>Meloidogyne sp.</i>
With corm rot	Fungus	<i>Botrydiplodia theobromae</i>
	and	<i>Chaetophoma sp.</i>
	and	<i>Rhizoctonia sp.</i>
	and	<i>Athelia rolfsii</i>
Corm and stem rot	Bacteria	<i>Erwinia carotovora</i> sub sp. <i>carotovora</i>
Bacterial leaf blight	Bacteria	<i>Xanthomonas campestris</i> pv. <i>aracearum</i>

Taro blight (*Phytophthora colocasiae*)

This is a fungus disease that produces dead spots on the leaves. Often the spots run down the leaf in a line, and there is a yellow border around the spots. The edge of the leaf away from the spot often dies. Early in the morning a white fuzz can be seen on the surface of the spots.

It is this disease that has caused so much trouble in coastal taro growing areas like Manus and Bougainville.

In most of the Highlands this disease does not cause much trouble because the altitude and cool temperature stop the disease spreading. Diseased plants can be seen in lower villages (below 800 m).



Taro shothole (*Phyllosticta colocasiae*)

This is another fungus disease that looks quite a lot like taro blight. It has round dead spots that have a yellow ring around them. Often there is a hole in the centre of the spot where the dead leaf tissue has fallen out. There is no white fuzz like with taro blight.

This disease is commonly seen on taro plants in the Southern Highlands. It never gets bad enough to kill the leaves or the plant, but it does some damage.



Brown leaf spot (*Cladosporium colocasiae*)

Irregular but almost round reddish brown blotches can often be seen on older taro leaves. They are due to another fungus.

The spots don't seem to do a lot of damage to the leaf and the growth of the plant does not seem to be seriously affected. It gets worse in humid damp conditions.

Leaf spot (*Neojohnstonia colocasiae*)

Yellow or brown spots round or irregular and 1.5 cm across occur on the leaves.



Leaf blight (*Thanatephorus cucumeris*)

Bacterial leaf spot

(*Xanthomonas campestris*)

Root rot

(*Pythium sp.* & *Phytophthora sp.*)

These rots of the corm and roots can cause problems while taro is growing in moist areas. The disease is reduced if healthy planting material is used, diseased plants are removed, water does not become stagnant around taro, and proper crop rotation is used. Some varieties get less damage. Where soils are wet or flooded, kinds of taro suited to these situations should be used.

Dasheen mosaic virus

This disease often shows itself on taro leaves as a fine feathery yellow and green streaking pattern around the veins of the leaf. The leaves can also become slightly wrinkled.

It is caused by a very small particle called a virus. These viruses are spread between plants in the mouthparts of small sap sucking insects such as whitefly. They also are spread in the taro planting material.



It does not get as serious as other virus diseases of taro in coastal areas, but it can be seen in Highland gardens.

Alomae & bobone viruses

These are serious virus diseases that make the leaves of taro go small and wrinkled then the whole plant can die.

In some areas on the coast it is causing serious damage. The very small disease particles are spread by insects but can also be in the planting material. Some varieties of taro get these diseases badly and others don't seem to get the disease too badly.



Storage of taro

Most taro tru will only store for one or two weeks after harvesting. This is because storage rots due to fungi and bacteria cause the taro to rot. The main organisms causing rots in storage have been identified as:

Botryodiplodia theobromae is a very common fungus that causes silvering of yam leaves, root rots of peanuts and many other rots. With taro in storage it causes a spongy black rot.

Fusarium solani is another very common fungus that often causes plants to wilt. With taro in storage it causes a dry rot sometimes called powdery grey rot.

and *Erwinia caratovora* is a bacteria that rots the strengthening substance in plant cell walls causing things like soft rot in marita and other plants.

INSECT PESTS

Taro insect pests

Taro beetles	Scarabaeidae (COL)	<i>Papuana biroi</i> End.
	Scarabaeidae (COL)	<i>Papuana huebneri</i> Fairm.
	Scarabaeidae (COL)	<i>Papuana japonensis</i> Arrow
	Scarabaeidae (COL)	<i>Papuana laevipennis</i>
	Scarabaeidae (COL)	<i>Papuana semistriata</i>
	Scarabaeidae (COL)	<i>Papuana trinodosa</i> Prell.
	Scarabaeidae (COL)	<i>Papuana woodlarkiana</i> (Montr.)
Taro hornworm/hawkmoth	Sphingidae (LEP)	<i>Hippotion celerio</i> (L.)
Taro leafhopper	Delphacidae (HEM)	<i>Tarophagus colocasiae</i>
	Delphacidae (HEM)	<i>Tarophagus persephone</i>
	Delphacidae (HEM)	<i>Tarophagus proserpina</i> (Kirk)
Aibika leaf miner	Gracillariidae (LEP)	<i>Acrocercops</i> sp.
Banana aphid	Aphididae (HEM)	<i>Pentalonia nigronervosa</i> Coq
Cacao armyworm	Noctuidae (LEP)	<i>Tiracola plagiata</i> Walk
Cacao looper	Geometridae (LEP)	<i>Ectropis bhurmitra</i> Walker
Cluster caterpillar	Noctuidae (LEP)	<i>Spodoptera litura</i> (Fab)
Corn earworm	Noctuidae (LEP)	<i>Heliothis armiger</i> Huebner
Dermolepida beetles (Chafer beetles)	Scarabaeidae (COL)	<i>Dermolepida nigrum</i> (Non f.)
	Scarabaeidae (COL)	<i>Dermolepida noxium</i> Britton
Melon aphid	Aphididae (HEM)	<i>Aphis gossypii</i> Glover
Shot hole weevils	Curculionidae (COL)	<i>Oribius cinereus</i> Mshl.
	Curculionidae (COL)	<i>Oribius cruciatus</i> Fst.
	Curculionidae (COL)	<i>Oribius destructor</i> Mshl.
	Curculionidae (COL)	<i>Oribius inimicus</i> Mshl
Sweet potato hawkmoth	Sphingidae (LEP)	<i>Agrius convolvuli</i> L.
Tobacco whitefly	Aleyrodidae (HEM)	<i>Bemisia tabaci</i> (Guen.)
	Lygaeidae (HEM)	<i>Astacops flavicollis</i> Walk.
	Lygaeidae (HEM)	<i>Astacops villicollis</i> (Stal.)
	Acridiidae (ORTH)	<i>Gesonula mundata sanguinolenta</i> Kraus

Taro beetles

These black or brown beetles are 2-3 cm long and seem to occur wherever taro is grown in Papua New Guinea. Their front legs are specially adapted for digging and they burrow under the plant eating the corm. The larvae or grubs also live in the soil and eat taro. There are several different kinds of taro beetle.



The only place where damage seems less is in very damp sites. Taro beetles can also damage a number of other plants.

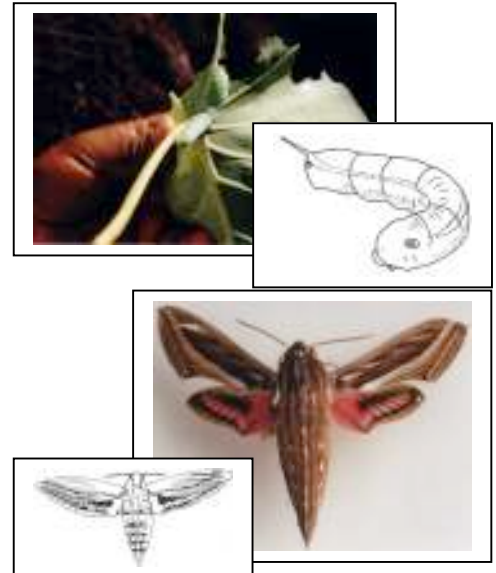
Taro hawkmoth

This large green caterpillar can often be found under the edge of a taro leaf eating the leaf. It has a pale stripe along the side, 2 large "eye" spots and a long pointed brown horn at the end.

Although it can be found in most taro gardens in the Highlands it never seems to develop large numbers except in dry areas. It can occur badly in some lowland gardens in the dry season.

A similar hawkmoth caterpillar with a distinctive striped pattern along its body can also be seen in some taro gardens. This is the sweet potato hawkmoth.

These caterpillars are large and can easily be caught and killed by hand.



Taro leafhoppers (*Tarophagus spp.*)



Cluster caterpillar (*Spodoptera litura*)

The caterpillars of this moth develop in large numbers clustered together on the leaf surface. The most practical method of control at village level is to collect the caterpillars in a paper bag when they are newly hatched and then to burn them.



Tobacco whitefly (*Bemisia tabaci*)

This small sap sucking whitefly can spread Dasheen mosaic virus.



Winged bean or asbin

Scientific name: *Psophocarpus tetragonolobus*

The plant

The winged bean is a climbing bean that produces pods with four wings along the side. This is why it is called winged bean in English. Under the ground it produces a thickened root or tuber that is eaten. This is where the Tok Pisin name asbin comes from. The seeds are round.

The two main types of winged bean are short-podded ones that are used for tubers and long-podded ones that have poor tubers. But a very large number of winged bean varieties occur in Papua New Guinea.



What's so special about winged beans?

Winged beans have recently been “discovered” by scientists and other people around the world. They have called it a plant with “exceptional merits”; a “miracle plant”; a “supermarket on a stalk” and many other excited comments. The reasons for these comments are because winged beans:

1. Grow well in the hot humid tropics.
2. Almost all parts of the plant can be eaten.
3. All parts of the plant have high food value, especially protein.
4. Winged beans generally suffer less from damage of bean insects, pests and diseases than other beans.
5. They are very good at fixing nitrogen for their own growth as well as for other plants.



Where do winged beans grow?

In Papua New Guinea, winged beans are grown in many areas of the country. They can be seen from sea level up to about 2300 m altitude although they are less common above 1850 metres and normally only produce tubers between 1200 and 1850 m altitude. They are common in Sepik areas in the lowlands and in the mid altitude highland regions especially the Eastern Highlands and Western Highlands.

For maximum seed production winged beans need temperatures between 23° and 27°C and for tubers the temperatures should be between 18° and 22°C.

Winged beans can only be grown in the tropics because flowers and seeds are not formed in countries out of the tropics. But they are grown in a number of other tropical countries particularly in the Asian region.

Winged beans can grow on a wide variety of soils. The acidity of soils is measured on a scale from 0 to 14 and it is called the pH scale. Better soils are near neutral or 7. Winged beans have been grown on soils with pH from 3.6 to 8.0. This is a wide range. When soils become very acid, the aluminium that is common in clays in soil can get into solution and into plants. Aluminium is not a plant nutrient and is not needed by plants. Winged beans are sensitive to aluminium in soil solution.

Soils should not be waterlogged.

Growing winged beans

Seeds are planted 2-3 cm deep and about 25-35 cm apart. If seeds have been dried and stored then they can suffer from hard seed coats and this delays the germination of seeds. But normally seeds start to grow in about 15 or 16 days. Plants grow slowly to start with so weeding is important but then they grow rapidly. After 46 to 92 days they are producing flowers. If fattened roots are important some of the leaves and flowers and tips are pruned off at this stage. These can be eaten. Pods develop 10 to 13 weeks after planting and tubers occur 4-5 months after planting.



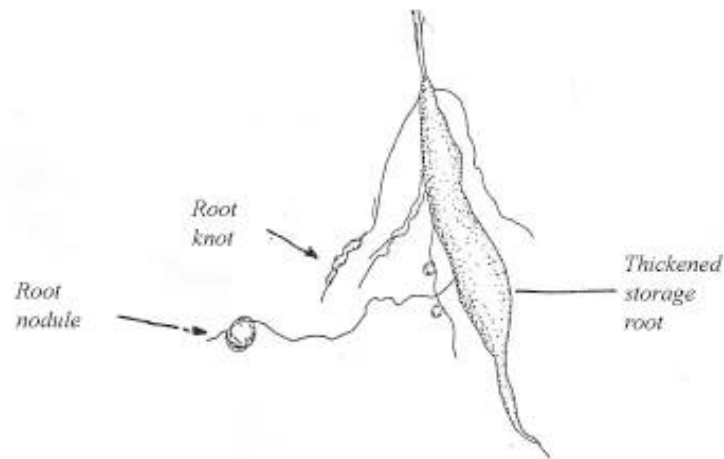
For tubers, plants are planted at special times to allow them to develop during the dry season.

Winged beans need to be staked for high yields. Stalks from pitpit are sufficient.

**Winged
beans being
grown for
tubers**



All beans have special bacteria (Rhizobia) that attach to the roots and enable beans to take nitrogen out of the air and change it into nutrient nitrogen that plants can use. With winged beans the lumps or nodules that contain these bacteria are very large, they form very easily even in soils where beans haven't been grown before and they work very efficiently as well. They enable winged beans to grow well, help them have a high protein content and can also help provide nitrogen in the soil for other plants.



Root knot and nodules

How much food is produced?

Winged beans are mostly grown for their tubers, pods and leaves. Dry beans are not used a lot in Papua New Guinea although firm mature beans are eaten fresh from cooked pods.

A single plant can produce up to 75 pods.

Dry bean yields of 45 to 330 g per plant can be produced depending on variety.

Tuber yields of 5500 to 12000 kg per hectare have been produced.

Winged beans as food

Seeds can contain a chemical (trypsin inhibitor) that stops the protein being properly digested by our bodies. This chemical is destroyed if seeds are soaked then boiled well. Tubers can also contain this chemical and need to be well cooked.

One of the main things about winged beans is that they are good at providing protein. The protein content of the different parts varies between varieties but some of the amounts are indicated below.

Plant part	Protein (g per 100 g)
Seeds	29.8 - 42.5
Fresh tubers	2.27 - 8.05
Fresh leaves	4.55 - 11.81
Fresh pods	1.31 - 2.73
Flowers	1.25 - 2.65

This means all parts of the winged bean plant are very good for providing protein. They are also good sources of vitamins, minerals and energy.

Winged bean tubers are tied in bundles and sold in markets. They won't keep for very long so need to be treated carefully and eaten quickly. In villages the most popular way to cook them is in a mumu in an earth oven. They are dry and firm and very nice tasting.

The leaves and flowers are mostly boiled.

Although pods are often roasted then the beans just eaten from the pod as it is split open, the beans have more food value if they are soaked then boiled.

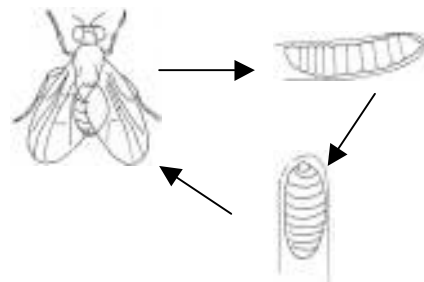
Food value per 100 g edible portion

Edible portion	Moisture %	Energy KJ	Protein %	ProVit A μ g	Provit C mg	Iron mg	Zinc mg
Seed dry	8.5	1764	41.9		Tr	15.0	
Seeds - young	87.0	205	7.0	13.0	18.3	1.5	0.4
Pods fresh	92.0	105	2.1				
Roots	57.4	619	11.6	0	0	2.0	1.4
Leaves	95.0	197	5.0	809	30	6.2	1.3

What insects damage winged beans?

Bean fly (*Ophiomya phaseoli*)

The bean fly can burrow into the young stems of seedling winged beans. This weakens the plants slowing down growth and causing plants to fall over. They suffer less of this damage than common bean.



Bean pod borer (*Maruca testulalis*)

The caterpillar of this moth is yellow with brown or black spots along the body. They are thin and up to 25 mm long. The moth lays eggs singly on the flowers then the larvae bore into the young pods leaving chewed up plant material over the hole where they bored in.



Winged bean blotch miner (*Leucoptera psophocarpella*)

This small leaf miner can cause serious damage in drier areas.



A number of other insects also damage winged beans.

Winged bean insect pests

Winged bean blotch miner	Lyonetiidae (LEP)	<i>Leucoptera psophocarpella</i> Brad. & Cart.
Amblypelta bugs	Coreidae (HEM)	<i>Amblypelta</i> spp.
Bean leaf rollers	Pyrilidae (LEP)	<i>Lamprosema indica</i> F.
	Pyrilidae (LEP)	<i>Lamprosema diemenalis</i> (Guenée)
Bean pod borer	Pyrilidae (LEP)	<i>Maruca testulalis</i> (Geyer)
Cacao armyworm	Noctuidae (LEP)	<i>Tiracola plagiata</i> Walk
Common grass blue butterfly	Lycaenidae (LEP)	<i>Zizina otis</i> (F.)
Cowpea aphid	Aphididae (HEM)	<i>Aphis craccivora</i> Koch
Green Vegetable bug	Pentatomidae (HEM)	<i>Nezara viridula</i> (Linnaeus)
Leaf eating ladybird	Coccinellidae (COL)	<i>Henosepilachna signatipennis</i> Boisd.
	Coccinellidae (COL)	<i>Henosepilachna haemorrhoea</i> (Biel)
Melon aphid	Aphididae (HEM)	<i>Aphis gossypii</i> Glover
Pea Blue butterfly	Lycaenidae (LEP)	<i>Lampides boeticus</i> L.
Grasshopper	Tettigoniidae (ORTH)	<i>Phaneroptera brevis</i> Aud.-Serv
Rice armyworms	Noctuidae (LEP)	<i>Mythimna loreyi</i> (Dup.)
	Noctuidae (LEP)	<i>Mythimna separata</i> (Walk.)
	Anthribidae (COL)	<i>Araecerus fasciculatus</i> Degeer
	Anthribidae (COL)	<i>Araecorynus cumingi</i> Jekel
Adults and nymphs feeding under leaves	Cicadellidae (HEM)	<i>Erythroneura</i> sp.
Larvae eating leaves	Lymantriidae (LEP)	<i>Euproctis</i> sp.
Grasshopper chewing leaves	Gryllidae (ORTH)	<i>Homeoxipha fuscipennis</i>
Larvae damaging leaves	Arctiidae (LEP)	<i>Nyctemera baulus</i> Boisduval
Beetles on pods	Cerambycidae (COL)	<i>Prosopius oblique plagiatus</i> Breuning
Beetles damaging dry pods	Cerambycidae (COL)	<i>Ropica honesta</i> Pascoe
Cicada on leaves	Cicadellidae (HEM)	<i>Zygina</i> sp.
Scale insect	Pseudococcidae (HEM)	<i>Planococcus pacificus</i> Cox

What diseases does winged bean get?

Winged bean diseases

Flower blight	Fungus	<i>Choanephora cucurbitarum</i>
Anthrachnose	Fungus	<i>Colletotrichum lindemuthianum</i>
Leaf spot	Fungus	<i>Didymella sp.</i>
Collar rot	Fungus	<i>Macrophomina phaseolina</i>
	and	<i>Fusarium spp.</i>
	and	<i>Thanatephorus cucumeris</i>
Sooty mould	Fungus	<i>Meliola erythrinae</i> var <i>psophocarp</i> i
Powdery mildew	Fungus	<i>Oidium sp.</i>
Leaf spot	Fungus	<i>Pseudocercospora psophocarp</i> i
False rust	Fungus	<i>Synchytrium psophocarp</i> i
Leaf curl	Possible virus	
Little leaf	Possible mycoplasma like organism	
Root knot	Nematode	<i>Meloidogyne incognita</i>
	and	<i>Meloidogyne javanica</i>

False rust (*Synchytrium psophocarp*i)

This light brown coloured fungus is well known to most village winged bean growers. The fungus can commonly be seen on pods and also grows on the leaves, stems, and flower buds. It makes the pods less attractive to eat. (Because fungi are often too small to see, this fungus disease is often a good one to use to teach people in villages about disease and what fungi are.) The disease spreads with temperatures between 10° and 25°C and when there is moisture on the plant surface.



Leaf spot (*Pseudocercospora psophocarp*i)

This fungal leaf spot grows on the leaves. It starts as small yellow spots on the top of the leaves and it is grey to black underneath. The whole leaf can become infected and die particularly during the rainy season. All varieties of winged bean get the disease.



Powdery mildew (*Erysiphe cichoracearum*)

This fungus causes a disease that looks like a white powder on the upper surface of the leaves. It grows on older leaves and the leaves become pale then die and fall off. It is most likely that this fungus is the same one that grows on cucumbers.

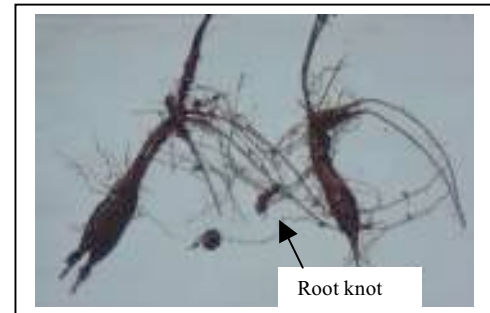
Collar rot (*Macrophomina phaseolina*, *Rhizoctonia solani* & *Fusarium spp.*)

These fungi cause the roots to die or the stem to die near the ground level. So the young plant (3 to 4 weeks old) is seen to wilt. If you look carefully the stem is more narrow near the ground and black dead spots occur on it. This disease can probably be avoided by planting seeds more shallowly and in well-drained soils.

What other pests damage winged bean?

Root knot nematodes (*Meloidogyne spp.*)

These very small worms (too small to see without special equipment) live in the soil and damage the roots of many different plants. They burrow into the roots and the damaged root becomes thick and twisted and no longer works properly to provide nutrients or water for the plant.



With winged beans (and other beans) it is important to be able to tell the difference between this root damage, and the good root tuber and the helpful bacteria that attach to the roots and help the plant fix nitrogen. If you pull up a plant and look at the roots, the bacteria nodules are just on the side of the roots (should be red inside if they are working properly) and can be pulled off the roots without damaging the roots. Root knot nematode is a twisted damaged root and cannot be pulled off. The asbin tuber is the developing fattened central root.

Yams

Tok Pisin: Yam tru
Mami

Scientific names:

Dioscorea alata - Greater yam

Dioscorea bulbifera - Potato yam

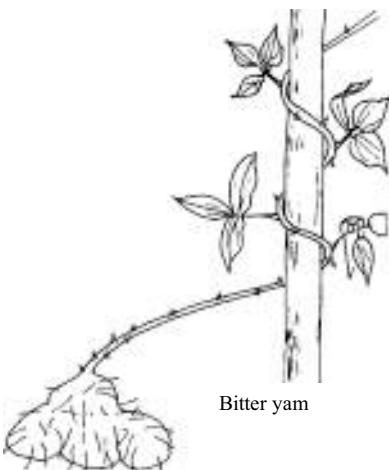
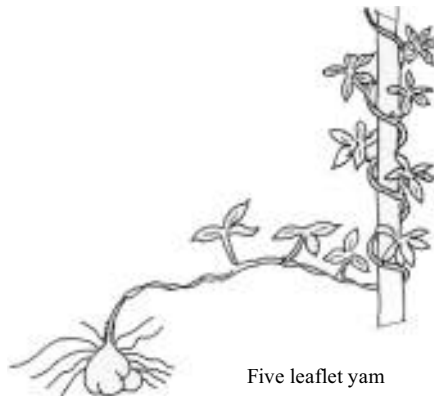
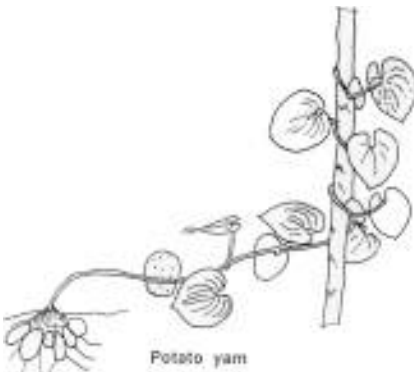
Dioscorea pentaphylla - 5 leaflet yam

Dioscorea esculenta - Lesser yam

Dioscorea nummularia - Greater yam

Dioscorea rotundata-

Four species of yams are commonly grown and used for food in Papua New Guinea but often naming in villages and naming by scientists does not agree. Many village people regard potato yam and 5-leaflet yam as varieties of greater yam.



What is a yam plant like?

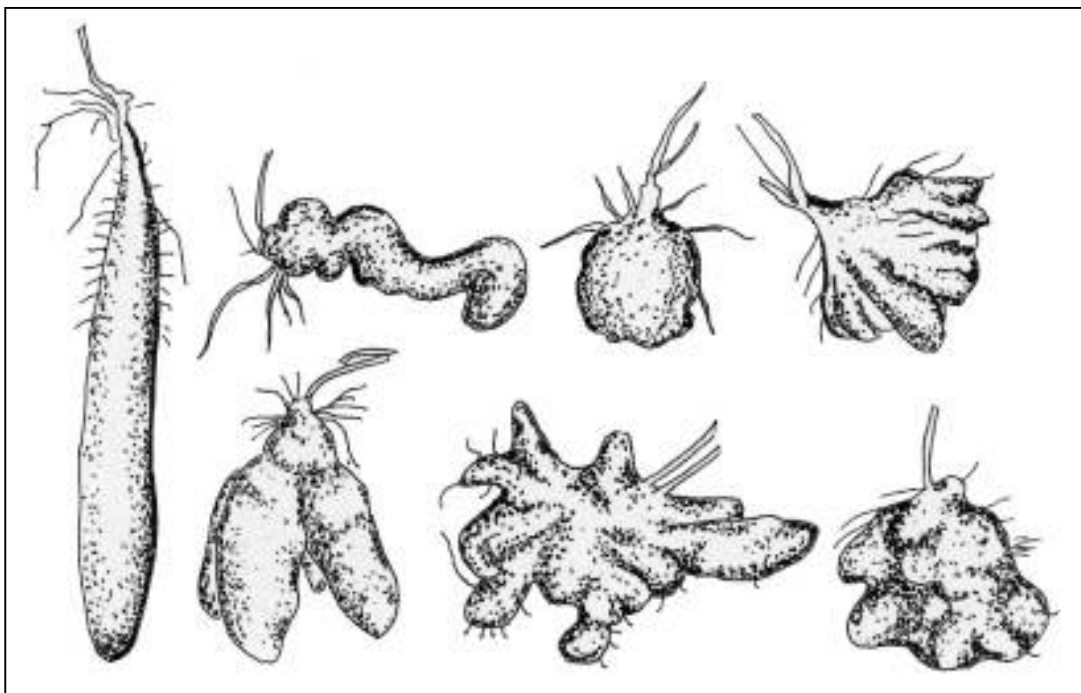
All yams have long creeping vines that wind around sticks.

Greater yam

The greater yam has a stem with wings on the sides making it square in shape. The heart shaped leaves are in pairs along the vine. Under the ground it normally produces one fairly large tuber. These tubers can be many different shapes.



Some of the tuber shapes of Greater yam





Greater yam has long angular vine. The stems are square and twine to the right around support sticks. The stem does not have spines. It is often coloured green or purple. The leaves are heart shaped and borne in pairs along the vine. The leaves vary in shape, size and colour with different varieties. Leaves can be 10-30 cm long by 5-20 cm wide. The leaf stalk is 6-12 cm long. The flowers occur in the axils of the upper leaves. The male flowers are in small heads along branched stalks. These can be 25 cm long and green. The female flowers are in shorter spikes. Many cultivated varieties do not produce fertile seed. The fruit are 3-winged and 2.5 cm long by 3.5 cm wide. The seeds when they occur have wings right around them. One large but often irregular shaped tuber occurs under the ground. A very large number of different varieties occur.

The tubers can vary in shape, size, colour, texture and other ways. Some varieties produce bulbils along the vine.

It grows from sea level up to about 1800 m in the tropics. Yams are most important in seasonally dry areas. They need a well-drained soil and it has to have reasonable fertility. The temperature maximum is $>30^{\circ}\text{C}$ while the minimum is 20°C . The optimum temperature range is $25\text{-}30^{\circ}\text{C}$. Rainfall is often seasonal in yam areas and the maximum to be needs 14-20 weeks rain with an optimum of 1,150 mm during the growing season. Yams can tolerate drought but give maximum yields with high rainfall. The critical rain period is during the first 5 months. Light influences tuber growth. A continuous exposure of tubers to light significantly reduces tuber yields. Day length - Yams are influenced by photoperiod. Short days (less than 10-11 hours) favours tuber development. It suits hardiness zones 10-12.

In most places the yam growth and maturity fits in with seasonal rainfall patterns. They are mostly planted just before the first rains where a 8-10 month rainy season exists and give better yields in 6-8 month rainy season areas when planted 3 months before the rains. Earlier planting requires larger sett size to withstand drying out.

Pre germination of tubers that are cut and stored in shady places gives improved yields over tubers left whole then cut into setts at planting. Because yam tubers have a period of dormancy, tubers do not normally commence regrowth for up to 5-6 months. This means they store better but there is a delay before they can be replanted. Dormancy can be broken using Calcium carbide treatment for 5 hours or by covering tubers with leaves of *Croton aromaticus* or *Averrhoa bilimbi*.

Yams are demanding in their nutrient requirements and are therefore often planted first in rotations. They need a fertile free draining soil. They cannot tolerate water logging.

In drier grassland areas mulching the mounds at planting has been found to improve establishment and yield.

In most places in Papua New Guinea the Greater yam is called yam tru in Tok Pisin. At Madang and along the Sepik coast it is called mami.

It is not easy to know all the different varieties of yams but there are some rules that are fairly often true. These rules can help a little bit to understand the types of yam tru.

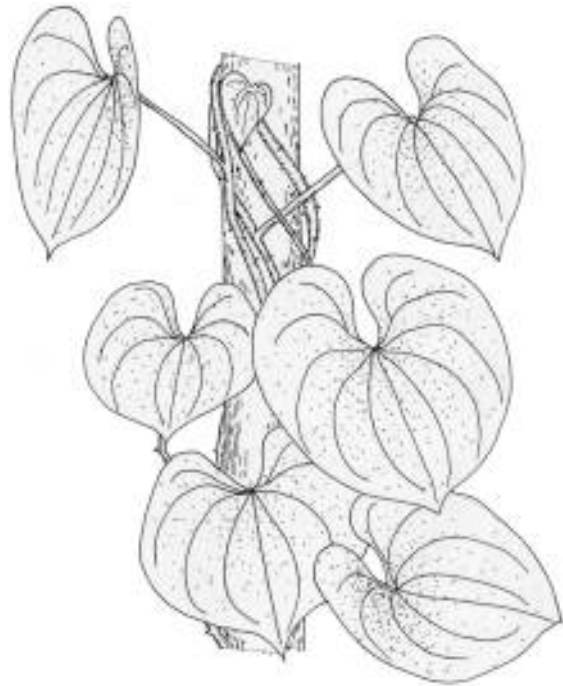
Some guidelines about varieties of Greater yam

Yams that are red inside are normally red at the top of the stalk that holds the leaf. Plants with a number of stems near the ground often have tubers that are branched. They sprout more easily.

The more the young stem branches, the less deep the tubers are in the ground. Leaves that are fatter and shorter indicate fatter yams, often angular in shape and with surface roots.

Lesser yam

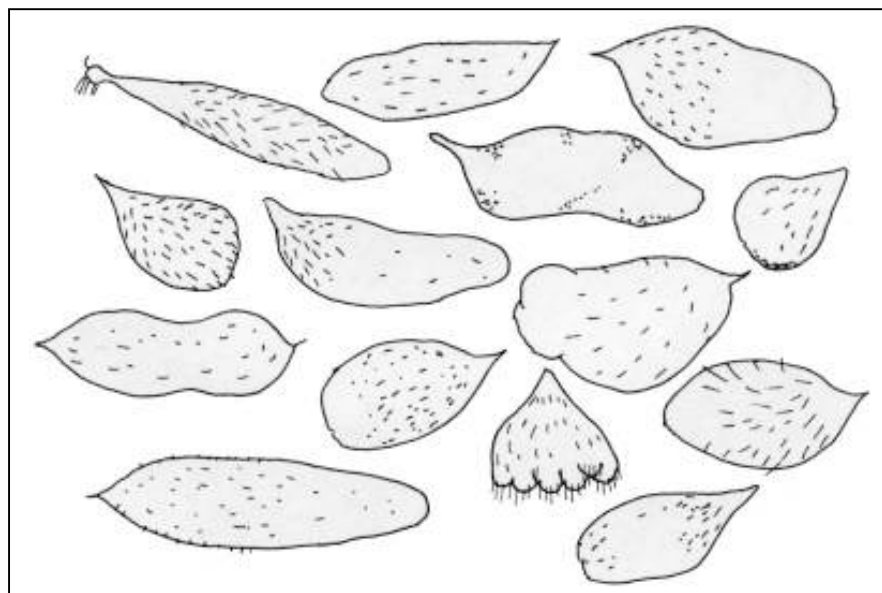
The Lesser yam is called mami in Tok Pisin in most areas of Papua New Guinea except Madang and the Sepik coast. It has a round thorny vine and a smaller more rounded leaf. The leaves are borne singly along the vine. Under the ground there are a clump of tubers. But there are also some very sharp thorns just under the ground, so be careful! The tubers again vary in shape, size and colour. One of the most noticeable differences between kinds is the amount of roots or hairs over the surface of the tubers.

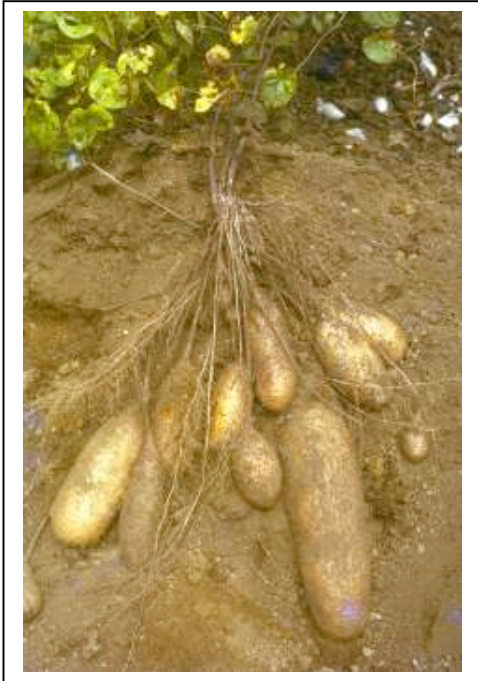


Some of the tuber shapes of Lesser yam

These are some of the kinds from Dreikiker at East Sepik.

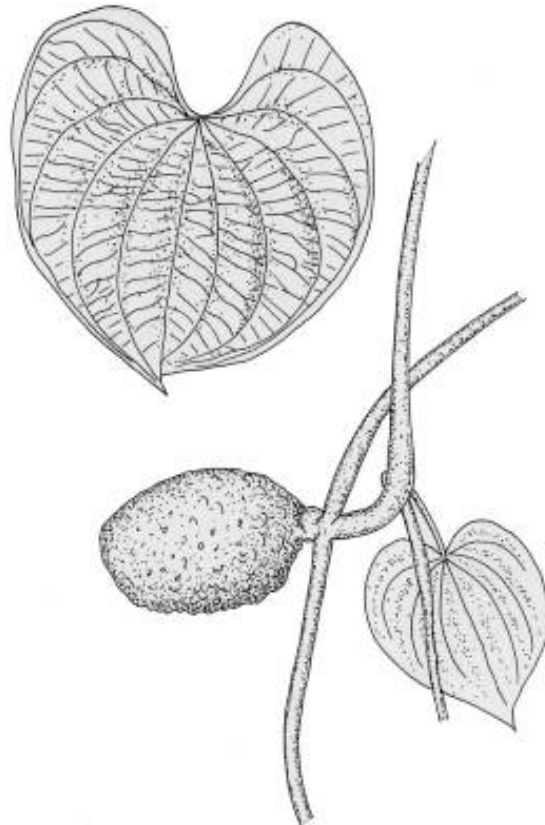
They were described by Dr.B.Allen at the 1981 Food Crops Conference.





Potato yam

This yam has a very long smooth vine that often climbs up trees especially near where the grassland and forest meet. Along the stem it produces round or lumpy potato like aerial tubers. (bulbils) They are in a branch where a leaf stalk joins the stem. There is also a tuber under the ground. Some people eat the aerial tuber and plant the tuber that is under the ground. Other people eat the underground tuber and plant the aerial tubers. This may depend on varieties.



Five leaflet yam

This yam has a leaf that is divided like the fingers on your hand. The number of leaflets can vary between 3 and 7 but there are mostly five. The leaves look a bit like cassava but they grow on a long vine that winds up a stick. There are also wild types that grow in the bush. This yam often has small aerial tubers (bulbils) along the vine.



Where do yams grow?

Most yams are truly tropical plants so they grow better in coastal areas. Also yams are well suited to growing in areas where there is a distinct wet and dry season. The pattern of growth of yams suits these climates. They can grow lots of leaves at the beginning of the wet season, store up food in the tubers as the leaves dry off with the approach of the dry season then the yams can be stored during the dry period.

Yam	Altitude above sea level
Greater yam	0-1650 metres
Lesser yam	0-800 metres
Potato yam	0-1700 metres
Five leaflet yam	0-1800 metres

Some of the places in Papua New Guinea where yams are important include Maprik in East Sepik; the Eastern Highlands; near Port Moresby; the Trobriands in Milne Bay; and Morehead in Western Province.

Around the world there are about 10 million tons of Greater yam grown each year in hot tropical countries. Practically all of these are grown in subsistence gardens similar to those in Papua New Guinea.

A man who collected Lesser yams from many different countries of the world found that the kinds of Lesser yams in Papua New Guinea were the best in the world.

How do you grow yams?

Yams are normally grown from tubers. With Lesser yam, one of the smaller tubers is often planted whole. With greater yam, any reasonable sized part of the tuber can be planted. Mostly the top piece is used because it produces new shoots the quickest and will grow the biggest tuber by harvest. But if a middle piece or a bottom piece of the tuber is cut off and stored carefully it too will produce new shoots and can be planted. Greater yam, potato yam and five-leaflet yam all sometimes produce aerial bulbils along the vine. These can be used for planting but do not always produce a big underground tuber in the first year.



A sprouting lesser yam



A top piece of greater yam

Although many yams often produce long flowers and both male and female flowers can be found on separate plants, these hardly ever produce true seeds that will grow. This is because of the different number of chromosomes that yams have and it makes yam breeding almost impossible.



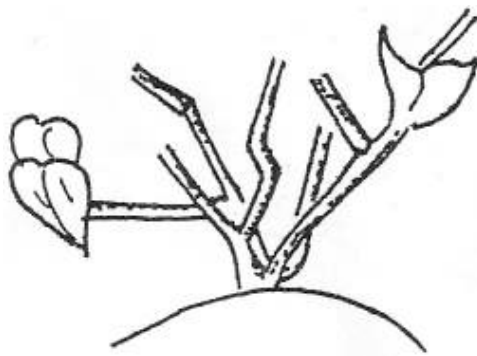
A male flower of Greater yam

Planting practices

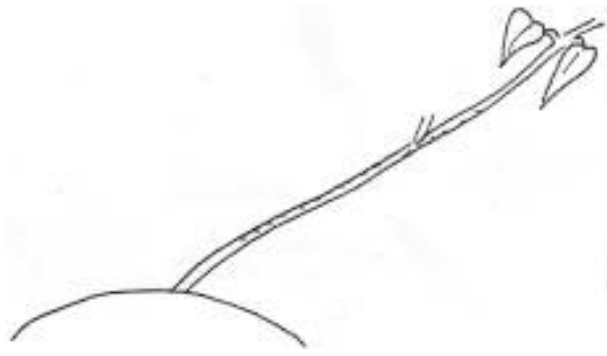
It is common practice in many areas to plant the yam piece upside down. The probable reason for this is to give the shoot and roots time to develop and get established away from the sun and wind, so that the plant does not dry out. People in yam areas have their varieties classified as to whether they are planted at the top or the bottom of the hole, and whether the shoot is pointed up or downwards. The reasons for this are not fully understood but village people have probably learnt by experience.

Yams must have a well-drained soil with plenty of air in the soil. So yams will not normally grow on heavy clay soils or in areas with a lot of soil moisture. The soil can be improved for yam growing by putting leaves and other plant material in the planting hole, by making a mound above the hole, or by planting on a hillside. In some very loose sandy soils such as near Port Moresby yams can just be planted in flat unmounded soils without digging a special yam hole but these situations are not common.

Yams should also have sticks to climb up. It is best to have a stick that is twisted or branched because the vine can slip down a very straight stick. Normally a stick 2 metres tall is sufficient. It needs to be a strong stick, firmly fixed in the ground. Yam varieties vary on the type of vine growth they have. This affects where the stick needs to be placed.



A broad irregular shaped yam tuber often has several branches and grows leaves early



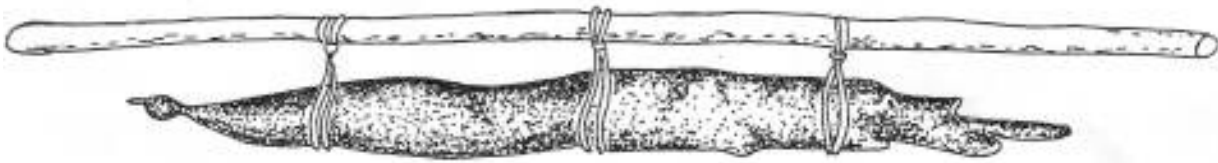
A long straight yam tuber often has a long unbranched vine with few leaves on the bottom section

The fat irregular yams can have the sticks near the mound as a thick clump of vines and leaves soon develops. But if the stick is put beside the mound of one of the long ceremonial yams the vine will often reach the top of the stick before it has produced more than a couple of leaves, and will then fall back down to produce its leaves on the ground. The stick often needs to be put at some distance from the yam hole. The tip can be picked off the vine if branching is wanted earlier.

It may be that the long vine yams are more common in forest areas and the shorter branched vines in grassland areas.

In some areas yam vines are allowed to creep over the ground and do not have sticks to climb. This method only works satisfactorily in dry places like the Markhum Valley and Central District because diseases of the leaves and vine can cause serious damage in wetter places. Where yams do not have sticks to climb plants need to be more widely spaced. Under most circumstances the amount of food produced can be doubled by allowing yam vines to climb up sticks.

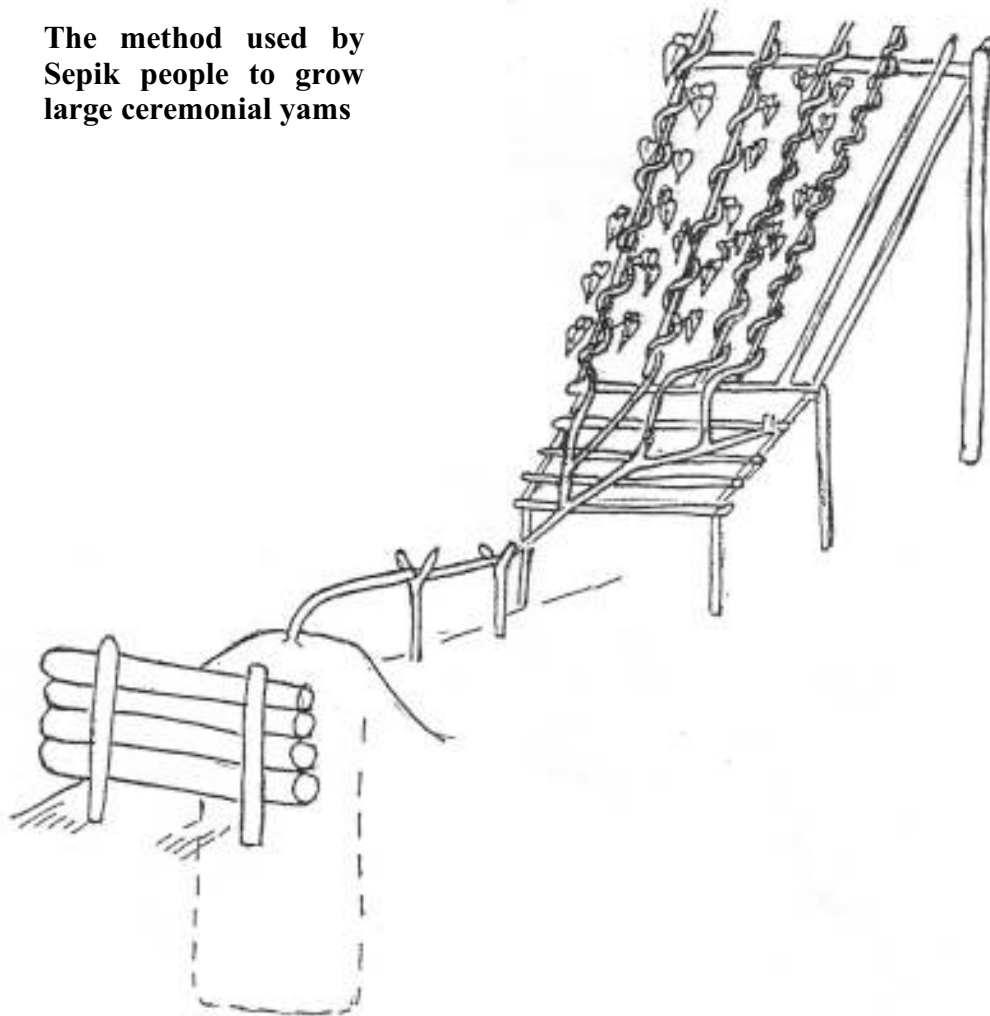
Potato yam vines are very long and heavy and it is often most easy to allow them to climb over logs or up trees.



A long ceremonial yam tied to a stick

People in the Sepik area grow some of the largest yams in the world. They do this by putting together all the important principles of yam growing.

**The method used by
Sepik people to grow
large ceremonial yams**



Ceremonial yams have very specialised production techniques. For general food production, use top pieces of the tuber after they have sprouted, use a branched stick for support of the vine, space plants about 1 m apart and choose a smooth round cultivar. Given the large diversity of cultivars of greater yam, for efficient production varieties need to be chosen which have regular rounded tuber shapes for easier harvesting and preparation; also selection needs to be made for varieties with less leaf spot and virus susceptibility and stable yield. Colour, cooking quality, storage ability, texture and other qualities need to be considered to suit the growers demands.

Pest and disease problems

The diseases of yams have not been well studied and are not well understood. Diseases on the leaves can be seen in almost all yam gardens and on all kinds of yams. Village people don't understand about disease so say the leaves died off early because of "fire" or lightning, or because garden taboos were broken.

The diseases that have been listed so far include:

Five leaflet yam

Leaf spot		
Rust	Fungus	<i>Uredo dioscoreae-sativae</i>

Greater yam

Anthracnose	Fungus	<i>Glomerella cingulata</i>
Leaf spot	Fungus	<i>Phyllosticta dioscoreae</i>
Rust	Fungi	<i>Goplana dioscoreae</i>
	and	<i>Goplana australis</i>
	and	<i>Uredo dioscoreae-sativae</i>
Mosaic		
Root knot	Nematode	<i>Meloidogyne sp</i>

Lesser yam

Leaf spot	Fungus	<i>Cylindrosporium dioscoreae</i>
Leaf spot	Fungus	<i>Guignardia dioscoreae</i>
Dark brown leaf blotch	Bacteria	<i>Xanthomonas sp.</i>
Mosaic	Perhaps virus	
Root knot	Nematode	<i>Meloidogyne incognita</i>

Potato yam

Brown mould under leaf	Fungus	<i>Pseudocercospora ubi</i>
Rust	Fungus	<i>Uredo dioscoreae-sativae</i>

Also general or non specific on "yams"

Leaf spot	Fungus	<i>Curvularia sp.</i>
Dry rot	Fungus	<i>Fusarium sp.</i>
Collar rot	Fungus	<i>Fusarium oxysporium</i>
	and	<i>Penicillium funiculosum</i>
	and	<i>Penicillium javanicum</i>
With tuber rot	Fungus	<i>Scutellinia badii-berbis</i>
Leaf spot	Fungus	<i>Mycosphaerella contraria</i>
Necrosis of tubers	Nematode	<i>Pratylenchus sp</i>

Anthracnose is caused by a common fungus and starts as spots but leaves and vines soon blacken and fall off. **Phyllosticta leaf spot** has a dark brown ring around a light brown spot and often there is a hole in the centre. **Cercospora leaf spots** tend to have a yellow ring around a brown dead spot.

These leaf spot diseases get worse in wet weather and under poor growing conditions. They often start on older leaves but can then spread to younger leaves and vines. There is a lot of obvious difference in the level of resistance to these diseases between the yam species and varieties.

In some areas of Papua New Guinea yam leaves develop **mottled yellow patterns** on the leaves and the vines stop growing. This disease is due to a virus.

Silvering of yam leaves. This can be due to a fungus called *Botryodiplodia theobromae* that is a very common fungus in Papua New Guinea and gets on many different plants. With greater yam the leaves start to develop a silvery colour and start dying off early. This fungus gets bad in coastal areas where temperatures are about 30°C and when yams are not growing well.

Root rots of yams have also not been well studied in Papua New Guinea. Rotting of yam tubers either in the ground or in storage can occur due to a fungus that is common in Papua New Guinea (*Botryodiplodia theobromae*). It can cause wet rot, soft rot and brown dry rot. Handling tubers very carefully is important in stopping this disease.



Anthraxnose Greater yam



Phyllosticta leafspot Lesser yam



Rust of Potato yam

Insects on yams

Sawfly

Yam sawfly	Tenthredinidae (HYM)	<i>Senoclista purpurata</i> (F.Sm.)	
------------	----------------------	-------------------------------------	--

Sap sucking bugs

Cotton aphid	Aphididae (HEM)	<i>Aphis gossypii</i> Glover	
	Miridae (HEM)	<i>Harpedona plana</i> Poppius	Nymphs and adults reported damaging greater yam leaves and some varieties suffered severe damage. The leaves go spotted with light patches.
Black leaf-footed bug	Coreidae (HEM)	<i>Leptoglossus australis</i> (Fab.)	
Yam mirid sapsucker	Miridae (HEM)	<i>Platypeltocoris similis</i> Popp	

Weevils or beetles

	Curculionidae (COL)	<i>Alcidodes australis</i> Boisduval	Reported causing minor damage to yam leaves.
	Curculionidae (COL)	<i>Eupholus nickerli</i> Hll.	
	Curculionidae (COL)	<i>Gymnopholus weiskei</i> Hllr.	Reported damaging yam. See PNG Ag J 18(3)
	Curculionidae (COL)	<i>Hypolixus mastersi</i> Pascoe	Reported damaging yam
	Crioceridae (COL)	<i>Liliocerus sp. nr. bakewellii</i> Baly	
	Crioceridae (COL)	<i>Liliocerus papuana</i> (Jac.)	Reported adults and larvae chewing leaves of greater yam.
Taro beetles	Curculionidae (COL)	<i>Papuana spp.</i>	

Larvae of moths or butterflies

		<i>Chrysodeixis chalcites</i> Esp.	Eating lesser yam leaves
	Geometridae (LEP)	<i>Hyposidra talaca</i>	Eating leaves of yam.
	Hesperiidae (LEP)	<i>Tagiades obscurus tindali</i> Rbb	Larvae feed on yam leaves throughout the year. PNG Ag J 21(7). Only slight damage
	Hesperiidae (LEP)	<i>Tagiades tregellius</i> Hopf.	Larvae rolling leaves
	Hesperiidae (LEP)	<i>Tagiades tregellius canonicus</i>	Eating leaves of yam
Yam hawkmoth	Sphingidae (LEP)	<i>Theretra nessus</i> Dry.	

Armoured scales

		<i>Abgrallaspis cyanophylli</i> (Signoret)	On greater yam.
		<i>Aspidiella hartii</i> (Cockerell)	On yams in storage. It can be on greater or lesser yam.
		<i>Aspidiotus destructor</i> Signoret	

Soft scales

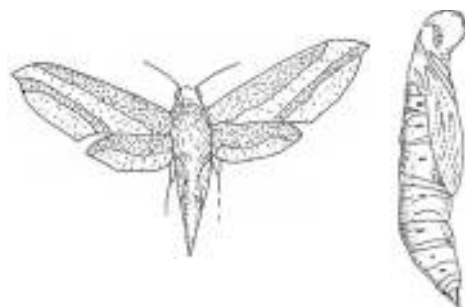
		<i>Icerya seychellarum</i> (Westwood)	
		<i>Coccus hesperidum</i> Linnaeus	

Mealybug

		<i>Planococcus pacificus</i> Cox	
Yam mealy bug		<i>Planococcus dioscoreae</i> Williams	

Yam hawkmoth

The larvae of a hawkmoth can be seen eating leaves in some yam gardens. It is a caterpillar with a long point on the end and it looks a bit like similar ones that are more commonly seen eating taro and sweet potato leaves. This one forms a pupae case in amongst the yam leaves and eventually hatches out to a moth.



Rats

Rats can be a big problem with stored yams unless the yams are well looked after.

Polynesian arrowroot

Scientific name: *Tacca leontopetaloides*

What is the plant like?

Under the ground there is a round swollen root or tuber. It can be 30 cm across and weigh 1 kg. Some varieties produce several smaller tubers.

The stem is hollow, and ribbed. This is one way to tell this plant from the somewhat similar looking leaf of Elephant foot yam. The leaf petiole is about 2 cm across and over one metre long.

The leaves have an irregular shape and are divided. The main part of the leaf is divided like the fingers on your hand and then these are again divided. They have light and dark green stripes. There are fine grooves along the leaf stalk.

A single flower stem grows up beside the leaf stem. On the top the flowers are green and a dull dark purple. There can be 30-40 small flowers and several long spreading and drooping coloured bracts. Flowers and fruits are produced throughout the year.

The fruits are yellowish green, long shaped and with 6 raised lines along the side. They can be 4 cm long and 2 cm wide and have several seeds inside.



Where is Polynesian arrowroot grown?

It is a crop mainly grown in tropical Asia and Polynesia. It is also grown in East Africa.

It is a coastal crop and is mostly grown on sandy beaches under coconuts and in grassland. It is grown on coral atolls. It is grown up to about 200 m altitude.

How does arrowroot grow?

Polynesian arrowroot is a plant that grows during the wet season and dries during the dry season.

When the leaves turn yellow and the plant dies back, the tubers are harvested. Small tubers are kept for replanting. Dying off mostly occurs from December to March. Plants take about 8 to 10 months to reach maturity.

Names

The common English name for this plant is Polynesian arrowroot but also Tahitian arrowroot and East Indian arrowroot. There are other arrowroot plants that must not be mixed up with this one.

The scientific name is *Tacca leontopetaloides*. A Dutch scientist called Rumphius worked in the Moluccas in Indonesia just West of New Guinea and he described *Tacca* plants in the year 1747. He used the word *tacca* from the local Malay language. In 1930 world scientists agreed that the other part of the name, *leontopetaloides*, was to replace the older name *Tacca pinnatifida*.

How is Polynesian arrowroot used?

The starchy tuber is eaten. Normally the tuber is scraped into small shreds and then washed in water. The starch is filtered out and allowed to settle. The starch is washed several times to get rid of bitterness that is common with this plant.

To get clean white starch, the tubers need to be carefully peeled.

The starch can be hung in a cloth to allow the water to drain and then it can be sun-dried. Once dry, the fine powdered arrowroot starch will store well in a sealed jar. The starch is tasteless.

The leaves have been recorded as eaten in Africa.

The yellow fruit is also eaten by children in some places.

Diseases

A leaf spot due to a fungus occurs on leaves of Polynesian arrowroot. The fungus is called *Cercospora taccae*. Mostly these fungal spots have a yellow ring around a brown dead spot.

Insect pests

Soft scale	Margarodidae (HEM)	<i>Icerya seychellarum</i> (Westwood)	
------------	--------------------	---------------------------------------	--



Queensland arrowroot

Names:

Scientific name: *Canna edulis*

What is the plant like?

This is a broad-leafed plant with purple leaf sheaths where the leaf clasps the stem and the large leaves have a brownish purple edge. It can grow up to 2 metres high.

Under the ground it has a large lumpy root like stem that is fleshy and purple. There is a clump of these corms and they are surrounded by leaf scars. New suckers and roots grow out from near these scars. A clump of shoots can occur for one plant.

The flowers develop on a stalk above the leaves and are small and dark red.



Where is it grown?

This arrowroot is mainly grown along the Papuan side and in Central and Milne Bay Provinces and around Port Moresby. It is commonly seen in the Koki and other markets around Port Moresby. It can be grown up to 1600 metres altitude. It can stand some shade but needs a heavy fertile soil to produce well.

How is it used?

The rhizomes are eaten after baking. The tubers can be grated then the starch removed by washing and straining. The leaves can be fed to animals.

Planting

Pieces of the rhizome are used for planting. A spacing of about 1 metre apart is suitable. It can be harvested after about 6-8 months.

Fongaar

Scientific name: *Ipomoea macrantha*

Synonym: *Ipomoea tuba*

Where did the name come from?

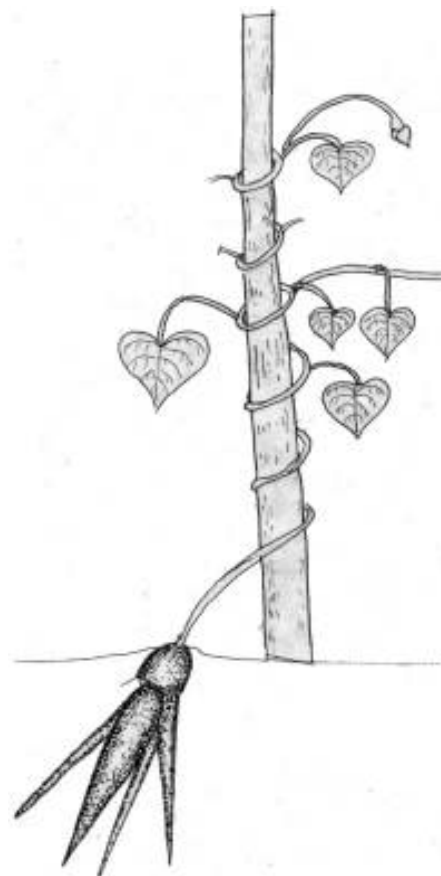
This root crop is grown in the Morehead area south of the River Fly. People in that area treat it as if it is another variety of yam. It is not a yam but a plant in the sweet potato family. It has a number of different names in Tok Ples. These include:

Name	Tok Ples
Hangaar	Arufe
Fongaar	Kondobl

Scientists have given this plant the name *Ipomoea macrantha*

What is the plant like?

The plant has a long angular vine 5 to 6 metres long and it climbs up stakes. The leaves are almost round and are produced singly along the vine. Flowers are somewhat like sweet potato flowers and are produced at the top of the vine. Under the ground it produces a group of large fleshy roots shaped like cassava roots. These are harvested after the vine and leaves die back. The flesh inside the root is white. There is slight variation in the plant with both long and more rounded tubers. There is also some variation in leaf shape.



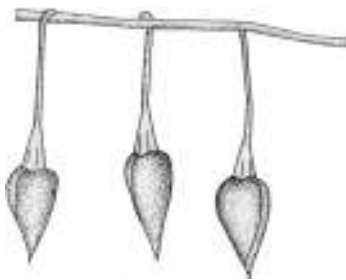
In some places the plant grows wild and is not eaten.

How is it grown?

People plant a section of the top of the fattened root which first grows vines and leaves, then the thickened storage organ is produced. The planting time depends on rains. In the Morehead area they can be planted in November if the rains come but are otherwise planted in December. They can be ready for harvest by July at the earliest and more commonly in September. So they take 7 - 9 months to grow to maturity.

Other parts of the fattened root can be used for planting.

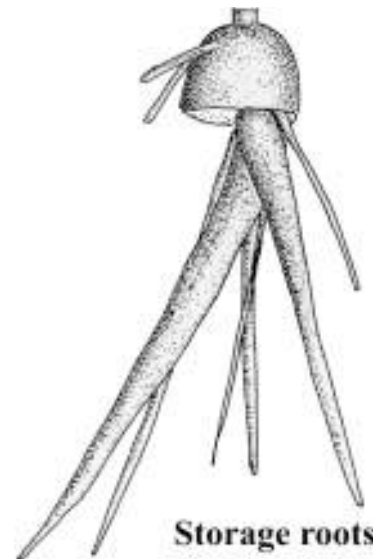
The root can be stored for some time after harvest and this is normally done along with yams in the yam houses. They can be stored for 4 to 5 months.



Flowers



Leaf with leaf spot



Storage roots

How is it used?

The roots are simply roasted and eaten in the same way as yams.

The thickened roots can be up to 65 cm long and 12 cm wide. They can weigh up to 2.5 kg.

Pests and diseases

These have not been studied. An obvious leaf spot occurs on the leaves. This is most likely due to a fungus.



Edible leafy greens

Aibika	104
Amaranth	110
Blackberried nightshade	118
Ferns	120
Climbing swamp fern	121
Tree ferns	122
Diplazium	123
Kumugras	124
Waterfern	124
Fig leaves	125
<i>Ficus pungens</i>	127
<i>Ficus copiosa</i>	128
Kangkong	129
Kalava (<i>Ormocarpum</i>)	131
Rungia	132
<i>Dicliptera papuana</i>	134
Tu-lip	137
Valanguar	135
Watercress	142
Rorippa	143
Water dropwort (<i>Oenanthe</i>)	145
Waterleaf	147



Edible leaves

Many plants have leaves that are edible and are of high nutritional value. This includes many plants that are grown for other reasons. Here is a list:

Sweet potato	Taro tru	Chinese taro
Swamp taro	Giant taro	Elephant foot yam
Cassava	Breadfruit leaves	Jackfruit leaves
Peanut	Winged bean	Lablab bean
Snake bean	Cowpea	Pigeon pea
Lima bean	Common bean	Pea
Jack bean	Mung bean	Green gram bean
Rice bean	Velvet bean	Broad bean
Highlands kapiak	Chilli	Wandering Jew
<i>Desmodium microphyllum</i>	Nettles	Choko
Cucumber	Pumpkin	Marrow
Snake gourd	Bottle gourd	Wax gourd
Bitter cucumber	Smooth loofah	Angled loofah
Swede	Brussels sprouts	Cauliflower
Kohl rabi	Broccoli	Turnip
Radish	Japanese radish	Celery leaves
Capsicum leaves	Hibiscus leaves	Carrot leaves
Beetroot leaves	Golden apple leaves	Coffee plum leaves
Rukam leaves	Durian leaves	Rosella leaves
Mulberry leaves	Indian mulberry leaves	

Some guidelines for edible green leaves

It is my impression that people in Papua New Guinea experiment with different leaves to see if they are edible and nice tasting. For example, in some areas people have tried eating European potato leaves and still at times eat the young leaves. These are poisonous due to a chemical called solanin and should not be eaten. So leaves can contain poisons and this needs to be thought about before leaves are eaten. Three types of poisons often occur in leaves. These are cyanide, oxalates and alkaloids. Cyanide is common in many plants especially on the tropics because it is made up of three simple things hydrogen, carbon and nitrogen, that occur in all plants. Cyanide is bitter, so if leaves or other plants have an unusual bitter taste it is good to be careful. But cyanide very easily gets destroyed on heating and cooking, so as long as most foods are well cooked, this poison does not cause much trouble. Many wild cassava plants, for example have high levels of cyanide and people know these are bitter and poisonous. Oxalates burn your throat. This effect is commonly known from taro family plants. Some kinds are worse than others. Leaves that burn the throat should be avoided. Alkaloids are less easy to detect without a chemical test. Plants and leaves known to have high levels of alkaloids should be avoided. Some wild yams have high levels of these chemicals.



Aibika



Okra



Amaranth



Basella



Chilli



Waterleaf



Rungia



Kangkong

Aibika

Tok Pisin: Aibika

Scientific name: *Hibiscus manihot* L.

The aibika plant

The aibika plant is a shrubby plant that can grow up to 1.5 or 2 metres tall. The leaves are large and can vary in shape. The bush produces a number of branches and when it is old it sometimes produces yellow hibiscus type flowers and seedpods. The stalks can be green or have red colours on them. Normally the leaves are very dark green, but occasionally pale green types occur.



Where is aibika grown?

Aibika is very common and popular in Papua New Guinea. It is also grown in a number of the island countries of the Pacific, and in Indonesia. It is a plant well suited to hot tropical countries. In Papua New Guinea it grows quickly and easily in coastal areas, but grows more slowly in the highlands. Above 1800 metres altitude above sea level, it only grows poorly and is often eaten by insects as fast as it grows.

Different kinds of aibika

Aibika plants vary in the shape of the leaves and in the amount of red colouring on the stalks and leaves.

Some of the leaf shapes look like this:



The narrow leafed types tend to compete less well with weeds. In some areas people tend to put the narrow leafed types in the middle of the garden, intercropped with kaukau, and the broad leafed kinds near stumps or logs and around the edges of gardens. The pale green leafed kinds that occur only grow very slowly.

How do you grow aibika?

Aibika is normally grown from cuttings. Lengths of about 25 cm (2 or 3 leaf joints or "nodes") of fresh green stem cuttings are used. These are simply stuck in the ground.

A fertile soil is needed. Therefore aibika can be planted in good soil in a newly cleared garden site, or it can be planted near houses where the soil fertility can be built up by adding scraps and compost and ashes.

The growth and colour of aibika leaves can be improved greatly by spraying the leaves each 2 or 3 weeks with a very small amount of the nitrogen fertiliser called urea, dissolved in water. (A 0.5% solution). This uses less fertiliser than putting it on the ground where it can wash away in the rain.

Picking out the tips of branches of aibika plants encourages the plant to produce more branches and therefore more leaves. But when you are harvesting leaves, you should not pick too many off the one bush at the one time. This is because it slows down the growth of more leaves.

If the soil is very fertile, older bushes, which are only growing a few leaves, can be chopped off. The stump left in the ground can then re-grow into a new bush.

What insects damage aibika?

As aibika is such a nice food, it is not surprising that quite a few insects also enjoy it! Many are pests of cotton as well.

Aibika insect pests

The insects damaging aibika can be sorted into 3 groups

1. Leaf chewing insects

Cluster caterpillar	Noctuidae (LEP)	<i>Spodoptera litura</i>
Cotton leaf roller	Pyalidae (LEP)	<i>Sylepta derogata</i>
Cotton semi-looper	Noctuidae (LEP)	<i>Anomis flava</i>
Horned weevil	Curculionidae (COL)	<i>Apirocalus ebrus</i>
Leaf beetles	Galerucidae (COL)	<i>Cassena spp.</i>
Shot hole weevil	Curculionidae (COL)	<i>Oribius spp.</i>
Small black flea beetle	Chrysomelidae (COL)	<i>Nisotra spp.</i>
Giant grasshopper	Acrididae (ORTH)	<i>Valanga irregularis</i>
Short horn grasshopper	Tettigoniidae (ORTH)	<i>Phaneroptera brevis</i>
Tortoise beetle	Cassididae (COL)	<i>Aspidomorpha australasiae</i>
A ladybird beetle	Coccinellidae (COL)	<i>Epilachna signatipennis</i>

2. Stem & leaf boring insects

Aibika shoot boring grub	Noctuidae (LEP)	<i>Earias vitella</i>
Aibika leaf miner	Gracillariidae (LEP)	<i>Acrocercops sp.</i>
A stem boring beetle	Languridae (COL)	<i>Anadastus albertisi</i>
A stem boring beetle	Cerambycidae (COL)	<i>Glenea aluensis</i>

3. Sap suckers

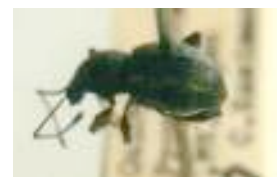
Tip wilt bugs	Coreidae (HEM)	<i>Amblypelta spp.</i>
Nigra scale	Coccidae (HEM)	<i>Parasaissetia nigra</i>
Cotton aphid	Aphididae (HEM)	<i>Aphis gossypii</i>
A small flatid	Flatidae (HOM)	<i>Colgar tricolor</i>
Indian cotton jassid	Cicadellidae (HEM)	<i>Amrasca devastans</i>
Red cotton bug	Pyrrhocoridae (HEM)	<i>Dysdercus cingulatus</i>
A small leaf hopper	Riconiidae	<i>Euricania discigutta</i>
Hibiscus mealy bug	Pseudococcidae (HEM)	<i>Maconellicoccus hirsutus</i>
Armoured scale	Diaspididae (HEM)	<i>Unaspis citri</i>
White scale	Coccidae (HEM)	<i>Pseudaulacaspis pentagona</i>



The most common insect, which can almost always be found on aibika in the highlands, is the small shiny black flea beetle. (*Arsipoda tenimberensis*). It jumps when it is disturbed and chews small round holes in the leaves.



In the Highlands, small grey long nosed weevils (*Oribius spp.*) also commonly chew irregular shaped holes in the leaves.



Because aibika is related to cotton, three similar moths have grubs which damage both cotton and aibika. These are the cotton looper, cluster caterpillar and the cotton leaf roller. The grubs of the first one move by forming loops, the grubs of the second one group together in clusters, and the grubs of the third one roll the leaf by turning it downwards. They all chew leaves.



The aibika shoot boring grub (*Earias sp.*) is the grub of another similar moth. The moth lays eggs on the young parts of the plants and then when the grubs hatch they burrow into the stem.



The nigra scale is a small black scale like insect that gets on the top stems of the plant. It sucks sap weakening the plant. The hibiscus mealy bug has a white floury type growth over the insect. It gets on the stems, sucks the sap and can weaken plants.



How do you control the insect damage?

One simple sensible way to make the damage due to insects less serious, is to grow the plants as well as possible so that the plant grows faster than the insects damage it. Remember aibika likes warm places and fertile soil. On the coast it is easily possible to get aibika to grow quickly but in the highlands insects can eat aibika as fast as it grows.

Oribius weevils are hard to kill with chemicals, but they can be caught and drowned in a tin of water which has a little kerosene on the top. As these insects breed slowly taking about one year for their life cycle, they can't breed up very quickly.

There are over 20 different kinds of aibika in Papua New Guinea and they all don't suffer the same amount of insect damage. So it is possible to pick out kinds that will be less damaged.

Chemicals to kill insects can be used but as they will also kill people, they are dangerous. The chemical called carbaryl will kill larvae of cotton aphid, aibika shoot boring grub, cluster caterpillar and probably cotton looper and cotton leaf roller. But before you use chemicals you must know a lot about them and how to use them. Also you mustn't eat any leaves for 7 days after spraying. It may be as simple, and safer, to pick the grubs off the plants.

What diseases does aibika get?

Aibika doesn't suffer from a lot of diseases. It can get a leaf spot due to a fungus, and it can get a white powdery mildew, also due to a fungus. But these don't seem to cause too much trouble and are not often seen. Sometimes the leaves get an irregular pattern of pale yellow patches amongst the green colour of the leaf. This is due to a virus but it does not seem to stop the growth very much. Cuttings rot off near ground level particularly if they are in wet ground. This is probably due to bacteria and fungi in the soil. In villages people plant a few extra plants to allow for this type of problem.



Leafspot



Collar rot

Other pests

On coastal areas near the main towns the giant African snail badly eats aibika. It is not known in the Highlands Provinces and would only survive in lowland areas. The Giant African snail causes very serious damage when it newly arrives in an area, but gradually over a year or two it causes less damage as things which control its numbers gradually start to breed up and restrict it. It can be controlled by poison baits and can also be restricted by methods like digging straight sided ditches around garden beds to keep it out.

Harvesting and using aibika

The young leaves and shoots are picked. They can be boiled, steamed or fried. Cooked aibika leaves can be very slimy. If it is preferred to have them less slimy, they need to be steamed, such as in bamboo, or fried.

The food value of aibika

Aibika is a very good quality edible green. Not only does it have high amounts of protein, minerals and vitamins, the protein and energy proportions are in a good ratio. This means that it is balanced in a way that makes it easy for the body to use it efficiently.

In a 100 gram portion of the leaves that are eaten, there are the following amounts of the different types of food nutrients.

/ 100 g edible portion								
	Moisture %	Energy cals	Protein g	Calcium mg	proVitA µg	provitC mg	Iron mg	Zinc mg
Leaves		47-103	2.6-5.7	580	90	118	3	

How much food is produced?

At the University of Papua New Guinea at Port Moresby, Dr Kesavan has measured yields of leaves of about 7 tons over an area of one hectare for one crop. This would be equal to harvesting 7 kg of leaves from a plot 10 square metres in size.



Amaranth

Tok Pisin: kumu, sometimes aupa

Scientific names: *Amaranthus caudatus* L.
Amaranthus cruentus L.
Amaranthus dubius Thell
Amaranthus tricolor L.
Amaranthus lividus L.
Amaranthus viridus L.

The amaranthus plant

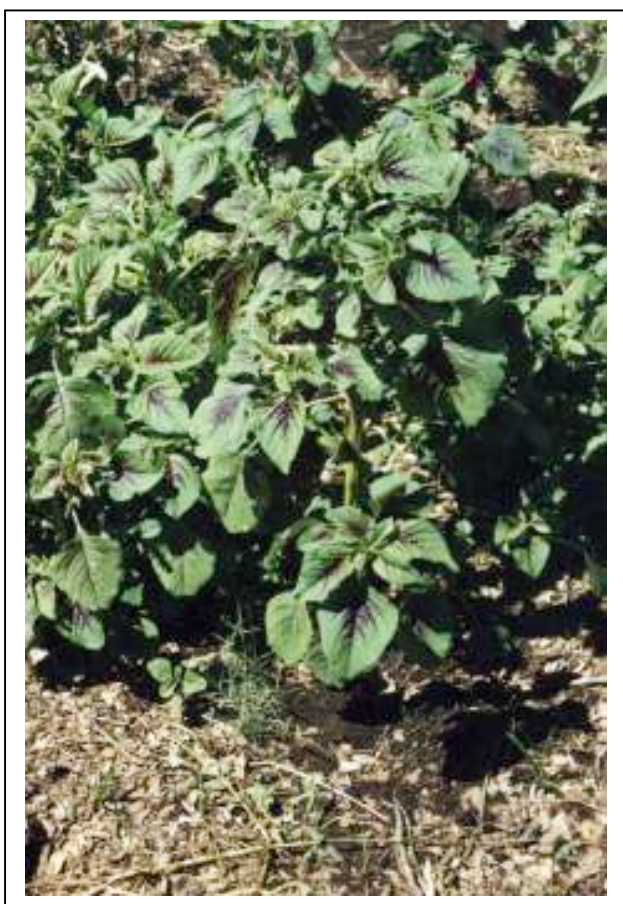
These plants are very quick growing leafy plants that grow in many countries of the world but are particularly suited to tropical countries.

They are mostly grown from seeds and the leaves either cut or the whole plant pulled up, then cooked and eaten.

Different species are used and these are often suited to particular places and climates. Weed species also occur which are not normally used for food.

The colouring of the leaves varies and they can be green, or have red and sometimes yellow colours.

In some countries the seeds of some kinds are eaten as a grain.



These two species seem to be the most important in the Highlands.



Amaranthus cruentus

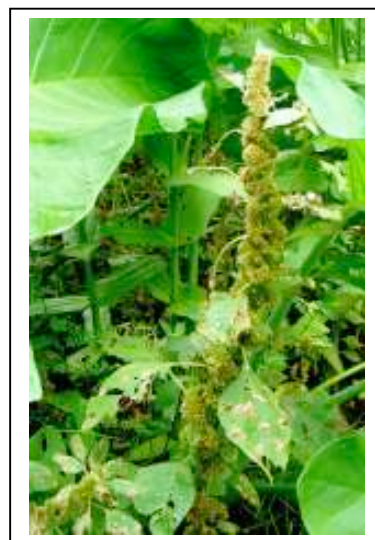
This one is often green and is more common in the higher areas.

It can be other colours on the leaves. Completely blue coloured kinds occur.

Amaranthus tricolor

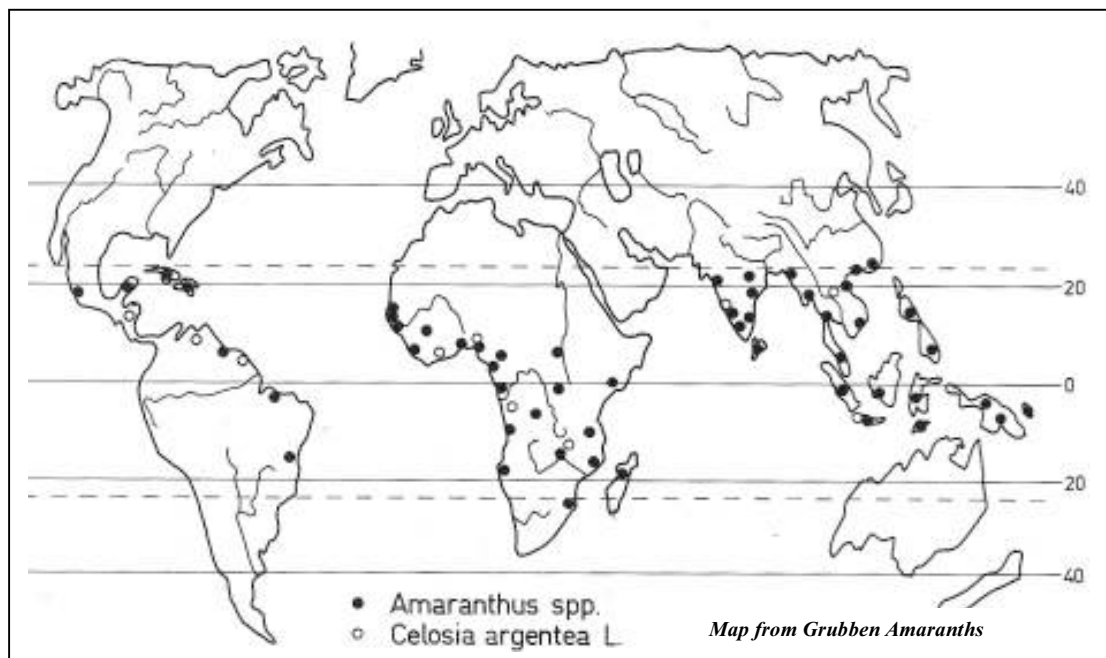
This one often has a red coloured mark in the centre of the leaf.

It tends to be more common in lower areas but is being introduced into higher places.



Where are amaranths grown?

Most people in most villages of Papua New Guinea grow and use amaranths. This is equally true in the Highlands Provinces. Amaranths are also grown and used in most countries of the tropical world. The map below shows some of the places where amaranths are important food.



Kinds of Amaranth

Village people can recognise the variety of amaranth that is commonest in their particular area. But different kinds of amaranths are being taken to different areas of Papua New Guinea. In the Southern Highlands people seem to have swapped their kinds of amaranth. At Erave, the people say that their traditional kind of amaranth is the one scientists call *Amaranthus tricolor*, and that the other one (*Amaranthus cruentus*) is introduced. In the Mendi area people say exactly the opposite about the same two plants.

There are some differences in appearance between the kinds of amaranth. Often the colour or shape of the leaves gives some idea, but it is not always accurate. If you want to be sure about the different species you need to look carefully with a hand lens. These female flowers towards the bottom of the flower head are different.



A cruentus



A tricolor



A dubius



A caudatus

The kinds of amaranths don't seem to cross-breed much with each other so that each kind remains fairly true to its original type. (They may have crossbred in the past to produce the different types.) So each kind in each area seems to remain much the same. Different ones have probably been brought in from other places. Also differences may be due to how they are grown.

How do you grow amaranths?

Amaranths are mostly grown from seeds. Sometimes people in the Highlands grow them from cuttings. The seeds are collected from a mature dry seed head of an old plant. In the Highlands, people often just store these dry flower stalks in their houses and then rub the flowers between their hands over the place where they want the plants to grow. This method is very simple and works alright. If you want to collect the seeds it is fairly easy. The flower heads can be banged on a mat or piece of cloth. Then the rubbish can be blown out of this mixture by dropping it and blowing gently as it falls.

Amaranthus seeds are very small. A thousand seeds weigh about 0.3 g. It is very difficult to sow such small seeds evenly over the ground. So there are a few different methods you can use to try and get the plants well spaced. One way is to mix the seeds with some sand and then when you sprinkle this along a row it will only contain a few seeds among the sand. The other way is to throw the seeds over a small plot of ground that will be a nursery. After 2 or 3 weeks the seedlings can be transplanted into the garden bed where they are to grow. If the seeds are just scattered over the garden, the small seedlings can be thinned out and either eaten or transplanted to a different spot.

It is important to be able to recognise an amaranth seedling when it is small. This is necessary so that it is not pulled out during weeding.

Seedlings look like this:



Seedlings are transplanted when about 5-7 cm tall.

What conditions do amaranth need to grow well?

Amaranths are tropical plants and like hot weather. Normally the hotter it is the better they grow.

They also like plenty of sunlight. Do not plant them in places where they will be shaded. The more sunlight the better they grow.

They need to have water most of the time they are growing. In areas with a high rainfall this is mostly not a big problem.

The soil must be fertile. If they are put in an old garden they will only grow very poorly. So you can either put them in a new garden site when it is cleared from bush, or you can build up the old ground by adding compost. The small gardens close to a house can often be built up to a good fertility by using the scraps and ashes and things that are left over near houses. Amaranths need high amounts of two special nutrients. These are nitrogen and potash. The ashes from fires are high

in potash and that is probably why people in the Highlands have learnt by experience to scatter seeds of amaranth over areas where they have burnt.

For amaranth seeds to germinate they need a temperature above 15°-17°C. In the higher areas of the Highlands above 1800 m., temperatures on the average are probably below this during the months of June, July, August and September. It may be more difficult to get amaranthus started during these months although this has not been studied.

Plant spacing

In other countries a spacing of about 8 cm x 8 cm is used if the plants are to be harvested by pulling up the whole plant. If the harvesting is to be done by picking off the top leaves, a wider spacing is normally used. When the tops are picked out 3 or 4 times over the life of the one plant, a spacing about 30 cm x 30 cm is used.

As far as producing a large amount of food is concerned, the spacing is not very important. Having between 200 and 1,000 plants on each square metre gives about the same total amount of food. The main thing that varies is the size of the leaves. Mostly people like larger leaves so a wider spacing of 8 cm to 10 cm for plants to be pulled out is suitable.

For plants to be harvested by picking out the tops, they can be picked down to about 15 cm high. Picking lower makes the plant flower later, but it also recovers more slowly from picking.

What is the growth of amaranth like?

Amaranths grow quickly. Seedlings come up above the ground in 3 to 5 days. They are 5 to 7 cm high and big enough for transplanting after about 20 days. The plants can be pulled out and used after 6 weeks. If they are harvested by picking out the tops, this can be started at 5 to 7 weeks and continued 3 or 4 times over the next 2 months.

Amaranths eventually stop producing leaves and grow flowers. Flowering occurs after about 3 months and seed can be recollected about a month later. Amaranths are called daylength neutral plants because they still produce flowers at about the same stage, irrespective of whether there are many or few hours of daylight. Because flowering stops harvesting of leaves, it is a problem, but there does not seem to be any easy way of slowing down flowering. Flowering can be delayed a little by picking out the tops down to a lower level. Also it is made a little later if plants are grown in the shade. But lower picking and growing in the shade mean the plants produce less food, so there is no point.



Plants need to be harvested and used when they are ready. If plants are left growing the amount of harvestable leaf gets less and the quality gets poorer.

Pests and Diseases

Amaranths have some pest and disease problems.

Amaranthus insect pests

Beet webworm	<i>Hymenia recurvalis</i>	Pyalidae (LEP)
Cacao armyworm	<i>Tiracola plagiata</i>	Noctuidae (LEP)
Shot hole weevils	<i>Oribius spp.</i>	Curculionidae (COL)
Paddy bugs	<i>Leptocorisa spp.</i>	Alydidae (HEM)
Sucking seed	<i>Cletus sp.</i>	Colobathristidae (COL)
	<i>Nisotra basselae</i>	Chrysomelidae (COL)
Nigra scale	<i>Parasaissetia nigra</i>	Coccidae (HEM)
Pineapple mealybug	<i>Dysmicoccus brevipes</i>	Pseudococcidae (HEM)
Mealybug	<i>Planococcus pacificus</i>	Pseudococcidae (HEM)

Beet webworm

An insect called the beet webworm damages the leaves. The adult of this insect is a moth about 2 cm across the wings. The wings are brown with white stripes. The female moth lays eggs under the leaves and these hatch out after about 5 days to grow into smooth green caterpillars about 2 cm long. These caterpillars eat the leaves and roll them up in a web. If needed, they could be killed by a chemical called carbaryl, but it is poisonous so needs to be handled carefully and people must not eat any of the plants for 7 days.



Cluster caterpillar

Another insect called the cluster caterpillar can also develop large numbers of caterpillars in some seasons and badly damage amaranth. This insect can breed up on other plants such as taro. The caterpillars stay together in groups that gives them the name "cluster" caterpillar.



Caterpillar



Other insects have not been studied. At Wapasali, people complained of mole crickets cutting off young plants and the young plants are probably chewed off, by the black cutworm.

Amaranth diseases

Leaf spot	Fungus	<i>Alternaria sp.</i>
Leaf blight	Fungus	<i>Colletotrichum sp.</i>
Wilt	Fungus	<i>Fusarium sp.</i>
Root knot	Nematode and	<i>Meloidogyne incognita</i> <i>Meloidogyne hapla</i>

Some diseases also damage amaranths. Young seedlings can be killed off by damping off fungi such as *Pythium* and *Rhizoctonia*. These fungi attack the stem just near the ground level and cause the young plants to fall over and die.

Also a fungus called *Choanephora cucurbitarum* (Burk et Rav) Thaxt. grows on the flowers of pawpaws, pumpkins, taro and rice in Papua New Guinea and is known to be a problem with amaranths in other countries. On amaranths it produces a wet rot of the leaves. This fungus is blown by the wind from rotting plant material, where it is common, and then grows on the leaves of amaranth. The wet rotting leaves become covered with grey fungal threads which have black heads covered with a mass of small spores.

For both these diseases, the most practical village level control is to make sure plants are growing as well as possible because healthy plants get less damage. This means good soil, good sunlight and careful gardening. A few extra plants can be planted to make up for the ones which die.

Amaranth as food

Amaranth leaves are very good quality food.

They are also popular. In the year 1670 a man called Rumphius said that in Asia amaranth was "a captain among potherbs". Amaranths are now starting to receive a lot of attention by world scientists. They have started holding worldwide conferences just to talk about amaranths. Many people are starting to discover a plant that Papua New Guineans have had and enjoyed for a long time.

Amaranths should be cooked because they can contain high levels of oxalates and cyanides which could be harmful if eaten raw.

The amount of different nutrients in 100 grams of the leaves are:

<i>Scientific name</i>	Moisture %	Energy KJ	Protein %	ProVit A µg	ProVit C mg	Iron mg	Zinc mg
<i>Amaranthus lividus</i>	84.6	84	3.4		63		
<i>Amaranthus spinosus</i>	91.7	84	3.6		46		
<i>Amaranthus tricolor</i>	91.7	96	2.5	292	43.3	2.3	0.9
<i>Amaranthus viridus</i>	87.3		4.5		169	6.0	

How much will a small plot produce?

Yields of up to one kilogram of edible leaves have been harvested by pulling out plants from an area of one square metre.

If plants are picked 3 or 4 times over 6-8 weeks then two kilograms of edible leaves can be harvested.

From a plant that grows so quickly and is such good quality food this is a very high production.

What signs does a plant on poor soil have?

The two most important nutrients that amaranth needs for good growth are nitrogen and potassium. Plants need 16 different kinds of nutrients to grow properly and if any one runs out then the plant normally shows this shortage in some particular way. If these two run out for amaranth then the signs that the plant show are:-

Nitrogen - the oldest leaves near the bottom of the plant start going yellow. This is because the plant needs more nitrogen to grow more new leaves at the top and there is not enough nitrogen in the soil for it to get it from there. So it re-uses the nitrogen it used in the oldest leaves. These leaves therefore go yellow.

Potassium - When this is short the edges of the oldest leaves go yellow.

These shortages of nutrients could be corrected by adding some nitrogen or potash fertiliser but it is most likely too late for this crop. So you could learn a lesson and build up the soil better for next time. Green plant material well composted provides nitrogen. Legumes also build up nitrogen in the soil. Ashes provide potash.



Blackberried nightshade

Scientific name: *Solanum nigrum*

The plant

This is a small leafy plant in the tomato and potato family. It is grown throughout the tropical world as a nutritious leafy vegetable.



Growing blackberried nightshade

This plant is sown by seed in some areas of the country, especially in the lowlands. But in the highlands it often just comes up naturally especially after grassland is burned with fire. In the high altitude areas at about 2400 m it is the first edible green to be ready when a new garden is established.

So this plant is common as both a sown and self sown vegetable in coastal areas and is common as a self sown vegetable in the high altitude areas but is much less commonly seen in the mid altitude zones between 800 to 1000 m.

Blackberried nightshade grows very quickly and produces lots of seed which also grow very easily. This means it can beat weeds and is one of the first edible greens in a new garden.

Seed germination 1 week

Plant establishment 8-10 weeks.

Harvested 5-8 times over a 6-8 week period.

Seeds are normally sown simply by broadcasting them over newly prepared garden land.

Names

This plant can occur in similar types but they contain different numbers of the genetic parts that control plant growth. These different types have been given different scientific names. It appears they can all interbreed. Plants like this are called a polyploid series and those with 2 sets of chromosomes are called diploid, those with 4 sets are tetraploid and those with 6 sets are called hexaploid. So the different name used are:

Diploid (n=12) *Solanum nodiflorum*

Tetraploid (n=24) *Solanum luteum*

Hexaploid (n=36) *Solanum nigrum*.

Scientists are still discussing these variations because of their concern that some of these plants may be poisonous. Many people in Papua New Guinea and in other tropical countries have eaten large amounts of these leaves all their lives and have not suffered any ill effects.

As a food

This plant occurs in many countries of the world and in many areas outside the tropics it is often regarded as poisonous. It has been tested in some tropical countries and no poison has been found.

In trials this plant has been found to produce large amounts of highly nutritious leaves under moderate fertility conditions.

The food value in 100 g edible portion

Edible portion	Moisture %	Energy KJ	Protein %	ProVit A μ g	Provit C mg	Iron mg	Zinc mg
Leaves	87.0	160	4.3	3660	20	1.0	

Pests and diseases

In Papua New Guinea not a lot of insects have been recorded on this food plant but also they have probably also not been studied. The ones that are known to damage it include:

Potato tuber moth	<i>Phthorimaea operculella</i>
Soft scales	<i>Icerya seychellarum</i>
	<i>Pulvinaria ubicola</i>
	<i>Saissetia coffeae</i>

The only disease recorded on it is:

Bacterial wilt *Pseudomonas solanacearum*

Probably some of the other diseases that affect tomato, potato and capsicum also affect it.



Ferns

Some times ferns are eaten in large quantities. At highland pig kills, ferns are one of the most common edible greens. Some ferns are only eaten with meat. Some other ferns are eaten more regularly. Some ferns are very much liked.

Ferns used as edible greens in Papua New Guinea

<i>Asplenium affine</i>	
<i>Blechnum sp.</i>	
* <i>Callipteris prolifera</i>	kumugras
<i>Ceratopteris thalictroides</i>	
<i>Cyathea angiensis</i>	tree fern
* <i>Cyathea contaminans</i>	tree fern
<i>Cyathea rubiginosa</i>	tree fern
<i>Cyclosorus truncatus</i>	giant tree fern
<i>Dennstaedtia</i>	
<i>Diplazium asperum</i>	
<i>Diplazium cordifolium</i>	
* <i>Diplazium esculentum</i>	
<i>Dryopteris arbuscula</i>	
<i>Dryopteris sparsa</i>	
<i>Gleichenia</i>	
<i>Helminthostachys zeylanica</i>	
<i>Lomagramma sinuata</i>	
<i>Microlepia speluncae</i>	
<i>Microsorium commutatum</i>	
<i>Microsorium irioides</i>	
<i>Microsorium linguaeforme</i>	
<i>Nephrolepis biserrata</i>	
<i>Orthiopteris sp.</i>	
<i>Pneumatopteris sogerensis</i>	
<i>Pteris moluccana</i>	
<i>Selaginella opaca</i>	
<i>Sphaerostephanos sp.</i>	
* <i>Stenochlaena palustris</i>	Climbing swamp fern

The ferns marked with an asterix * are probably the ones most commonly used. Other ferns as well are used.

Most of these ferns are not planted but are left when clearing land and are maintained and sometimes transplanted. Normally they are eaten with meat. In some areas they are eaten in large quantities when people kill large numbers of pigs.

With ferns it is mostly just the very young tender leaves that are cooked and eaten. So they are harvested just after the fronds have started to uncurl but before they have begun to harden.

Climbing swamp fern

Tok Pisin:

Scientific name: *Stenochlaena palustris*

Tok Ples names:

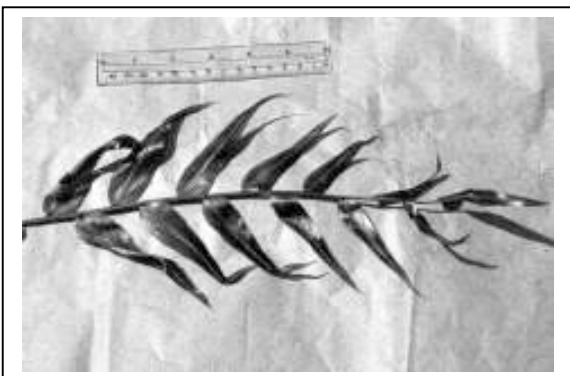
Foi - tunane sai

Kaluli - sa

Podopa - orare

The climbing swamp fern

It is a climbing fern with a thin smooth rhizome which climbs up sago palms and tree trunks. The fronds have several leaflets and they are often red in colour. The fertile fronds are thinner than the other fronds and they are produced at the top of the plant.



Where does it grow?

This fern grows in the lower areas of the Highland Provinces and in other coastal areas of Papua New Guinea. It probably grows up to 900 metres altitude above sea level. It also grows in other warm countries. It likes to grow in a warm, waterlogged, partly cleared forest site. Therefore it is suitable and common in sago type places. It cannot stand frost.

If you want to it is easy to grow from spores.

How is it used?

The young shiny leaflets are picked and cooked and eaten.

Tree ferns

Scientific name: *Cyathea spp*

Three different tree ferns have been recorded as being used for edible green fronds in the highland regions. These are

<i>Cyathea angiensis</i>	tree fern
* <i>Cyathea contaminans</i>	tree fern
<i>Cyathea rubiginosa</i>	tree fern

* This is probably the most commonly used one.

(With *Cyathea angiensis* the fronds occur in a ring of 4 or 5 fronds around the stem and the old fronds fall off immediately;)

These tree ferns can have a trunk up to 2 or 3 metres tall. The fronds are over a metre long and they have scales on all surfaces.

The different species grow at different altitudes.

<i>Cyathea angiensis</i>	600 to 2200 metres altitude
<i>Cyathea contaminans</i>	200 to 1600 metres altitude
<i>Cyathea rubiginosa</i>	110 to 2840 metres altitude

They can very commonly be seen being eaten at highland pig kills. Normally they are only eaten with meat and as meat is not a common item in the diet people do not eat these fern fronds every day. Only the very young fronds are used.



The ferns grow in high rainfall forest areas but commonly to grow in cleared grassland areas if the roots are into moist soil. They are common in the higher altitude zones. When people are making gardens they carefully leave these ferns to grow. Occasionally people transplant one to a more suitable site or nearer their home.

They can easily be grown from spores on the back of the fronds. They can also be transplanted if some of the roots are left on the trunk and the fronds are trimmed. They require abundant moisture and often grow near streams. They also do best in light shade.

These plants are frost tender.

Diplazium ferns

<i>Diplazium asperum</i> <i>Diplazium cordifolium</i> * <i>Diplazium esculentum</i>

The naming of some of these ferns by scientists has been confused. Sometimes these ferns are called *Athyrium asperum*, *Athyrium cordifolium*, and *Athyrium esculentum*.

<i>Diplazium asperum</i> <i>Diplazium cordifolium</i> <i>Diplazium esculentum</i>	250 to 1500 metres altitude
---	-----------------------------

Diplazium asperum is a fern that has fronds up to 3 metres high. The stem of the fern is mostly underground and densely covered with roots. The leaf stalk is rough. They grow best in humid moist and lightly shaded places near creeks and on the edge of forests. They normally grow wild.

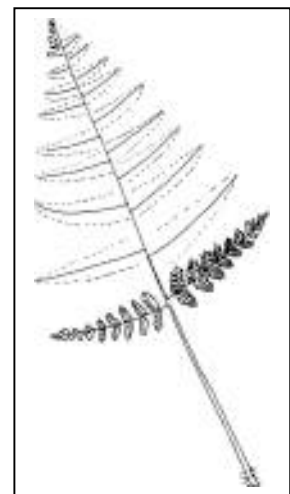
The young, not quite unfolded fronds are eaten cooked.

Diplazium cordifolium is a fern with a tufted rhizome and covered with brown or black scales. The fronds are up to 50 cm long and 12 cm wide. They stick straight up. The fronds are not divided. To grow it must have a minimum temperature over 10°C. It likes a moist protected situation.

Diplazium esculentum is the one of these three ferns that is most commonly recorded eaten. It is a large fern with an upright stem. The leaf stalks are black near the bottom. The end sections of the leaf are divided into many leaflets that are about 8 cm long and 1 cm wide. It is most common in coastal areas and especially in wet areas. It occurs in Malaysia, Indonesia, Philippines and Fiji and is used as a food in these countries.



Diplazium esculentum



Diplazium asperum

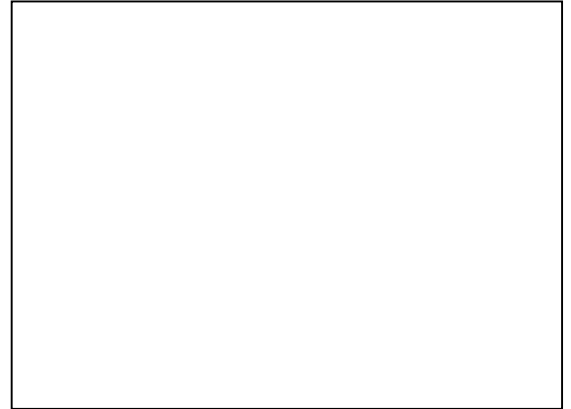
Kumugras

Tok pisin: Kumugras

Scientific name: *Callipteris prolifer*

Tok ples Kuanua: Tubua

This is a fern with a tough woody black rhizome and covered with black scales. They have a narrow, black toothed edge. The fronds are erect and up to 2 metres long. They can be 55 cm wide. They are fleshy and pale green. It likes hot humid conditions.



Water fern

Scientific name *Ceratopteris thalictroides*

This is a fern that grows in water and can float on water. It can also grow on dry land in humid regions. It grows as tufted clumps. The rhizome is short, upright and fleshy with a few scattered scales. The fronds are up to 20 cm long. They are fragile and spongy and light green. The leaves are like carrot tops. The fertile fronds are taller and narrow with the edges curved back under.

It is common near the coast and up to 1200 metres altitude. It is common in flooded coastal streams and near mangroves in fresh water swamps. In other countries it has often been grown along with rice, in paddies and also in areas with flooded taro.

Small pieces of the plant will root in mud. The spores can also grow into new plants.

The plant is edible. It can be eaten raw or cooked. It is used for food in many tropical countries.

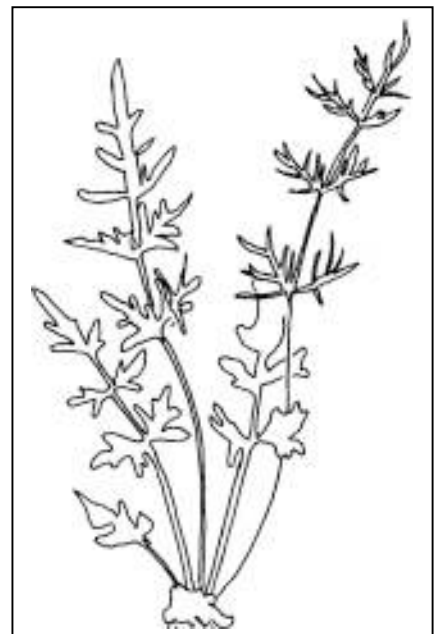


Fig leaves

<i>Ficus ampelas</i>	
<i>Ficus botryocarpa</i> var. <i>subalbidoramea</i>	
<i>Ficus carica</i>	
<i>Ficus copiosa</i>	
<i>Ficus dammaropsis</i>	Highlands kapiak
<i>Ficus iodotricha</i>	
<i>Ficus itoana</i>	
<i>Ficus nodosa</i>	
<i>Ficus pachyrachus</i>	
<i>Ficus pungens</i>	
<i>Ficus tinctoria</i>	Dye fig
<i>Ficus wassa</i>	

Papua New Guinea has a very large number of trees in the fig family. There are probably more than 600 different ones. Many of them have not yet been properly described and named scientifically. Figs have milky sap when the branches are broken. This family also includes trees like breadfruit and mulberry.

For many of these figs the fruit or leaves are eaten.

Ficus copiosa and *Ficus wassa* are probably the two most widely used in the country. *Ficus dammaropsis* or highlands "kapiak" is common in the highlands and the young leaves are eaten, the fruit are eaten and the leaves are often used for wrapping food while it is being cooked. *Ficus tinctoria* or the dye fig is common on some of the islands.





Ficus pungens



Ficus dammaropsis
Highlands kapiak



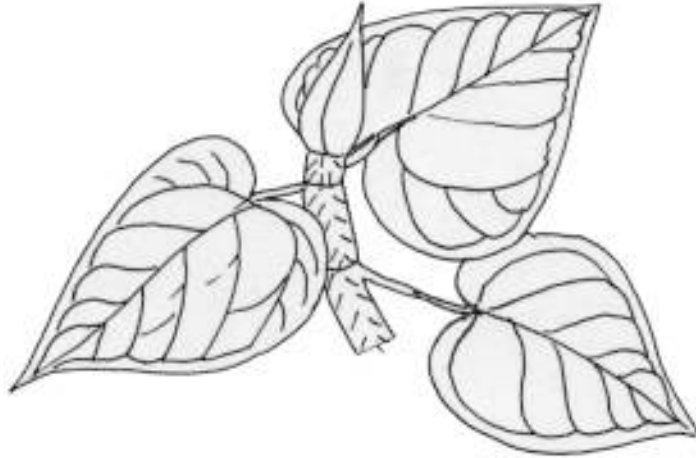
Ficus nota

Ficus pungens

(Scientific name)

No common Tok Pisin or English name

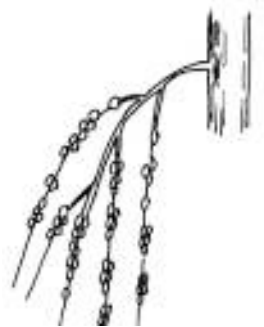
This is a fig family tree and therefore has white milky sap inside. The other part of the scientific name "pungens" refers to the very sharp thorns that are on the small branches near the leaves.



**Young leaves
and thorns**

It is a medium sized tree with large leaves about 25 cm across. The young leaves are light green.

It grows small fruit on long stalks that hang down from the trunk of the tree. These small fruit are about 0.5 cm across and are not eaten.



**Small fruit hanging
on stalks from the
trunk.**

Where does the tree grow?

It only grows in the lower areas below about 1600 metres above sea level. It is common and used in areas like Tari, Poroma, Kagua and most of the lower areas. It mostly grows along the edge of rivers and beside drains and creeks. It mostly just grows naturally from seeds.

How is it used?

The young leaves are cooked and eaten. They are normally only eaten with pig at pig kills.

Ficus copiosa

(Scientific name)

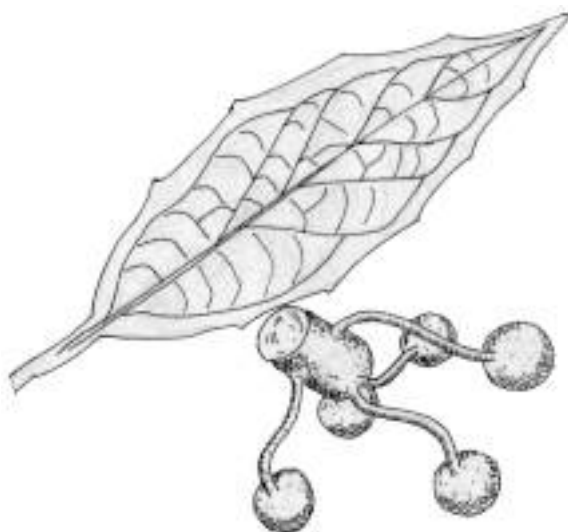
In some areas of the country this tree is planted, pruned and carefully looked after. At Tari in the Southern Highlands, for example people grow this tree from cuttings and use it as a dividing hedge between garden plots. It is pruned to keep its shape and the leaves are regularly harvested and eaten.

But as well this fig tree grows widely naturally in many areas of the country and is commonly used for food.

A leaf tip



A fruiting stalk



Kangkong

Scientific name: *Ipomoea aquatica*

What is the kangkong plant like?

Kangkong is a creeping sweet potato like plant. It has hollow stems and can float on water.

The leaves are green and are normally not divided like some sweet potato leaves, but the shape and size varies a little between different kinds.

The trumpet shaped flower looks like a sweet potato flower and is normally white.

The runners develop roots at the nodes and also branch. This branching increases when tips are picked off.



Names

Sometimes this plant is called water spinach in English. But more commonly the name kangkong is used. Kangkong is the name used in Tok Pisin and is also the same in Malaysian and Indonesian.

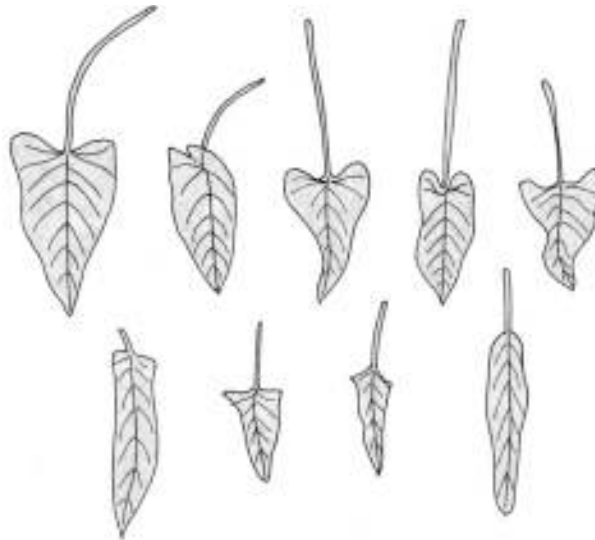
It was given the scientific name *Ipomoea aquatica* by a man called Forskal in the year 1775. Sometimes other scientific names like *Ipomoea reptans* and *Ipomoea repens* are also used for the same plant. The first name is the correct one. Two different varieties of kangkong occur. One floats on water and is grown from cuttings and the other grows on dry land and is grown from seeds.

Where is kangkong grown?

In Papua New Guinea kangkong is a coastal plant and probably only grows satisfactorily up to about 1000 metres. It suits damp places and grows well in swamps. It can grow as a partly floating plant in swamps and lagoons behind the beach along the coast.

Kangkong is grown in a number of other tropical countries including Malaysia, Indonesia, Egypt, Fiji and especially Hong Kong and Taiwan. In some of these countries they grow the dry land form in gardens.

Some of the leaf shapes in kangkong



Dryland kangkong

In recent years dryland kangkong has been introduced into Papua New Guinea. It is grown in garden beds as a clumpy plant and the leaves are eaten.



Kalava

Scientific name: *Ormocarpum orientale*

The plant

This is a traditional green leafy vegetable in Papua New Guinea. Some of the Tok Ples names for it are:

Rabaul	Kalava
Gulf Province	Ula
Kawito	Gaga lave

The scientific name was given it by a scientist named Merrill, who was studying the collections of a Botanist called Rumphius, who had worked in the Mollucas West of Papua New Guinea in the 18 century.

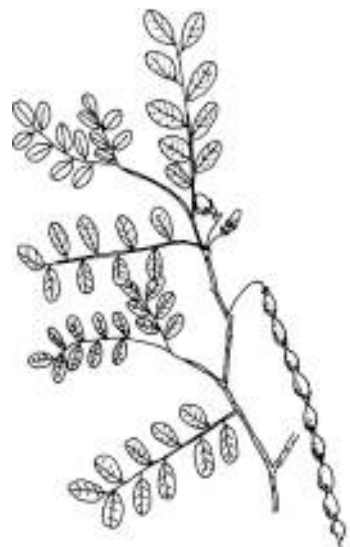
This plant has name been taken to some other places in Papua New Guinea as a food by people have they have moved to live or work. It can be seen in places like Manus and Kimbe.

As well as being planted it also grows wild in the scrub just behind the beach. The wild type is also eaten. Amongst the Tolai people at Rabaul this is one of the shrubs planted as a boundary marker. It mostly occurs below 30 m altitude.



It is a leguminous shrub. It grows to about 7.5 m tall and has a light brown bark which strips off showing greener bark underneath. The leafy shoots are hairy. When the plant flowers it has a flower like a bean and a pale yellowish green in colour with reddish veins. It produces a pod that is up to 9 cm long and jointed in a chain of 2 to 8 seeds. The seeds are small 5 mm and bean shaped. The kind that is planted in gardens tends to have thinner twigs that hang over and the leaves are finer.

It can be planted by cuttings. It also grows from seed.



Rungia

Scientific name: *Rungia klossii*

The Rungia plant

It is a clumpy much branched bush about 40 cm high. Often the leaves are dark green but varieties occur with yellow patterns on the leaves. It has a pale blue flower. At least 20 different varieties occur.



A market bundle of Rungia and Setaria pitpit

Names

This plant has the scientific name *Rungia klossii*. It was given this name in 1916 after the plant was first collected on a botany expedition into West Papua in 1912. This expedition was organised by a Mr. Baden Kloss from the Museum at Kuala Lumpur in Malaysia, so the second part of the name was called after him.

In English it has no common name but could easily just be called Rungia. It has Tok Ples names in highland areas of Papua New Guinea. eg.

Place	Tok ples name
Mendi	taine
Tari	kereba
Eastern Highlands	moku

Where does Rungia grow?

Rungia is only known from Papua New Guinea and Irian Jaya. It occurs in the highlands and grows up to about 1900 metres altitude. In recent times it has been taken down to the coast but as it doesn't grow fast enough to be able to compete with weeds in coastal areas, it is less important.

In some areas such as Telefomin the plant is only poorly known as a wild plant and people pick leaves from selfsown plants in the bush. But in most other highland areas it is one of the most popular and most widely cultivated green leafy vegetables.

The most important areas for Rungia are between 1000 and 2000 metres altitude.

How do you grow Rungia?

Rungia is grown from cuttings. Often cuttings about 25 cm long are used. These stems often already have roots developing from the nodes or quickly develop roots. A number of these cuttings are often planted together giving a clump of plants. These grow slowly at first. It requires a fairly fertile soil and a damp area. Plants are put about 50 cm apart.

Rungia is planted at any time of the year. It takes about 3 to 4 months for a plant to be maturely established. Once established the young tips (2 or 3 leaves) are picked regularly. Regular picking keeps branches short and productive of leaves. The leaves are picked at 1 or 2 monthly intervals for a couple of years.

Rungia is commonly grown in new sweet potato gardens with either sweet potato or highland pitpit in highland gardens.

How much is produced?

The tips that are picked weigh about 0.8 g. One plant produces about 2 kg of leaf tips over a one-year period. If the plants were spaced at 50 cm spacing this would give a yield of 4 kg per square metre of garden.

Rungia as food

The young leaf tips are eaten raw or cooked. After harvesting they will not keep very long. (2-3 days).

Food value (per 100 g of edible portion)

	Moisture %	Energy cals	Protein g	Calcium mg	proVitA µg	provitC mg	Iron mg	Zinc mg
Leaves	87.9	33	2.5	272				

Dicliptera papuana

(Scientific name)

No common English or Tok Pisin name

The plant

This is a clumpy, much branched bush. Most people in villages recognise it as related to *Rungia*. It grows naturally along damp creek banks. It forms a leafy bush up to 1 metre high.

It produces flowers in clumps in the place where the leaves join the stem. The flower petals are blue.

There are small hairs on the leaves and stems. The stems have small grooves running along them.



**A leaf tip of *Dicliptera*
drawn almost true to size**



**A flowering stalk and
flower with blue petals**

How is the plant grown and used?

This plant is planted in gardens in some areas such as the Mendi valley above Mendi and in the Baiyer area. In other areas such as near Lake Kutubu in the Foi area it is harvested from the wild but not planted. At Pangia the Wiru people never eat it.

It grows easily from cuttings of the stem. Normally a group of stalks are planted together to produce a clumpy bush.

The leaf tips are picked and cooked.

Valanguar

Names

Tok Ples Kuanua: Valanguar

Scientific name: *Polyscias* spp.

Because this plant varies a lot and produces many different leaf shapes the scientific naming has become very confused. Many different names have been used. The names *Nothopanax*, *Aralia* and *Panax* have been used as well as a number of other names. It seems the correct name is *Polyscias* but all the different species or varieties have not yet been sorted out. Most likely the ones used for food are:

Polyscias cumingiana

Polyscias fruticosa

Polyscias macgillivrayi

Polyscias scutellaria

Polyscias verticillata



Polyscias fruticosa



Polyscias guilfoylei



Polyscias scutellaria



Polyscias verticillata



Polyscias multijuga



Polyscias samoensis

Some of these are used in the Solomon Islands and in other Pacific islands.

Because of the amount of confusion over the naming of this plant and the amount of material written about it, a summary of the different names often used is given in this table.

<i>Polyscias cumingiana</i> (Presl.) F Vill.	
Syn.	<i>Panax pinnatum</i> Lamk. <i>Panax secundum</i> Schilt. <i>Paratropia cumingiana</i> Presl. <i>Aralia filicifolia</i> C.Moore <i>Panax rumphiana</i> Harms. etc.
<i>Polyscias fruticosa</i> (L.) Harms.	
Syn.	<i>Panax fruticosum</i> L. <i>Aralia tripinnata</i> Blanco <i>Nothopanax fruticosum</i> (L.) Miq. etc.
<i>Polyscias macgillivrayi</i> (Seem) Harms	
Syn.	<i>Nothopanax macgillivrayi</i> Seem <i>Panax macgillivrayi</i> (Seem) Benth. <i>Polyscias grandifolia</i> Volkens etc.
<i>Polyscias scutellaria</i> (Burm.f.) Fosb.	
Syn.	<i>Scutellaria prima</i> Rumph. <i>Crassula scutellaria</i> Burm.f <i>Aralia cochleata</i> Lamk. <i>Panax scutellarioides</i> Reinw. ex Bl. <i>Nothopanax cochleatum</i> (Lamk.) Miq <i>Nothopanax scutellarium</i> (Burm.f.) Merr. etc.
<i>Panax verticillata</i> Stone	

This plant is probably most commonly known as a food amongst the Tolai people of Rabaul and they have taken it to other places in the country. It is often used to form a hedge around their houses and gardens. Constantly picking the leaves helps maintain it as a small pruned shrub. As a shrub they grow from 2 to 5 m tall. The species is probably *Polyscias verticillata*.

The leaves are yellow or pale green. They are used for food from Indonesia to the Pacific Islands but are also grown in many areas simply as an ornamental.

The plants are easily grown from stem cuttings.

The young leaves have a nice smell and are used as a vegetable as well as to flavour stews.



Tu lip

Tok Pisin: Tu lip

Scientific name: *Gnetum gnemon*

What does a tu lip tree look like?

It is a small tree often only 8-10 metres high. It is a fairly straight tree with one trunk that has branches spread out along its length. The branches are not very long so that the tree does not spread out very wide.



Drawing by Celia Bridle

The tu lip tree

In Tok Pisin this small tree is called tu lip. As people in Holland and other countries grow a flower called tulip, we need to point out that the two plants, or their names have nothing in common. The "tu-lip" tree has no common English name although in some countries it is called jointfir. Scientists use the Latin name of *Gnetum gnemon*. This name was given to it by a famous botanist called Linnaeus more than 200 years ago.

People in Papua New Guinea call it "tu lip" because of the way the leaves are arranged. It has two leaves (tu lip) opposite each other along the branches. Often the branches also come out in pairs opposite each other.

The fresh young leaves have a slightly brownish green colour and are in pairs. The older leaves are dark green and shiny.



When the tree has fruit it can be covered with green nut-like fruit that turn red when ripe.



The male and female flowers are separate and are on different trees. So only female trees bear fruit. The flowers are grouped on spikes that develop near the base of the leaves. The flowers are yellow.

This tree is common with some other closely related plants that are called *Gnetum* has rings or hoops at the places where the leaves occur. These can be seen in this picture.



A tu lip tree has ridges running across the trunk that can help you recognise the tree

Why is the tu lip tree so useful?

The young leaves of the tree are eaten and are a very popular green vegetable. They are very good quality food. They have been described as one of God's good gifts to Papua New Guinea.

The nut like fruit and seeds can be eaten. They are also very good food value.

The bark of the tree is good for making ropes and nets.

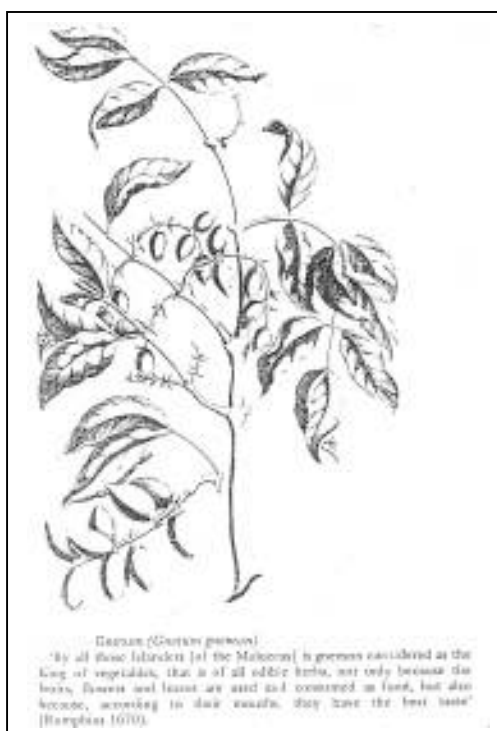
The timber can be burnt green, as firewood.

The timber will last for a long time when used for posts in wharves in fresh water.

Where does the tu lip tree occur?

It grows wild in lowland and lower mountain regions of Papua New Guinea. People in these areas look after it and leave it growing when they are clearing new gardens in the rainforest. They often transplant seedling trees into their gardens and they also grow their own trees from seed.

But the tu lip tree is common in a number of other Asian and Pacific Island countries. Another famous botanist called Rumphius spent many years in Asia. In the year 1670 he commented on the tu lip tree in his notebook. The picture and his comments are reproduced here.



What is the food value of tu lip?

In 100 grams of the part you eat the following amounts of different kinds of food occur.

	Moisture %	Energy cals	Protein g	Calcium mg	Iron mg	proVitA µg	provitC mg	Zinc mg
Leaves	75.4	43-90	3.9-6.4	266-330	2.7-7.7	5900-7100	113-200	
Fruit	80	66	5	163	2.8	600	100	
Dry seeds		345	12			0		

This means that the leaves are very good quality food. The fruit and seeds are also very good quality food. If you eat a nice big bowl of these leaves they will provide a lot of your body-building and your health food needs.

How do you prepare the food?

The young tender leaves are picked and boiled or fried.

The red fruits that are about 2.5 cm long can be eaten raw but they are tough.

The seeds of the ripe fruits are eaten roasted, boiled or fried. Before cooking the seeds it is necessary to either remove the tip or crush the seed, or seeds can explode on heating.

The young flowers including the young fruits are sometimes cooked and eaten.



Snack foods
from tu-lip

Because the parts eaten can contain irritating substances the various parts are normally cooked before being eaten.

How do you grow tu lip trees?

Tu lip trees often grow wild. You can find a small wild plant in the bush and transplant it to where you want it.

You can also grow trees from seed. Collect a very ripe red fruit from a tree. It has one seed inside. If you simply plant it the seed sometimes takes a long time to start growing. You may have to wait 6 months. This is because the seeds have a hard outside layer and it is difficult for moisture to get in to start the seed growing. To get the seed to start growing more quickly you can carefully file a small hole through the outside layer of the seed.

If you are going to plant several trees they should be planted about 6 m apart.

Because this tree grows naturally under larger trees in the rainforest it is suited to growing in places where there is some shade. Therefore you can plant the tree in a partly shaded place if you want to.

If you want to, you can grow trees from cuttings. This means you take a small branch off a tree and plant it in warm moist soil where it will develop roots and grow.

How much food?

The leaves of very small seedling tu-lip trees in the rainforest are harvested of their young leaves as people walk past. So an early harvest can be gained. Like many tropical trees, tu-lip trees grow by producing flushes of new leaves throughout the year. So leaves are not always equally available. In fact many tulip trees have fresh young leaves for picking at one main season of the year.

It is not equally important in all these areas. At Erave people harvest it out of the bush where trees grow naturally. But they don't use it a lot. At Podopa villages, like Woposali and Boro, and Foi villages such as Hegiso, trees are grown in and around the villages. People in these areas recognise and have names for 3 or 4 different varieties. Near Bosavi, the Kaluli people mainly harvest leaves and seeds from wild trees. Although trees are rarely planted the self-sown trees are protected when clearing bush for gardens and they are look after in gardens.

Pests and diseases

Tu-lip insect pests

<i>Eucalymnatus tessellatus</i> (Signoret)	Coccidae (HEM) soft scale
<i>Milviscutulus mangiferae</i> (Green)	Coccidae (HEM) soft scale

Probably the insect pests of tu-lip have not been properly studied.

Watercress

Names:

English: Watercress

Tok Pisin: Wara kebis

Scientific name: *Nasturtium officinale*

The plant:

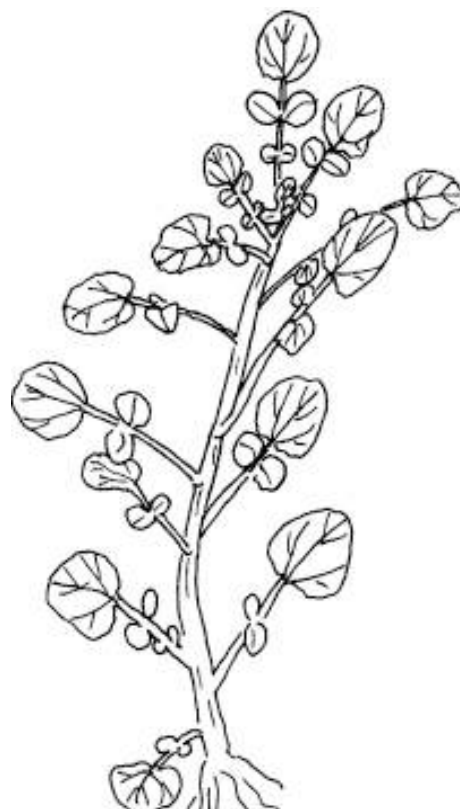
This plant has been introduced but has become an important and popular edible green in the highlands regions.

This small plant keeps living for many years once established. The stems are hollow, angular and with many branches. The plant has roots along the stem at the node and cuttings quickly form roots in water. The leaves consist of 3 to 7 pairs of small leaflets then a larger leaflet at the end. The flowers are small and white and a small narrow curved seedpod is produced. Flowers are not always produced and need days with more than 12 hours of sunlight to form.

It is grown from rooted sections of the plant. These are established in the mud beside a stream or in a shallow flowing creek. Once it is established it often keeps growing with very little care or maintenance. It does best in creeks that flow off limestone country. Plants can float on the water. It will not tolerate drying out. It can also be grown from seeds.

The young leaves and stems are eaten. They can be eaten raw and has a spicy flavour. It can also be served cooked. Cooking should be used if the water in the stream is not pure and clean.

This plant keeps growing well in mountain streams up to at least 2900 metres altitude.



Rorippa

Names:

There are several plants in Papua New Guinea that are probably all *Rorippa spp.* but several of them have been called *Nasturtium sp.* They are grown or used as food plants. These include:

Rorippa schlechteri

Rorippa islandica (Oed) or yellow marsh grass. This one is self sown and used in the high altitude regions.

Rorippa schlechteri is grown as a vegetable in gardens in the highlands. It is sown by broadcasting the seeds. Because it has a well-developed taproot, the plant does not transplant easily. Normally the whole plant is eaten cooked.



Plants grow quickly and are harvested after 4 to 6 weeks.

It is common in the highlands from 1000 to 2200 metres altitude but will grow down to the coast.

It appears to get damaged by similar insects to cabbage.



Insect pests

It is badly damaged by caterpillars of the insects that commonly damage cabbage in the highlands especially the cabbage cluster caterpillar.

Cabbage cluster caterpillar *Crociodolomia binotalis* Pyralidae (LEP)

The caterpillars of this moth have an orange head and are green with 3 white lines on top. They are up to 2 cm long and live for 14 days. The moth is 12 mm long and with a wingspan of 22 mm. The moth is greyish brown with irregular markings. There are two small white spots of the front wings. These caterpillars eat holes in the leaves of a number of plants in the cabbage family. They leave dark chewed-up lumps on the leaves. They can regularly cause 90% damage to the more leafy types. Plants damaged include *Nasturtium schlechteri*. The insect avoids light so eats on the underside of leaves. They are difficult to control but can be controlled with chemicals.



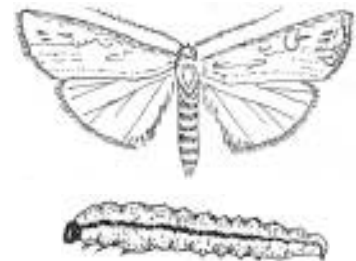
Diamond back moth *Plutella xylostella* (L.) Plutellidae (LEP)

This moth is brown with a diamond shape on its back. It is about 7 to 12 mm long. The green caterpillars eat irregular shaped holes on the leaves of cabbage family plants. They are very common. The larvae drop from the plant on silken threads when they are disturbed. They damage *Nasturtium schlechteri*, and other plants in the cabbage family. The moth tolerates a wide range of climates but gets worse in hot dry areas. They are difficult to control but can be controlled with chemicals.



Black cutworm *Agrotis ipsilon* (Hufnagel) Noctuidae (LEP)

The caterpillars of this moth are brown on top with green sides and up to 30 mm long. They have a shiny skin. They cut off seedlings at ground level. They hide in the soil coiled up in a ball. The moth has a wingspan of 40 to 50 mm and the front wings are brown while the rear wings are yellow/brown. They do this damage at night. Damage occurs in a range of plants grown from seed including *Rorippa sp.*, and cabbage. They tend to get worse in areas that have been low-lying damp areas especially where there have been many weeds present.



Water dropwort

Scientific name: *Oenanthe javanica*

The plant

This plant is a hollow stemmed creeping green leafy vegetable. The stem is often up to 100 cm long and normally lies along the ground and turns up near the tip.

The leaves are finely divided like carrot tops but the size, shape and colour of the leaves can vary quite a bit, even on the one plant. The leaves often have leaf sheaths that wrap around the stem.

The flowers occur at the ends of the branches and are a group of small white flowers.



Where does the plant grow?

In Papua New Guinea this is one of the commonest green leafy vegetables of the Highland areas. In recent times it has been introduced into coastal areas and still grows quite well. Floating masses of it can be seen in some coastal streams such as West New Britain.

In the highland areas it is common in gardens up to 2600 metres altitude and has been seen growing up to 3400 m altitude.

It normally grows near creeks or in wet or damp patches in gardens. The hollow stemmed branches can actually float on water and the plants seem to thrive along drains and ditches.

This plant is also grown as food in several other countries. It is common in Indonesia and Malaysia and is also grown in India, Vietnam, China, Taiwan and a number of other South East Asian and Pacific countries. It is a traditional vegetable with ceremonial importance in Japan.

Names

Because the leaf shape and appearance of this plant can vary considerably, it has had some different scientific names. The correct name is *Oenanthe javanica* and it was given this name by a scientist called De Candolle in 1830. The other most commonly used scientific name has been *Oenanthe stolonifera* but as the two plants are the same this name has now been replaced.

It has no commonly accepted English or Tok Pisin name. Names such as water celery and water dropwort have been used in English. Because several other *Oenanthe spp.* plants are very poisonous, it is probably not a good idea to just use "oenanthe" as the name and run the risk of confusing a good vegetable with other poisonous plants. It has many different Tok Ples names.

Growing water dropwort

This plant often grows wild. These selfsown plants are not as tasty as the cultivated types but they are eaten.

The plant is also grown in gardens. It is planted by using cuttings. Often 5 or 6 cuttings are planted in a hole made with a digging stick. In moist soil the plants establish quickly and easily.

It is also possible to grow the plants by seeds, but these are rarely used in PNG.

Water dropwort as food

The leaves and young tips of the plant are often eaten raw or cooked.

The amount of different nutrients in a 100 g sample of this food is shown in this table.

	Moisture %	Energy cals	Protein g	Calcium mg	proVitA µg	provitC mg	Iron mg	Zinc mg
Leaves	90.6	28	1.8	113	2190	14	3	

A chemical called myristicin has been shown to occur in water dropwort. Because of this, it may not be good to eat large amounts of this vegetable.



Leaf shapes



Market bundle

Waterleaf

Tok Pisin:

Scientific name: *Talinum triangulare*

The waterleaf plant

This plant is a small shiny leafed plant that grows up to about 60 cm tall. The leaves have very short stalks and are fairly soft and light green in colour.

The plant produces a flower stalk at the top. This stalk is triangular shape. A clump of pale pink flowers, with 5 petals, grows at the top.

The plant grows upright and has a number of branches.



Where is waterleaf grown?

Waterleaf or *Talinum* is grown in a number of tropical countries. Tolai people say the Japanese brought it to the Gazelle. How long it has been in Papua New Guinea is not known, but it has only recently been brought from the Gazelle Peninsula to the Kutubu area in the Southern Highlands. It is seen in some coastal areas but not always used.

It is grown in Africa, South America, Indonesia and the Philippines. It suits the lowlands probably below about 1000 metres altitude as it does best in hot places.

How do you grow waterleaf?

Waterleaf can be grown from seeds or cuttings.

The seeds are very small and black. It takes 4000 seeds to weigh one gram. It is not easy to collect seeds because the seed capsules split open very easily and the seeds drop out. Also plants don't always produce seeds readily. But you can collect seeds and grow plants from seeds. This is

easiest by sowing seeds in a small nursery then transplanting the small plants when they are about 5-8 cm high. With very small seeds like these, it is best to mix the seeds with dry sand before sowing. Then a small amount of the seed/sand mixture can be sown and the seeds will not be too close together. Seeds will grow in about 6 days.

Another way to grow waterleaf is to use cuttings. Cuttings of 15-20 cm long can be taken from the older, but not the woody part of the stem. The leaves should be taken off the cuttings. The cuttings need to be planted in warm moist soil. They should be about 20 cm apart.

Older waterleaf plants can be cut back and allowed to sprout again.

Is waterleaf in any way special?

Waterleaf is one of the plants scientists call C4 plants because it has some special ways of moving food around and storing food inside the plant. This means it can normally grow very fast if it is given the right conditions. The conditions these types of plants prefer are high temperatures, high soil fertility, plenty of sunlight and sufficient water. But even though the plant grows best under these conditions it doesn't have to have them. It can grow reasonably well under lower soil fertility conditions and is very good at surviving dry times and will grow with a little shade.

How is waterleaf used?

The young tender leaves and tips of branches are picked off. Sometimes they are eaten raw in salads, but more commonly they are cooked. The bottom part of the leaves sometimes turns slightly brown on cooking and the cooking water can become a little coloured. It is best to steam the leaves in bamboo.

The leaves have a slightly sour taste and are a little slimy.

Pests and diseases

In other countries few pests or disease problems have been noticed. These have not been looked at in Papua New Guinea.

How much food is produced?

In other countries, waterleaf plants are ready to start picking after about 4 weeks. Leaf tips may be picked every two weeks for up to a year. Normally the top shoots are picked out first, to let the side shoots grow.

Up to 5 kg of edible tips have been harvested from one square metre area of plants over one year.

Food value

Waterleaf leaves are a quite reasonable quality green leaf vegetable.

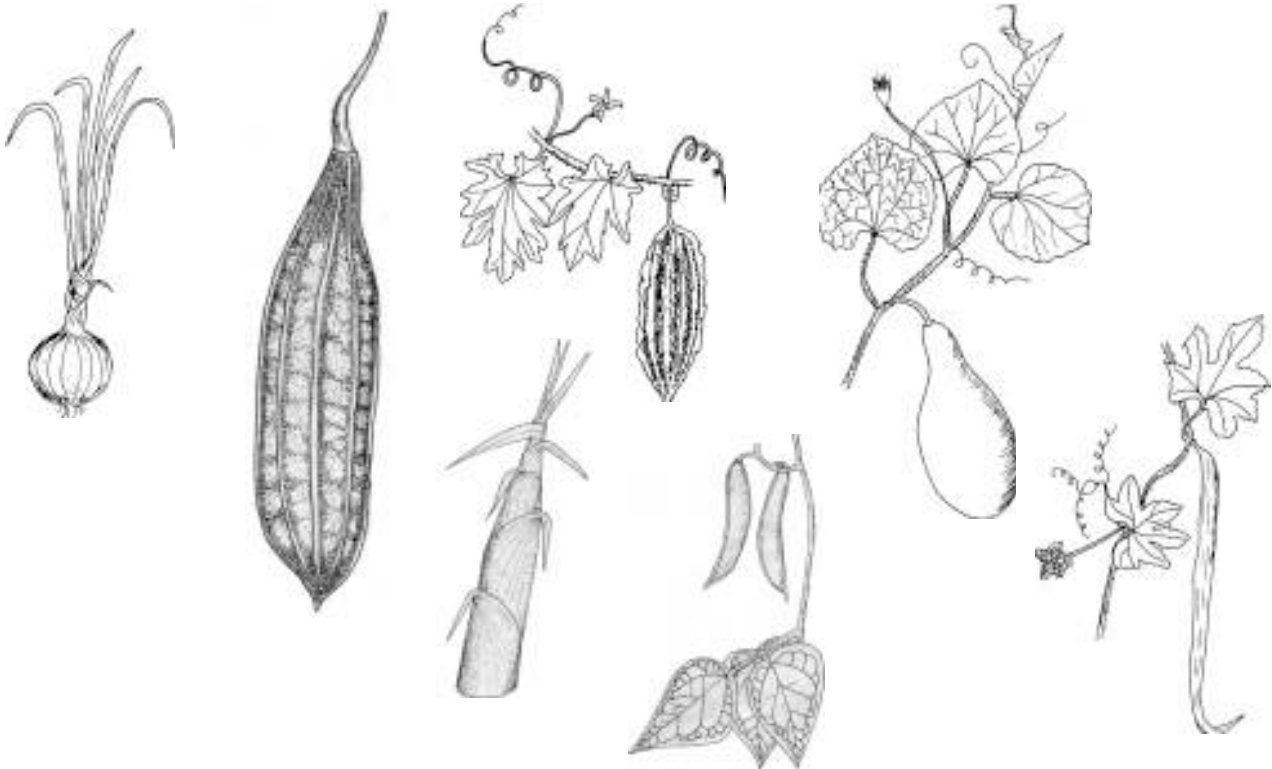
The amount of different nutrients that it contain in each 100 gram portion of the leaves that are eaten is shown in this table.

	Moisture %	Energy cals	Protein g	Calcium mg	Iron mg	proVitA µg	provitC mg	Zinc mg
Leaves	92.4	23	1.9	90	4.8	3	60	

These leaves contain reasonably high levels of the chemical called oxalates. This is the chemical that causes some taro plants to burn your throat and it occurs fairly commonly in tropical leafy vegetables. Too much of it is not good.

Vegetables

Bamboo	- small and large	
Beans	- common bean	
	- cowpea	
	- long or snake bean	
	- lablab bean	
	- lima bean	
Cabbage family	- cabbage	
	- Chinese cabbage	
	- <i>Nasturtium schlechteri</i>	
Capsicum and chilli		
Corn		
Ginger		
Job's tears		
Peanut		
Pitpits	- coastal or long pitpit	
	- highlands or short pitpit	
Pumpkin family	- bottle gourd	
	- choko	
	- cucumbers	
	- pumpkins	
	- angled loofah	
	- smooth loofah	
	- bitter cucumber	
	- <i>Trichosanthes pulleana</i>	
Onions	- leeks	
	- spring onions	



Bamboo

One of the common bamboos in Papua New Guinea is the coastal bamboo or mambu in Tok Pisin which is grown near houses and is used for cooking utensils and building materials and also has shoots which are eaten. It is easily grown by planting cut portions of the green stalks.

In the highlands from about 1200 m altitude to 1900 m another large bamboo is grown. This one is traditional to Papua New Guinea and is common in large clumps near houses. It is commonly used for cooking leaves and small insects and sago and pieces of meat over the fire. It is also used for carrying water. It has young shoots that are cooked and eaten.

In some areas especially near Lake Kutubu, there is another small bamboo that is grown in gardens and eaten like a pitpit. They are planted from cuttings of the cane and take about one year to produce. The young shoots are cooked and eaten. This bamboo has canes that grow about 5 m tall but often they do not stay erect but fall over on the ground. The canes are about 3 cm thick. It flowers almost continually and this plant is also harvested from the wild and eaten.



Bambusa vulgaris



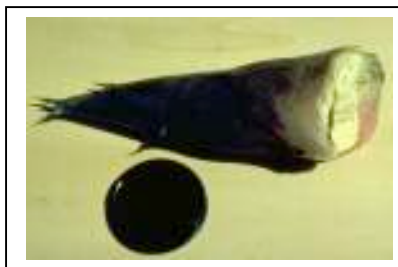
Nastus elatus



Bambusa forbesii



Nastus elatus



Bambusa forbesii



Beans

Several different beans are grown for food in Papua New Guinea. These include:

- Common bean
- Snake bean
- Lablab bean
- Lima bean
- Winged bean
- Cowpea

And some less well known ones like:

- Mung bean
- Green gram
- Scarlet runner bean
- Soybean
- Rice bean
- Yam bean
- Sword bean
- Jack bean
- Velvet bean
- Adzuki bean

This article will mainly be about common bean, snake bean, cowpea, lima bean and lablab bean. These are the ones most widely grown throughout the country. Winged beans are important but are dealt with separately. Peanuts are also described in a separate article.



Common bean



Rice bean



Yardlong bean



Cowpea



Lablab bean



Lima bean



Sword bean



Jack bean



Scarlet runner bean



Soybean



Broad bean



Pigeon pea



Yam bean



Winged bean

Common bean

Scientific name: *Phaseolus vulgaris*

Common bean or French bean can be either a short or a climbing bean. It occurs in many different varieties. The pods are slightly curved and with a distinct beak at the end. Normally there are 4 to 6 beans in a pod. The climbing kinds can be 2 metres tall and the dwarf ones 20 to 60 cm tall. There are also kinds that are grown for the dry mature seeds but these are less common in food gardens.

The unripe pods are cooked and eaten.

These beans perform reasonably well in the highlands but mostly in the lowlands they are too badly damaged by pest and disease.

Snake bean

Scientific name: *Vigna unguiculata* subsp. *sesquipedalis*

Names

This bean has been called yard-long bean and sometimes the vegetable cowpea and in other places, the asparagus bean.

What is the bean like?

Mostly this bean is a climbing bean grown in the lowlands. There are short or dwarf varieties available but these are normally not popular. The pods can be up to 1 metre long and are flexible and mostly less than a centimetre thick. The seeds are widely spaced in the pod. This bean is grown from sea level up to about 300 metres altitude. It is normally easier and more successful to grow this bean than common bean in the lowlands.

How does it grow?

This bean grows very quickly and well on the coast of Papua New Guinea. It needs to have sticks to climb up or can be put near a fence or small tree. Often, a circle of sticks tied together, are placed in a circle and a number of seeds planted in a mound. It only grows as an annual bean so seeds need to be replanted each year. It needs a good rainfall and is not suited to areas with drought. When the climbing bean is growing very vigorously the top is picked out to prevent it getting too tall.

How is snake bean used?

Mostly the young green pods are eaten cooked. The young shoots are also eaten cooked. The ripe seeds can also be eaten. The pods need to be harvested every 2 or 3 days.

Diseases and pests

Although this bean gets most of the insect and disease problems of other beans it is normally less damaged and can give very good production in most places. Maybe a part of the reason is that it grows very quickly. It can be badly attacked by aphids. Diseases get worse if the bean does not have sticks to climb. The damage by bean pod borer is less if snake beans are grown intercropped with maize. It does not seem to affect the yield of corn cobs where beans are grown with them.



Cowpea

Scientific name: *Vigna unguiculata*

This bean is grown as a cover crop in some plantations and is also a good vegetable. In some areas of Papua New Guinea it has become popular and common. The Baiyer River area is one such area. It will grow from sea level up to about 1800 metres altitude.

What is the bean like?

It is a creeping bean type of plant with short straight, firm pods. Some kinds produce more leaves and are used more as cover crops and other kinds produce more pods and seeds. These are the ones that are best as vegetables. Flowers occur in pairs at the end of the flowering shoots.



How is it used?

The young pods can be eaten and the young leaves can also be cooked and eaten. The more mature seed pods are often cooked then the seeds eaten from the pod by running the thumb along the length of the pod to push the seeds into the mouth.

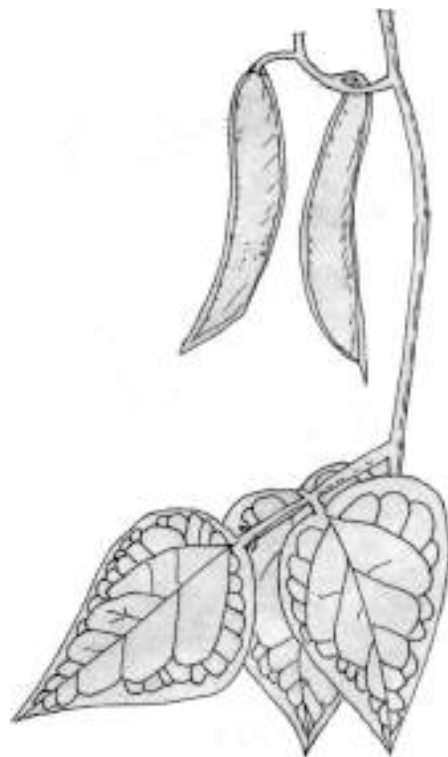


Lima bean

Scientific name: *Phaseolus lunatus*

What is this bean like?

This is vigorous climbing bean that can keep growing for some years. The leaves are slightly rounded at the base and pointed at the tip. The flower is white or yellow. The keel of the flower is twisted which helps tell the difference between this bean and Lablab bean. The pods are flat and have 3 or 4 seeds that vary in colour. The seeds are large. The pods are long (10 cm), flattened and curved. The curved pods were considered like the moon, so were given the Latin name *lunatus* or moon. The seeds have a short round hilum where the seed is attached to the pod. The seeds also have lines going out from this point across the bean seed. It is one of the traditional beans in the highlands of Papua New Guinea.



Where does it grow?

It most commonly occurs between 500 metres and 2100 metres altitude in the highlands, but it will grow up to the limit of cultivation at about 2700 metres. It needs a soil temperature of above 15.5°C for the seeds to germinate and a day temperature of about 22°-30°C for satisfactory flowering. It does not suit waterlogged soil.

How is it grown?

It is grown from seed. Coloured seeds are often hard to get to grow but white seeded kinds start growing easily. So for coloured kinds, it is important that they are planted when regular rain occurs as the water washes away some of the chemicals that stop the bean growing.

When is food produced?

Young pods can be harvested about 3 months after planting beans.

What is the food like?

Leaves tend to be bitter and seeds can also contain poison. They should be cooked and the cooking water changed. White seeded varieties have less of this problem than the highly coloured seeded kinds.

Diseases and pests

A rust fungus grows on the leaves. The fungus is called *Phakopsora vignae*.



Lablab bean

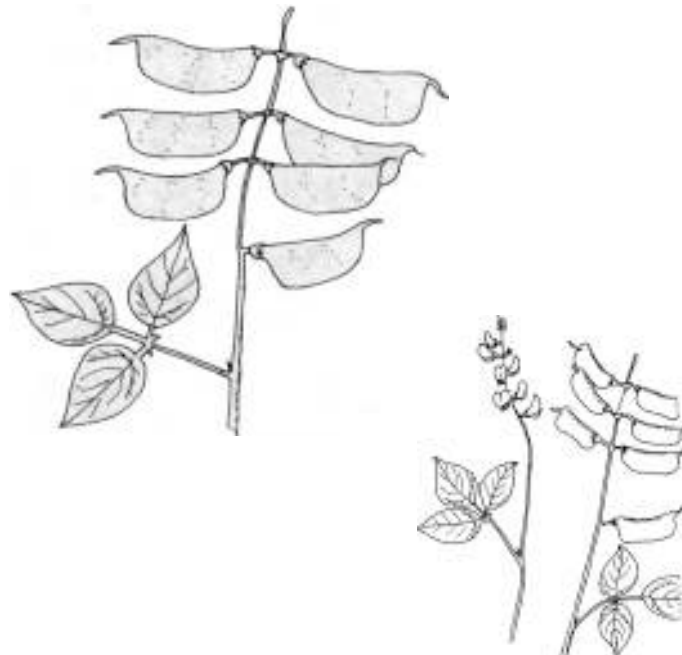
Scientific name: *Lablab purpureus*

This plant has been given different scientific names at different times. The correct name is *Lablab purpureus* and the other two names *Lablab niger* and *Dolichos lablab* are now no longer correct. It is similar in many ways to lima bean (*Phaseolus lunatus*). It can be distinguished from this other bean because the keel or boat like part of the flower is not twisted and there is a long point on the end of the pod. As well on the seeds there is a long narrow white slit (hilum) where the seed is attached to the pod.

Because this is a traditional bean in the highlands of Papua New Guinea it has names in Tok Ples but often no Tok Pisin name that distinguishes it from other beans. A number of different varieties occur in village gardens.

It is a plant that could keep growing from year to year, but mostly in Papua New Guinea it only lasts for a short time of 1 to 3 years. It is a climbing bean and the vines can be from 1 to 5 metres long. For this reason it is often planted near fences or at the edge of gardens. The leaves are made up of 3 almost triangular leaflets. The plant often has a purple appearance. The flowers are mostly white but they can be red or blue. They are produced on a long flower stalk.

The pods are flattened with a pointed end and can be up to 12 cm long and 2 cm wide. There are between 3 and 5 seeds inside and these can vary from white to a dark colour.



Where does it grow?

This bean is mostly grown between 750 and 2175 metres altitude. It is a bean that can survive a drought and can grow in low rainfall areas. It can grow on poorer soils but does not do well on waterlogged soil. It is good at fixing nitrogen in the soil. It needs temperatures between 18°C and 30°C to grow best. It can continue to grow where temperatures are down to 9°C. Light frosts will damage the leaves but may not kill the plant. In humid weather less seed pods form.

How quickly is food produced?

Young pods are ready for harvesting between 4 to 6 months after the beans are planted and the mature seeds are ready between 6 to 8 months after planting. The pods can continue to be harvested over 2 or 3 years. In cold weather less flowers and pods are produced.

Which parts are eaten?

It is possible to eat the young leaves and shoots as well as the young pods and the ripe seeds. They should all be cooked as some types can have a poison in them. With some types, the cooking water is thrown away, as it contains the poison after cooking.

This bean can have a thickened root that can be eaten.

What pests and diseases cause problems?

Two fungal diseases are often seen on these beans.

These are angular leaf spot due to a fungus called *Cercospora canescens* and a leaf spot due to a fungus called *Ascochyta dolichi*.

These diseases seem to commonly occur but they may not result in serious loss of beans.



Food value of bean family plants per 100 g edible portion

Common name	Moisture %	Energy KJ	Protein %	ProVit A µg	Provit C mg	Iron mg	Zinc mg	Edible portion
Aila	43.0	1008	4.5	0	2			Nut
Common bean	10.0	1386	25.0	10	1	8.0	2.8	Seeds dry
Common bean	92.0	142	3.0		20	0.8	0.2	Seeds green
Common bean	88.0	151	2.5	750	27	1.4	0.2	Pods green
Common bean	77.3	351	6.6	668	25	1.8	1.0	Pod + seed
Common bean	80.4	304	5.6		17	1.3		Seeds green boiled
Common bean	90.7	121	4.2	0	38.7	0.8	0.4	Seeds sprouted
Cowpea	11.2	1189	23.5		1.5	6.4		Seeds - dry
Cowpea	88.4	143	4.2	712IU	35	4.7	0.3	Leaves raw
Cowpea	91.3	92	4.7	576IU	18	1.1	0.2	Leaves - boiled
Cowpea	75.5	406	3.2	79	2.2	1.1	1.0	Seeds boiled
Cowpea	89.5	142	2.6	45	17.0	0.7	0.2	Pods boiled
Green gram bean		439	7.0	2.4RE	1.0	1.4		Seed cooked
Green gram bean	11.0	1432	22.9	55	4	7.1		Seeds dry
Green gram bean	90.4	126	3.0	2	13.2	0.9	0.4	Seed sprouted
Kudzu	68.6		2.1			0.6		Roots
Lablab bean	10.0	1428	22.8		Tr	9.0		Seeds - dry
Lablab bean	82.0		4.5		1	10.0		Pods fresh
Lablab bean	86.9	209	3.0	14	5.1	0.8	0.4	Seeds - young
Lima bean	12.0	1407	19.8	Tr	0	5.6		Seed dry
Lima bean	67.2	515	6.8	37	10.1	2.5	0.8	Seed - cooked
Lima bean	70.2	473	6.8	30	23.4	3.1	0.8	Seeds raw
Mung bean	12.0	981	22.0	24	Tr	8.0		Seeds - raw
Mung bean	93.4	88	2.0	1	11.4	0.7	0.5	Seeds sprouted
Peanut	4.5	2364	24.3	0	Tr	2.0	3.0	Seed dried
Peanut	45.0	1394	15.0	Tr	10	1.5		Seed fresh
Pigeon pea	10.0	1449	19.5	55	Tr	15.0		Seeds dry
Pigeon pea	71.8	464	6.0	13	28.1	1.6	0.8	Seeds young
Rice bean	13.0	1373	20.9			10.9		Seeds
Scarlet runner bean	12.0	1419	20.3	Tr	7	9.0		Seeds
Soybean	9.0	1701	33.7	55		6.1		Seeds
Soybean	68.0	584	13.0	16	27	3.8	0.9	Seeds immature
Soybean	79.5	339	8.5	1	8.3	1.3	1.0	Seeds sprouted
Velvet bean	7.29		29.32		4.78			Seeds
Winged bean	8.5	1764	41.9		Tr	15.0		Seed dry
Winged bean	87.0	205	7.0	13.0	18.3	1.5	0.4	Seeds - young
Winged bean	92.0	105	2.1					Pods fresh
Winged bean	57.4	619	11.6	0	0	2.0	1.4	Roots
Winged bean	95.0	197	5.0	809	30	6.2	1.3	Leaves

Diseases of the bean family of plants

Aila nut

		Fungus	<i>Helotium inocarpi</i>
--	--	--------	--------------------------

Bean-common

	Leaf spot	Fungus	<i>Alternaria tenuis</i>
	Leaf spot	Fungus	<i>Ascochyta phaseolarum</i>
	Anthracnose	Fungus	<i>Colletotrichum lindemuthianum</i>
	Angular leaf spot	Fungus	<i>Phaeoisariopsis griseola</i>
	Collar rots	Fungi	<i>Athelia rolfsii</i>
		and	<i>Rhizoctonia solani</i>
	Leaf blight	Fungus	<i>Thanatephorus cucumeris</i>
	Leaf spots	Fungi	<i>Cercospora canescens</i>
	(on old leaves)	and	<i>Cladosporium oxysporum</i>
		and	<i>Corynespora cassicola</i>
		and	<i>Periconia byssoides</i>
	Floury white mould	Fungus	<i>Mycovellosiella phaseoli</i>
	Rust	Fungus	<i>Uromyces appendiculatus</i>
	Mosaic	Virus	Bean common mosaic virus ?
	Root knot	Nematode	<i>Meloidogyne arenaria</i>
		and	<i>Meloidogyne incognita</i>
	Bacterial blight	Bacteria	<i>Xanthomonas phaseoli</i>
	On seeds	Fungus	<i>Aspergillus sp.</i>

Broad bean

	Leaf spot	Fungus	<i>Ascochyta sp.</i>
	Leaf spot	Fungus	<i>Cladosporium sp.</i>
	Sooty mould	Fungus	<i>Epicoccum sp.</i>
	Leaf blight	Fungus	<i>Fusarium sp.</i>
	Leaf spot	Fungus	<i>Phoma sp.</i>

Cluster bean (Guar bean)

	Powdery mildew	Fungus	<i>Oidium sp.</i>
--	----------------	--------	-------------------

Cowpeas (and snake bean)

	Leaf spot	Fungus	<i>Alternaria sp.</i>
	Leaf spot	Fungus	<i>Ascochyta phaseolarum</i>
	Leaf spot	Fungus	<i>Cercospora canescens</i>
	Leaf spot	Fungus	<i>Corynespora cassicola</i>
	Root rot	Fungus	<i>Fusarium sp.</i>
		and	<i>Athelia rolfsii</i>
	Leaf spot	Fungus	<i>Phoma exigua</i>
	Powdery mildew	Fungus	<i>Sphaerotheca fuliginea</i>
	Leaf blight	Fungus	<i>Thanatephorus cucumeris</i>
	Rust	Fungus	<i>Uromyces vignae</i>
	Mosaic	Virus	Cowpea mosaic virus
	Root knot	Nematode	<i>Meloidogyne javanica</i>
	Storage rot	Fungus	<i>Botrydiploia theobromae</i>

Green gram bean

	Leaf spot	Fungus	<i>Cercospora canescens</i>
	Powdery mildew	Fungus	<i>Oidium sp.</i>
	Yellow mosaic	Possibly virus	

Jackbean

	Leaves small & distorted	Probably virus	
--	--------------------------	----------------	--

Kudzu

	Yellow mould	Fungus	<i>Mycovellosiella puerariae</i>
	False rust	Fungus	<i>Synchytrium minutum</i>
	Leaf spot		

Lablab bean

	Leaf spot	Fungus	<i>Ascochyta dolichi</i>
	Angular leaf spot	Fungus	<i>Cercospora canescens</i>
	Tip wilt	Fungus	<i>Choanephora cucurbitarum</i>
	Leaf blight	Fungus	<i>Thanatephorus cucumeris</i>
	Small twisted leaves	Probably virus	
	Root knot	Nematode	<i>Meloidogyne arenaria</i>

Lima bean

	Rust	Fungus	<i>Phakopsora vignae</i>
	Concentric spots	Fungus	<i>Phoma exigua</i>
	Root knot	Fungus	<i>Meloidogyne incognita</i>

Mung bean

	Leaf spot	Fungus	<i>Alternaria sp.</i>
	Leaf spot	Fungus	<i>Phoma exigua</i>
	Leaf spot	Fungus	<i>Phyllosticta sp.</i>
	Leaf spot	Fungus	<i>Myrothecium roridum</i>
	Collar rot	Fungus	<i>Athelia rolfsii</i>
	Mosaic	Virus	
	Root knot	Nematode	<i>Meloidogyne incognita</i>

Pea

	Leaf spot	Fungus	<i>Ascochyta pinodes</i>
	Leaf spot	Fungus	<i>Mycosphaerella pinodes</i>
	Brown mould	Fungus	<i>Fulvia fulvum</i>
	Powdery mildew	Fungus	<i>Oidium sp.</i>
	Leaf spot	Fungus	<i>Phyllosticta sp.</i>
	Mosaic	Probably virus	
	Root knot	Nematode	<i>Meloidogyne incognita</i>
	Dry rot seeds	Fungus	<i>Penicillium sp.</i>

Peanut

	Seedling death	Fungus	<i>Aspergillus niger</i>
	Collar rot	Fungus	<i>Athelia rolfsii</i>
		and	<i>Botryodiplodia theobromae</i>
	Large leaf spot	Fungus	<i>Leptosphaerulina trifolii</i>
	Leaf spot	Fungus	<i>Cercosporidium personatum</i>
	Leaf spot	Fungus	<i>Colletotrichum sp.</i>
	Leaf spot and pod rot	Fungus	<i>Leptosphaerulina trifolii</i>
	Leaf spot	Fungi	<i>Mycosphaerella arachidicola</i>
		and	<i>Mycosphaerella berkeleyi</i>
	Collar rot	Fungus	<i>Phomopsis sp.</i>
	Rust	Fungus	<i>Puccinia arachidis</i>
	Root rot	Fungus	<i>Pythium sp.</i>
		and	<i>Rhizoctonia</i>
	Blackening stems	Fungus	<i>Thanatephorus cucumeris</i>
	Bacterial wilt peanut	Bacterium	<i>Pseudomonas solanacearum</i>
	Mosaic	Virus	
	Leaf mottle	Virus	Marginal leaf chlorosis virus
	Mild mottle	Virus	Cowpea mild mottle virus

Pigeon pea

	Leaf spot	Fungus	<i>Mycovellosiella cajani</i>
	Pink disease	Fungus	<i>Phanerochaete salmonicolor</i>
	On seeds	Fungus	<i>Aspergillus niger</i>
		and	<i>Chaetomium sp.</i>
		and	<i>Curvularia lunata</i>
		and	<i>Fusarium solani</i>
		and	<i>Penicillium sp.</i>
		and	<i>Nigrospora oryzae</i>

Rice bean

	Blossom blight	Fungus	<i>Choanephora cucurbitarum</i>
	False rust	Fungus	<i>Synchytrium phaseoli</i>
	Rust	Fungus	<i>Uromyces sp.</i>
	Root knot	Nematode	<i>Meloidogyne arenaria</i>
		and	<i>Meloidogyne javanica</i>
	On seeds	Fungus	<i>Aspergillus niger</i>
		and	<i>Penicillium sp.</i>
		and	<i>Periconia byssoides</i>
		and	<i>Rhizopus nigricans</i>
		and	<i>Verticillium sp.</i>

Soya bean

	Leaf spot	Fungus	<i>Ascochyta sp.</i>
		and	<i>Cercospora canescens</i>

	Rust	Fungus	<i>Phakopsora pachyrhizi</i>
	Bacterial leaf spot	Bacteria	<i>Xanthomonas campestris</i>
	Leaf distortion	Possibly virus	
	Mosaic	Possibly virus	
	Yellow mosaic	Virus	
	Root knot	Nematode	<i>Meloidogyne sp.</i>

Winged bean

	Flower blight	Fungus	<i>Choanephora cucurbitarum</i>
	Anthracnose	Fungus	<i>Colletotrichum lindemuthianum</i>
	Leaf spot	Fungus	<i>Didymella sp.</i>
	Collar rot	Fungus	<i>Macrophomina phaseolina</i>
		and	<i>Fusarium spp.</i>
		and	<i>Thanatephorus cucumeris</i>
	Sooty mould	Fungus	<i>Meliola erythrinae</i> v. <i>psophocarpi</i>
	Powdery mildew	Fungus	<i>Oidium sp.</i>
	Leaf spot	Fungus	<i>Pseudocercospora psophocarpi</i>
	False rust	Fungus	<i>Synchytrium psophocarpi</i>
	Leaf curl	Possible virus	
	Little leaf	Possible mycoplasma like organism	
	Root knot	Nematode	<i>Meloidogyne incognita</i>
		and	<i>Meloidogyne javanica</i>

Yard-long bean (Snake bean)

	Leaf spot	Fungus	<i>Choanephora cucurbitarum</i>
	Powdery mildew	Fungus	<i>Sphaerotheca fuliginea</i>
	Rust	Fungus	<i>Uromyces vignae</i>
	Mosaic	Virus	Cowpea mosaic virus



Floury white mould bean



False rust Kudzu



Leaf spot Aila



Leaf spot winged bean

Insect pests of bean family plants

Aibika leaf miner *Acrocercops sp.* Also damages soybean.

Bean leaf rollers *Lamprosema indica* and *Lamprosema diemenalis*. Larvae tie leaves of beans together with silken threads. Then they eat away the leaf tissue. They damage peas, peanut, soybean, winged bean, cowpea, snake bean, mung bean, velvet bean, pigeon pea and other beans. They feed on most species of grain and vegetable legumes in Papua New Guinea.

Bean pod borer *Maruca testulalis* These insects can cause serious damage to the pods and seeds of most beans. They damage Lima, snake, mung, adzuki, rice bean, snake bean, cowpea, winged bean, soybean, velvet bean, and pigeon pea. The larvae bore into the young pods and can enter the stems. The hole where they enter the plant is normally filled with chewed up plant material. They also eat other plant parts.

Cacao armyworm *Tiracola plagiata*. On lima beans, common beans, winged bean. The larvae eat young soft growing parts of the plants and can also eat weeds and other bush trees.

Cluster caterpillar *Spodoptera litura*. They damage a range of crops - beans including winged bean, peas, peanuts. Quite often the damage is only slight but in some seasons they can do extensive damage. They move between crops and the numbers depend on the climatic conditions.

Coconut spathe moth *Tirathaba rufivena* and also *Tirathaba igneivena*. The larvae attack beans.

Coffee leaf roller *Homona coffearia*. Damages by eating leaves and rolling up leaves. Also damages soybean, pea, snake bean, velvet bean, peanut, mung bean. It is more serious in the highlands.

Common grass blue butterfly *Zizina otis*. The larvae feed on the leaves of a range of beans including pigeon pea, snake bean, soybean and winged bean.

Corn earworm *Heliothis armigera*. The larvae feed on leaves and fruit. They damage a range of plants, pigeon pea, garden peas, beans. Rain helps the pupae develop and warm moist weather makes the pest worse.

Cotton semi-looper *Anomis flava*. The larvae of this moth can often damage black velvet bean throughout the year. They eat the tissue of leaves leaving veins.

Green looper *Chrysodeixis chalcites*. Larvae also damage beans, and legumes. Reported snake bean, eating leaves. They can completely eat the soft tissue of leaves of soybean.

Pea Blue butterfly *Lampides boeticus*. The larvae feed on flowers and bore in the pods of a number of legumes including snake beans, pigeon pea, mung bean, cowpea, peas, winged bean, pigeon pea and Crotalaria.

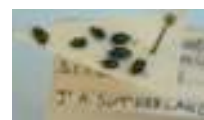
Rice armyworms *Mythimna loreyi* & *Mythimna separata*. They are reported damaging winged bean leaves.

Winged bean blotch miner *Leucoptera psophocarpella*. Damages winged bean leaves on the underside of leaves.

Phyllocnistis sp - a leaf miner also listed as occurring on winged bean

Bean weevil *Acanthoscelides obtectus*. It damages the seeds of all beans both in the field and in storage. The larvae feed inside the seeds then leave round holes as the adults leave. In the field the damage by the very small larvae is scarcely noticed and the main damage is done after harvest. They are favoured by warm dry conditions.

Black flea beetle *Arsipoda tenimberensis*. This insect damages common bean and soybean and probably some other plants. The insect causes characteristic damage. It is widespread but the damage is normally not important.



Horned weevil *Apiocalus spp.* Occur up to about 1600 m altitude. Damage to peanut, mung bean. It mainly attacks growing points and soft shoots. It chews the leaves eating holes and this is often called shot hole damage. Other insects do similar damage. The damage is often not serious.



Cassena papuana Chrysomelidae beetle. Leaf beetles attack beans including common bean, mung bean, soybean, snake bean, broad bean. Important occasionally.



Psylliodes sp nr fulvipes Chrysomelidae beetle. Feeding on snake bean. Cause minor damage to leaf epidermis.



Leaf eating ladybird *Henosepilachna signatipennis* and *Henosepilachna haemorrhoea* (*Epilachna signatipennis* also eats bean leaves.) Both the larvae and adults eat the leaves, young fruit and flowers of plants. They eat common bean, winged bean, mung bean, soybean, and a number of other legumes. They tend to prefer higher humidity. Many ladybird beetles look similar but are in fact good insects because they feed on aphids. These *Epilachna* species have a covering of fine hairs that helps tell them from the good species.



Monolepta beetles *Monolepta spp.* They damage leaves and flowers of mungbeans. They feed on young shoots.



Pumpkin beetles *Aulacophora spp.* They damage beans including common bean, mung bean, soybeans, peanuts, broad beans.



Shot hole weevils *Oribius spp.* They feed on a wide range of plants. Targets are one. They also eat snake bean, mung bean, lima bean, and others. They chew irregular shaped holes.



Amblypelta bugs *Amblypelta spp.* They suck sap and secrete a toxic saliva. A few insects can cause extensive damage. They attack mung beans, winged bean. They can cause plants to wilt and fruit to drop off.



Cacao mirid *Helopeltis clavifer*. They have piercing mouthparts that secrete a toxic substance that produces a dead spot on the plant. They can cause the death of the terminal bud and growing shoot of plants. One insect can make 50 feeding punctures a day. Young fruits can die and older fruits can be deformed. They have been recorded damaging 25 species of plants in PNG. These include snake bean, and Leucaena. The insects occur from sea level up to 1670 m altitude.



Cowpea aphid *Aphis craccivora* These aphids are often found feeding on snake beans. They rarely cause much damage. Large numbers get on cowpea in the wet season. They can also attack other beans including winged bean, mung bean and lima bean. They cluster in large numbers near the tips of stems and shoots and their feeding causes these parts to be deformed. Plants can be stunted and wilt. Their importance for spreading viruses is not known. They can spread cowpea mosaic virus. They also damage peanuts. They can be spread in the wind.



Foxglove aphid *Aulacorthum solani* Reported on beans. It attacks plants in the potato/tomato family spreading virus diseases.



Grass bug *Alticus tibialis* Sap feeder on mung bean and soybean. Can also feed on peanuts.

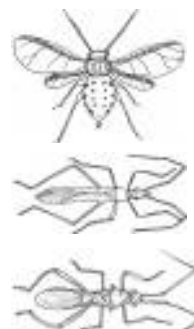


Green peach aphid *Myzus persicae*. It does damage by direct feeding and by transmitting viruses. Often the insect is scarcely noticed and the main result is the diseases it spreads. The direct feeding damage cannot normally be seen. It attacks a very large number of plants and spreads a very large number of virus diseases. It damages beans.

Green vegetable bug *Nezara viridula*. They damage a number of vegetables and fruits by sucking the sap. They damage beans, including winged bean, rice bean, soybean, broad bean, mung bean, snake bean. Both the young nymphs and the adults suck sap. The sucking of the sap causes plants to wilt. Also it can cause lumps and deformed fruit. The insects give off a smell that affects food to eat. It is a more serious pest in the lowlands.



Melon aphid *Aphis gossypii*. Large numbers can cause leaves to curl and this can stunt the plant growth. It can reduce the numbers of flowers and fruit formed. The aphids also release a sticky substance called honeydew and this often encourages the growth of sooty moulds. Aphids transmit disease. They damage winged bean.



Paddy bugs *Leptocorisa spp.* Bugs can feed on beans.

Pod sucking bug *Riptortus spp.* It can cause severe damage to winged beans, snake beans, mung beans, soybeans, lima beans, peas, common bean and probably other beans. It sucks the pods. They occur throughout the year.



Stink bug *Plautia brunneipennis*. Reported sucking sap of snake bean.

Sugarcane aphid *Aphis sacchari*. It can damage beans. Sugarcane is the major hosts.



Bean fly *Ophiomyia phaseoli*. Plants turn yellow and stems become swollen and cracked and break off in wind. This insect commonly does serious damage during dry seasons. 8 to 10 maggots per plant can kill a seedling. Common bean is very easily damaged. It is probably the most important bean pest. It has been recorded on common bean, snake bean, soybean, mung bean.

Shootfly *Atherigona orientalis* Larvae also attack fruit of common bean.

Phaneroptera brevis *Phaneroptera brevis*. It attacks beans including winged bean, pigeon pea, peas, by eating the leaves. It is often found in shady places.



Red spider mite *Tetranychus marianae*. It commonly attacks leaves of peas, dwarf beans and winged beans. Other plants can also be attacked. They live on the lower surfaces of leaves often near veins. Yellow spots are produced then drying of the leaves occurs. They suck sap and leave a fine silk webbing. They get worse in hot dry weather. They can cause heavy damage to beans.

Other bean insect pests:

<i>Adoxophyes tetrastrecta</i> Meyrick	leaf roller
Larvae reported damaging leaves velvet bean.	
<i>Adoxophyes sp</i>	leaf roller
Reported damaging peanuts, soybean, peas.	
<i>Anticarsia irrorata</i> F.	Noctuidae (LEP.)
Reported eating leaves of mung bean and snake bean. Also known to attack velvet bean.	
<i>Araecerus fasciculatus</i> Degeer. Coffee weevil.	
Reported damaging winged bean.	
<i>Araecorynus cumingi</i> Jekel	Anthribidae (COL.)
Reported damaging winged bean.	
<i>Bothrogonia sp</i>	Cicada bug
Sap-sucker of kidney bean.	
<i>Brachyplatys papuus</i> Guer.	Pentatomidae (HEM.)
Recorded damaging beans. Also damages some tree legumes.	
<i>Brachyplatys sp</i>	Pentatomidae (HEM.)
Recorded sucking pod of velvet bean.	
<i>Caedius demeijerei</i> Geb.	Tenebrionidae (COL.)

Reported damaging beans especially young seedlings to which they can cause considerable damage. The adults are found on the ground under beans.

Chauliognathus waroensis Wittmer Cantharidae (COL.)

Reported damaging bean leaves in highlands.

Coelophora inaequalis F. Coccinellidae (HEM.)

Reported damaging soybean. Leave circular holes in leaves. Normally predator of aphids.

Colposcelis vignaphila Bryant Chrysomelidae (COL.)

On common bean.

Demonax collaris Pascoe Cerambycidae (COL.)

Reported damaging soybean in highlands.

Epilachna signatipennis Boisd.- leaf eating beetle

Reported damaging rice bean, common bean, cowpea, lima bean.

Erythroneura sp. Cicadellidae [Jassidae](HEM.)

Adults and nymphs feeding on underside of leaves of winged bean. Damage sometimes severe.

Euproctis sp. Lymantriidae (LEP.)

Reported eating leaves of winged bean.

Euricania discigutta (Walk.) Plant hopper

Reported damaging beans.

Euricania villica plant hopper

Reported sucking sap of common bean.

Halticus minutus Reuter flea hopper.

Reported on peanuts and beans. Sucking sap of common bean, soybean.

Homeoxipha fuscipennis Gryllidae (ORTH.)

Reported chewing leaves of winged bean.

Hyposidra talaca (Wlk.) Geometridae (LEP.)

Eating leaves of common bean. The caterpillar attacks many woody plants. The larvae are brown and bear rows of white spots across the body. The mature larvae lower themselves on threads and pupate 2-4 cm deep in the soil. The eggs are iridescent and in clusters. One female may deposit several hundred eggs. A life cycle takes 2.5 to 3.5 months at 1700 m altitude.

Megalurothrips usitatus Bagnall Thrip

- on mung bean, peanut, soybean, lima bean.

Melacanthus argineguttatus Alydidae (HEM.)

Recorded sucking pods of mung bean.

Nyctemera baulus Boisduval Arctiidae (LEP.)

Larvae damaging winged bean leaves.

Nysius epiensis China Lygaeidae (HEM.)

Reported damaging beans. Adults cause yellow spotting of foliage. Also on peanuts.

Orchamoplatus mammaeferus (Quaintance & Baker) Aleyrodidae

On beans.

Pachybrachius nervosus Horv. Lygaeidae (HEM.)

Reported causing yellow spotting on beans.

Piezodorus rubrofasciatus Fab. Pentatomidae (HEM.)

Sucking pods of mung bean.

Plautia brunneipennis Stink bugs

Reported damaging snake bean.

Prosopius oblique plagiatus Breuning Cerambycidae (COL.)

Reported on pods of winged bean.

Rhinoscapha funebris Chev. Weevil

Reported on soybean.

Rhyparida coriacea Jac. Chrysomelidae (COL.)

Reported feeding on leaves of mung bean.

Rhyparidella wauensis

Reported adults eating leaves of soybean, mung bean, broad bean.

Ropica honesta Pascoe Cerambycidae (COL.)

Reported damaging dry winged bean pods.

Zygina sp. Cicadellidae (HEM.)

Reported on winged bean leaves.

Cabbage family

Several different plants in the cabbage family are grown for food in Papua New Guinea. Some of these like broccoli, brussels sprouts, kohlrabi, and cauliflower are mostly only grown by Europeans or for sale to Europeans. Others like European cabbage have become very popular and common in the high areas in the highlands. Some plants in this family have also been grown for many years or are probably traditional Papua New Guinea food plants. Some of these do not have common English names eg *Nasturtium schlechteri*. Others like watercress have been introduced into highland creeks and in some areas almost grow naturally. Chinese cabbage is popular and common in coastal areas. Others like Chinese radish and English radish are often only grown for sale. Only some of these plants will be described here.

Cabbage

Scientific name: *Brassica oleracea*

How is it grown?

One of the interesting things about the way this crop is grown in Papua New Guinea is that seed are not regularly used and people grow it from shoots off the old stem. When a cabbage is harvested, the top head part of the cabbage is cut off and the stalk is left growing in the ground. This produces a ring of new shoots and these are broken off and planted. This is a good cheap way of getting new plants and works well as long as the old plant does not have some diseases that are a problem with cabbage.



Chinese cabbage

Two main kinds of Chinese cabbage are grown in Papua New Guinea. One is a more tightly headed cabbage and is more commonly seen in the highlands. The other is a more open leafy cabbage and is more common on the coast. They have slightly different scientific names.

	Pak choi	<i>Brassica campestris</i> ssp. <i>pekinensis</i>
and	Petsai	<i>Brassica campestris</i> ssp. <i>chinensis</i>



Nasturtium schlechteri

See Rorippa - under greens

Diseases of the Cabbage family (Brassicaceae)

Broccoli

	Grey leaf spot	Fungus	<i>Alternaria brassicae</i>
		and	<i>Botrytis sp.</i>
	Black rot	Bacteria	<i>Xanthomonas campestris</i>
	Root knot	Nematode	<i>Meloidogyne sp.</i>

Brussels sprouts

	Black leaf spot	Fungus	<i>Alternaria brassicicola</i>
	Black rot	Bacteria	<i>Xanthomonas campestris</i>

Cabbage

	Black leaf spot	Fungus	<i>Alternaria brassicicola</i>
	Leaf spot	Fungus	<i>Colletotrichum sp.</i>
	Ring spot	Fungus	<i>Mycosphaerella brassicicola</i>
	Downy mildew	Fungus	<i>Peronospora parasitica</i>
	Black rot	Bacteria	<i>Xanthomonas campestris</i>
	Soft rot	Bacteria	<i>Erwinia carotovora</i> subsp. <i>carotovora</i>
	Collar rot	Fungus	<i>Thanatephorus cucumeris</i>
	Damping off	Fungus	<i>Pythium sp.</i>
		and	<i>Rhizoctonia sp.</i>
	Root knot	Nematode	<i>Meloidogyne incognita</i>

Cauliflower

	Black leaf spot	Fungus	<i>Alternaria brassicicola</i>
	Leaf spot	Fungus	<i>Cercospora brassicicola</i>
	Black rot	Bacteria	<i>Xanthomonas campestris</i>
	Root knot	Nematode	<i>Meloidogyne sp.</i>

Chinese cabbage

	Grey leaf spot	Fungus	<i>Alternaria brassicae</i>
	Black leaf spot	Fungus	<i>Mycosphaerella brassicicola</i>
	Leaf spot	Fungus	<i>Septoria sp.</i>
	Wet rot	Fungus	<i>Choanephora cucurbitarum</i>
	Downy mildew	Fungus	<i>Peronospora parasitica</i>
	Leaf wilt (Soft rot)	Bacteria	<i>Erwinia carotovora</i>
	Black rot	Bacteria	<i>Xanthomonas campestris</i>
	Seedling wilt	Fungus	<i>Fusarium oxysporium</i>

Radish

	Leaf spot	Fungus	<i>Alternaria raphani</i>
--	-----------	--------	---------------------------

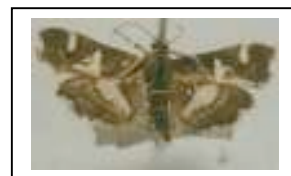
Turnip

	Leaf spot	Fungi	<i>Alternaria brassicae</i>
			<i>Alternaria brassicicola</i>
	Black rot	Bacteria	<i>Xanthomonas campestris</i>

Insect pests of cabbage family plants

Beet webworm *Hymenia recurvalis* (Fab.) Pyralidae LEPIDOPTERA

The caterpillars roll up the leaves of a number of plants and form a web. They eat the leaves. They damage Chinese cabbage. It feeds on the underside of leaves.



Black cutworm *Agrotis ipsilon* (Hufnagel) Noctuidae LEPIDOPTERA

The caterpillars cut off seedlings at ground level. They do this damage at night. Damage occurs in a range of plants grown from seed including *Rorippa* sp. cabbage. They tend to get worse in areas that have been low-lying damp areas especially where there have been many weeds present.



Cabbage cluster caterpillar *Crociodolomia binotalis* Zeller Pyralidae LEPIDOPTERA These caterpillars eat holes in the leaves of a number of plants in the cabbage family. They leave dark chewed-up lumps on the leaves. They can regularly cause 90% damage to the more leafy types. The hearts of cabbage can often be completely destroyed. Plants damaged include cabbage, Chinese cabbage, kohlrabi, broccoli, turnip, radish and *Nasturtium schlechteri*. The insect avoids light so eats on the underside of leaves.



Cacao armyworm *Tiracola plagiata* Walk Noctuidae LEPIDOPTERA

Some of the crops attacked include cabbage, cauliflower. The larvae eat young soft growing parts of the plants and can also eat weeds and other bush trees. The insect tends to build up on trees like leucaena shade or other large areas of one crop then spread in plague numbers into surrounding gardens.



Cluster caterpillar *Spodoptera litura* (Fab) Noctuidae LEPIDOPTERA

They damage a range of crops - cabbage, Brussels sprouts, kohlrabi. Quite often the damage is only slight but in some seasons they can do extensive damage. They move between crops and the numbers depend on the climatic conditions.



Corn earworm *Heliothis armigera* (Huebner) Noctuidae LEPIDOPTERA

The larvae feed on leaves and fruit. They damage a range of plants, including cabbage. Rain helps the pupae develop and warm moist weather makes the pest worse.



Diamond back moth *Plutella xylostella* (L.) Plutellidae LEPIDOPTERA

The caterpillars eat irregular shaped holes on the leaves of cabbage family plants. They are very common. The larvae drop from the plant on silken threads when they are disturbed. They damage cabbage, turnip, broccoli, kohlrabi, brussels sprouts, chinese cabbage, *Nasturtium schlechteri*, and possibly other plants in the cabbage family. The moth tolerates a wide range of climates but gets worse in hot dry areas.



Green looper *Chrysodeixis chalcites* (Esp.) Noctuidae LEPIDOPTERA

Larvae commonly eating cabbage leaves. Also damages cabbage family plants.

A semi looper, *Phytometra orichalcaea* (F.) (LEP.) [Probably syn. *Plusia orichalcaea* L.] is reported on Chinese cabbage, turnip and Brussels sprouts. It is an attractive golden-coloured moth.



Horned weevil *Apiocalus* spp. Curculionidae COLEOPTERA

Occur up to about 1600 m altitude. Damage to cabbage. It mainly attacks growing points and soft shoots. It chews the leaves eating holes and this is often called shot hole damage. Other insects do similar damage. The damage is often not serious.



Grass bug *Alticus tibialis* Reut Miridae HEMIPTERA

Sap feeder on Chinese cabbage.



Green peach aphid *Myzus persicae* Sulzer Aphididae HEMIPTERA

It does damage by direct feeding and by transmitting viruses. Often the insect is scarcely noticed and the main result is the diseases it spreads. The direct feeding damage cannot normally be seen. It attacks a very large number of plants and spreads a very large number of virus diseases. It is always present on cabbages in the highlands.



Cabbage leaf miner *Lyriomyza brassicae* (Riley) Agromyzidae DIPTERA

The larvae burrow into the leaves of cabbage, Chinese cabbage, radish, broccoli, and turnip. It probably damages other cabbage family plants.

Phaneroptera brevis Tettigoniidae ORTHOPTERA

It attacks Chinese cabbage, cabbage, radish, brussels sprouts by eating the leaves. It is often found in shady places.



Minor pests

<i>Adoxophyes</i> sp.	Tortricidae (LEP.) -leaf roller
Reported damaging chinese cabbage.	
<i>Araecerus</i> sp. (See <i>Oxyderes</i>)	Anthribidae (COL.)
Related to coffee bean weevil. Damaging cabbage.	
<i>Colgar tricolor</i> Dist.	Flatidae (HOM.)
Reported damaging chinese cabbage, cabbage; Sap sucker.	
<i>Coproporus</i> sp.	Staphylinidae (COL.)
Reported damaging cabbage.	
<i>Diachrysia orichalcaea</i> Fab	Noctuidae (LEP.)
Reported doing damage to cabbage.	
<i>Euricania discigutta</i> (Walk.)	Ricaniidae (HEM.)- plant hopper
Reported damaging cabbage, chinese cabbage.	
<i>Halticus minutus</i> Reuter	Miridae (HEM.)-flea hopper.
Reported sucking sap of chinese cabbage and radish	
<i>Nyctemera baulus</i> Boisduval	Arctiidae (LEP.)
Larvae damaging leaves of cabbage.	
<i>Odontomyia</i> sp	Stratiomyidae DIPT.)
Larvae in cabbage.	
<i>Onthophagus</i> sp <i>nr papuensis</i> Harold	Scarabaeidae (COL.)
On cabbage.	
<i>Phormesa</i> sp.	Colydiidae (COL.)
On cabbage.	
<i>Spilosoma owgarra</i> Bethune-Baker	Arctiidae (LEP.)
Larvae feeding on cabbage. Reddish brown "bear caterpillars". Eat various vegetables.	
<i>Valanga</i> sp.	Acrididae (ORTH.)
Giant grasshoppers reported causing damage to Chinese cabbage.	

Capsicum and chilli

Name: Capsicum
Also called red and green peppers

Scientific name: *Capsicum annum*

The plant

This is a plant that grows from seeds each year. It grows up to 1.5 metres high and produces several branches. The flowers occur singly in where the leaves join the stalk and mostly the flowers are yellow. The fruit come in various shapes from round to long. The larger types can have fruit up to 8 cm across. They also vary in colour from green to red to yellow. Inside the fruit there are many seeds.



In Papua New Guinea the capsicum grows well at sea level but will also grow up to about 1900 metres altitude. It is killed by frost.

Growing capsicums

They are grown from seed. The seed can be collected from mature fruit. It is possible to plant the seed directly in the garden or the plants also transplant quite easily. Seedlings are normally transplanted about one month after seed are planted. They need a well drained and fertile soil. It is often best therefore to plant capsicums on raised beds in the garden especially in wet areas.

Fruit can be harvested after about 3 or 4 months. From then on regular harvests of fruit can be made for about one year.

Pests and diseases

Capsicum insect pests

<i>Atherigona orientalis</i> Schiner	Muscidae (DIPT)	Shootfly
<i>Carpophilus maculatus</i> Murray	Nitidulidae (COL)	Damaging fruit
<i>Bactrocera bryoniae</i> (Tryon.)	Tephritidae (DIPT)	Fruit fly
<i>Bactrocera musae</i> (Try.)	Tephritidae (DIPT)	Banana fruit fly
<i>Bactrocera trivialis</i> Drew	Tephritidae (DIPT)	Fruit fly larvae destroying fruit
<i>Euproctis</i> sp.	Lymantriidae (LEP)	Reported eating leaves
<i>Heliothis armigera</i> (Huebner)	Noctuidae (LEP)	Corn earworm
<i>Homeoxipha fuscipennis</i>	Gryllidae (ORTH)	Reported chewing leaves
<i>Macrosiphum euphorbiae</i> (Thomas)	Aphididae (HEM)	Potato aphid
<i>Pinnaspis strachani</i> (Cooley)	Diaspididae (HEM)	Armoured scale
<i>Planococcus pacificus</i> Cox	Pseudococcidae (HEM)	Mealybug
<i>Plautia brunneipennis</i>	Pentatomidae (HEM)	Stink bugs
<i>Pseudaulacaspis pentagona</i> (Targioni)	Diaspididae (HEM)	White scale
<i>Pulvinaria ubicola</i> (Cockerell)	Coccidae (HEM)	Soft scale
<i>Thrips tabaci</i> Lind.	Thripidae (THYS)	Onion thrips
<i>Silba</i> sp.	Lonchaeidae (DIPT)	Larvae boring into fruit

Capsicum diseases

Leaf spot	Fungus	<i>Alternaria</i> sp.
Collar rot	Fungus	<i>Athelia rolfsii</i>
Fruit rot (Anthracnose)	Fungus	<i>Glomerella cingulata</i>
Fruit rot	Fungus	<i>Curvularia</i> sp.
Leaf blotch	Fungus	<i>Thanatephorus cucumeris</i>
Wilt	Fungus	<i>Fusarium solani</i>
Root rot	Fungus	<i>Pythium</i> sp.
	and	<i>Fusarium</i> sp.
Bacterial wilt	Bacteria	<i>Pseudomonas solanacearum</i>
Storage rot	Bacteria	<i>Erwinia carotovora</i>
Bacterial leaf spot	Bacteria	<i>Xanthomonas campestris</i> pv. <i>vesicatoria</i>
Leaf distortion	Virus	Possibly potato virus y
Root knot	Nematode	<i>Meloidogyne incognita</i>

As food

The leaves of capsicum or peppers can be eaten and are good quality food. They maintain a good texture when cooked and have a mild spicy flavour.

The fruit can be eaten raw. Normally they get hotter or more spicy as they get ripe and red. Some kinds especially the longer types are normally hotter. They can also be cooked or used to add flavour to other food dishes. Normally the central part of the fruit and the seeds are removed before eating.



Chilli

English name: Chilli
Tok Pisin name: Sili
Tok Ples Kuanua: Lobo

Scientific name: *Capsicum frutescens*

The plant

This small shrub is about one metre tall and continues to grow for several years. Plants often occur self-sown from seeds dropped by birds. The flowers are pale green and about 8 mm across. The chilli has several fruit in a cluster on a stalk. They change from green to yellow to red as they ripen. The fruit are about 2 cm long.



Growing chilli

Chilli will grow from sea level to about 1800 metres altitude. It cannot stand frost. The seeds are very small and are best sown in a nursery and then the young plants transplanted when they have 4 or 5 leaves. (After 3 or 4 weeks). They can be planted at about 80 cm apart. Pruning out the tops of the bushes increases the branching of the plant.

Chilli insect pests

Horned weevil *Apiocalus* spp. Curculionidae COLEOPTERA

Green peach aphid *Myzus persicae* Sulzer Aphididae HEMIPTERA

Banana fruit fly *Bactrocera musae* (Try.) and *Bactrocera bryoniae* (Try.) Tephritidae DIPTERA

Idopsis coerulea Faust. Curculionidae (COL.)

Causing minor shot hole damage.

Red twig borer *Zeuzera coffeae* Nietner Cossidae (LEP.) Reported damaging chilli plant by boring into stems. Larvae are red to violet brown often with yellow rings. They bore into woody stems. A circular tunnel is formed under the bark. The end of the branch dies. The moths fly at night. Up to 1000 eggs per female. Development takes 4-5.5 months. Control is seldom necessary.

Scales and mealy bugs

Aonidiella aurantii (Maskell)

Icerya seychellarum (Westwood)

Coccus hesperidum Linnaeus

Parasaissetia nigra (Nietner)

Pulvinaria psidii Maskell

Pulvinaria ubicola (Cockerell)

Saissetia coffeae (Walker)

Chilli diseases

Fruit rot	Fungus	<i>Glomerella cingulata</i>
Leaf & fruit blotch	Fungus	<i>Thanatephorus cucumeris</i>
Root knot	Nematode	<i>Meloidogyne incognita</i>

As food

The small red fruit are very hot to eat due to a chemical called capsaicin. They are therefore used to add spice and flavour to other foods.

The leaves can be eaten cooked and are nice tasting leafy greens.

/ 100 g edible portion

	Moisture %	Energy cals	Protein g	Calcium mg	Iron mg	provitA µg	provitC mg	Zinc mg
Leaves	82	53	5.8	246	1.4	68		
Fruit	91							



Corn

Tok Pisin: Kon

Scientific name: *Zea mays*

The corn plant

The corn plant is a grass family plant that can grow up to 2 or 3 metres tall. It has prop roots near the ground and these help to hold the plant up.



When it is nearly full grown it develops a cob (female flower) in the place where the leaves join the stem. It also grows a male flower at the top of the plant. When the cob is mature, the plant dies.

Sometimes corn is called maize. This is really just another name for the same plant. But there are special types of corn like sweet corn and pop-corn.

The clump of corn seeds that grows on a stalk is called a corncob or an ear of corn. As it is growing, a stringy group of hairs comes out the top of the cob. These are called the tassel.

Getting corn seed

One of the important things for growing good corn is to get some good seed.

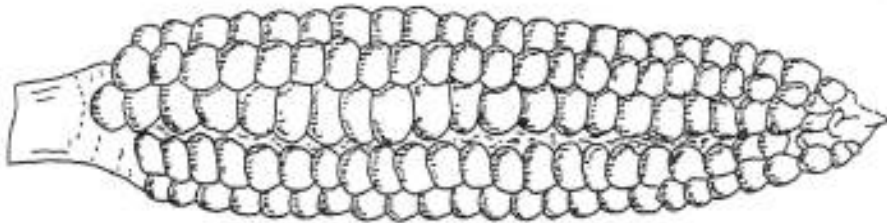
Corn has two types of seed. One is called hybrid seed and it can produce very well if it is grown under very good conditions. But you can't save your own seed to re-plant. This is because the plants which come up may not be very good plants at all. Hybrid seed needs to be produced by a specialist. So you must buy hybrid seed from a seed producer.

The other kind of corn seed is called open pollinated. It is the kind most people in Papua New Guinea use. They save their own seed to re-plant. But most people in village gardens run into a problem when they save their own corn seed. The plants gradually get smaller and smaller until only very small plants with very small cobs are produced. These small cobs are nice and sweet but they don't provide much food. The reason for this is that in a village garden there is often only a few corn plants. Also the plants are often widely spaced and people just save one or two cobs to use for seed. So what happens is that the corn plants inbreed. Instead of pollen going around between several plants and then seed being saved from a few different cobs the pollen just goes to the flower on the same plant or to a few plants close by. So the seed becomes inbred and produces smaller plants.

The way to stop this is:

1. Save seed from a large corn garden. (Over 200 plants that are getting ready at the same time and close together in the same garden.)
2. Collect your seed from a few different cobs and mix the seed together before planting.

If these two rules were followed when saving corn seed in a village a big improvement could be made in how much food is produced from corn plants.



A good corncob

As well as making sure that seed is looked after and collected properly, it is only sensible to start with a good type of corn that is suited to your area. Often the seeds that you buy in packets from stores have come from another country and are not suitable for Papua New Guinea. The Agricultural Officers have picked out some good kinds of corn for Papua New Guinea. You can get some seed from your didiman to start you off.

Planting corn

Corn needs fairly good soil. So there is no point in planting it in a fairly old kaukau garden. It can either be put in a freshly cleared garden or one where the soil fertility has been built up, such as around a house.

Most village people plant 2 or 3 seeds in the one hole. This is because they know that an insect called the black cutworm will probably eat off one or two, so one may survive. If all the plants grow and are not killed then the smallest plants are often pulled out. This is one way of dealing with seedling losses like cutworm damage. Some village people have found another way of stopping cutworm damage. They plant the seed and then put a bamboo container around it to protect it. People who have old fish tins use them for the same purpose after they have cut both the top and the bottom out of the tins.

The other thing that can commonly be seen is a person carrying a corncob and picking the seeds off to drop in the holes as they are made. This is the wrong way to mix and collect corn seeds and the reason has been explained above.

A bamboo ring to protect young corn plants from cutworms.

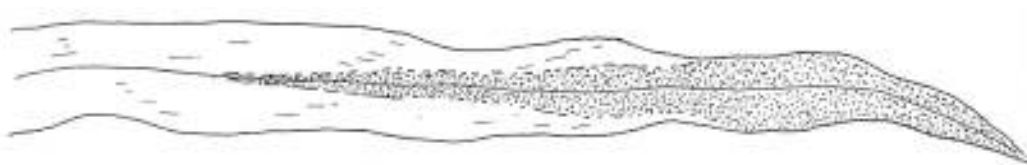


Why do corn leaves go dry?

Sometimes the leaves of corn, instead of remaining dark green, get dry brown marks. This can be either due to disease or due to the plant running out of the nutrients it needs to grow. (Old plants also turn brown naturally as they die off.) It is possible to learn to tell the difference between these marks.

Nitrogen deficiency

One of the commonest nutrients that corn plants run short of is nitrogen. A plant that is short of nitrogen has the older bottom leaves going dry. The dry brown mark is a distinctive shape. It starts at the tip of the leaves and goes in a V shape down the centre of the leaves.



A corn leaf showing nitrogen deficiency

Potassium

Plants that are running out of the nutrient potash go dry and brown along the edges. Also the leaves may be a lighter green than normal and sometimes they are twisted. Cobs get thinner at the top end.



A corn leaf showing potash shortage

Phosphorus

It is not as easy to be sure of a plant that is getting short of the other important nutrient called phosphorus. Plants short of phosphorus are smaller and the leaves are bluish green with red marks. But some leaves can be naturally reddish blue and leaves can change to these colours for other reasons.



Nitrogen deficiency



Potash deficiency

Phosphorus

Potassium

Nitrogen



Diseases

Diseases are different from these marks because a disease is caused by a small, living thing and it is actually growing on or inside the plant. The things causing disease are very small but it is often possible to see the marks due to the disease.

Corn diseases

Leaf spot	Fungus	<i>Bipolaris zeae</i>
Leaf spot	Fungus	<i>Curvularia lunata</i>
Tropical rust	Fungus	<i>Puccinia polysora</i>
Rust	Fungus	<i>Puccinia sorghi</i>
Downy mildew	Fungus	<i>Peronosclerospora sacchari</i>
	and	<i>Peronosclerospora sorghi</i>
Leaf spot	Fungus	<i>Phoma sorghina</i>
Leaf blotch	Fungus	<i>Setosphaeria turcica</i>
Leaf spot	Fungus	<i>Cercospora sorghi</i>
Leaf blight	Fungus	<i>Cochliobolus heterostrophus</i>
Blister smut	Fungus	<i>Ustilago zeae</i>
Head smut	Fungus	<i>Sphacelotheca reiliana</i>
Irregular bleached areas	Fungus	<i>Thanatephorus cucumeris</i>
Collar rot	Fungus	<i>Pythium butleri</i>

Diseases

In the highlands one of the commonest leaf diseases on corn produces long yellow to brown spots on the leaves. It is called corn leaf blight and is due to a fungus. Often the spots start as pale soft watery looking marks that turn yellow and later brown and dead. The spots can join and the leaf dies early. In moist weather these spots produce dark green spores (or "seeds") in the centre of the spots. These spores can blow in the wind onto other corn plants. Also they can stay alive on old corn plants for many months. Therefore it is important to move corn to a new or different garden to help avoid the disease. As well it is important to get rid of old corn plants, to use clean seed and to look for kinds of corn that get the disease less.



A corn leaf with spots due to corn leaf blight

Corn rust

Two fungi cause yellow or light red looking lumps on the leaves of corn. These diseases cause the leaves to get dry quickly and therefore smaller cobs are produced. Getting rid of old diseased plants helps reduce the damage to new corn plants. As well, a lot of the corn seed given out by didimen throughout Papua New Guinea in the last few years is of kinds that get this disease less.

A corn leaf showing small raised red spots of rust



Corn also gets some other leaf diseases but these have not been seen very often in the Highlands. White long stringy patterns on corn leaves can be due to downy mildew fungus, a virus or magnesium deficiency.

Corn blister smut

Diseases don't only get on leaves. One of the more serious fungal diseases that grows on corn in the Highlands is called corn blister smut. It grows on the cob but can also get on the leaves. It causes large grey swellings and lumps on the corncob. These lumps are filled with powdery grey spores and there is a silvery skin over them. It completely spoils the cob.

The spores can live in the ground for many years. This makes it hard to avoid the disease once it gets into an area. The disease can be controlled by using clean seed, as the disease can be on the seed. As well it is important to pull out and burn any plants you see with the disease. Corn should also be planted into new or clean gardens.

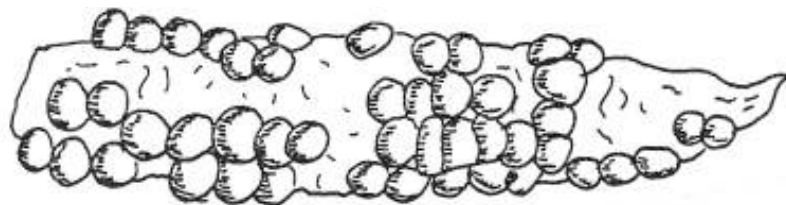
**A corncob
showing blister
smut disease**



Poor pollination

Sometimes corncobs can be poor for other reasons. Cobs can be harvested on which only some of the seeds have developed. This is because the other seeds were not fertilised by pollen. The reasons it was not fertilised are normally:

1. There was not enough pollen around because plants were planted too far apart
2. The silky threads of the tassel were not sticking out of the top of the cob by the time the pollen fell. This is mostly because the plant was not growing well enough.



A poorly pollinated corncob

Insects

Some of the insects that badly damage corn in other parts of Papua New Guinea do not seem to be a problem in most parts of the Southern Highlands. This includes the European corn borer and the corn earworm. Other armyworm caterpillars like the lawn armyworm only come in plagues occasionally.



A black cutworm caterpillar



The cutworm moth

The black cutworm is the grey or green caterpillar of a moth. The moth is brown on the front wings and yellow and brown on the hind wings. The caterpillars curl up and hide near the base of the plants of just under the soil during the day. Then at night they come out and chew off plants near ground level. One method of stopping them has already been mentioned.

Insect pests of corn

African armyworm	<i>Spodoptera exempta</i> (Walker)	Noctuidae	LEPIDOPTERA
Cape gooseberry budworm	<i>Heliothis assulta</i> Gn.	Noctuidae	LEPIDOPTERA
Corn earworm	<i>Heliothis armigera</i> (Huebner)	Noctuidae	LEPIDOPTERA
Maize stem borer	<i>Ostrinia furnacalis</i> (Guen.)	Pyralidae	LEPIDOPTERA
Paddy armyworm	<i>Spodoptera mauritia</i> (Boisduval)	Noctuidae	LEPIDOPTERA
Rice armyworms	<i>Mythimna loreyi</i> (Dup.) & <i>Mythimna separata</i> (Walk.)	Noctuidae	COLEOPTERA
Rice leaf roller	<i>Cnaphalocrocis medinalis</i> (Gn.)	Pyralidae	LEPIDOPTERA
Violet rice stem borer	<i>Sesamia inferens</i> (Walker)	Noctuidae	LEPIDOPTERA
Black flea beetle	<i>Arsipoda tenimberensis</i> Jacoby	Chrysomelidae	COLEOPTERA
False wireworm	<i>Gonocephalum ochthebioides</i> Ful.	Tenebrionidae	COLEOPTERA
Leaf beetles	<i>Cassena intermedia</i> Jac. & <i>Cassena papuana</i> (Jac.)	Chrysomelidae	COLEOPTERA
Monolepta beetles	<i>Monolepta</i> spp.	Chrysomelidae	COLEOPTERA
Pumpkin beetles	<i>Aulacophora</i> spp.	Chrysomelidae	COLEOPTERA
Shot hole weevils	<i>Oribius</i> spp.	Curculionidae	COLEOPTERA
Corn laternfly	<i>Peregrinus maidis</i> (Ashmead)	Delphacidae	HEMIPTERA
Corn leaf aphid	<i>Rhopalosiphum maidis</i> (Fitch.)	Aphididae	HEMIPTERA
Red cotton bug	<i>Dysdercus cingulatus</i> (F.) & <i>Dysdercus sidae</i> Montr.	Pyrrhocoridae	HEMIPTERA
Sugarcane aphid	<i>Aphis sacchari</i> Zehntner	Aphididae	HEMIPTERA
White jassid	<i>Cicadella spectra</i> (Dist.)	Cicadellidae	HEMIPTERA
Fruit fly	<i>Dacus papuaensis</i> Malloch	Tephritidae	DIPTERA
Melon fruit fly	<i>Dacus cucurbitae</i> Coq	Tephritidae	DIPTERA
Shootfly	<i>Atherigona orientalis</i> Schiner	Muscidae	DIPTERA
	<i>Chaetocnema basalis</i> (Baly)	Chrysomelidae	COLEOPTERA
	<i>Coelophora ripponi</i> Crotch	Coccinellidae	HEMIPTERA
Adults feeding on cobs	<i>Compsolacon gracilis</i> Candeze	Elateridae	COLEOPTERA
Plant hopper	<i>Euricania discigutta</i> (Walk.)	Ricaniidae	HEMIPTERA
Damaging corn	<i>Hypolixus mastersi</i> Pascoe	Curculionidae	COLEOPTERA



Aphids



Borers



Mildew

Corn as a food

Most Papua New Guinea village people harvest corn from the gardens when it is in a fairly firm mature stage and eat it the same day. It is mostly roasted over the fire.

The food value of corn varies with the type of corn and its stage of maturity. An approximate value for corn as eaten in Papua New Guinea is below. It is the amount of different nutrients in 100 gms of the part eaten.

	Moisture %	Energy cals	Protein g	Calcium mg	Iron mg	proVitA µg	provitC mg	Zinc mg
Corn	62.5	134	4.2	5	0.9			

This means that corn is a food high in energy and quite high in protein. Corn should be included in the diet as often as possible because of this good food value.

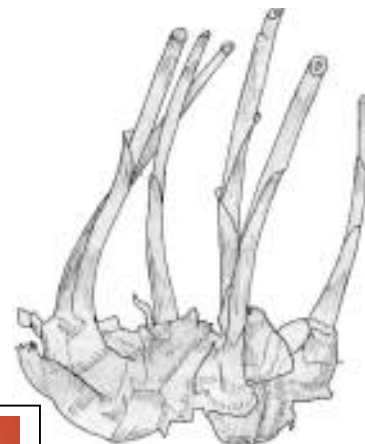
Ginger

Tok pisin: Kwarare

Scientific name: *Zingiber officinale*

The plant

This plant has underground stems (rhizomes) that are branched and thickened. These stems are yellow on the outside and about 2 cm thick. These have a distinct smell when cut or bruised. The leaves are long and carried on a stem which is up to a metre high. The leaves clasp the stem near the base.



Growing ginger

Ginger is popular in Papua New Guinea not just as a flavouring, but is eaten in quite large quantities. It will grow well from sea level up to about 1900 metres altitude but is also grown at high altitudes. In several areas it is regarded as a men's crop and is also used in magic and medicine.

Ginger is grown by planting a piece of the underground stem. This is planted about 5 to 7 cm under the soil. It requires a good fertile soil and preferably good sunlight although some varieties will grow quite well in light shade. During the early growth it needs adequate rainfall but near maturity often ripens better with a drier season. The soil needs to be well drained so often ginger is grown on raised beds.

As food

The underground stem is eaten. It can be eaten raw. The young shoots of the plant are spicy and can be eaten.

Pests and diseases

Diseases of ginger

Leaf spot	Fungus	<i>Pyricularia zingiberi</i>
Leaf spot	Fungus	<i>Phaeodactylum alpiniae</i>
Leaf blotch	Fungi	<i>Curvularia sp.</i>
	and	<i>Glomerella cingulata</i>
	& Bacteria	<i>Corynebacterium sp</i>
Root knot	Nematode	<i>Meloidogyne incognita</i>
	and	<i>Meloidogyne javanica</i>

Ginger insect pests

Leaf eating ladybird *Henosepilachna signatipennis* Boisd.

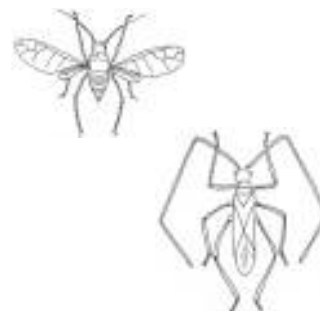
and *Henosepilachna haemorrhoea* (Biel) Coccinellidae (COL)

Both the larvae and adults eat the leaves, young fruit and flowers of plants. They eat ginger. They tend to eat the fleshy part of the leaf underneath the leaf. They tend to prefer higher humidity. These ladybird beetles have a covering of fine hairs which helps tell them from the good species which feed on aphids.



Banana aphid *Pentalonia nigronervosa* Coq Aphididae HEMIPTERA

Bananas are the main plant attacked, but taro and ginger family plants can also be attacked. Honey dew secreted by the insects cause sooty moulds to grow. Ants also occur in association with these insects and they help reduce the affect of predators.



Cardamom mirid *Ragwelellus horvathi* Poppius Miridae (HEM)

The adults and nymphs feed on leaves of cardamom leaving clear empty cells between the veins. They also damage ginger. Damage can be severe. The level of shade does not seem to affect the likelihood of damage.

Other minor pests

<i>Dichocrosis sp.nr punctiferalis</i> Guenee	Pyrilidae (LEP.) Peach yellow moth
Reported damaging wild ginger. Occurs to 1750 m. Found incidentally on many plants. Caterpillar is red brown and lives in a web made of frass. The pupa lies in a fairly solid cocoon.	
<i>Dindymus pyrochrous</i> Boisd.	Pyrrhocoridae (HEM.)
<i>Lema wauensis</i> Gres.	Chrysomelidae (COL.)
<i>Meijerella inaequalis</i> Becker	Chloropidae (DIPT.)
Larvae in ginger. Syn. <i>Oscinella inaequalis</i>	
<i>Thressa punctifera</i> de Meijere	Chloropidae (DIPT.)

Armoured scales and mealy bugs

<i>Aspidiella hartii</i> (Cockerell)	
<i>Pinnaspis strachani</i> (Cooley)	
<i>Icerya seychellarum</i> (Westwood)	On wild ginger.
<i>Ferrisia virgata</i> (Cockerell)	
<i>Planococcus pacificus</i> Cox	

Wild ginger

Scientific name: *Zingiber zerumbet*

This species also occurs in Papua New Guinea. The leaves are slightly wider and more rounded than ginger.

Job's tears

Tok Pisin: no name

Scientific name: *Coix lachryma-jobi*

Tok Ples names: Mendi - holo

The Job's tears plant

This is a grass that grows each year from seeds. It can be up to 2 metres tall. Near the ground it has thick roots that hold the plant up. It produces large seeds that turn grey as they get older.



Where it grows?

It grows wild in swampy places from sea level up to 2000 metres above sea level.

The seeds

In many places the seeds are used for making necklaces. In the Mendi Valley the seeds are eaten regularly, by children. In some other countries the seeds are planted and the seeds used more commonly for food. The seeds are hard but they can be crushed and the flour collected. This flour cannot be used for bread unless it has other flour added because the bread won't rise.

The seeds store well, so they could also have some use as pig or poultry food.



Peanuts

Name: Peanut (Groundnut)
Tok Pisin: Pinat

Scientific name: *Arachis hypogea*

The plant

This is a spreading leafy plant that grows each year from seed. The plant is about 25 to 50 cm high and produces yellow flowers. The leaf has four leaflets. The stalk or peg from the flower grows down into the soil and then produces the pod and seed under the ground. The flower needs to be no more than 18 cm from the soil for the seedpod to develop under ground.

Two main kinds occur. They are often called runner and bunch types. The runner kind has a vegetative or leafy branch between each fruiting branch and therefore produces a more spreading type of plant. This is called "Virginia" peanut. These have a longer growing season and the seeds need to be stored for a while before they will start to regrow. (30 days.) The pods have 2 dark brown seeds. The other kind produces fruiting branches in a sequence one after the other along the branches. These are called "Spanish-Valencia" types. They grow as a more upright plant and grow more quickly. They have lighter coloured leaves and the pods have 2 to 6 seeds that are often white.



Growing peanut

Peanuts grow well from sea level up to about 1650 metres altitude. It needs a temperature of about 28°C and between 24°C and 33°C. The plants get killed by frost. They need a well-drained soil and cannot stand waterlogging. Therefore they are often grown on raised garden beds. They do better in drier areas but need 300 to 500 mm of rain during the growing season. Near harvest dry weather is needed.

Peanuts require soil with good levels of calcium or they produce empty pods. Many soils in Papua New Guinea already have good levels of limestone. Adding gypsum will improve this. If the nutrient boron is short then flowers won't flower and fruit properly. Because peanuts are legumes, they have root nodule bacteria that can fix their own nitrogen and this means they can still give good yields in grassland soils where nitrogen is at a lower level.

The seeds or nuts are normally removed from the shell before planting and are sown 2 to 3 cm deep. A suitable spacing is 10 cm between plants and 60 to 80 cm between rows. The soil needs to be weeded and loose by the time the flowers are produced to allow the peg for the seedpods to penetrate the soil. Normally when the whole plant dies off the plant is ready to pull. They are left to dry in the sun for 3 or 4 days. It takes about 4 or 5 months from planting to maturity.



Lamprosema indica



Homona coffearia



Achaea janata



Ectropis sabulosa

Pest and disease

Peanut insect pests

Bean leaf rollers	<i>Lamprosema indica</i> F.	Pyalidae (LEP)
and	<i>Lamprosema diemenalis</i> (Guenee)	Pyalidae (LEP)
Cacao false looper	<i>Achaea janata</i> (Linnaeus)	Noctuidae (LEP)
Cacao looper	<i>Ectropis sabulosa</i> Warr.	Geometridae (LEP)
Cluster caterpillar	<i>Spodoptera litura</i> (Fab)	Noctuidae (LEP)
Coffee leaf roller	<i>Homona coffearia</i> Nietn.	Tortricidae (LEP)
Cowpea aphid	<i>Aphis craccivora</i> Koch	Aphididae (HEM)
Grass bug	<i>Alticus tibialis</i> Reut	Miridae (HEM)
and	<i>Alticus minutus</i> Reut	Miridae (HEM)
Horned weevil	<i>Apiocalus</i> spp.	Curculionidae (COL)
Mole crickets	<i>Gryllotalpa africana</i> Pal.	Gryllotalpidae (ORTH)
Pineapple mealy bug	<i>Dysmicoccus brevipes</i> (Cockerell)	Pseudococcidae (HEM)
Pumpkin beetles	<i>Aulacophora</i> spp.	Chrysomelidae (COL)
Taro beetles	<i>Papuana</i> spp.	Scarabaeidae (COL)
Leaf roller	<i>Adoxophyes melichron</i>	Tortricidae (LEP.)
	<i>Euborellia annulipes</i> Lucas	Labiduridae (DERM.)
	<i>Megalurothrips usitatus</i> Bagnall	Thripidae (THYS.)
	<i>Nysius epiensis</i> China	Lygaeidae (HEM.)
	<i>Orosius argentatus</i> Evans	Cicadellidae (HEM.)
	<i>Oxidus gacilis</i>	
	<i>Philia femorata</i> Walk.	Pentatomidae (HEM.)
	<i>Coccus longulus</i> (Douglas)	Coccidae (HEM)
	<i>Planococcus pacificus</i> Cox	Pseudococcidae (HEM)

Diseases

Leaf loss due to leaf spot and rust can be considerable during the wet season. Plants maturing as the dry season starts get less leaf spot damage. The Spanish sequential branching types of peanuts get more damage from leaf spot.

Seedling death and collar rot can become important in damp soils.



Peanut diseases

Seedling death	Fungus	<i>Aspergillus niger</i>
Collar rot	Fungus	<i>Athelia rolfsii</i>
	and	<i>Botryodiplodia theobromae</i>
Large leaf spot	Fungus	<i>Leptosphaerulina trifolii</i>
Leaf spot	Fungus	<i>Cercosporidium personatum</i>
Leaf spot	Fungus	<i>Colletotrichum sp.</i>
Leaf spot and pod rot	Fungus	<i>Leptosphaerulina trifolii</i>
Leaf spot	Fungi	<i>Mycosphaerella arachidicola</i>
	and	<i>Mycosphaerella berkeleyi</i>
Collar rot	Fungus	<i>Phomopsis sp.</i>
Rust	Fungus	<i>Puccinia arachidis</i>
Root rot	Fungus	<i>Pythium sp.</i>
	and	<i>Rhizoctonia</i>
Blackening stems	Fungus	<i>Thanatephorus cucumeris</i>
Bacterial wilt peanut	Bacterium	<i>Pseudomonas solanacearum</i>
Mosaic	Virus	
Leaf mottle	Virus	Marginal leaf chlorosis virus
Mild mottle	Virus	Cowpea mild mottle virus

Bacterial wilt of peanut is caused by a bacteria *Pseudomonas solanacearum*. Plants wilt and when the stems are cut there is a brown discolouration of the tissues. Temperatures between 25° and 35°C suit the disease best. The bacteria can spread in soil or by water running down hill from an infected area. It affects plants by blocking the conducting cells that allow food and water to pass up and down the plant. Plants wilt and die. This bacterium affects many different plants including tomato, potato. Control is by avoiding infected soils. Don't plant crops that can be damaged downhill from infected crops. For most crops resistant varieties have been developed. For further information see Plant pathology Note No.15 of Harvest 7(4) p180 and Tomlinson, D. L., Mogistein, M., 1989, Occurrence of bacterial wilt of peanut (*Arachis hypogea*) caused by *Pseudomonas solanacearum* and opportunistic infection of aibika (*Abelmoschus manihot*) in Papua New Guinea. Plant Pathology 38(2), 287-289.

Collar rot of peanuts is also called Aspergillus crown rot peanuts and is caused by a fungus *Aspergillus niger*. (*Athelia rolfsii* fungus can also cause collar rot of peanuts.) If seeds are dug up they are covered with a sooty looking mass of black spores. The young seedlings can fall over and die due to the stem rotting off near the ground. The lower leaves of the plant become yellow. All stages from planted seeds to mature plants can be attacked. The fungus can live in dry soils and the disease likes high temperatures (30°C to 35°C). The fungus lives in the soil and on rotting plant materials. Seeds can also be infected and often carry the disease. The fungus is common in soil. It gets most serious where peanuts are grown in the same area for several crops. Plants can die. For control don't plant seed too deeply; use good quality undamaged seeds and chemical seed dressings can be used (But they are dangerous). Crop rotation or moving garden sites is important. Remove old plant rubbish (not only peanut plants). Be careful not to damage growing plants.

Peanut leaf spot has two similar fungi involved *Mycosphaerella arachidis* and *Mycosphaerella berkeleyi* of which the asexual stages are *Cercospora arachidicola* and *Cercosporidium personatum*. Small brown pale areas develop on the older leaves of peanuts. These spots become dark brown (with *C. arachidicola*) and black (with *C. personatum*). The disease is worse with temperatures between 20°C and 30°C and high humidity. Heavy rain helps the fungus spread. Poor soil fertility can increase the damage. The disease can live on old plants and peanut rubbish. Leaves can fall off early and less peanuts are then harvested. For control remove old peanut plants and plant peanuts in different areas each time. Use wider spacing between plants. Chemical fungicides can be used.

Peanut marginal chlorosis is caused by peanut marginal leaf chlorosis virus. Two or three weeks after sowing the leaves of diseased plants turn yellow on the edges. They also become wrinkled. The plants are smaller than normal. The virus spreads in the seeds. No insects appear to be involved. The disease can be transmitted by grafting and could possibly be transmitted by plants rubbing together. The plant produces less nuts than normal. (About half). Control is by using seed from healthy plants.

Peanut mild mottle is caused by cowpea mild mottle virus. Small pale indistinct spots develop on the leaf surface. Veins on the leaf can go pale or clear. The leaves can turn yellow, go brown or bronze underneath or the leaves die. Leaves can also roll upwards. This disease can be spread by being in the seed before they are planted or it can be spread between plants by a small sap sucking insect called the tobacco whitefly. So far the disease is only of minor

importance. This virus disease can occur on many different bean family plants. For control it is necessary to pull out and burn diseased plants. Other bean family plants should be checked and either removed if diseased or kept at a distance from peanut plants. Do not use seed from infected plants. Whitefly can be controlled by insecticides. Further information can be found in Philemon, E. C., Harvest 12(4) p 15 or Plant Pathology Note No 32.

Peanut rust is caused by a fungus *Puccinia arachidis*. Orange red lumps occur on both top and bottom side of peanut leaves. It gets worse in the wet seasons. It is mostly spread by wind and rain. Leaves and plants can die. It gets worse as plants get near maturity. Some varieties get less disease so should be used. Other information can be found in CMI Descriptions of Pathogenic Fungi No 53 and Map 160 and Pest Control in Groundnuts. PANS Manual No 2 p 27.

Pepper spot & scorch of peanuts is caused by a fungus *Leptosphaerulina trifolii*. Very small spots (less than 1 mm) develop on the upper side of the leaf. Spots can join together and cause leaves to die. If the disease is near the edge of the leaf it can be brown with a yellow margin and is called scorch. It gets worse with warm wet weather. The disease is spread by wind. It can be controlled with fungicide chemicals.

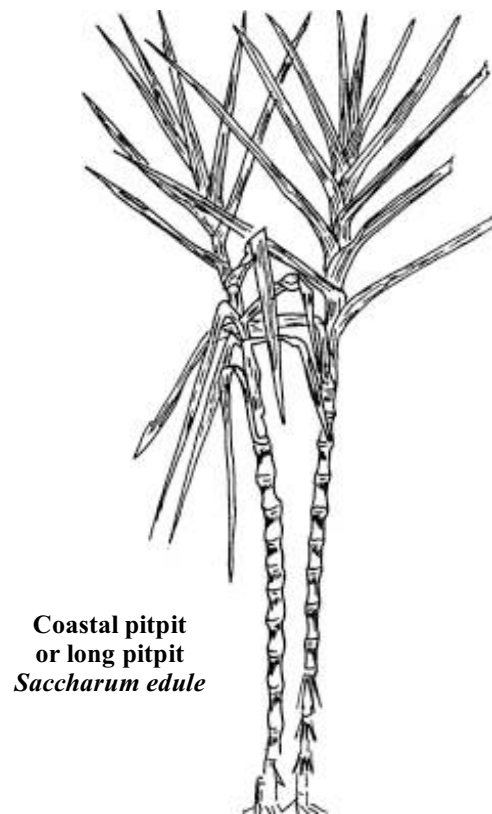
Stem rot of peanuts is also called Sclerotium crown rot and is caused by a fungus *Athelia rolfsii* of which the asexual stage is *Sclerotium rolfsii*. White fungal threads can be seen over brown diseased areas of the stem near ground level. Small hard round bodies (called sclerotia) are produced near the soil. The disease spreads more rapidly under high humidity and wet soil. It can still grow with soil pH from 1.4-8.8. It can live for many years in the soil. The fungus can live in the soil for several years. The fungus spreads in moist weather and can grow over the surface of the soil. It mainly spreads on plant remains but can also spread on seed and on tools. Whole plants or single runners can die. Pegs carrying the peanuts may rot off so that the nuts stay in the ground. Other plants that get the disease include cabbage, beans, capsicum, giant taro, artichoke, lettuce, naranjilla, pawpaw, peanut, peas, pomelo, potato, rice, corn, sugarcane, sunflower, sweet potato, tomato and pepper. For control improve the drainage and grow the crop well with good weeding, careful digging etc. Use resistant varieties. Runner types of peanuts get less damage. Use good crop rotations. The disease gets worse where leaf spot has been bad. Harvest the crop as soon as it is ready.

Peanuts that are not quickly and properly dried can develop fungal attack and a disease called aflatoxin that makes them poisonous.

As food

Mostly the seeds are eaten raw. Occasionally the seeds are roasted or processed then eaten. The leaves are occasionally cooked and eaten.

Pitpits



Coastal pitpit
or long pitpit
Saccharum edule



Highlands pitpit
Or short pitpit
Setaria palmifolia



Coastal pitpit

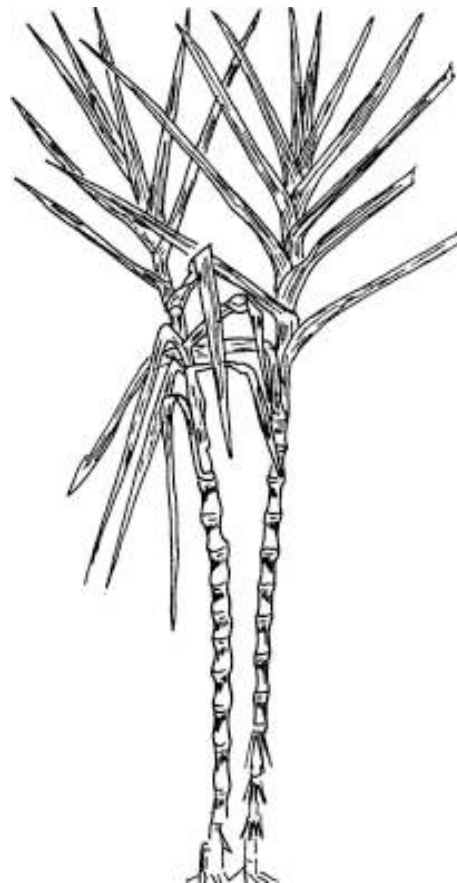
Tok Pisin: Pitpit

Scientific name: *Saccharum edule*

The pitpit plant

The pitpit plant looks like sugarcane to which it is related. Normally the stalk is thinner than sugarcane.

It can grow up to 3 metres high and produces suckers near the base so that normally a clump is produced.



At one season of the year it produces a seed head or flower that remains inside the top of the plant and is the part that is eaten.



Pitpits

In Papua New Guinea in Tok Pisin, several tall grass plants are called pitpit. Two of these are grown in gardens to be eaten as food. One of them is like sugarcane, it tends to grow at lower altitudes and it is therefore often called coastal pitpit or lowland pitpit. It is also sometimes called long pitpit because it is a taller plant. Its scientific name is *Saccharum edule* and this means the sugarcane grass that can be eaten. It was given this name by a man called Hasskarl in the year 1842. This is the pitpit that this article is about.

The other pitpit that is grown for food is often called highland pitpit or short pitpit because it is a shorter plant and it grows better up in the highlands. Its scientific name is *Setaria palmifolia* and it is described in a separate article.

Occasionally the young shoots are eaten of the pitpit that is used for fences.

Where is coastal pitpit grown?

Coastal pitpit is grown throughout Papua New Guinea from the sea level up to about 1700 metres altitude.

It is also grown in some other countries. It is grown in the Solomon Islands, Vanuatu, and Fiji and also in Indonesia.

How do you grow pitpit?

Pitpit is grown by taking cuttings of the cane, and sticking them in the ground. Mostly cuttings about 30-50 cm long are used and they need to be planted in a moist soil. They easily dry out so need to be planted soon after cutting. These cuttings soon develop roots and produce a number of shoots so that a clump of canes grows.

Coastal pitpit stalks can be planted at any time of the year. It takes 6-9 months from planting till a crop is ready to harvest. But the time of flowering in coastal pitpit is controlled by the sun. Early in the year about February to March most plants develop a thickened clump of leaves at the top. When these are broken off and opened by removing the outside leaves the very fine yellow unopened flower is seen. It is this flower that is eaten

An easy way some people plant coastal pitpit is to cut a long pitpit stalk. Then at the places where they want to plant it in the garden they stick the stalk into the ground and chop off the longer top piece with a bush knife. They cut it so that about 15 cm is under the ground and 15 cm left sticking out of the ground. The longer piece is then stuck in the ground in another place and cut off again.

If the pitpit flower is not picked when it is ready it starts to go brown due to a fungal rot.

In places where the soil is very fertile the canes can be cut off after harvest and new shoots will sucker out around the base and grow to produce another clump.

Pest problems

Coastal pitpit is attacked by some insect and disease problems. For these see under the sugarcane section.

The most common and most important insect pest of coastal pitpit are borers boring into the canes. These are normally the larvae of the same moths that bore into sugarcane. Several different moths cause this damage because there are different moths in different places throughout the country. In the Southern Highlands it mostly seems to be a small white grub with black spots along its back. Its scientific name is *Chilo terrenellus*. If it eats its way up the stalk till it damages the growing point it can kill the stalk.

A number of different fungal leaf spots can be seen growing on the leaves of pitpit. They are mostly the same as the fungal diseases that grow on sugarcane. It is not known how important they are to growing good pitpit.

Coastal pitpit as food

In 100 grams of the part you eat there are the following amounts of nutrients.

	Moisture %	Energy cals	Protein g	Calcium mg	Iron mg	proVitA µg	provitC mg	Zinc mg
	92.4	25-38	4.1-4.6	10-40	2	0	21-50	

This means that coastal pitpit is only moderately good at providing energy but it is quite high in protein. It is therefore especially good as a body building food and can make an important contribution to the diet.

Young coastal pitpit flowers can be eaten raw. But they are fairly dry. In coastal areas one of the favourite ways to eat this pitpit is fried in grated coconut milk. The pitpit can be baked in its leaves over an open fire. Or it can be boiled or fried along with other greens.



Highland pitpit

Tok Pisin name: Pitpit

Scientific name: *Setaria palmifolia*

The highland pitpit plant

This is a short, broad-leaved grass family plant. The leaves have ridges running along their length. They also normally have a wrinkled section near the middle of the leaf. The leaf blade is short (30-40 cm) and fat (6-8 cm) and the leaves spread out along opposite sides of the shoots.

Normally a plant produces a clump of shoots due to both suckers near the base and buds growing from the side of the short stem.

A plant grows from 60 cm to one metre tall.



Several different kinds of highland pitpit occur. These have different amounts of red, green and white colouring on the leaf and also where the leaves wrap around the stem.

It is the young tender tightly wrapped leaves inside the thickened base of the shoot that is eaten.

The wild relative from which the garden pitpit has been produced can often be seen growing in grassland around garden areas. It is a thinner plant often produces a flower and the young shoots are also eaten.

Where is highland pitpit grown?

Highland pitpit is common and an important food plant in many areas of Papua New Guinea.

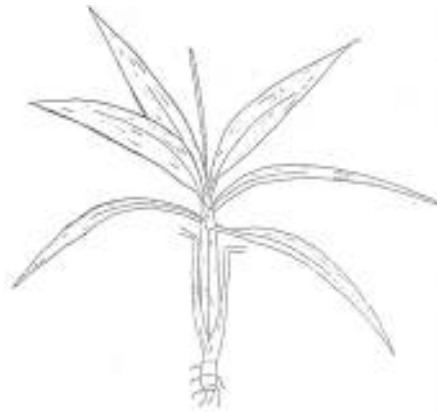
It tends to be more important in the highlands. It grows and produces reasonably well between the altitudes of 400 and 2400 metres above sea level. It can be grown down to the coast.

But Papua New Guinea is not the only country that grows this plant as food. It is grown in Fiji, Hawaii, Tonga and some other Pacific countries.

How do you grow pitpit?

It is grown by planting young shoots.

A young shoot of the type that is planted.



The young shoots are broken off the side of the plant. Shoots near the ground often have roots already growing on them so these shoots start growing more quickly. Portions of the stem can be planted because buds near the joints along the stem can produce new shoots.

This pitpit needs reasonably fertile soil and won't grow or produce well in old kaukau gardens. A leaf of a plant growing in good fertile soil is dark green.



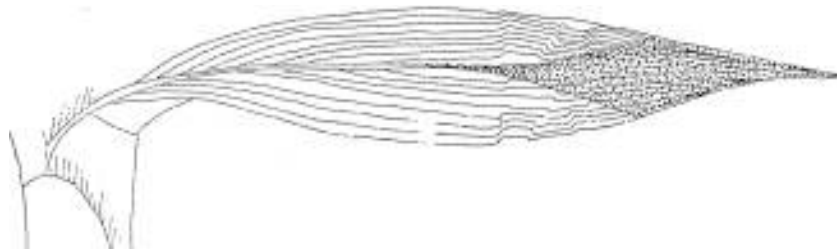


A normal, dark green pitpit leaf.

Why are some pitpit leaves dry?

It is necessary to learn to tell the difference between a plant that is running out of nutrients (gris) and a mark due to a disease.

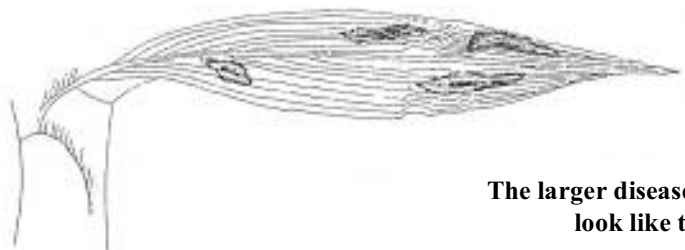
One of the commonest "dry" marks on pitpit is a leaf tip going dry and brown from the tip down. The dry mark extends in a V shape down the centre of the leaf. This is most likely nitrogen deficiency. It mostly occurs on older leaves and in older gardens.



**A leaf going dry due
to nitrogen deficiency**

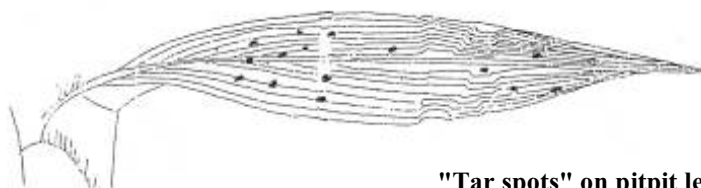
Sometimes leaves go dry along the edge. This is possibly potash deficiency.

Disease leaf spots can often be seen on pitpit leaves. The cause is most likely a fungus. The importance of these has not been measured. There appear to be two different types of leaf spots probably due to two different fungi.



**The larger disease leaf spots
look like this**

Other fungal diseases also occur. Small black spots called "tar spots" can sometimes be seen on leaves. They are like small specks of tar that have been dropped on the leaf. They are due to another fungus but they don't appear to be important.



"Tar spots" on pitpit leaves

Two "rust" fungi have also been recorded on pitpit leaves.

Insects damaging pitpit

Borers get into pitpit and kill the shoots. These borers are mostly the larvae of the moths that bore into sugarcane and coastal pitpit. The amount of damage varies but it can sometimes be serious. A shoot of a plant that has been damaged by a borer goes dry and the shoot or whole plant can die.

Pests and disease of Highland pitpit

Damage	Cause	Scientific name
Tar spot	Fungus	<i>Phyllachora sp.</i>
Rust	Fungus	<i>Uredo palmifoliae</i> Cummins
and	Fungus	<i>Uromyces leptodermus</i> Sydow
Leaf spots	Fungus	Probably fungi
Borers	Insect	<i>Chilo sp.</i>

Wild highlands pitpit

In most areas in the highlands the wild relative from which the garden pitpit has been produced can be seen growing. Often it occurs along tracks and roadsides near creeks and in old garden sites. Most Southern Highlands people have a different name for this plant in their local languages. But they know it is the wild plant from which the better, fatter garden plant was produced.



The shoots of this plant are also eaten although they are mostly eaten raw by hunting parties and people walking through the area.

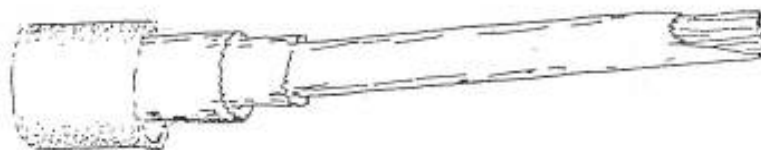
The plant also gets similar diseases to the garden variety.

Harvesting and use of pitpit

The young end and side shoots are harvested from pitpit plants. Sometimes these are tied in a bundle and sold in markets.

The amount of the shoots that is eaten varies. The tough outside leaves are stripped off. These are normally fed to pigs.

Then the younger more tender inside of the shoot is eaten.



A shoot stripped for eating

At least in some of the higher places in the Highland Provinces these young shoots are often eaten raw. But they can also be mumued in an earth oven or steamed in bamboo, or boiled or fried in a saucepan. Often they are eaten with a kumu called *Rungia*.

How much food is produced?

In trials between 8 and 18 kilograms of shoots have been harvested from individual plants over one year. These plants were spaced one metre apart. But only a third or less of these shoots were actually eaten as the outside portion was fed to pigs and the tender inside shoot eaten.

So a garden plot of pitpit of 10 square metres may produce between 25 and 60 kilograms of edible shoots.

Pitpit is often grown mixed with other crops in the food garden. It is also commonly grown in partly shaded places such as under yar trees. How much it produces in these situations is not known.

The food value of pitpit shoots

In a 100 gram portion of the shoots that are eaten there are the following amounts of different nutrients.

	Moisture %	Energy cals	Protein g	Calcium mg	Iron mg	proVitA µg	provitC mg	Zinc mg
	23-27		0.5-2.3	7-21	0.9-2	500	12-33	

(A 100 g edible portion is about 5 large stripped shoots.)

This means that pitpit shoots are not very good as a means of getting energy and the protein content is probably higher than root crops like kaukau but not as good as most dark green leaves.

Nevertheless they are an enjoyable and reasonably nutritious food.

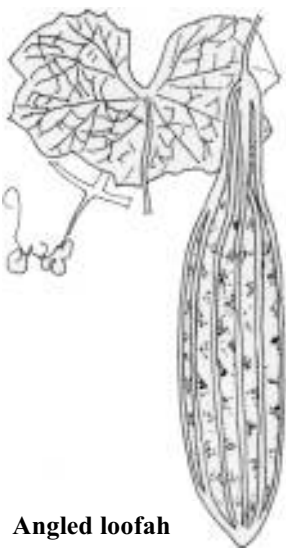
Pumpkin family plants

There are quite a few plants in the pumpkin family that are used as food in different areas of Papua New Guinea. Often it is the leaves and seeds that are used as well as the fruit.

The scientific and common names of those that are known to be used as food, are listed in the table below.

Angled loofah	<i>Luffa acutangula</i>
Bitter cucumber	<i>Mormordica charantia</i>
Bottle gourd	<i>Lagenaria siceraria</i>
Choko	<i>Sechium edule</i>
Cucumber	<i>Cucumis sativa</i>
Kongkonga	<i>Diplocyclos palmatus</i>
Marrow	<i>Cucurbita pepo</i>
Melon	<i>Cucumis melo</i>
Pumpkin	<i>Cucurbita maxima</i>
Pumpkin	<i>Cucurbita moschata</i>
Smooth loofah	<i>Luffa cylindrica</i>
Snake gourd	<i>Trichosanthes cucumerina</i>
	<i>Trichosanthes pulleana</i>
Watermelon	<i>Citrullus lanatus</i>
Wax gourd	<i>Benincasa hispida</i>

What do they all look like?



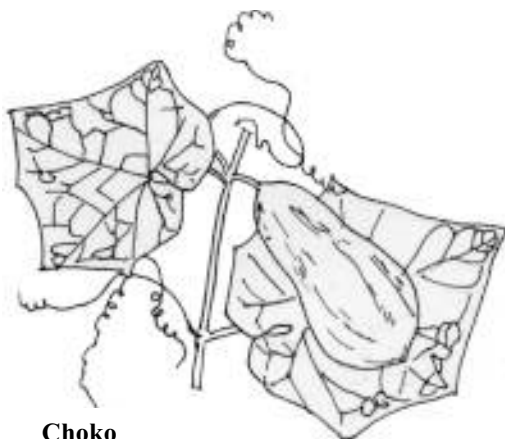
Angled loofah



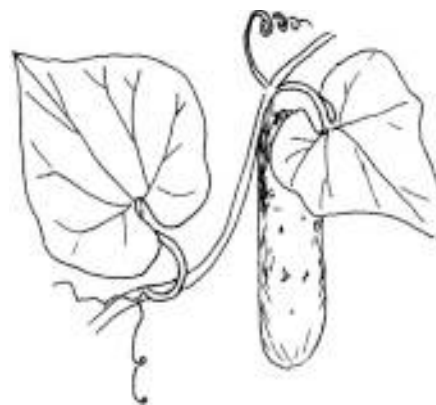
Bitter cucumber



Bottle gourd



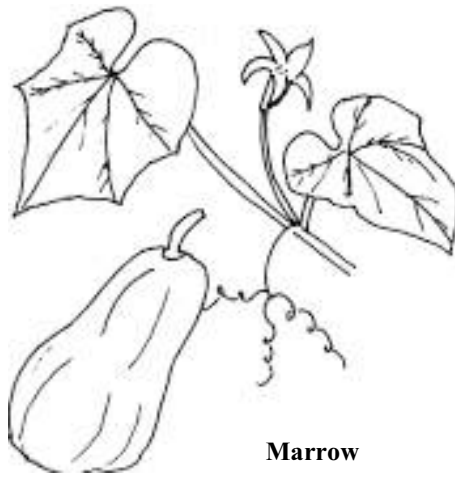
Choko



Cucumber



Kongakonga



Marrow



Melon



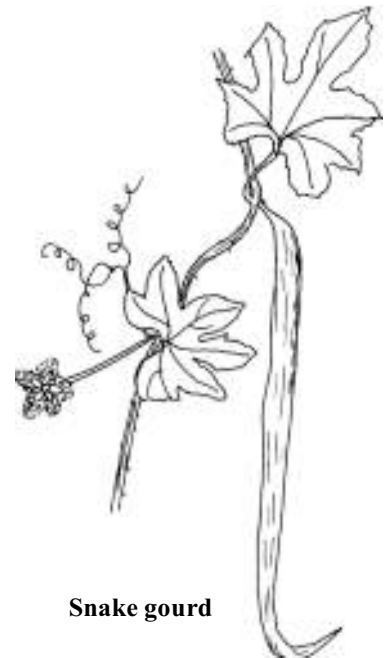
Pumpkin



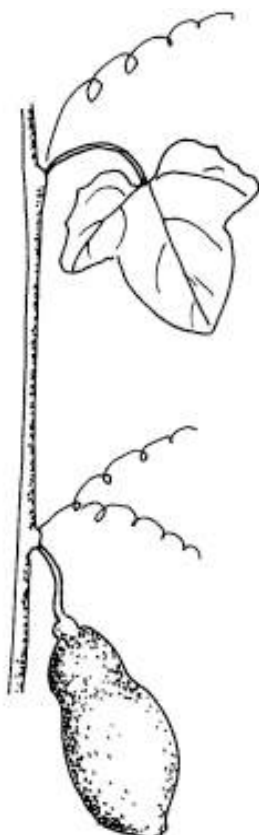
Cucurbita maxima



Cucurbita moschata



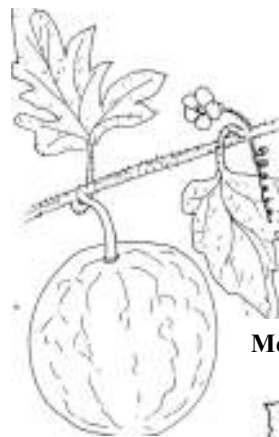
Snake gourd



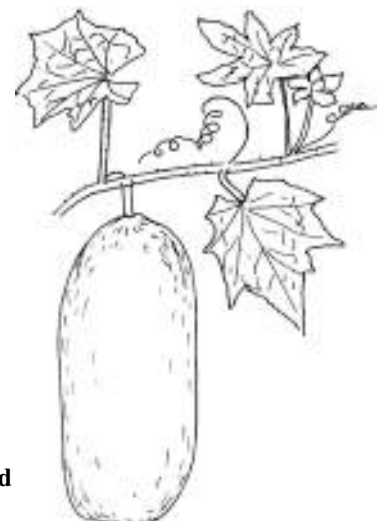
Tricosanthes pulleana



Smooth loofah



Melon



Wax gourd

Which parts are eaten?

	Fruit	Leaves	Seeds	Flowers	Roots
Wax gourd	√	√	√	√	
Kongakonga		√			
Watermelon	√	√	√		
Melon	√	√			
Cucumber	√	√	√		
Pumpkin	√	√	√		
Native pumpkin	√	√	√		
Marrow	√	√	√		
Bottle gourd	√	√			
Angled loofah	√	√			
Smooth loofah	√	√	√	√	
Bitter cucumber	√	√	√		
Choko	√	√	√		√
Snake gourd	√	√			
<i>Tricosanthes</i>			√		

Where are they grown?

	Altitude	Rainfall	Comments
Wax gourd	Lowlands	Medium dry areas	Only occasionally in Rabaul market
Kongakonga			Mainly used at Rabaul
Watermelon	Lowlands	Hot dry areas	Common in all coastal areas especially dry sandy areas
Melons	Lowlands	Dry areas	not common
Cucumbers	All areas		Very common in all highland areas
Pumpkin	Drier areas		More common in highlands
Native pumpkin	Lowlands	Wetter areas	Common for leaves
Marrow			Not common
Bottle gourd	All areas		As food only eaten in some highland areas eg Upper Mendi
Angled loofah	Lowlands		Occasional in several lowland areas
Smooth loofah	Lowlands		Occasional in lowland areas
Bitter cucumber	Lowlands		Occasional in several coastal areas
Choko	Mid altitude	Moderate rainfall	Very common in mid altitude areas
Snake gourd	Lowlands		Occasional mainly in Sepik
<i>Tricosanthes pulleana</i>	Highlands		Occasional in many areas

Bottle gourd

Tok Pisin: Botel

Scientific name: *Lagenaria siceraria*

Tok Ples names:

Mendi - pe hipap

The Bottle gourd plant

This plant is in the pumpkin family. It can climb over logs by attaching the tendrils that grow out of the stem near the leaf. The leaves are large and have soft hairs especially underneath.

The plant produces male flowers first and these are on long stalks. These don't produce fruit. Further along the stalk female flowers on short stalks are produced. If these are pollinated by pollen carried by insects from the male flowers then fruit will be produced.

The seeds are brown and in the light green pulp of the fruit. The shape of the fruit varies.



Where are bottle gourds grown?

Bottle gourds have been grown for thousands of years in Africa, South America and are also grown in India, China and many Asian and Pacific countries.

They are also grown in many areas of Papua New Guinea.

In the Southern Highlands Province they are common in some areas such as the Upper Mendi Valley, but are grown sometimes in most places.

How does a bottle gourd grow?

It grows quickly and may start to flower 2 months after sowing the seeds.

When fruit start to develop the vine mostly stops growing. If the fruits are removed growth of the vine continues.

Young fruits can be ready for harvesting about 3 months after planting.

Young fruits when harvested will only keep for a very short time of about 1-2 weeks.

Diseases

Bottle gourd leaves can get a white powdery type of growth over the leaves. This is due to a powdery mildew fungus. Sometimes as well the leaves and plant can die off early with leaves turning brown. This is called anthracnose. Both these diseases are less if plants are well staked up so that leaves dry quickly after rain. Also some kinds of bottle gourd get less damage.

Diseases	Fungal cause
Powdery mildew	<i>Oidium sp.</i>
Anthracnose	<i>Glomerella cingulata</i>

How do you grow bottle gourds?

The seeds are light brown colour and look like this.



They need to be spaced about 1 metre apart.

They need to be in a sunny position so should not be put under yar trees or in shady places.

Preferably they should be allowed to climb over a trellis or logs so that the wind can dry the leaves quickly after rain.

The soils need to be fairly fertile because bottle gourds grow rapidly. Therefore they should be in newer gardens or in soil where the fertility has been built up.

They are killed by frost.

How to use bottle gourds, and their food value?

Normally the young bottle gourd fruits are eaten as a boiled vegetable.

Sometimes the seeds are used in soups.

The young leaves are also eaten in some places.

Some kinds of bottle gourds can have a bitter taste.

The bottle gourd is a nice addition to the diet but it has little food value. The amounts of different food nutrients in 100 g portion of the part that is eaten are:

	Moisture %	Energy cals	Protein g	Calcium mg	Iron mg	proVitA µg	proVitC mg	Zinc mg
Fruit	96.1	12	0.2	20	0.7	0	6	

The mature fruit are dried and cleaned and used as containers. They make very good bottles and containers for seeds and other things.

Choko

Tok pisin: Sioko

Scientific name: *Sechium edule*

Tok Ples names:

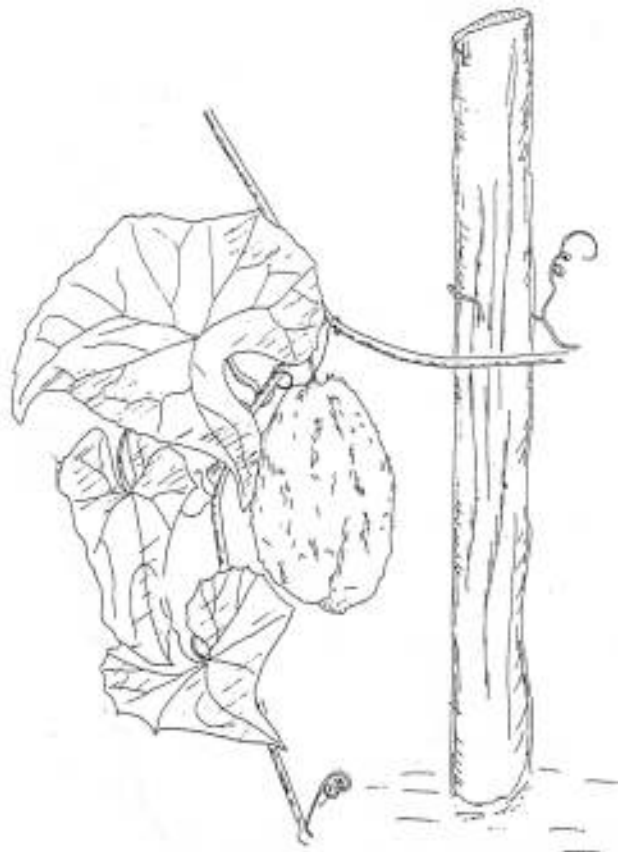
Foi - soja sai

The choko plant

The choko plant belongs to the pumpkin family. The vine on which the leaves and fruit are produced can grow quite long. It can be up to 15 m long. As well it has strong tendrils that can attach to fences and trees so that the plant can climb well.

The choko leaves are about 15-20 cm across and have a rough feel.

The choko fruit is produced in the angle where the leaf joins the vines. Fruit can be up to 20 cm long and they are rough or irregular shaped on the outside. There are white and green-fruited varieties. Some fruit have sharp spikes on the skin. Inside the fruit there is one seed about 4 cm long.



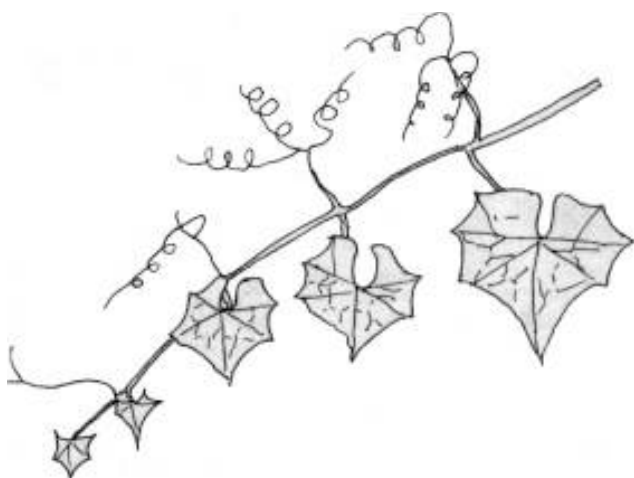
A choko attached to a post

A choko plant produces a large thickened root tuber and the plant can regrow from this tuber and go on growing year after year.

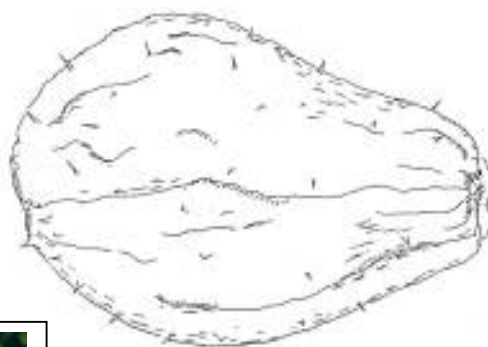
The importance of chokos

Although choko is a plant that was introduced to the Highlands Provinces only in recent years it has become very popular and widely used in some areas.

Chokos will grow from sea level up to at least 2200 m altitude. But at altitudes of about 800 to 1200 metres they grow particularly well and very easily. Therefore people like the Foi near Lake Kutubu, the Pole at Erave and the Podopa near Woposali have adopted choko tips as one of their main edible greens. In most of these areas the soft fleshy fruit are not particularly popular and are only eaten occasionally. Also the large underground tuber that is edible, has been tried by many people in these areas but it is not liked very much. The underground tuber is something like a yam but is softer and it is not eaten often.

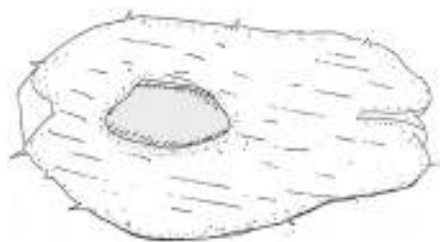


A choko fruit



Planting chokos

The choko fruit has one large seed inside. But the seeds cannot be dried out at all or it won't grow. Therefore the whole fruit is planted.



**A choko fruit cut
in half showing
the seed inside**



**A choko fruit growing
roots and shoots**

Often chokos start to develop shoots and roots while they are still attached to the original plant. These eventually fall off and continue growing if they fall on soft moist dirt.

If the fruit is planted it is planted on its side and only lightly covered with soil.

Choko plants can be grown from cuttings of the vine.

In areas where chokos are important they often just keep growing from the original plants or from fruit that falls naturally. Therefore near Erave and Kutubu large choko gardens can be seen where people mainly only ever go to harvest and rarely replant.

Chokos need some support to climb over. This is normally most cheaply and easily done by planting it near a fence, tree or logs.

Production

Chokos need a reasonably well-drained soil. But they can be grown under shade. In the lower altitude hotter places it seems as if shade is important for growing good chokos.

Plants take about 4 months from planting until fruit are produced.

Fruit can weigh 400 to 500 grams.

Tubers of 5 kg weight have been recorded.

Chokos as food

Normally the leaf tips, the underground tuber and the fruit are all cooked before eating. Sometimes the young seeds are eaten.

In 100 grams of the part that is eaten chokos have the following amounts of nutrients.

	Moisture %	Energy cals	Protein g	Calcium mg	Iron mg	proVita µg	provitC mg	Zinc mg
Fruit	89-92	6-8	0.8-0.9	10	0.4	650	20	
Leaves	89	25	4	60	1.4	25		
Roots	79	17-23	2					

This means that the leaves are good food, the tuber is quite good and the fruit are poor for providing nutrients for people.

Cucumber

Name: English: Cucumber
Tok Pisin: Kukamba

Scientific name: *Cucumis sativus*

People in the highlands of Papua New Guinea, claim that they have always had cucumbers. They maintain that they are one of their traditional foods. They have local names in Tok Ples languages. They are common and popular in most highland regions.

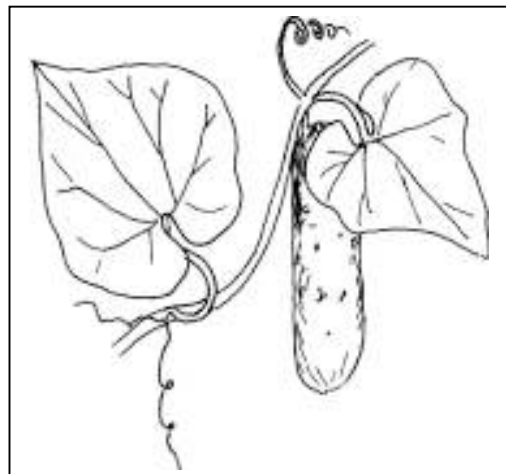
They are grown from sea level up to about 2200 m altitude.

Cucumbers are grown from seed and they are easy to grow. Mostly they are planted in new gardens when people have cleared and established a new garden. In many areas this is early in the new year. So often cucumbers occur in large numbers.

Two or three seeds are sown with a spacing of about 1 metre square per plant but often they are intercropped with other plants. They are ready to harvest in about 6-8 weeks and produce about 10 fruit per plant.

People mostly eat them fresh for a snack in the garden.

Cucumbers suffer badly from mildew fungus on the leaves. Normally this means there are not enough tops for the young leaves to be eaten.

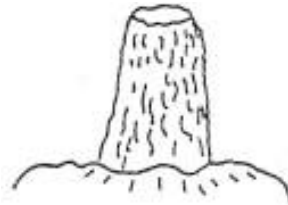


Pumpkin

Two main kinds of pumpkin are grown in Papua New Guinea. The easiest way to tell the difference between these species is by the way the stalk joins to the fruit. With *Cucurbita moschata* the stalk becomes larger and is ridged near where it is attached to the fruit. The other one is *Cucurbita maxima*. There are many different varieties of both these pumpkins.



Cucurbita moschata



Cucurbita maxima

The one, *Cucurbita moschata*, is often called the native pumpkin because it is more suited to the lowlands and to warmer climates.



Pumpkins are easily damaged by mildew fungi and also by fruit flies especially in the lowlands. Normally if seed is saved from local varieties of pumpkins it gets less mildew damage than from imported seeds.

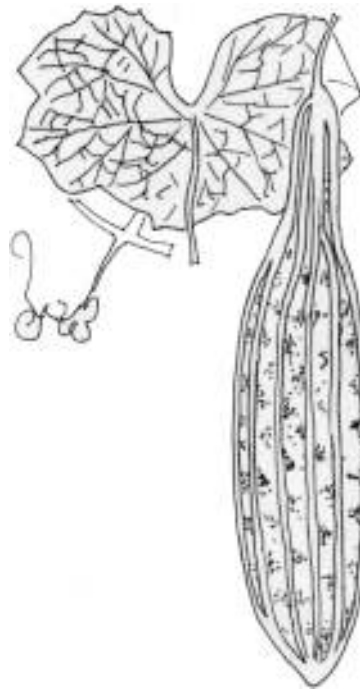


Fluted gourd

Name:

Scientific name: *Luffa acutangula*

This plant grows in lowland areas and is a large vigorous climber with square stems. Normally plants are allowed to climb over a fence. It has yellow flowers that open at night. Most flowers are male. The fruit can be up to 40cm long and with about 10 large ridges along their length. The fruits are green when young and turn to brown when ripe. On the inside the flesh is white.



It is grown from seed and fruit are ready about 6 to 10 weeks after planting. The immature fruit are cooked and eaten.

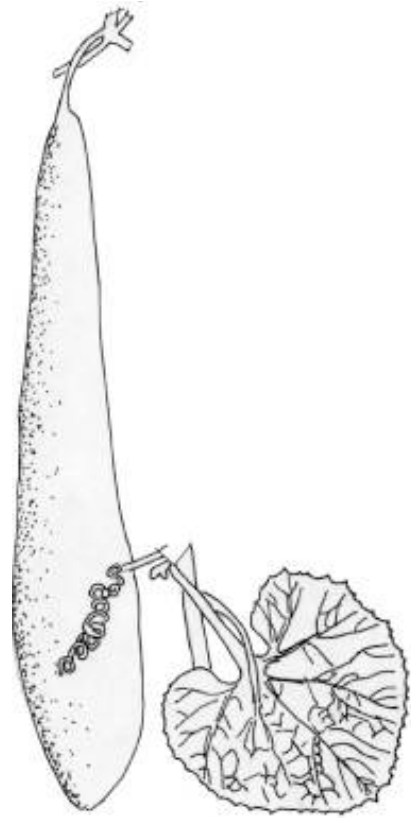


Smooth loofah

Name:

Scientific name: *Luffa cylindrica*

The smooth loofah is grown in a number of coastal areas. The stem is five angled and slightly hairy. The fruit is long (30 cm) and smooth. The young fruit are soft, but as they get old they develop a thin hard skin that peels off. The fruit often have streaks along them. The young fruit are cooked and eaten.

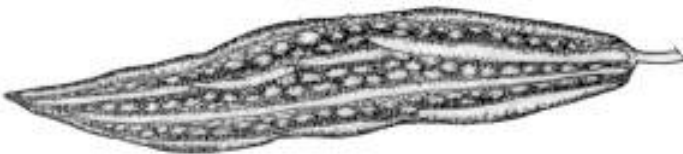


Bitter cucumber

This pumpkin family plant has fruit that are lumpy in appearance and are green but turn yellow when fully ripe. Inside there are seeds in a bright red flesh. The vine on which it grows is slender, grooved, long and with many branches. It has coiled tendrils opposite the leaves with which it can attach to a fence or logs. The leaves are deeply divided and sometimes notched or toothed.

It is grown from seed. Seeds have a hard coat and often germinate slowly. Then plant grows very quickly and can be producing fruit in 2 months.

The fruit is somewhat bitter and is less bitter when fruits are younger. The seeds should not be eaten. The flesh around the seeds is eaten, cooked or used to add flavour to other food.



Wax gourd

Name: Wax gourd

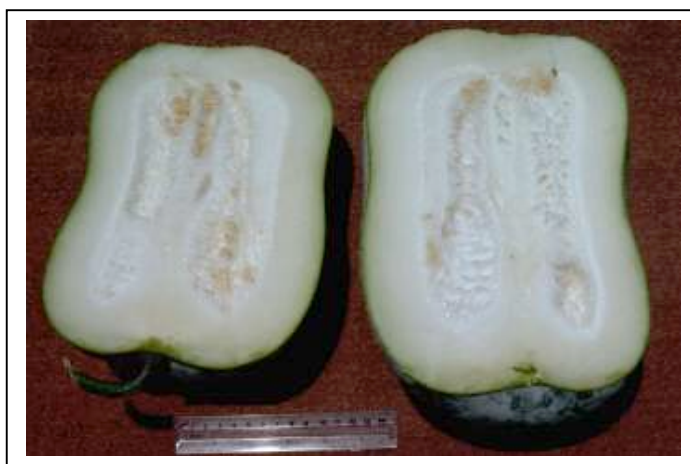
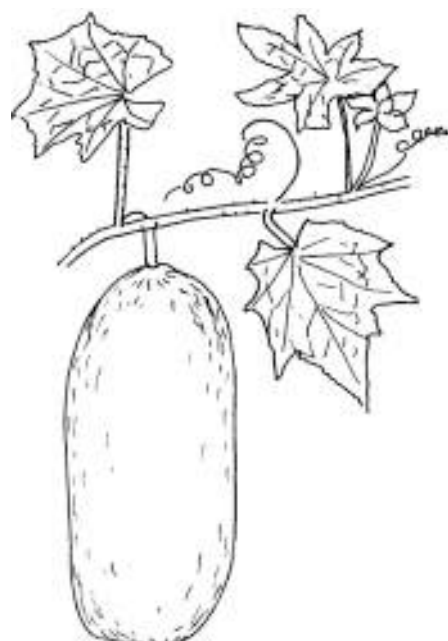
Scientific name: *Benincasa hispida*

This is a very large fruit that is oval or like a ball in shape. They can be 35cm high x 20cm wide and they are green but covered with a white wax that is easily removed. Inside the flesh is white and the seeds are in a spongy section in the middle. The seeds are flat smooth and pale.

In the Rabaul area this gourd is often grown for sale to Chinese people. It brings a very good price.

The plants are grown from seed and are ready for harvest in about 4-5 months. They are better suited to coastal areas where there is a seasonal dry period. Preferably they should be allowed to climb over a strong trellis, or fence.

The fruit can be eaten cooked. The seeds can also be fried and eaten. The young leaves and flower buds can also be cooked and eaten. The fruit keeps well.



Pumpkin family insect pests

Leaf chewing insects

<i>Achaea janata</i> (Linnaeus)	Noctuidae (LEP)	Cacao false looper
<i>Chrysodeixis eriosoma</i> Doubleday	Noctuidae (LEP)	Green looper
<i>Epilachna cucurbitae</i> Richards	Coccinellidae (COL)	Leaf eating ladybird.
<i>Henosepilachna spp.</i>	Coccinellidae (COL)	Leaf eating ladybird
<i>Oribius spp.</i>	Curculionidae (COL)	Shot hole weevils
<i>Rhyparidella wauensis</i>	Chrysomelidae (COL)	Adults eating leaves of pumpkin
<i>Tiracola plagiata</i> Walk	Noctuidae (LEP)	Cacao armyworm
<i>Psylliodes sp nr fulvipes</i> Jacoby	Chrysomelidae (COL)	Feeding on pumpkin leaves

Sap sucking insects

<i>Altica sp</i>	Chrysomelidae (COL)	Damage to pumpkin leaves
<i>Alticus tibialis</i> Reut	Chrysomelidae (COL)	Grass bug
<i>Aphis gossypii</i> Glover	Aphididae (HEM)	Melon aphid
<i>Aphthona bicolorata</i> Jacoby	Chrysomelidae (COL)	Eating epidermis
<i>Aphthona sp nr scutellata</i> Baly	Chrysomelidae (COL)	Damage to pumpkin leaves
<i>Atherigona orientalis</i> Schiner	Muscidae (DIPT)	Shootfly
<i>Aulacophora spp.</i>	Chrysomelidae (COL)	Pumpkin beetles
<i>Crioceris clarkii</i> Baly	Crioceridae (COL)	Feeding on leaves of pumpkin
<i>Bactrocera cucurbitae</i> Coq	Tephritidae (DIPT)	Melon fruit fly
<i>Bactrocera decipiens</i> Drew	Tephritidae (DIPT)	Fruit fly only on New Britain
<i>Bactrocera strigifinis atritus</i> May	Tephritidae (DIPT)	Fruit fly on fruit and flowers
<i>Dysmicoccus brevipes</i> (Cockerell)	Pseudococcidae (HEM)	Pineapple mealybug
<i>Ferrisia virgata</i> (Cockerell)	Pseudococcidae (HEM)	
<i>Leptoglossus australis</i> (Fab.)	Coreidae (HEM)	Black leaf-footed bug
<i>Leptotheca ciskii</i> Weise	Coccinellidae (COL)	Reported on pumpkins.
<i>Macrosiphum euphorbiae</i> (Thomas)	Aphididae (HEM)	Potato aphid
<i>Mictis profana</i> F.	Coreidae (HEM)	Crusader bug
<i>Monolepta spp.</i>	Chrysomelidae (COL)	Monolepta beetles
<i>Paradacus perplexus</i>	Trypetidae (DIPT)	In New Britain damaging pumpkin fruit
<i>Pinnaspis strachani</i> (Cooley)	Diaspididae (HEM)	
<i>Planococcus citri</i> (Risso)	Pseudococcidae (HEM)	
<i>Planococcus pacificus</i> Cox	Pseudococcidae (HEM)	

In some of the coastal areas, fruit fly damage to pumpkin fruit can be very serious. Aphids can be important for spreading viruses. Pumpkin beetles are yellow and about 7mm long and are very common. They can stop fruit forming by damaging flowers as well as eating leaves and burrowing into stems.



Pumpkin beetle



Green looper



Leaf eating ladybird



Cacao armyworm



Psylliodes



Grass bug



Melon aphid



Aphthona



Shootfly



Crioceris



Melon fruitfly



Pineapple mealybug



Leptotheca



Crusader bug



Monolepta beetle

Diseases pumpkin family

Bitter cucumber

Leaf spot	Fungus	<i>Cercospora citrullina</i>
Powdery mildew	Fungus	<i>Oidium sp</i>
Downy mildew	Fungus	<i>Pseudoperonospora cubensis</i>
Root knot	Nematode	<i>Meloidogyne incognita</i>
	and	<i>Meloidogyne javanica</i>

Bottle gourd

Powdery mildew	Fungus	
Anthraxnose	Fungus	<i>Colletotrichum lagenarium</i>

Choko

Leaf spot	Fungus	<i>Ascochyta sp.</i>
Leaf blotch		
Soft rot	Bacteria	<i>Erwinia carotovora</i>

Cucumber

Leaf spot	Fungus	<i>Alternaria alternata</i>
Leaf spot	Fungus	<i>Corynespora cassicola</i>
With fruit rot	Fungus	<i>Choanephora cucurbitarum</i>
Powdery mildew	Fungus	<i>Oidium sp.</i>
Downy mildew	Fungus	<i>Pseudoperonospora cubensis</i>
Leaf spot	Fungus	<i>Phyllosticta sp.</i>
Damping off	Fungi	<i>Pythium butleri</i>
	and	<i>Pythium deliense</i>
Fruit rot	Bacteria	<i>Erwinia carotovora</i>
Root knot	Nematode	<i>Meloidogyne incognita</i>
Storage rot	Fungus	<i>Colletotrichum sp.</i>
	and	<i>Fusarium sp.</i>
	and	<i>Phoma exigua</i>
	and	<i>Pythium sp.</i>

Melon (Rockmelon)

Black rot	Fungus	<i>Mycosphaerella melonis</i>
Powdery mildew	Fungus	<i>Oidium sp.</i>
Downy mildew	Fungus	<i>Pseudoperonospora cubensis</i>
Root knot	Nematode	<i>Meloidogyne incognita</i>

Pumpkin

Storage rot	Fungus	<i>Colletotrichum lagenarium</i>
Sooty mould	Fungus	<i>Epicoccum sp.</i>
Powdery mildew	Fungus	<i>Erysiphe cichoracearum</i>
Downy mildew	Fungus	<i>Pseudoperonospora cubensis</i>
With storage rot	Fungus	<i>Rhizoctonia sp.</i>
Mosaic	Virus	Melon mosaic virus

Rockmelon (See Melon)

Snake gourd

With leaf spot	Fungus	<i>Colletotrichum orbiculare</i>
Leaf spot	Possibly bacterial	

Squash and marrow

With storage rot	Fungus	<i>Aspergillus sp.</i>
Leaf spot	Fungus	<i>Cercospora sp.</i>
Storage rot	Fungus	<i>Colletotrichum lagenarium</i>
	and	<i>Fusarium sp.</i>
Powdery mildew	Fungus	<i>Oidium sp</i>
Downy mildew	Fungus	<i>Pseudoperonospora cubensis</i>
Mould under leaf	Fungus	<i>Cercospora citrullina</i>
Possible virus		

Watermelon

Leaf spot	Fungus	<i>Cercospora citrullina</i>
Leaf spot	Fungus	<i>Colletotrichum lagenarium</i>
	and	<i>Leptosphaerulina trifolii</i>
Black rot	Fungus	<i>Mycosphaerella melonis</i>
Powdery mildew	Fungus	<i>Oidium sp.</i>
Damping off	Fungus	<i>Pythium irregulare</i>
Mosaic	Probably virus	

Root knot	Nematode	<i>Meloidogyne incognita</i>
Zucchini		
Leaf spot	Fungus	<i>Alternaria cucumerina</i>
Fruit rot	Fungus	<i>Choanephora sp.</i>
Powdery mildew	Fungus	<i>Erysiphe cichoracearum</i>
Storage rot	Fungus	<i>Fusarium sp.</i>
Downy mildew	Fungus	<i>Pseudoperonospora cubensis</i>

The downy mildews can be serious with most of the pumpkin family plants especially in the wet season. Some varieties of pumpkin family plants get serious damage. Having plants climb over logs or other frameworks so that they are exposed to the sun and off the ground help control the disease by letting the leaves dry quickly.

Powdery mildews tend to be more of a problem in the highlands. A fine layer of spores give a powdery appearance to the surface of the leaves.

Often the kinds of pumpkin plants that have been grown for years have more resistance to these diseases than the ones grown from seeds bought from stores. Using good crop rotations and planting pumpkin family plants in new gardens away from old plants is important for control of diseases.



Cucumber mosaic virus



Leaf spot (Watermelon)

Downy mildew (Cucumber)



Onions

Several plants in the onion family are grown occasionally in Papua New Guinea. These include:

Bulb onions	<i>Allium cepa</i> var. <i>cepa</i>
Shallots	<i>Allium cepa</i> var. <i>aggregatum</i>
Leek	<i>Allium porrum</i>
Garlic	<i>Allium sativum</i>
Chives	<i>Allium schoenoprasum</i>
Chinese chives	<i>Allium tuberosum</i>

Onions are liked as food and flavouring in Papua New Guinea but only some of them are grown. Bulb onions are mostly imported. Shallots are grown quite widely on the coast and in the highlands. Leeks are seen commonly in some areas of the highlands.

Onion family diseases

Bunching onion (*A. fistulosum*)

Leaf spot	Fungus	<i>Alternaria porri</i>
-----------	--------	-------------------------

Leek

Leaf blight	Fungus	<i>Alternaria porri</i>
-------------	--------	-------------------------

Onion

Leaf tip withering	Fungus	<i>Alternaria porri</i>
Smudge	Fungus	<i>Colletotrichum circinans</i>
Soft rot	Bacteria	<i>Erwinia carotovora</i>
	and	<i>Pseudomonas cepacia</i>

Shallot

Leaf tip burn	Fungus	<i>Alternaria porri</i>
Leaf tip wither	Fungus	<i>Sclerotinia fuckeliana</i>
Smudge	Fungus	<i>Colletotrichum circinans</i>

Onion family insect pests

Black cutworm	<i>Agrotis ipsilon</i> (Hufnagel)	Noctuidae	LEPIDOPTERA
Onion aphid	<i>Neotoxoptera formosana</i> (Takahashi)	Aphididae	HEMIPTERA
Onion thrips	<i>Thrips tabaci</i> Lind.	Thripidae	THYSANOPTERA
Eating leaves of onion	<i>Helicoverpa assulta assulta</i>	Noctuidae	LEPIDOPTERA



Bulb onion



Spring onion



Leek



Chinese chives



Garlic

Fruit

Avocado		221
Bukubuk		224
Citrus		226
Custard apple family	Bullock's heart	233
	Cherimoya	235
	Soursop	238
	Sweetsop	240
Five corner		242
Indian mulberry		249
Golden apple		244
Guava & cherry guava		246
Laulaus (<i>Syzygium spp.</i>)	Malay apple	253
	Rose apple	256
	Surinam cherry	255
	Watery rose apple	254
Lovilovi family		257
Mango		258
Marita		261
Mon (<i>Dracontomelon</i>)		265
Mulberry		267
Mundroi (<i>Corynocarpus</i>)		269
Myristica		
Naranjilla		270
Tamarillo or tree tomato		272
Passionfruits & Granadilla		275
Pawpaw		279
Pineapple		284
Sugarcane		287
Ton (<i>Pometia pinnata</i>)		296
Watermelon		298

Avocado

Tok pisin name: Bata

Scientific name: *Persea americana*

The plant

The avocado tree can grow up to 20 metres high and can be spreading or upright in shape. The bark is grey and rough.

The leaves are entire and oval in shape. They are about 10 cm long. The leaves fall off during some times of the year.

The flowers are about 1.5 cm wide and yellowish green in colour and near the ends of branches in clusters. The flowers are produced in very large numbers and often only one fruit forms for each 500 flowers. The fruit is oval shaped and green on the skin with one large seed inside. The seed is covered with a brown papery skin. The flesh of the fruit is also greenish yellow. The shape of the fruit and the colour of the skin can vary considerably. The fruit hang from stalks often in a bunch.



It needs to be in a frost free location but can grow from sea level up to about 2250 metres altitude. The wood is rather soft so branches can break off in strong wind. Some kinds of avocado can grow in fairly salty soil.

Growing avocados

Avocado trees can be grown from seed. The seeds grow easily but are sometimes slow growing. If they are planted in a nursery the young trees are ready for transplanting after 6 to 12 months. To be sure of getting a good quality fruit, grafted trees should be used. Seedling trees start to produce fruit after about 5 or 6 years. Trees growing under good conditions should last for 50 years.

Fruit production tends to be seasonal and often trees produce larger crops every second year.

Pest and disease

Avocado diseases

Root rot	Fungi	<i>Phytophthora cinnamomi</i>
	and	<i>Phellinus noxius</i>
	and	<i>Rigidoporus microporus</i>
	and	<i>Fusarium solani</i>
Leaf spot	Fungus	<i>Corynespora sp.</i>
Pink disease	Fungus	<i>Phanerochaete salmonicolor</i>
Algal spot (red rust)	Alga	<i>Cephaleuros virescens</i>
Sooty mould	Fungus	

The trees can easily be damaged by root rot especially if they are in poorly drained soil. Trees with this disease slowly start to look wilted and the leaves fall and the tree dies. When new leaves are growing they are small and often yellow. If the roots are checked the smaller roots will be sick or very few of them will be found. The fungus that causes the problem grows in soils with temperatures between 10° and 30° C but are normally in wet and poorly drained soils. In Papua New Guinea the *Phytophthora cinnamoni* fungus has not been recorded below about 750 metres altitude but it is common in the highlands.

Shoots of trees can be killed out with Pink's disease. If this is noticed the branch should be pruned out and then sprayed or painted with a fungicide chemical tridemorph.



Insect pests avocado

<i>Abgrallaspis cyanophylli</i> (Signoret)	Diaspididae (HEM)	Armoured scales
<i>Adoxophyes</i> sp	Tortricidae (LEP)	Leaf roller
<i>Amblypelta</i> spp.	Coreidae (HEM)	Amblypelta bugs
<i>Aspidiotus destructor</i> Signoret	Diaspididae (HEM)	Coconut scale
<i>Ceroplastes destructor</i> Newstead	Coccidae (HEM)	Soft scale
<i>Ceroplastes rubens</i> Maskell	Coccidae (HEM)	Pink wax scale
<i>Chrysomphalus dictyospermi</i> (Morgan)	Diaspididae (HEM)	Armoured scale
<i>Coccus hesperidum</i> Linnaeus	Coccidae (HEM)	Soft brown scale
<i>Coccus longulus</i> (Douglas)	Coccidae (HEM)	Soft scale
<i>Colgar tricolor</i> Dist.	Flatidae (HOM.)	
<i>Dysmicoccus nesophilus</i> Williams	Pseudococcidae (HEM)	Mealy bug
<i>Eupholus</i> spp.	Curculionidae (COL)	Eupholus weevils
<i>Euricania villica</i>	Ricanidae (HEM.)	Plant hopper
<i>Ferrisia virgata</i> Cockerell	Pseudococcidae (HEM)	Striped mealy bug
<i>Fiorinia fioriniae</i> (Targioni)	Diaspididae (HEM)	Armoured scale
<i>Gascardia destructor.</i> De Lotto	Coccidae (HEM)	Soft wax scale
<i>Graphium agamemnon</i> L.	Papilionidae (LEP)	Green spotted triangle
<i>Helopeltis clavifer</i> (Walker)	Miridae (HEM)	Cacao mirid
<i>Hemiberlesia lataniae</i> (Signoret)	Diaspididae (HEM)	Armoured scale
<i>Hemiberlesia palmarum</i> (Cockerell)	Coccidae (HEM)	Soft scale
<i>Homeoxipha fuscipennis</i>	Gryllidae (ORTH)	
<i>Hyposidra talaca</i> (Wlk.)	Geometridae (LEP)	
<i>Icerya seychellarum</i> (Westwood)	Margarodidae	
<i>Idopsis grisea</i> Faust.	Curculionidae (COL)	
<i>Milviscutulus mangiferae</i> (Green)	Coccidae (HEM)	Soft scale
<i>Milviscutulus spiculatus</i> Williams	Coccidae (HEM)	Soft scale
<i>Morganella longispina</i> (Morgan)	Diaspididae (HEM)	Armoured scale
<i>Oribius</i> spp.	Curculionidae (COL)	Shot hole weevils
<i>Paratella miniata</i> Mcl.	Flatidae (HEM)	
<i>Perissopneumon</i>		Mealy bug
<i>Pinnaspis strachani</i> (Cooley)	Diaspididae (HEM)	Armoured scale
<i>Planococcus citri</i> (Risso)	Pseudococcidae (HEM)	Mealy bug
<i>Pseudodoniella typica</i> China & Carvalho	Miridae (HEM)	
<i>Saissetia coffeae</i> (Walker)	Coccidae (HEM)	Coffee scale
<i>Selenothrips rubrocinctus</i> (Giard)	Thripidae (THYS)	Cacao thrips
<i>Terentius nubifasciatus</i> Walker	Membracidae (HOM)	
<i>Xyleborus perforans</i> (Wollaston)	Scolytidae (COL)	Island pinhole borer

Avocado fruit as food

The flesh of the fruit is soft and can be spread like butter. It has a high oil content up to 25% of the fresh weight. The fruit is good for feeding babies. The flesh of the fruit can be scooped out with a spoon or stick and adding salt or pepper adds flavour.

Food value per 100 g edible portion

	Moisture %	Energy KJ	Protein %	ProVit A µg	Provit C mg	Iron mg	Zinc mg
Fruit	74.4	805	1.8	480	11	0.7	0.4

Avocados are one of the fruits with high food value especially protein. They are rich in vitamins.

Fruit will not store for a long time.

Bukubuk

Tok Ples Kuanua: Bukubuk

Scientific name: *Burckella obovata*

What is a Bukubuk like?

A bukubuk fruit is a soft green fruit up to 15 cm across. The outside of the fruit has five or so large fleshy lobes. Inside there is a hard pointed seed. The flesh of the fruit is white. It has a texture and taste something like cantaloupe.



The fruit grows on a large tree that can be 36 metres high and have a trunk 2 m through. The tree often has buttresses.

The branches have lots of twigs on them and the leaves are often crowded at the tips of these small branches. The leaves are simple, produced one after another alternatively along the branch, and they are shiny.

A white sticky sap is produced from the broken ends of twigs and leaves.

The flowers are in groups just back from the ends of the twigs. The flowers are small and white. They have 4 sepals and a corolla with 8 lobes.





Where do bukubuk's grow?

They are truly tropical trees that mostly grow in the lowland rainforest. They occur as occasional trees scattered through the rainforest, and are also planted.

These fruit trees occur on islands such as Manus, New Britain and North Solomons, and also in other South Pacific countries such as Vanuatu.

How did it get its name?

The name Bukubuk is a Tolai word used by the people of the Gazelle Peninsula at Rabaul. As the fruit are sold in the Rabaul market, this name is also known by a number of other people. Bukubuk means lumpy, because the fruit has bumps on it. The fruit also grows in other areas of PNG and has other Tok ples names.

Scientists have given it a Latin name *Burckella obovata*. This is the same in all languages of the world. It belongs to a family of plants called Sapotaceae. These plants have milky sap in them.

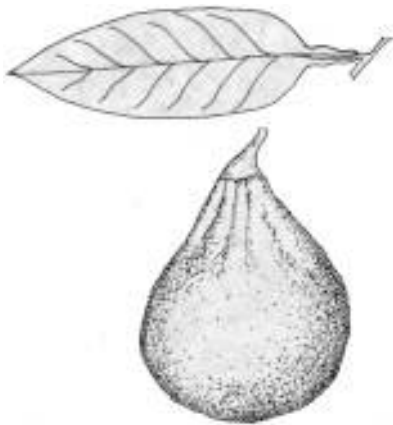
Tok Ples names

Papua New Guinea			
	Province	Language	Tok ples name
	Manus		Nanat
	New Ireland		Natu
	New Britain	Kuanua	Bukubuk
	North Solomons		

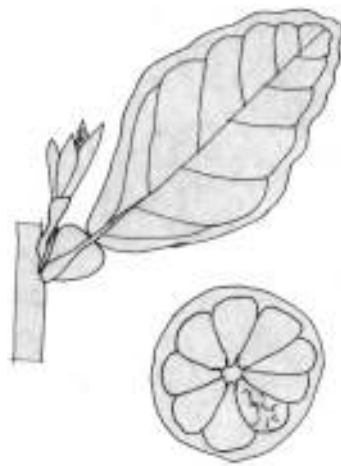
Citrus or muli family

The plants in this family used for fruit in Papua New Guinea include:

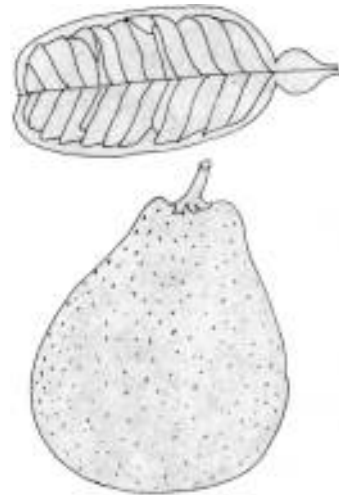
<i>Citrus aurantifolia</i>	Lime
<i>Citrus aurantium</i>	Sour orange
<i>Citrus grandis</i>	Pomelo
<i>Citrus hystrix</i>	"Wild" citrus
<i>Citrus limon</i>	Lemon
<i>Citrus medica</i>	Citron
<i>Citrus paradisi</i>	Grapefruit
<i>Citrus reticulata</i>	Mandarin
<i>Citrus sinensis</i>	Sweet orange
<i>Clymenia polyandra</i>	Clymenia
<i>Fortunella margarita</i>	Kumquat
<i>Triphasia trifolia</i>	Lime berry



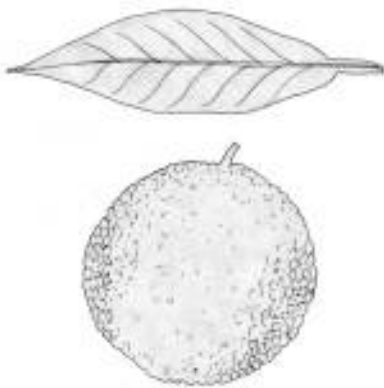
West Indian lime
Citrus aurantifolia



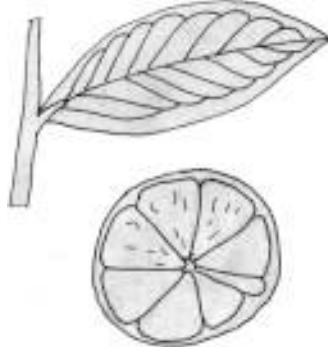
Grapefruit
Citrus paradisi



Pomelo
Citrus grandis



Sweet orange
Citrus sinensis

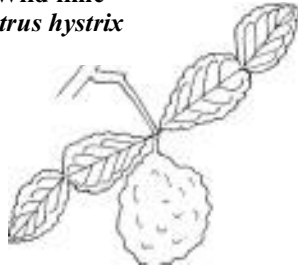


Mandarin
Citrus reticulata



Clymenia
Clymenia polyandra

Wild lime
Citrus hystrix



Lemon
Citrus limon



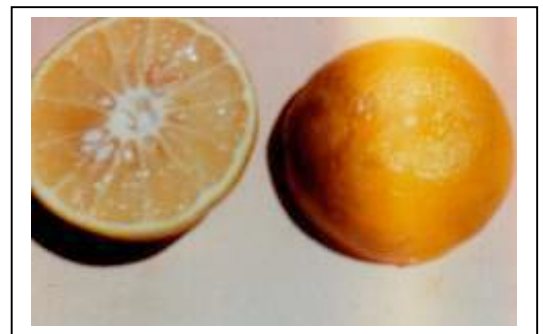
West Indian lime



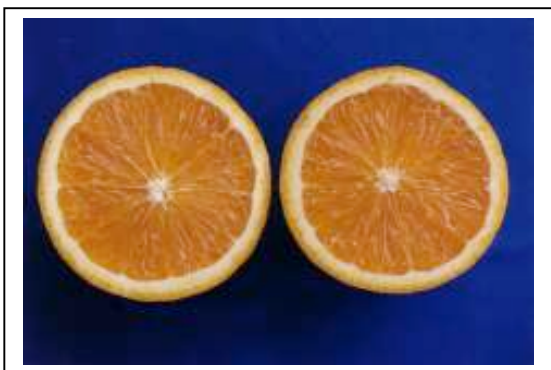
Pomelo



Citron



Grapefruit



Orange



Clymenia

There are many books that deal in great detail with citrus as a crop so it is not intended to deal with all the plants or details here. Only some notes will be included.

The majority of citrus in Papua New Guinea are seedling plants and as these do not breed true to type the fruit is often of poor quality. As well at least in coastal areas they are subject to many pests and diseases and so production is often very poor. Many citrus fruit in Papua New Guinea do not develop true colour but remain green when ripe. They could be degreened but the flavour remains the same.

If the purpose of growing a fruit like citrus is for the food value, there are far more nutritious fruits such as guava that are easy to grow and more popular and much more nutritious.

Of the citrus, lime, pomelo and *Clymenia* reach levels of some significance in coastal areas and on some of the islands. Lime berry is grown and enjoyed in some coastal areas such as near Rabaul and is enjoyed. *Clymenia polyandra* is an indigenous citrus occurring only in Papua New Guinea and only on some of the islands. *Citrus hystrix* or "wild" citrus is cultivated in some coastal areas but only used for flavouring drinks. Of the subtropical species lemon, orange and mandarin, there is sometimes reasonable production in a few mid altitude areas.

Growing citrus

Citrus seed normally germinates and starts growing in about 3 or 4 weeks. For good citrus production it is best to bud selected material onto an appropriate rootstock. Some of the research stations provide planting material.

Flowering in citrus continues throughout the year in the tropics except where rainfall or drought causes fluctuations in flowering and fruiting.

Fruit matures quickly under the warm conditions in much of Papua New Guinea. For example oranges are mature in 6 months, but the quality is poor.



Lime berry



Kumquat

With citrus several plant nutrients needed in small amounts can become short and these quickly show up as poorly growing or poorly coloured leaves. Common deficiencies are zinc, manganese and copper. Boron deficiency is common on acid soils with high rainfall. Citrus will grow on soils of a range of acidity from 5.5 to 8.0 but they will not tolerate waterlogged soils.

Citrus will grow between temperatures of about 12°C and 30°C but they are mostly sensitive to frost especially during flowering. So the best altitude range for citrus is about 800 to 1200 metres except for Pomelo and Clymenia that will grow nearer the coast. In several areas the West Indian lime grows quite well near the coast. Citrus normally grows best where it has full sunlight. Where the rainfall is even and the temperature remains fairly even citrus flowers most consistently. A rainfall between 1000 and 2000 mm is best.

There are a large range of diseases and pests that get on citrus.

Citrus pests

<i>Agrilus occipitalis</i> Esch	Buprestidae (COL)	
<i>Amblypelta theobromae</i> Brown	Coreidae (HEM)	Tip wilt bug
<i>Aonidiella aurantii</i> Mask.	Coccidae (HEM)	Red scale
<i>Aonidiella citrina</i> (Coq)	Diaspididae (HEM)	Yellow scale
<i>Coccus viridis</i> (Green)	Coccidae (HEM)	Green scale
<i>Dacus cucurbitae</i> Coq.	Tephritidae (DIPT)	Melon fruit fly
<i>Dacus tryoni</i> Frogg	Tephritidae (DIPT)	Queensland fruit fly
<i>Eudecatoma</i> sp.	Eurytomidae (HYMEN)	Wasp
<i>Homona coffearia</i> Nietn.	Tortricidae (LEP)	Coffee leaf roller
<i>Leptoglossus australis</i> (Fabricius)	Coreidae (HEM)	Black leaf footed bug
<i>Mictis profana</i> F.	Coreidae (HEM)	Crusader bug
<i>Oribius cinereus</i> Mshl.	Curculionidae (COL)	Shot hole weevils
<i>Oribius cruciatus</i> Fst.	Curculionidae (COL)	Shot hole weevils
<i>Oribius destructor</i> Mshl.	Curculionidae (COL)	Shot hole weevils
<i>Oribius inimicus</i> Mshl.	Curculionidae (COL)	Shot hole weevils
<i>Papilio aegeus ormenus</i> Guerin	Papilionidae (LEP)	Citrus butterfly
<i>Phyllocnistis citrella</i> Staint	Phyllocnistidae (LEP.)	Citrus leaf miner
<i>Planococcus citri</i> (Risso)	Pseudococcidae (HEM)	Citrus mealy bug
<i>Rhinoscapha thomsoni</i> Wterh.	Curculionidae (COL)	Citrus leaf eating weevil
<i>Rhopalosiphum maidis</i> (Fitch.)	Aphididae (HEM)	Corn leaf aphid
<i>Saissetia coffeae</i> Walker	Coccidae (HEM)	Brown coffee scale
<i>Spodoptera litura</i> (Fab)	Noctuidae (LEP)	Cluster caterpillar
<i>Tiracola plagiata</i> (Walker)	Noctuidae (LEP)	Cacao armyworm
<i>Toxoptera aurantii</i> B.de Fonsc.	Aphididae (HEM)	Black citrus aphid
<i>Toxoptera citricidus</i> (Kirk)	Aphididae (HEM)	Brown citrus aphid
<i>Unaspis citri</i> (Comst.)	Diaspididae (HEM)	White louse scale

Several other mealbugs occur in Papua New Guinea and also get on citrus. These include: *Dysmicoccus nesophilus*, *Ferrisia virgata*, *Laingiococcus painei*, *Maculicoccus malaitensis*, *Nipaecoccus viridus*, *Planococcus lilacinus*, *Planococcus pacificus*, *Pseudococcus elisae*, *Pseudococcus longispinus*, *Rastrococcus vicorum*.

There are also several other soft scales in Papua New Guinea that get on citrus. These include: *Icerya purchasi*, *Icerya seychellarum*, *Steatococcus samaraius*, *Anthococcus kerevatae*, *Ceroplastes destructor*, *Ceroplastes rubens*, *Coccus hesperidum*, *Coccus longulus*, *Drepanococcus chiton*, *Kilifia acuminata*, *Milviscutulus mangiferae*, *Parasaissetia nigra*, *Pulvinaria psidii*, *Saissetia miranda*, *Saissetia neglecta*, *Vinsonia stellifera*.

And there are several other armoured scales that occur in Papua New Guinea and get on citrus. These include: *Aonidiella eremocitri*, *Aspidiotus destructor*, *Aspidiotus excisus*, *Chrysomphalus aonidum*, *Chrysomphalus dictyospermi*, *Chrysomphalus pinnulifer*, *Duplaspidotus claviger*, *Fiorinia coronata*, *Fiorinia fioriniae*, *Hemiberlesia lataniae*, *Hemiberlesia palmarum*, *Howardia biclavata*, *Ischnaspis longirostris*, *Lepidosaphes beckii*, *Lepidosaphes gloverii*, *Lepidosaphes tokionis*, *Lopholeucaspis baluanensis*, *Morganella longispina*, *Parlatoria proteus*, *Pinnaspis buxi*, *Pinnaspis strachani*, *Pseudaulacaspis pentagona*.

Diseases of the Citrus family

Citron

Scab	Fungus	<i>Sphaceloma fawcettii</i>
Algal spot	Alga	<i>Cephaleuros virescens</i>

Clymenia citrus

Scab	Fungus	<i>Sphaceloma fawcettii</i>
------	--------	-----------------------------

Grapefruit

With leaf spot	Fungus	<i>Glomerella cingulata</i>
Algal leaf spot	Alga	<i>Cephaleuros virescens</i>
Bacterial canker	Bacteria	<i>Xanthomonas campestris</i>
Unthrifty plants	Nematode	<i>Tylenchulus semipenetrans</i>

Lemon

Leaf spots	Fungi	<i>Ascochyta citri</i>
	and	<i>Glomerella cingulata</i>
Scab	Fungus	<i>Sphaceloma fawcettii</i>
Pink disease	Fungus	<i>Phanerochaete salmonicolor</i>
Bacterial canker	Bacteria	<i>Xanthomonas campestris</i>

Lime

Sooty mould	Fungus	<i>Meliola citricola</i>
Pink disease	Fungus	<i>Phanerochaete salmonicolor</i>
Collar & root rot	Fungus	<i>Phellinus noxius</i>
Bacterial canker	Bacteria	<i>Xanthomonas campestris</i>

Mandarin

Sooty mould	Fungus	<i>Meliola citricola</i>
Pink crust of stems	Fungus	<i>Podonectria sp</i>

Orange

Pink disease	Fungus	<i>Phanerochaete salmonicolor</i>
Unthriftness	Nematode	<i>Tylenchulus semipenetrans</i>

Pomelo

Collar rot	Fungus	<i>Athelia rolfsii</i>
------------	--------	------------------------

Because many of these pests and diseases are common and serious, in my opinion, if you are more interested in growing food than growing insects and diseases then I think there are more useful crops for Papua New Guinea than citrus! There are many plants with much higher Vitamin C than citrus.

Food value of 100 g of edible portion - fruit

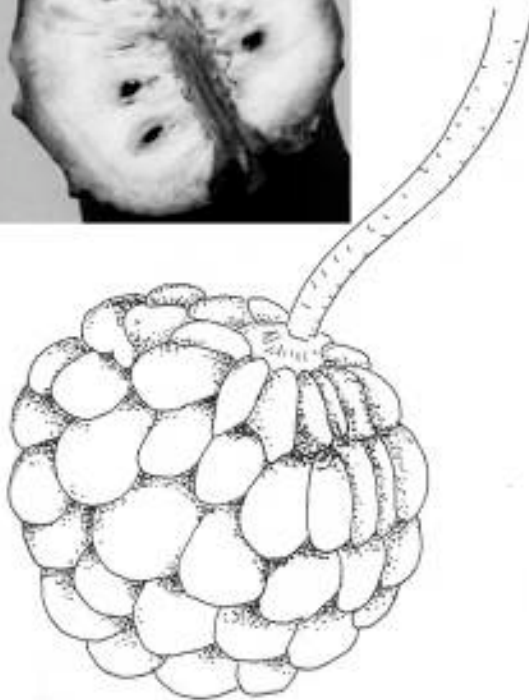
Scientific name	Common name	Moisture %	Energy KJ	Protein %	ProVit A µg	Provit C mg	Iron mg	Zinc mg
<i>Citrus aurantifolia</i>	West Indian lime	91.0	133	0.7	4	40	0.25	0.1
<i>Citrus aurantium</i>	Sour orange	86.0	205	0.9	4	53	0.5	
<i>Citrus grandis</i>	Pomelo	89.1	159	0.76	0	61.0	0.11	0.1
<i>Citrus hystrix</i>	Wild lime							
<i>Citrus limon</i>	Lemon	83.3	65	1.1	Tr	80	0.4	0.1
<i>Citrus limon</i>	Lemon	91.3	31	0.3	Tr	50	0.1	Tr
<i>Citrus medica</i>	Citron	90.2	170	0.7		53	0.5	0.1
<i>Citrus paradisi</i>	Grapefruit	43.5	45	0.3	Tr	19	0.1	0.1
<i>Citrus reticulata</i>	Mandarin	87.6	184	1.5	42RE	136	0.8	
<i>Citrus sinensis</i>	Orange	86.8	197	0.94	21	53.2	0.1	0.1

This hybrid is
often called
Custard apple

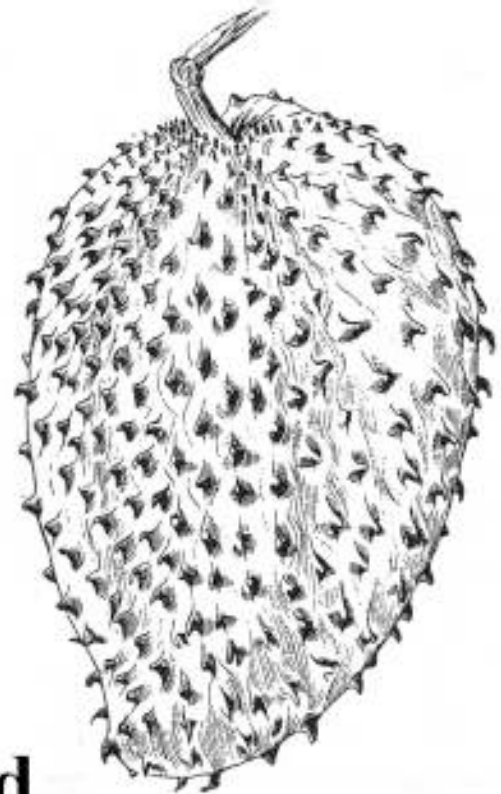


Atemoya
Annona cherimolia x A squamosa

The Mountain soursop
Annona montana is not
shown and may not yet
be in Papua New Guinea

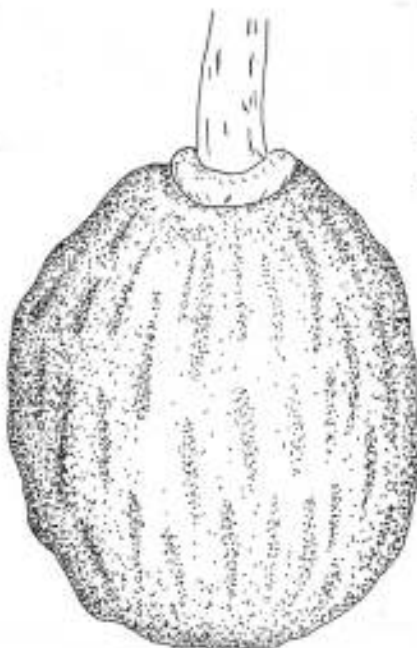


Sweetsop
Annona squamosa

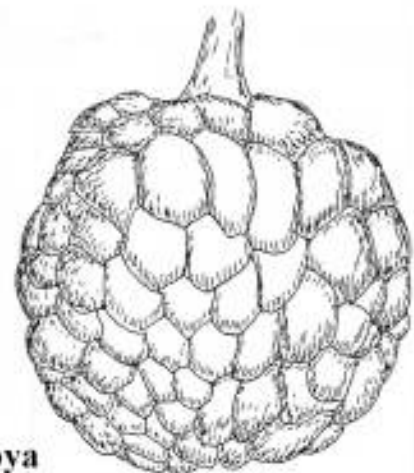


Soursop
Annona muricata

Custard apple family



Bullock's heart
Annona reticulata



Cherimoya
Annona cherimola

Custard apple family

Four or five fruits in this group of plants are grown for their edible fruits in Papua New Guinea. Sometimes they are called Custard apples but because this name is used for different ones at different times it is best to use other separate names. The names used here are:

English name	Tok Pisin	Scientific name
Bullock's heart		<i>Annona reticulata</i>
Cherimoya		<i>Annona cherimolia</i>
Soursop	Sapasap	<i>Annona muricata</i>
Sweetsop		<i>Annona squamosa</i>
Atemoya		<i>A.cherimolia x A.squamosa</i>

In other tropical countries there are about 8 other fruit trees in this group called *Annona* that are grown for their edible fruit.



Atemoya



Soursop



Bullock's heart



Sweetsop

Pest and disease

Diseases of the Custard apple family

Plant	Disease	Cause	Scientific name
Custard apple (See Soursop)			
Soursop	Sooty mould	Fungi	<i>Capnodium sp</i>
		and	<i>Chaetothyrium sp.</i>
		and	<i>Microxyphium sp.</i>
	Pink disease	Fungus	<i>Phanerochaete salmonicolor</i>
	Blossom blight	Fungus	<i>Glomerella cingulata</i>
	Algal leaf spot	Alga	<i>Cephaleuros virescens</i>
Sweetsop			
	Blossom blight	Fungus	<i>Glomerella cingulata</i>
	Pink disease	Fungus	<i>Phanerochaete salmonicolor</i>

Insect pests of Custard apple family

<i>Abgrallaspis cyanophylli</i> (Signoret)	Diaspididae (HEM)	Armoured scale
<i>Adoxophyes sp.</i>	Tortricidae (LEP)	Leaf roller damaging soursop
<i>Amblypelta spp.</i>	Coreidae (HEM)	Amblypelta bugs
<i>Anthococcus kerevatae</i> Williams	Coccidae (HEM)	Soft scale
<i>Apiocalus spp.</i>	Curculionidae (COL)	Horned weevil
<i>Aspidiotus destructor</i> Sign.	Diaspididae (HEM)	Coconut scale
<i>Aleurodicus destructor</i> (Mackie)	Aleyrodidae	Coconut white fly
<i>Chrysomphalus aonidum</i> (Linnaeus)	Diaspididae (HEM)	Florida red scale
<i>Coccus celatus</i> De Lotto	Coccidae (HEM)	Soft scale
<i>Coccus longulus</i> (Douglas)	Coccidae (HEM)	Soft scale
<i>Dasychira mendosa</i> Hubn.	Lymantriidae (LEP)	Caterpillar eating leaves soursop
<i>Drepanococcus chiton</i> (Green)	Coccidae (HEM)	Wax scales Attended by ants
<i>Dysmicoccus brevipes</i> (Cockerell)	Pseudococcidae (HEM)	Pineapple mealybug
<i>Euricania villica</i>	Ricanidae (HEM)	Plant hopper sucking sap of soursop
<i>Ferrisia virgata</i> (Cockerell)	Pseudococcidae (HEM)	
<i>Graphium agamemnon</i> L.	Papilionidae (LEP)	Green spotted triangle
<i>Hemisphaerinus sp.</i>	Issidae (HEM)	Sucking sap of soursop
<i>Hemiberlesia palmarum</i> (Cockerell)	Diaspididae (HEM)	Armoured scale
<i>Homona coffearia</i> Nietn.	Tortricidae (LEP)	Coffee leaf roller
<i>Howardia biclavis</i> (Comstock)	Diaspididae (HEM)	Armoured scale
<i>Hyposidra talaca</i> (Wlk.)	Geometridae (LEP)	Eating leaves of custard apple, soursop
<i>Icerya seychellarum</i> (Westwood)	Margarodidae (HEM)	Scale
<i>Laingioccoccus painei</i> (Laing)	Pseudococcidae (HEM)	
<i>Oribius cinereus</i> Mshl.	Curculionidae (COL)	Shot hole weevils
<i>Parasaissetia nigra</i> (Nietner)	Coccidae (HEM)	Nigra scale
<i>Pinnaspis strachani</i> (Cooley)	Diaspididae (HEM)	Armoured scale
<i>Planococcus lilacinus</i> (Cockerell)	Pseudococcidae (HEM)	Mealy bug
<i>Planococcus pacificus</i> Cox	Pseudococcidae (HEM)	Mealy bug
<i>Pseudococcus longispinus</i> Targioni	Pseudococcidae (HEM)	Longtailed mealybug
<i>Saissetia coffeae</i> (Walker)	Coccidae (HEM)	Coffee scale
<i>Steatococcus samaraius</i> Morrison	Margarodidae (HEM)	Scale
<i>Terentius nubifasciatus</i> Walker	Membracidae (HOM)	Sap-sucker of soursop
<i>Unaspis citri</i> (Comstock)	Diaspididae (HEM)	White louse scale

Bullock's heart

Scientific name: *Annona reticulata*

What is the plant like?

The Bullock's heart is a small tree up to 7.5 m tall. It has several branches near the base. New shoots have short brown hairs but older wood is smooth and shiny. Trees lose their leaves at some times of the year.

It has spear shaped leaves. They have short leaf stalks. Around the edge of the leaf is a clear edge. Leaves smell when crushed.

The flowers are greenish yellow. They occur in groups where the leaves join the stalk. They occur on new wood growth.

The fruit are round and about 10 to 12 cm across. They are yellowish brown in colour. Over the surface of the fruit there is a fine hexagonal pattern. There are large brown seeds inside the fruit. The flesh is yellow. The fruit are eaten raw.



Where is the Bullock's heart grown?

The Bullock's heart is a tropical plant. It occurs in the lowlands and up to about 1200 metres altitude. It occurs around some coastal towns.

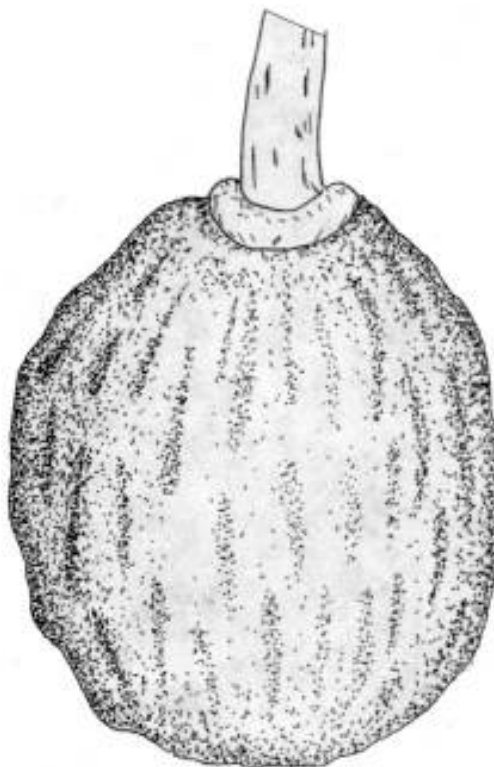
It is less suited to dry climates.

How do you grow Bullock's heart?

Mostly trees are grown from seed. These trees vary quite a bit. Seedlings are easy to transplant. Trees need to be about 7 m apart.

Better kinds can be grown using budding or grafting.

Trees begin to produce fruit after about 3 to 5 years. Trees flower and produce fruit throughout the year.



Cherimoya

Scientific name: *Annona cherimola*

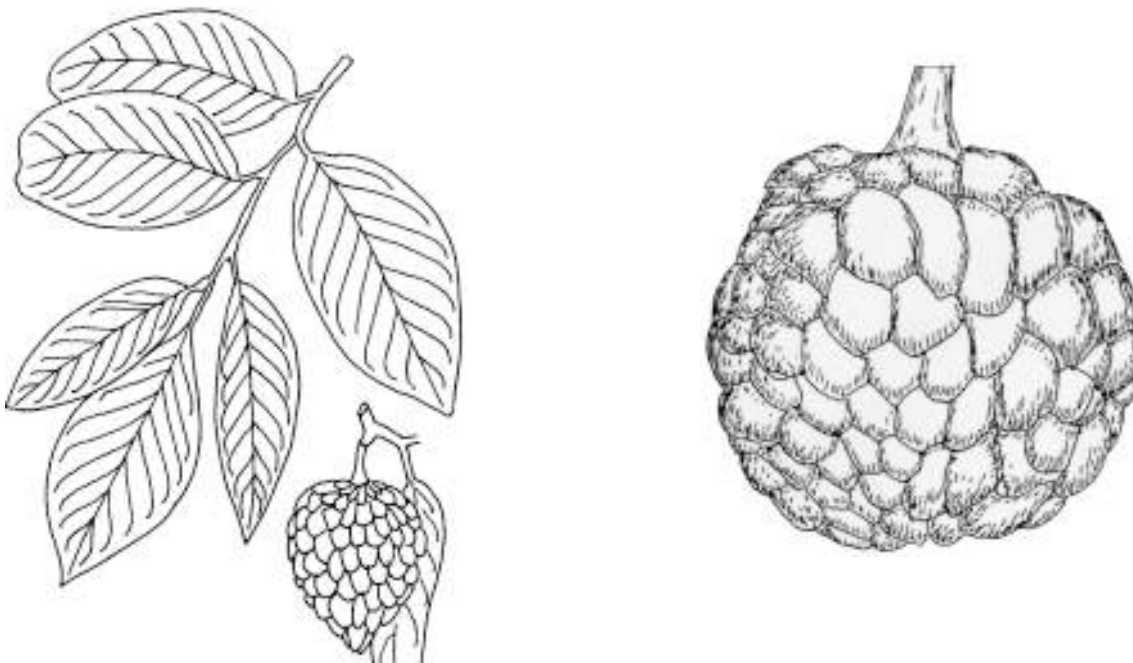
What is the plant like?

This is a small tree up to 6 m tall. It grows new shoots from the branches after the leaves fall.

The leaves are quite large (10 cm x 25 cm) and are light green. Underneath the leaves are densely covered with short soft hairs.

Flowers usually occur singly on young and old wood. They are long (2.5 cm) and narrow.

Fruit are up to 15 cm long and 10 cm wide. The fruit is fairly round but covered with many fleshy, scale like parts. The outside of the fruit can be dark green to black. Dark brown seeds about 1 cm long are inside the flesh. The flesh around the seeds is eaten.



Where does it grow?

The cherimoya is better suited to slightly cooler places and to drier climates. Therefore it does better in the hills than on the coast. It will probably grow well at about 1000 m altitude and may grow up to about 2300 m.

How do you grow cherimoya?

Trees are mostly grown by using seed. Seeds can be stored for several years and will still grow or they can be planted fresh. Seeds grow in about 4 weeks. Seedlings can be transplanted when one year old. They are easy to transplant and even trees 3 or 4 years old can be transplanted when the leaves have fallen off.

**Cherimoya
seeds**



For better kinds of trees it is necessary to use budding or grafting.

Trees can be spaced 8 metres apart. They can be pruned to give a better-shaped tree.

Hand pollination of the flowers can give more even shaped fruit and also ensure more fruit are formed. To do this, flowers are gathered in a small brown paper bag and kept till the pollen falls. Then with a small brush the pollen is put on freshly open flowers. The three petals of the flower are gently held open and the pollen spread around on the female flower parts (pistils).

Food value of 100 g edible portion:

Edible portion	Moisture %	Energy KJ	Protein %	ProVit A µg	Provit C mg	Iron mg	Zinc mg
Fruit raw	73.5	395	1.3	1	9	0.5	

Soursop

Scientific name: *Annona muricata*

The plant

Soursops or sapasap are small coastal trees that have been introduced to Papua New Guinea originally from South America. The trees are up to 5 or 6 metres high and have low branches with limbs that turn upwards giving the tree a slender look. The bark is brown and smooth. The tree has leaves all year round.

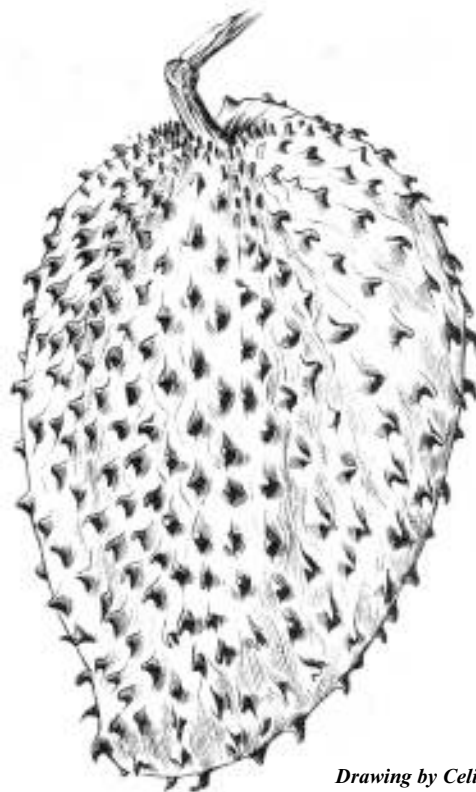
The leaves are long (14 cm) and narrow (4 cm) slightly shiny on top and without hairs. The leaves are carried one after the other on opposite sides of the branches. The leaves feel thick and like leather.

The flowers are large (2-3 cm long), rounded and produced on short stems on the branches. The flowers have thick yellow petals. Mostly only one or two flowers are produced together.

The fruit is large and has soft spines over its surface. The fruit can be 15 to 25 cm long and can weigh up to 2 kg. The fruit is dark green in colour, soft and fleshy and heart shaped but often with one side flattened.

Inside, the fruit has many black seeds scattered through the white juicy pulp. Not all of the segments of the fruit have a seed in them. Seeds are commonly 1 to 2 cm long. The fleshy pulp has fibres in it.

The leaves, fruit and flowers can all have a slightly unpleasant smell.



Drawing by Celia Bridle

Where do soursops grow?

Soursops are a tropical plant. They grow best in the hot lowlands. They are mostly grown from sea level up to about 1000 m altitude. In Papua New Guinea they are seen around many coastal towns.

The trees can withstand temperatures down to freezing (0°C) for a short time but salt laden winds from the sea can kill the trees.

They need a well-drained soil and cannot tolerate waterlogging. The trees continue to grow and produce satisfactorily in fairly poor compact soil. But improving the fertility increases the amount of fruit.

They can grow well in hot humid areas but a fungus disease called Blossom blight can cause flowers to fall off.

How do you grow soursops?

Plants can easily be grown from seeds. Seeds can be planted fresh or stored. Seeds grow in about 15 to 20 days. Trees grown from seeds vary in the quality of the fruit.

Trees can also be grown from cuttings or by grafting. This allows better trees to be selected and produced.

Trees need to be about 5m apart.

Hand pollination of flowers can increase the number of fruit that are produced.

How well do trees produce?

Trees grow quickly. They can start producing fruit in 3 or 4 years.

Trees flower and fruit throughout the year but there is normally one season when more fruit are getting ripe. Often a tree only produces 12 to 20 fruit in a year.

Soursop as food

The fruit contain 81% moisture and 12.7% total sugars. The fruit have 0.4% protein. The flesh of the fruit is therefore juicy and somewhat sweet but with a sour taste due to the amount of acid they contain.

Soursop seeds are poisonous.

Pest and Disease

In Papua New Guinea trees are often infested with scale insects and mealy bugs. Red ants live in connection with these insects in many places so that trees and branches are often covered with ants. As well, these scale insects and mealy bugs leave behind them a liquid called honey dew. A black sooty mould fungus then grows on the leaves where the honeydew occurs. As a result, leaves are commonly covered by a black sooty mould. The mould can be rubbed off with the fingers as it only grows on the surface of the leaf. If the scale insects are controlled the sooty mould stops growing.

In wet humid places another fungus grows on the flowers and causes them to fall off. This is called Blossom blight and is due to a fungus (*Colletotrichum gloeosporoides* Penz.). Improving the growing conditions and allowing more sunlight in by pruning can help reduce the amount of damage by this disease.

Sweetsop

Scientific name: *Annona squamosa*

Names.

Sometimes this fruit is also called a custard apple. But as custard apple is also used occasionally for other fruits in this same group, particularly the atemoya, it is less confusing to refer to this fruit as the sweetsop.

What is a sweetsop like?

The tree is a small tree that can be up to 6m high and it has irregularly spreading branches.

The leaves are oblong and narrow and often about 12 cm long by 4 cm wide. The leaves have fine hairs underneath. The leaves smell when crushed. They are a dull green colour.

The flowers droop or hang down from the branches either singly or in groups of 2 or 3. The flowers are a greenish colour.

The fruit are 8-10 cm across and green in colour. The outside is made up of loosely overlapping fleshy parts of the female flower (carpels).

Inside the fruit there are several shiny black seeds about 1.5 cm long. These seeds are amongst the white soft flesh of the fruit.



Where do sweetsops grow?

Sweetsops occur in the tropical lowlands. They are common and grow naturally on some of the dry hills around Port Moresby. But sometimes in these hot dry areas trees do not set fruit well. Fruit production is often better in places with a more humid atmosphere. Trees fruit well at Bulolo.

The trees will probably grow satisfactorily up to about 1000 metres altitude.

Sweetsops cannot stand frost but they are able to survive droughts better than many fruit trees. Trees do not like waterlogged soils. Sweetsops can grow on fairly poor dry stony soils.

Trees often lose their leaves in the dry season.

How do you grow sweetsops?

Sweetsops are mostly grown from seeds. Seeds can be stored for several years and will still grow. But it is better to use fresh seeds if they are available. Seeds germinate and start to grow 50 to 70 days after planting. Soaking the seeds for 3 days in water often helps them to grow.

Trees can start to produce fruit 2 years after they are planted.

If you want to save and grow a particularly good kind of sweetsop, it is better to use methods such as grafting than to sow seeds. A small branch is grafted onto the roots and tree of another sweetsop plant that is already growing. By this method, the new branch will grow and produce fruit exactly the same as the tree it came from. Plants are very hard to get to grow from cuttings. A spacing of 6 m apart is suitable for sweetsop trees.

How are the fruit used?

The sweet soft fleshy layer around the seeds can be eaten raw. When the fruit is ripe it is easy to separate the different soft fleshy parts of the fruit.

Often it is easiest and best to harvest the fruit when they are nearly ripe and then let them ripen in a warm place.

The seeds, leaves and roots are poisonous. Both a chemical called an alkaloid, and hydrocyanic acid have been shown to occur in these parts of the plant.



Five Corner or Carambola

Scientific name: *Averrhoa carambola*

What is the tree like?

The five-corner tree is a small tree which can grow up to 12 m tall. It has a nice shady crown of leaves. The trunk of the tree is short or crooked and has branches near the base. The bark is smooth and dark grey. The tree has many branches and the twigs bend easily and tend to hang down.

A leaf is made up of 2 to 11 leaflets. There is a leaflet at the end so that an uneven number of leaflets occur. The leaves are darker green and more shiny on top. The leaflets don't occur exactly opposite each other along the stalk. Also leaflets get larger as they go along the stalk. The leaflets are uneven in shape, one side being broad and the other narrow. The leaves tend to hang flat if the tree is shaken and at night the leaves also hang close together.

The flowers are small (8 mm long) and red and white in clusters or groups on the small twigs and branches. The flowers have 5 petals and 5 sepals. The flowers have a sweet smell.

The fruit is a star shaped or 5 angled fleshy fruit. The colour becomes yellow to orange as fruit ripen. The fruits are waxy in appearance and you can almost see through them. They are smooth and thin skinned. Fruit can be 10 cm or more long. The flesh of the fruit is very juicy with a sweet sour taste. They also have a scented perfume or smell.

In the bottom section of each lobe of the fruit there are 1 or 2 seeds. The seeds are shiny, thin, light brown and about 1 cm long.



Where do five corners grow?

Five corners need a warm tropical climate so they are mostly seen in the coastal lowlands below about 500 m altitude. They will grow up to 1200 m.

Five corner can grow on several different types of soil. The soil should be well drained.

It is suited to moist places but performs better in areas where there is some dry season rather than in places with heavy, constant rain.

Trees are fairly wind resistant providing the winds are not cold.

Trees can start bearing after 3-4 years.

How do you grow five-corner?

Many five-corner trees in Papua New Guinea have been grown from seeds. This is the easiest way to grow a tree but sometimes the fruit is sour and not as enjoyable to eat. Seeds grow easily but in fact only a small number of seeds are fertile. Well-developed seeds should be chosen. Because seeds are produced from pollen coming from other flowers (cross pollination), not all the seedlings that grow will be the same.

To avoid this problem and to produce fruit of the better, sweeter kinds it is necessary to use specialised vegetative methods of growing new trees. Taking buds off good trees, or grafting twigs from them, onto 1-year old seedling roots is the commonest method.

Trees live for a long time and fruit is produced at most times of the year. Flowers and fruit can be found on the tree at most times of the year. Flowers and fruit can be found on the tree at most times although there is often 2 or 3 main flushes of flowering and fruiting.

The tree does not require pruning or any special care once established.

Flowers are cross-pollinated by bees, flies and other insects. Hand pollination does not help fruit set much.



Golden apple

Scientific name: *Spondias cytherea*

What is a Golden apple like?

Often a Golden apple tree grows to a large tree that can be up to 30 m high but is more often 15 m high in cultivation. It has a trunk 60 cm across which can have buttresses. The bark on the trunk of the tree is fairly smooth. The twigs break off easily. The wood is soft and not much use.

The leaf is made up of 4 to 12 pairs of leaflets that have fine teeth around the edge. The leaves are smooth and dark green on top and pale green underneath. The leaves of the tree fall off for a part of the year. The old leaves wither to a bright yellow colour.

The flowers are produced near the ends of the branches and mostly the flowers develop before the new young leaves grow. The flowers occur as several flowers on long stalks. They are small and white. They look something like a mango flower.

The fruit is yellow, oval and up to 7 cm long and 4 cm across. Sometimes the outside of the fruit has a mottled black colour. There is one large stone inside divided into 5 cells with a seed in each. The stone is branched and has fibres.



Where do Golden apples grow?

This fruit tree occurs commonly both wild and cultivated in lowland rainforest areas throughout Papua New Guinea. It covers the full range from wild unused fruit trees in the forest to a planted, pruned and highly regarded village fruit tree. The wild trees are probably spread around by birds, pigs and people.

Naturally, trees mostly occur on deep alluvial soils and are rare on thin limestone soils. They are in well-drained soils or in dry forests. Trees grow from sea level up to about 950 m altitude. Trees can start to fruit after about 4 years. Fruiting is seasonal.

The trees also grow in Indonesia, the Philippines, Thailand and a number of other Pacific countries. It has also been taken to other tropical countries.

Names

Some of the Tok Ples names for this plant are:

Place	Name
Manus	drine
Kavieng	kulis
Rabaul	kru or kuris
Lake Kutubu	kinaio
Madang	huneg

The older scientific name for this plant was *Spondias dulcis*

How are Golden apples grown?

Trees are mostly grown from seed. The seeds do not produce true to type so that poor and sour fruit are often produced. It is possible to grow plants from cuttings although it is difficult. Doing this would enable better types of fruit to be regrown. It can also be grown using budding.

Young trees benefit by shade during their first year. The top can be cut off trees to give a lower and more spreading tree.

Insect pests of Golden apple

Coconut scale	<i>Aspidiotus destructor</i> Sign.
Armoured scale	<i>Chrysomphalus dictyospermi</i> (Morgan)
Armoured scale	<i>Hemiberlesia palmae</i> (Cockerell)
	<i>Icerya seychellarum</i> (Westwood)
Mealy bug	<i>Planococcus pacificus</i> Cox

The insect pests on Golden apple have probably not been properly studied.

How is Golden apple used?

The fruit are eaten raw after the sour skin is peeled off. Sometimes lime is added to the fruit. The fruit is sour. It has the texture of an apple. Sometimes the fruit is eaten with salt or mixed with coconut. Fruit production is seasonal probably early in the year. The young leaves of the tree are eaten often raw but also cooked.

The food value of fruit per 100 g edible portion

Moisture %	Energy KJ	Protein %	ProVit A µg	Provit C mg	Iron mg	Zinc mg
70.0	657	0.6				

Guava

Scientific name: *Psidium guajava*

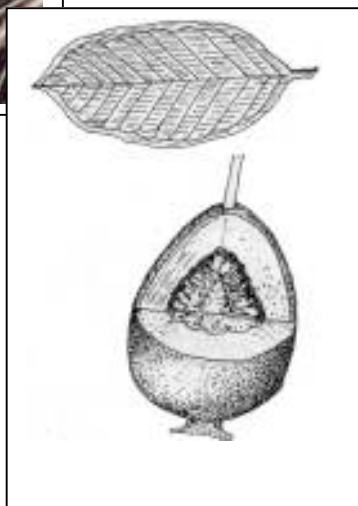
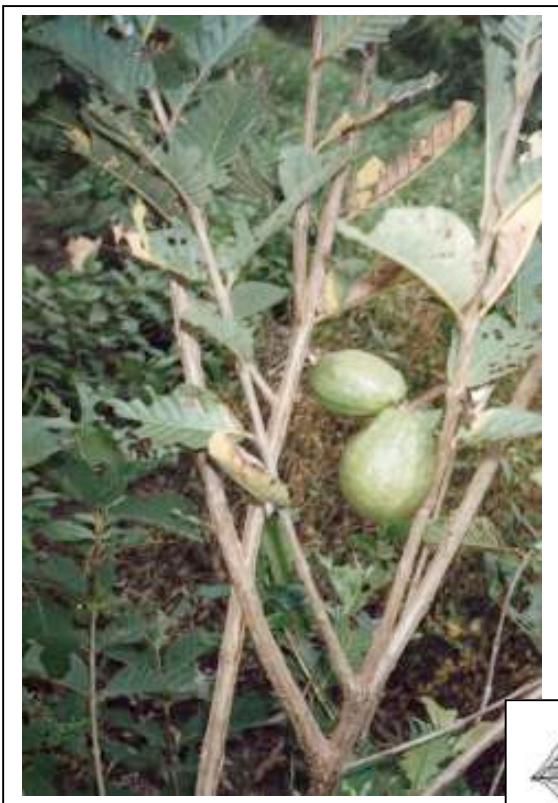
Guava trees

Trees grow between 3 and 10 m tall. They have thin trunks and straggly branches. The bark is smooth and peels off in thin flakes. The tree branches close to the ground and can have suckers around the base.

Leaves are produced in pairs opposite each other. The leaves are smooth, light green in colour and with distinct veins. They are about 15 cm long.

The young twigs are four angled.

Flowers are produced where the leaves join the branches. The fruit is green but becomes yellow/orange when fully ripe.



Growing guavas

Most of the guava trees in Papua New Guinea have been grown from seed or have just grown naturally from seed scattered by birds and bats. To get really good quality fruit it is necessary to grow trees using budding, grafting, cuttings of stems or roots, or by air layering. This enables trees exactly the same as the original trees to be produced. If vegetative methods are to be used it is as well to look up the details of the methods in other books as these methods do not always work easily with guava. Better fruit have thinner skins, fewer seeds and less of the tough "stone" cells.

On fruit can produce about 50 seeds for sowing. Seeds will still grow after a year or more, but it is best to plant them while fresh. Guavas come up when land is cleared and grow easily in grassland. Seeds normally start to germinate in 2 or 3 weeks. Guavas can produce fruit after about 3 years and keep producing for up to 30 years.

Pruning back the tips of guava branches (about 10 cm) increases the yield of fruit.

Guavas produce more and better fruit if the trees are well looked after and the soil fertility improved. This can be done with animal manures or commercial fertilisers. Spraying the trees with 1% urea solution onto the leaves has helped flower and fruit formation.

Flowering occurs throughout the year. It takes about 5 months from flowering until fruit are ready.

Where guavas grow

Guavas grow well up to an altitude of about 1600 m and will grow easily on a range of soils and in different climates. It suits the lowlands and can't stand frost. It is not greatly troubled by temporarily waterlogged soils and can survive some drought. It will grow on fairly poor and acid soils.

Guavas grow best when the average temperature is between 23°C and 28°C.

Guavas as food

Guavas have very high levels of vitamin C and are much better than citrus for this. Because the vitamin C level is high near the skin, the method used especially by children of eating the fruits skin and all is a good method. Guavas also make good jellies, and juice.

The food value per 100 g edible portion of the fruit

Edible portion	Moisture %	Energy KJ	Protein %	ProVit A µg	Provit C mg	Iron mg	Zinc mg
Fruit	77.1	238	1.1	60	184	1.4	0.2



Insects

Fruit flies can damage guavas. The maggots of the flies bore in the fruit.

Guava insect pests

Amblypelta bugs	Coreidae (HEM)	<i>Amblypelta</i> spp.
Banana fruit fly	Tephritidae (DIPT)	<i>Bactrocera musae</i> and <i>Bactrocera bryoniae</i>
Brown coffee scale	Coccidae (HEM)	<i>Saissetia coffeae</i>
Cacao mirid	Coreidae (HEM)	<i>Helopeltis clavifer</i>
Coconut scale	Diaspididae (HEM)	<i>Aspidiotus destructor</i>
Spiralling whitefly	Aleurodidae (HEM)	<i>Aleurodicus dispersus</i>
Striped mealybug	Pseudococcidae (HEM)	<i>Ferrisia virgata</i>
Weevil	Curculionidae (COL)	<i>Apirocalus cornutus</i>
Fruit flies	Tephritidae (DIPT)	<i>Bactrocera frauenfeldi</i> , <i>B. trivialis</i>
Moth larvae	Lymantriidae (LEP)	<i>Lymantria rosina</i>
Mealybug		<i>Perissopneumon</i> sp.
Mirid sap-sucker	Miridae (HEM)	<i>Ragwellelus festinus</i>
Moth	Saturniidae (LEP)	<i>Syntherata janetta</i>
Armoured scales	Diaspididae (HEM)	<i>Abgrallaspis cyanophylli</i>
	Diaspididae (HEM)	<i>Chrysomphalus dictyospermi</i>
	Diaspididae (HEM)	<i>Hemiberlesia lataniae</i>
	Diaspididae (HEM)	<i>Hemiberlesia palmarum</i>
	Diaspididae (HEM)	<i>Unaspis citri</i>
Soft scales	Margarodidae (HEM)	<i>Icerya purchasi</i>
	Margarodidae (HEM)	<i>Steatococcus samaraius</i>
	Coccidae (HEM)	<i>Ceroplastes destructor</i>
	Coccidae (HEM)	<i>Coccus longulus</i>
	Coccidae (HEM)	<i>Eucalymnatus tessellatus</i>
	Coccidae (HEM)	<i>Parasaissetia nigra</i>
	Coccidae (HEM)	<i>Pulvinaria psidii</i>
	Coccidae (HEM)	<i>Saissetia neglecta</i>
Mealybugs	Pseudococcidae (HEM)	<i>Dysmicoccus brevipes</i>
	Pseudococcidae (HEM)	<i>Dysmicoccus nesophilus</i>
	Pseudococcidae (HEM)	<i>Planococcus citri</i>
	Pseudococcidae (HEM)	<i>Planococcus pacificus</i>
	Pseudococcidae (HEM)	<i>Rastrococcus vicorum</i>

Guava diseases

Fruit rot	Fungus	<i>Botrydiplodia theobromae</i>
Fruit canker	Fungus	<i>Pestalotiopsis psidii</i>
Fruit rot	Fungus	<i>Sclerotium rolfsii</i>
Algal spot	Alga	<i>Cephaleuros virescens</i>

Pest and disease do not appear to be a major problem with Guava. In some areas of the country guava grow very easily.

Indian Mulberry

Scientific name: *Morinda citrifolia*

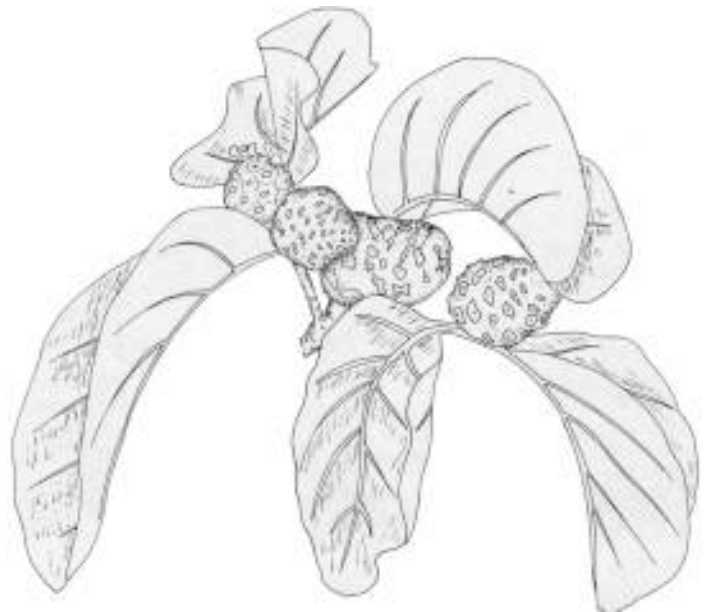
What is the plant like?

The Indian mulberry tree is a small tree up to 4 or 5 metres high.

The leaves are produced opposite each other and leaves can often be 25 to 30 cm long. They are thick, shiny and dark green.

The white flowers are in a round head and only one flower is in bloom at a time. It has 5 white petals on the end of a green tube.

The fruit is about 5 to 10 cm long. It is made up of several small fruit fused together to give an appearance a little like the divisions on the skin of a pineapple. The fruit starts off green but becomes white when ripe. Mostly the edible flesh surrounds a large number of kernels. The ripe fruit develops a bad smell.



Where do Indian Mulberries grow?

In Papua New Guinea, these trees grow wild in the bush, at least along the Northern Coast of New Guinea in the Sepik and New Britain areas. Mostly selfsown plants, they are near sea level and up to about 30 metres altitude.

But they are also grown as fruit trees and can be cultivated up to 500 metres altitude. They do well in areas with limestone rocks. They need to grow in well-drained soil and often do well in dry places.

The tree grows in countries from the Pacific to India.

How do you grow Indian mulberry?

Trees often grow naturally from seed. Seed float easily in water and often grow along foreshores. Fruit is produced year round.

Use

The green fruit can be used as a vegetable. The ripe fruit can be eaten raw. It is usually collected after it falls from the tree. A drink can be made from the juice.

The young leaves can be cooked, or eaten raw. They can be used as a wrapping to cook food in, and then the wrapping leaves eaten as well.

The bark of the tree yields a red dye, the root a yellow dye.

It is not a popular or important food but is used in times of scarcity.

Scale insects and mealy bugs on Indian mulberry

<i>Aonidiella comperei</i> McKenzie	Diaspididae (HEM)	
<i>Chrysomphalus aonidum</i> (Linnaeus)	Diaspididae (HEM)	Florida red scale
<i>Hemiberlesia lataniae</i> (Signoret)	Diaspididae (HEM)	
<i>Hemiberlesia palmarum</i> (Cockerell)	Diaspididae (HEM)	
<i>Pinnaspis bux</i> (Bouche)	Diaspididae (HEM)	
<i>Pinnaspis strachani</i> (Cooley)	Diaspididae (HEM)	
<i>Pseudaulacaspis pentagona</i> (Targioni)	Diaspididae (HEM)	White scale
<i>Coccus viridis</i> (Green)	Coccidae (HEM)	Green scale
<i>Eucalyptus tessellatus</i> (Signoret)	Coccidae (HEM)	
<i>Milviscutulus mangiferae</i> (Green)	Coccidae (HEM)	
<i>Milviscutulus spiculatus</i> Williams	Coccidae (HEM)	
<i>Parasaissetia nigra</i> (Nietner)	Coccidae (HEM)	Nigra scale
<i>Pulvinaria psidii</i> Maskell	Coccidae (HEM)	
<i>Saissetia coffeae</i> (Walker)	Coccidae (HEM)	Coffee scale
<i>Saissetia miranda</i> (Cockerell & Parrott)	Coccidae (HEM)	
<i>Dysmicoccus nesophilus</i> Williams	Pseudococcidae (HEM)	
<i>Planococcus pacificus</i> Cox	Pseudococcidae (HEM)	

Malay apple & laulaus

A group of fruit trees in Papua New Guinea are often called laulaus in Tok Pisin. The naming in Tok Pisin, English and among scientists is confused for the plants in this group. It is not even certain how many different ones have fruit which are eaten in Papua New Guinea. The most likely ones, and the names used in this article are:

English	Scientific name
Malay apple	<i>Syzygium malaccensis</i> L.
Rose apple	<i>Syzygium jambos</i> L.
Watery rose apple	<i>Syzygium aquea</i> Burm.f.
Giant laulau	<i>Syzygium megacarpa</i> Craib
Java apple	<i>Syzygium javanica</i> Lam.
Surinam cherry	<i>Eugenia uniflora</i> L.

By some scientists the name *Eugenia* is used instead of the name *Syzygium* for the same plants. It seems that the name *Syzygium* is the correct name for the plants grown in the Asia Pacific region.

Name	Tree height	Fruit shape	Leaf shape	Flowers	Grown by
Watery rose apple	3-10 m		10-16 cm long 4-8 cm wide clasp stem	White	Seed or air layering
Rose apple	7.5-10 m		12-20 cm long narrow, pointed	Yellow	Seed or cuttings
Java apple	5-15 m		12-25 cm long 4-10 cm wide	White or pale yellow	Seed
Malay apple	5-20 m		15-50 cm long 7-20 cm wide	Red	Seed or cuttings
Surinam cherry	2-7.5m		2.5 - 5 cm long	Small and white	Seed or cuttings

There are probably other species in this family also grown and used for their edible fruit in Papua New Guinea especially down in the Western Province near Balimo.

The ones most commonly used in Papua New Guinea seem to be the Malay apple, Watery rose apple and Surinam cherry. These will be described in more detail.



Watery rose apple



Rose apple



Malay apple



Surinam cherry

Pest and disease

Causing galls on leaves	Gelechiidae (LEP)	<i>Idiophantis chirodaeta</i>
Mealy bugs	Pseudococcidae (HEM)	<i>Planococcus pacificus</i>
Soft scales	Coccidae (HEM)	<i>Icerya seychellarum</i>
	Coccidae (HEM)	<i>Anthococcus kerevatae</i>
	Coccidae (HEM)	<i>Ceroplastes ceriferus</i>
	Coccidae (HEM)	<i>Coccus longulus</i>
	Coccidae (HEM)	<i>Kilifia acuminata</i>
	Coccidae (HEM)	<i>Milviscutulus mangiferae</i>
	Coccidae (HEM)	<i>Pulvinaria psidii</i>
	Coccidae (HEM)	<i>Vinsonia stellifera</i>
Armoured scales	Diaspididae (HEM)	<i>Abgrallaspis cyanophylli</i>
	Diaspididae (HEM)	<i>Aspidiotus destructor</i>
	Diaspididae (HEM)	<i>Chrysomphalus dictuospermi</i>
	Diaspididae (HEM)	<i>Hemiberlesia lataniae</i>
	Diaspididae (HEM)	<i>Hemiberlesia palmae</i>
	Diaspididae (HEM)	<i>Lepidosaphes rubrovittata</i>
	Diaspididae (HEM)	<i>Morganella longispina</i>

The scales and mealy bugs suck sap, spoil fruit and help produce sooty mould

Diseases

Diffuse leaf spot		
Sooty moulds	Fungi	<i>Chaetothyrium womersleyi</i>
	And	<i>Brooksia tropicalis</i>



Watery rose apple



Rose apple



Malay apple



Surinam cherry

Malay apple

Tok Pisin: Laulau

Scientific name: *Syzygium malaccensis*

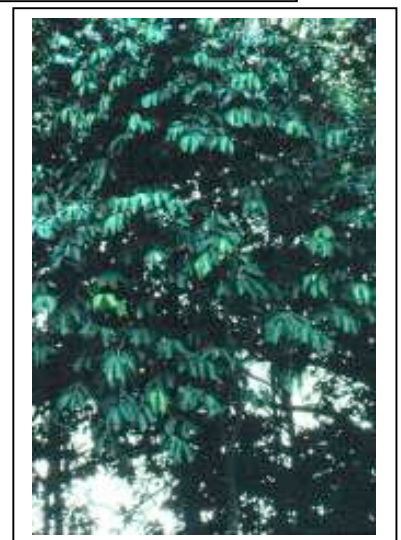
What is the plant like?

This is a medium sized tree up to 20 m tall. The tree is cone shaped with branches being shorter near the top.

The leaves are dark green, thick and glossy. The leaves have short thick leaf stalks.

The flowers are in showy clusters with bright red stamens. These fall off and form a carpet of red under the tree.

The fruit are up to 8 cm long, rounded in shape and white to red in colour. The skin is thin and the flesh crisp, white and juicy. The fruit contains one round seed.



Watery rose apple

Scientific name: *Syzygium aquea*

What is the plant like?

The tree is between 5 and 10 metres tall. The twigs are angular.

The leaves are in opposite pairs, pointed and large (up to 20 cm long). Often the leaves don't have a leaf stalk and they clasp the stem. They are shiny on both sides. The leaves are light green.

Flowers are white or pale cream and in clusters. They grow on new wood. They are about 2 cm across.

Fruit are bell shaped and pale green, white, pink or red in colour. The flesh inside is mostly white.

Growing watery rose apple

Trees grow well in the humid tropics on well-drained soil. They will grow up to about 1500 m altitude.

Trees are often grown from seed. They can occur wild in the forest where they are looked after or they can be planted. They are easy to grow from cuttings and this method is often used.

Trees need to be 6-8 m apart if several are planted together.

Trees often flower and fruit twice a year.



Surinam cherry

Scientific name: *Eugenia uniflora*

What is the plant like?

The tree can be grown as a small bush and pruned into a hedge but if given space and good soil can grow up to 7 metres tall.

The leaves are dark green and small (2-5 cm long). They are shiny and young leaves are a red colour.

The flowers are small (1-2 cm across) and white. They are produced in the axil where the leaf joins the stem.

Fruit are on long slender stems, bright red in colour and 2-3 cm across. The fruit have up to 8 ribs or indented lines around the fruit. Mostly there is one round seed inside. The skin of the fruit is thin and the flesh juicy. The flesh is often red and is sour.

How do you grow Surinam cherry?

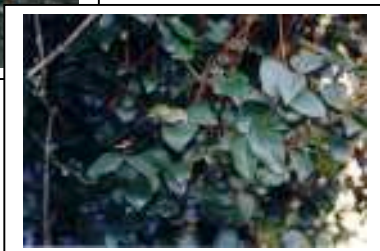
Mostly trees are grown from seed. Seeds grow within 3 to 5 weeks. Seeds should be planted from freshly harvested fruit. If the seedlings are put in a nursery they should be transplanted to where they will grow when they are 20 cm tall. Grafting of cuttings from better trees can be used.

Trees can start to produce fruit after 3 years.

Trees can be pruned and trained into a hedge. Trees that are pruned often will produce less fruit.

Where do trees grow?

This tree originally came from Brazil. It is tropical but will stand some cold once the trees are growing well. It may grow up to 1700 m in Papua New Guinea but is not often seen above about 800 m. It is better suited to wet than dry climates.



Rose apple

Scientific name: *Syzygium jambos*

What is the plant like?

This is a small tree up to 10 m tall.

The leaves are thick and shiny. They are long (22 cm) and sword shaped, or tapered at each end.

The flowers are greenish white and large (8 cm). They are at the end of the small branches or twigs.

Fruit are round (5 cm across) and white. At the top of the fruit the thickened parts of the flower (calyx) form a flattened extended end to the fruit. The fruit has one or two seeds inside.

Growing rose apple

Trees can be grown from seed. Like many of the fruit trees in this family when a seed is planted, several seedlings can grow from the one seed.



Flacourtia's or lovi lovi family

These fruit trees are a little difficult to separate into the four species. Four trees in the group have become distributed around coastal areas of Papua New Guinea. They are:

Coffee plum	<i>Flacourtia jangomas</i>
Rukam	<i>Flacourtia rukam</i>
Lovilovi	<i>Flacourtia inermis</i>
Governor's plum	<i>Flacourtia indica</i>

Flacourtias are trees or erect shrubs that may or may not have spines on the trunk and branches. Often wild forms have thorns and cultivated ones have no thorns. The leaves have short stalks and are mostly toothed or wavy along the edge.

Some of the differences between them can be seen from this table.

Name	Tree	Leaf	Fruit	Flowers
Coffee plum	Small to 10 m Deciduous	3-6 prs of side veins Blade 5-12 cm long Leaf blade pointed	Fruit has a single peg on top	Unisexual
Rukam	To 20 m tall. Evergreen. Thorny	5-10 prs side veins Blade 7-20 cm long	Fruit with a circle of 4-7 pegs. Pink to red.	Unisexual. Separate trees.
Lovilovi	Small to 15 m Evergreen. Thorns	5-10 prs side veins Blade 7-20 cm long	Fruit has cluster of 4- 6 pegs. Bright red.	Bisexual.
Governor's plum	Small to 15 m. Deciduous. Often thorny	Leaf blade blunt. Blade 2-5cm long	Fruit small (1 cm). Fruit dark red	Unisexual

These trees can be grown from seed, but they do not always breed true so that fruit may not be as nice as that from the original tree. Because of this it is better to grow new trees by either using air layering or budding. For lovilovis, seedlings take about 18 months to be large enough to plant out. Trees need to be spaced about 14 m apart.



Flacourtia inermis



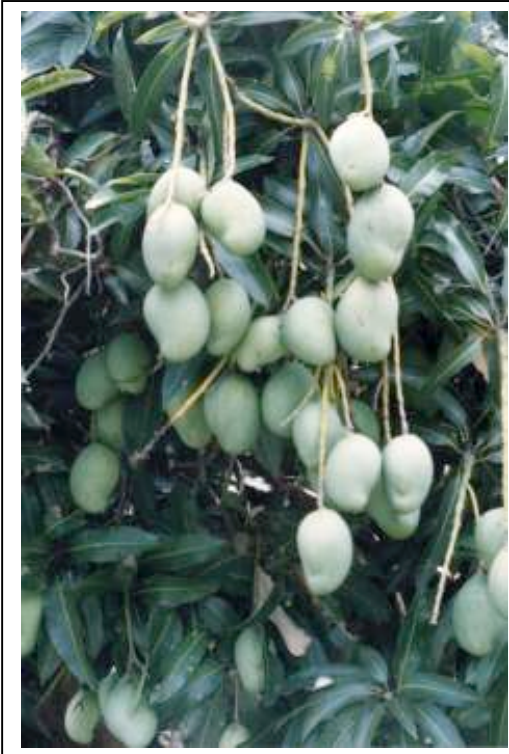
Flacourtia rukam

Mango

Several different species of mango trees grow in Papua New Guinea. The commonest one is the main mango *Mangifera indica* but at least three wild species are also occasionally used for food. These are *Mangifera minor* Bl.; *Mangifera foetida* Lour. and *Mangifera altissima* Blanco. *Mangifera minor* has flowers that are shorter than the leaves.

The Mango Tree

The mango tree is a large evergreen tree up to 40 metres high with smooth leaves and a rough brown bark. The dark green leaves are 12 to 30 cm long but like many tropical trees the young leaves are flushed red. The flowers are small and occur in clusters at the ends of branches. The flowers are pinkish white or yellow. Fruit are 5 to 20 cm long. The fruit often have long tough fibres inside. The fruit have one large woolly stone inside.



Growing mangoes

Most of the mango trees in Papua New Guinea are seedling trees. Mangoes grow and perform best in moderately dry coastal climates. They therefore do well near Rabaul, Port Moresby and in the Markham Valley. They will grow up to about 1900 metres altitude but only fruit poorly in these areas. They grow best where the temperature is 24° to 27°C. Where trees are grown in high rainfall places the trees grow well with lots of leaves but less fruit.

Normally mango seeds should be planted fresh but village people often dry and store seed before planting. Mango seeds can produce several trees from one seed and these are trees which are all the same in quality, like vegetatively produced trees. Several varieties of mango occur which differ mainly in the shape and colour of the fruit. For the best trees it is important to use grafted trees, as the fruit will be the same as the parent tree. These grafted trees tend to be lower with more spreading branches. Because mangoes can produce several shoots from the one seed and some of these are asexually produced, these can breed true to type.

The trees can be topped to produce a more spreading tree that means it is easier to harvest the fruit. Trees will grow quite well on poorer types of soils. The sap of the tree can cause skin rashes in some people. Trees begin to produce fruit after 4 or 5 years.

Fruit production is seasonal. The season is about November. Up to 400 or 600 fruit can be produced by one tree. Flowers are pollinated by flies, and normally trees are cross pollinated although some varieties can self pollinate. Fruit matures in about 2 to 4 months. Often trees produce a large crop one year then a smaller crop the next year.

Pests and disease

Fruit flies are a problem with mango fruit especially where the fruit are left to ripen on the tree. To help control these it is important to get rid of fallen ripe fruit.

Anthraxnose is the name of a fungus disease that causes blossom blight, twig dieback and fruit rot. This disease gets worse when there is a wet season and high humidity near flowering time. Having trees well spaced and pruning out sections where branches and leaves are crowded together helps control this a little.

Flowers and small fruit can also drop because of very cloudy days and because rainy weather during flowering stops the pollinating insects and washes the pollen away.



Insect pests recorded on mango in Papua New Guinea

<i>Aleurodicus dispersus</i> Russel	Aleyrodidae (HEM)	Spiralling whitefly
<i>Amblypelta</i> spp.	Coreidae (HEM)	Tip wilt bugs
<i>Aspidiotus destructor</i> Sign.	Diaspididae (HEM)	Coconut scale
<i>Bombotelia jocosatrix</i> (Guen.)	Noctuidae (LEP)	Large mango tip borer
<i>Ceroplastes rubens</i> Mask.	Coccidae (HEM)	Pink wax scale
<i>Chlumetia transversa</i> Walker	Noctuidae (LEP)	Mango shoot caterpillar
<i>Coccus viridis</i> (Green)	Coccidae (HEM)	Green scale
<i>Bactrocera bryoniae</i> (Tryon.)	Tephritidae (DIPT)	Fruit fly
<i>Bactrocera frauenfeldi</i> Schiner	Tephritidae (DIPT)	Fruit fly
<i>Dysmicoccus brevipes</i> (Cockerell)	Pseudococcidae (HEM)	Pineapple mealy bug
<i>Helopeltis clavifer</i> (Walker)	Miridae (HEM)	Cacao mirid
<i>Idioscopus clypealis</i> (Leth.)	Cicadellidae (HEM)	Mango hopper
<i>Idioscopus niveosparsus</i> (Leth.)	Cicadellidae (HEM)	Mango hopper
<i>Ischnaspis longirostris</i> (Sign.)	Diaspididae (HEM)	Armoured scale
<i>Noorda albizonalis</i> Hamps	Pyrilidae (LEP)	Red banded mango borer
<i>Protaetia fusca</i> Herbst.	Scarabaeidae (COL)	Mango flower beetle
<i>Rhyparida clypeata</i> Jacoby	Chrysomelidae (COL)	
<i>Saisettia coffeae</i> Walker	Coccidae (HEM)	Brown coffee scale
<i>Scopelodes dinawa</i> B.Bak	Limacocidae (LEP)	Cup moth
<i>Scopelodes nitens</i> B.Bak	Limacocidae (LEP)	Cup moth
<i>Selenothrips rubrocinctus</i> (Giard)	Thripidae (THYS)	Cacao thrips



Tip wilt bug



Large mango tip borer



Moth of mango shoot caterpillar



Mango hopper



Cacao mirid



Mango flower beetle



Cup moth



Cup moth pupa



Cacao thrips

Mango diseases

Sooty mould	Fungi	<i>Asterina</i> sp
	and	<i>Meliola mangiferae</i>
Pink disease	Fungus	<i>Phanerochaete salmonicolor</i>
Leaf spot (Anthracnose)	Fungus	<i>Glomerella cingulata</i>
	(and possibly	<i>Stigmina mangiferae</i>)

Food value

The fruit are eaten fresh but can also be used for jam or juices. The young leaves can be cooked and eaten. The seed can also be eaten.

The food value of 100 g of the edible portion:

	Moisture %	Energy cals	Protein g	Calcium mg	Iron mg	provitA µg	provitC mg
Fruit	82.6	62	0.6	10	0.3	1880	36
Leaves			3-4				

Some mangoes have a turpentine flavour and others are more fibrous. Some of the elongated kinds are often the best.

Marita

Tok Pisin: Marita

Scientific name: *Pandanus conoideus*

The marita pandanus plant

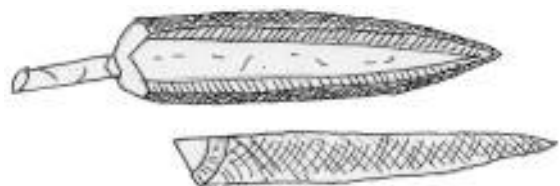
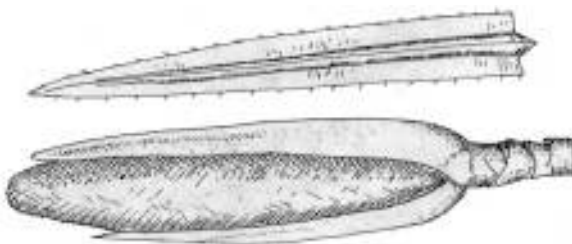
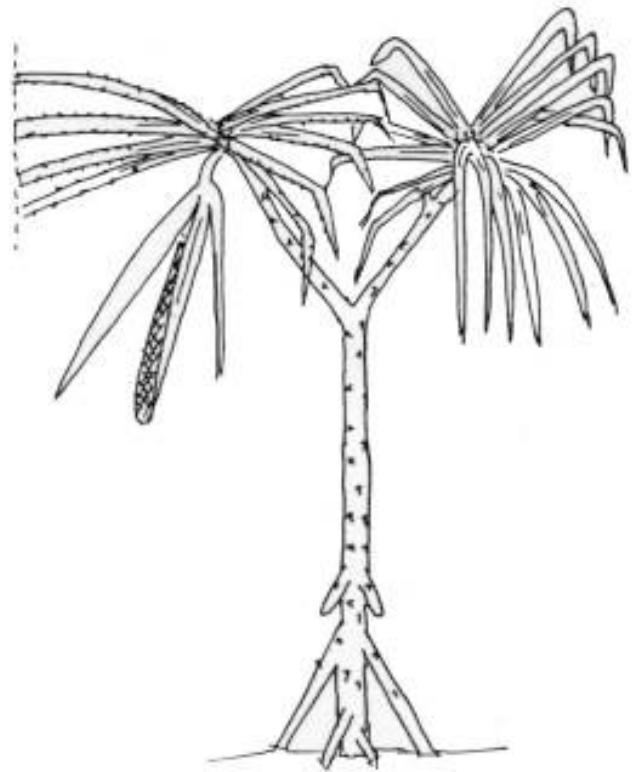
This pandanus is a short tree with several branches. Near the base it has several prop roots that help hold the plant up.

The leaves are between 1 and 2 metres long and about 10 cm wide. There are thorns along the edges of the leaf.

Trees may have up to 8 or 10 main branches. Trees grow up to about 5 metres tall. There are spikes on the trunk and branches.

The fruit are long (30 to 60 cm) and mostly red although yellow kinds occur. The fruit is hard and has small lumps or spikes over the surface. The fruit grows at the ends of the branches between the leaves and it has 3 straight leaf-like bracts along the edges.

The leaves grow opposite each other but are twisted to look like a spiral.



Where is marita grown?

Marita is grown throughout Papua New Guinea from sea level up to about 1650 metres altitude above sea level.

It is only grown in Papua New Guinea.

In these areas, people often plant marita along the roads and walking tracks. It is also planted in most gardens and serves as a reminder that the land is owned, by the person who planted the marita. So, often marita plants belonging to one person are scattered in lots of different places.

How do you plant marita?

Marita pandanus is normally planted from suckers or cuttings. The end of a branch can be cut off and used as a cutting. A new shoot normally sprouts out of the branch just below where the end was cut off. The cutting will soon develop roots and become established when it is planted.

A more popular method is to use a sucker or shoot growing from the plant down near the ground. The sucker is separated from the parent plant then replanted in its new place. These suckers grow more quickly and can bear fruit after 18 months to 2 years. A cutting off a branch may take up to 4 or 5 years before it produces a fruit.

How is marita used?

A marita fruit is harvested when the colour starts to change to a brighter red or yellow. Sometimes it also starts to crack slightly at this stage. The fruit is cut from the branch.



Marita fruit

A ripe marita fruit is normally split into 3 sections along its length. Traditionally this was often done with a knife made from the sharpened leg bone of a cassowary.



**Fruit
split
open**





Then the central yellow stalk and pith area are dug out. The outside hard red layer is then cooked. Preferably it is cooked using hot stones although sometimes it is boiled in a saucepan. After cooking for about half an hour the hard pits are squeezed from the soft red juice by squeezing through the hands. Water is added to make an oily red soup.



Squeezing marita with water.

The soup is then eaten. Sometimes it is eaten, by dipping green leaves or sago into the soup. At other times it is eaten with a spoon made from the marita leaf. Some people just suck the cooked juice from the seeds. As well, some people use the oily juice to cook food in.

The pits or seeds are thrown away, normally to pigs.

A harvested marita fruit will only keep for about one week. After cooking it will only last for about 12 hours.

When is the marita season?

Marita is a seasonal crop but the fruiting season is not a short clearly marked one. The main season goes from about October to March but individual trees can bear almost throughout the year. Near the sea the marita season is longer and more spread out but as the places increase in altitude above sea level the season becomes more distinct. The marita season is an important occasion. During the season people often use marita twice a day.

Diseases, insects and other pests

Some diseases can fairly often be seen on the leaves of marita pandanus. Two fungi are common. One causes a black leaf mould that grows in a line along the leaf. The other one causes a brown dead spot that has a yellow ring around it. It is not known how much damage these diseases cause.



Black leaf mould



Leaf spot

In marita areas fruit which still aren't ripe sometimes "stink nating" going soft and squashy. They are mostly just cut off the tree and left to rot. The cause is not known.

The larvae of an insect can often be seen eating marita leaves. If it eats the growing point it can kill the branch or the tree. This insect can get so bad that a poor marita season results.

In some areas tree kangaroos can also do serious damage to fruiting marita.

The food value of marita

Not very much is known about the food value of marita. Often the red colour in plants is a chemical called carotene that produces vitamin A. In marita the red colour is not carotene. Marita appears to have a fairly high oil content.



Mon

Scientific name: *Dracontomelon dao*

What is Mon?

Mon is the Tok Pisin name of a common coastal tree that has edible fruit. Scientists have given it the Latin name *Dracontomelon dao*. This name was first given to the tree in 1908. Other scientific names were originally given. Two other names still sometimes used are *Dracontomelon mangiferum* and *Dracontomelon puberulum*. They all refer to the same plant.

What is Mon like?

It is a large forest tree with large buttresses at the base. The tree is in the mango family and has leaves made up of about 6 to 10 pairs of leaflets along a stalk. The flowers are small and grow as a group of small flowers at the ends of branches. They are pale yellow and about 1 cm wide.

The fruit are round, 3 or 4 centimetres across and have a small amount of edible flesh around a large seed. The fruit turn yellow when ripe. The fruit have 5 small scale-like flakes around the middle.



The wood of the Mon tree is pale brown with black stripes and is sold as a timber called New Guinea walnut.

Where does Mon grow?

Mon trees are tropical trees and grow in several Asian countries including Papua New Guinea. Countries that have Mon include Thailand, India, China, Cambodia, Malaysia, Indonesia, Philippines, Papua New Guinea and the Solomon Islands.

The tree only grows properly in high rainfall areas and is mostly in coastal areas but sometimes up to 500 or 1000 metres altitude.

Trees are more common along rivers and are also planted in villages.

In Papua New Guinea, Mon trees are particularly popular as fruits in the Madang Province. Trees in the bush inland often have smaller fruit that are more sour. Fruit near the coast are larger and sweeter.

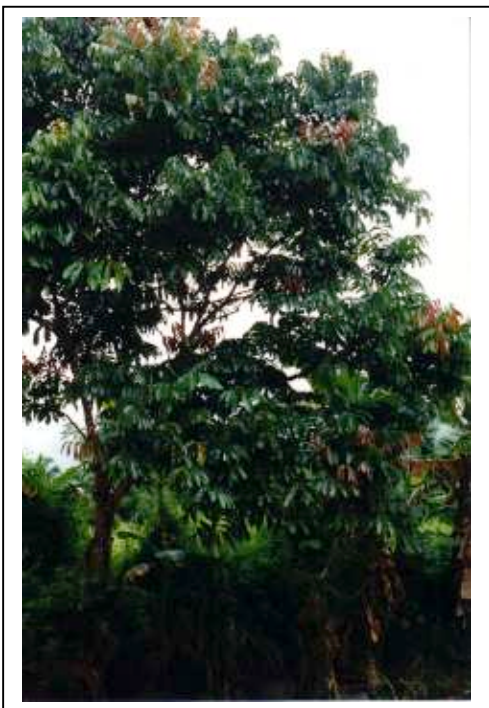
How do you grow Mon fruit?

Mon trees often grow naturally in the lowland bush. But in areas where mon are popular, and where sweeter kinds of mon occur, trees are planted. They are grown by using the seed out of the centre of a fruit.

If the tree is well looked after and well grown, it can start producing fruit after 3-4 years.

Using Mon fruit.

Mon fruit are produced seasonally. The season normally coincides with the breadfruit and mango season. The fruit turn slightly yellow when ripe and the seed inside turns brown. If the seed inside is white, then the fruit is not ripe.



Mulberry

Names: White mulberry
Black mulberry

Scientific name: *Morus alba*
and *Morus nigra*

The plant

These are small trees that grow up to about 9 metres high. They lose their leaves during the year. The leaves are oval and toothed around the edge. The fruit is dark red to black in colour. Mulberries leaves are often used for silkworms.

Trees often bear fruit twice a year. The trees will live for many years.



Growing mulberries

They need a fertile and well-drained soil but can grow in acid soils. They are grown mainly between 700 m and 2400 metres altitude.

The tree grows easily from cuttings but can also grow from seed that often fall and grow naturally. When cuttings are used a piece of the current season's growth should be used. It should be about 30 cm long and preferably with a heel of two-year old wood.

If the growing point of the tree is pinched out it causes the tree to spread out more and this makes it easier to harvest. Because trees "bleed" or lose sap easily it is best not to do too much pruning.



Mulberry insect pests

<i>Tiracola plagiata</i> Walk	Noctuidae (LEP)	Cacao armyworm
<i>Maconellicoccus hirsutus</i> (Green)	Pseudococcidae (HEM)	Hibiscus mealy bug
<i>Lagria sp.</i>	Chrysomelidae (COL)	Shot hole damage to leaves
<i>Rhyparida coriacea</i> Jac.	Chrysomelidae (COL)	Feeding on leaves.
<i>Howardia biclavis</i> (Comstock)	Diaspididae (HEM)	
<i>Icerya seychellarum</i> (Westwood)	Margarodidae (HEM)	
<i>Parasaissetia nigra</i> (Nietner)	Coccidae (HEM)	Nigra scale
<i>Planococcus pacificus</i> Cox	Pseudococcidae (HEM)	

A spray of white oil and malathion could be used for scale insects but because people eat mulberry leaves it is a dangerous practice to spray. Normally scale insects can be controlled by ladybird insects.

Mulberry diseases

Leaf spot	Fungus	<i>Phyllosticta sp.</i>
-----------	--------	-------------------------

The fruit are eaten raw. Mulberry fruit leave a dark purple stain. If some unripe berries are rubbed over the stain it can be removed.

The leaves are edible cooked.



Mundroi

Scientific name: *Corynocarpus cribbianus*

What is Mundroi?

Mundroi is the name used on Manus Island for the fruit of a tree that scientists call *Corynocarpus cribbianus*. The first botanist to describe the tree was F.M.Bailey in Queensland in 1897, but the name was changed a couple of times until in 1956 *Corynocarpus cribbianus* was decided as the correct scientific name.

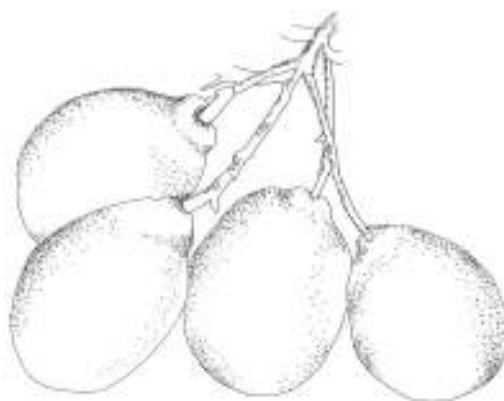
There are only 4 species of trees in this group of plants called *Corynocarpus*. And the group is not closely similar to other plants so scientists are still trying to work out how it is related to other groups of plants. One of the other species, *Corynocarpus laevigata*, is called karaka in New Zealand, and the flesh of the fruit is eaten raw, and the kernel is soaked and steamed to remove poison, then eaten, by Maori people.

The group of plants called *Corynocarpus* only occur in an area between New Zealand and New Guinea, including a little bit of Queensland in Northern Australia.



What is a Mundroi like?

The mundroi tree is quite a large tree up to 20 metres high. The fruit are produced in clusters at the ends of the branches and are shaped something like a mango. The fruit are smooth on the outside and green when ripe. There are two different kinds of fruit that vary on the colour of the ripe fruit. One kind turns a reddish pink when ripe while the other kind turns a creamy white. This second kind has the larger fruit.



The fruit grows up to 10 or 12 cm long and 6-8 cm across. Inside there is one large seed, and the flesh around the seed is eaten.

The fruit is only eaten when fully ripe and it is harvested after it has fallen from the tree. The fruit is eaten either raw or cooked. The flesh of the fruit is sweet but not juicy.



The mundroi tree has leaves that are dark green on top and pale green underneath. They have veins that join in loops. The veins are raised on the underneath side of the leaf.

Mundroi trees are normally planted. They are grown from seed. The similar karaka tree in New Zealand will grow from cuttings, so it would be worth trying this with mundroi.

The flowers have a sweet smell and the petals are white with slightly red tips.

Naranjilla

Tok Pisin: temeta?

Scientific name: *Solanum quitoense*

The naranjilla plant

This plant is a small shrub that grows about 1 or 2 metres high. It has fine hairs over it and also thorns.



The leaves are large and green with small brown hairs on them.

The fruit are round and about 5 cm across. They are covered with white hairs which can easily be rubbed off. These fruit are produced in groups along the stem and branches of the shrub. The fruit are an orange colour on the outside and the flesh inside is green.

How is it used?

The fruit have a slightly acid taste. They are mostly used for drinks and sweet dessert dishes.

How is it grown?

Inside the fruit there are lots of seeds. These can be sown to produce new plants.

The plant can also be grown from cuttings. The cuttings need to be about 15 cm long. When the cuttings have been collected they should be dried for a few days to let the cut surface heal. This stops the cuttings from rotting when they are planted. They can then be planted in moist soil.

Where is it grown?

The naranjilla is a South American plant.

It is grown in some of the highland areas of Papua New Guinea.

It is grown around the Eastern Highlands and in the Southern highlands it is grown in the Pangia district near Mele village. The people there know and use it. It has probably only recently been introduced.

It grows best in the medium altitude areas of the tropics. In other countries it grows between 800 and 2000 metres above sea level.

Pests and diseases

In Papua New Guinea these haven't yet been looked at. As the plant is in the tomato and potato family it will probably suffer from root knot nematode and bacterial wilt.



Tree tomato

(Also called tamarillo)

Scientific name: *Cyphomandra betacea*

This is a small fruit tree or shrub in the tomato and tobacco family. People often use the same Tok Pisin name as for tobacco because they understand this fruit is related to tobacco.

The shrub grows up to about 4 metres high and has soft wood. It only lives for a short time of about 4 or 6 years. Trees need to be about 3 m apart. The leaves are more or less heart shaped and softly hairy.

The fruit are about 6 cm long and acidic. They have a pointed end. They can be red, orange or purple in colour. They are produced after about one year. The flesh of the fruit is light orange with black seeds.

It occurs fairly commonly in the highlands between 750 and 2300 metres altitude. It is slightly more hardy to cold temperatures than the tomato. They do best where average temperatures are about 15° - 21 °C.



Growing tree tomatoes

The trees can be grown in shade as well as in full sunlight. They need fertile soil. The plants cannot stand waterlogging or drought.

Trees can be grown from seed or cuttings. The cuttings produce a lower bushier type of plant. Cuttings of 60 to 90 cm long stalks are suitable. Because the roots are easily damaged by nematodes, plants grafted onto rootstocks that are resistant to nematode will live longer.

The plant is shallow rooting and therefore needs to be weeded carefully so that the roots are not damaged. You should not use a hoe when weeding.

Tree tomato diseases

Leaf spot	Fungus	<i>Ascochyta sp.</i>
Spots (Anthracnose)	Fungus	<i>Glomerella cingulata</i>
Root rot	Fungus	<i>Phytophthora palmivora</i>
	and	<i>Pythium sp.</i>
Root knot	Nematode	<i>Meloidogyne sp.</i>

The root rot fungus can mean it is difficult to get plants established in old gardens. The root knot nematodes also mean trees can die more quickly than they should, and sometimes in 3 or 4 years.

Insects.

At least one fruit fly damages the fruit of tree tomato.

<i>Dacus tryoni</i> Frogg	Tephritidae (DIPT)	Queensland fruit fly
---------------------------	--------------------	----------------------

Tree tomato fruit as food

The fruit can be eaten raw or cooked.

The food value of 100 g of the edible portion is:

Moisture %	Energy KJ	Protein %	ProVit A µg	Provit C mg	Iron mg	Zinc mg
86.2	113	2.0	500	28	0.7	



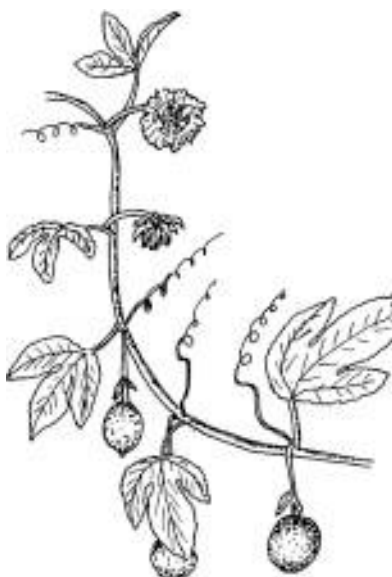
Passionfruits

Several passionfruit plants are used for their edible fruits in Papua New Guinea. These include:

<i>Passiflora edulis</i>	Purple passionfruit
<i>Passiflora foetida</i>	Passionflower
<i>Passiflora laurifolia</i>	Yellow granadilla
<i>Passiflora edulis</i> v <i>flavicarpa ligularis</i>	Yellow passionfruit
<i>Passiflora mollissima</i>	Banana passionfruit
<i>Passiflora tripartita</i> var. <i>quadrangularis</i>	Granadilla



Yellow passionfruit



Purple passionfruit



Passionflower



Granadilla



Banana passionfruit



Yellow granadilla

Purple passionfruit

This passionfruit has been introduced to several areas of the highlands to grow for sale of the fruit for juice. It is now fairly common in villages. It suits alternate wet and dry season climates and probably grows best at about 1000 metres altitude. It grows up to 3,000 metres altitude. It can only withstand very light frosts. There is a yellow variety that is grown at lower altitudes. (There is also a different species with yellow fruit but which has larger entire leaves.)

The plant is a semi woody vine with tendrils that help it cling onto a fence or trellis. Once established, the plant will keep growing for several years. The leaves are deeply three lobed and toothed along the edge. The flowers smell sweetly and are about 4.5 cm across. They are borne singly near the leaves along new shoots. The flowers are very attractive. The fruit has a brittle outside shell and inside are many small seeds, surrounded by a yellow juicy pulp. The fruit is 4-6 cm long. Often several vines are needed near each other to allow the pollen to spread between plants and enable fruit to develop. Bees and other insects help pollinate the plants. Plants can be pollinated by hand by taken the pollen from the flower on one plant and putting it on the flower on another plant. This needs to be done during the morning.

It can be grown from seed or by layering where the vine is put under the ground until roots develop then this section is cut off and replanted. The seed do not germinate quickly (2 weeks to 3 months) but are fairly easy to grow. It can also be grown from cuttings of mature wood. The cuttings should be about 15 cm long that have 2 or 3 nodes and are from vines about the thickness of a pencil. The vines are normally grown over a trellis or along a fence or over a house. The first main crop is produced 18 months after planting.

The fruit turns purple, wrinkles then falls off when ripe.

The fresh fruit can be eaten, by simply cutting the fruit in half, and eating the soft contents in the centre.



Purple passionfruit



Yellow passionfruit

Yellow passionfruit. Although there is a yellow variety of the purple passionfruit, this species has leaves that are large (10-20 cm across) and flowers that are 7-10 cm across. The fruits are also larger being 7-10 cm across.

Banana passionfruit has become a wild plant in the high altitude areas and at areas above 2400 metres can often be seen growing extensively over the forest trees. The long yellow fruit are particularly picked and eaten by children.

Granadilla. This plant has distinct four angled stems. It grows in the lowlands and suits warm moist climates. It has large green tendrils that cling onto fences. The flower is large (10 cm across) and with purple threads. The fruit are large (30 cm x 15 cm) and green but turn slightly yellow when ripe. The flesh is white and juicy with many seeds. The seeds are flattened and dark brown and about 1 cm long.

It can be grown from seeds or cuttings. This plant often sets better fruit if it is hand pollinated.



Banana passionfruit

Banana passionfruit



Granadilla

Granadilla

Yellow granadilla. The leaves of this one do not have lobes and they are rounded (10 cm x 5 cm) hairless and rough. The flowers are large (6 cm across). The fruit are oblong and taper at both ends. They are about 8 cm x 5 cm and smooth and yellow when ripe. This one is less common. The fruits are eaten raw.

Passionflower is a common weed and children eat the small round yellow berries. It has been used as a cover crop in plantations.



Diseases passionfruit family

Banana passionfruit			
	Fruit spots	Fungus	<i>Colletotrichum sp.</i>
Granadilla			
	Stem death	Fungus	<i>Glomerella cingulata</i>
	Chlorotic spot	Virus	Chlorotic spot virus
Passionfruit			
	Brown leaf spot	Fungus	<i>Alternaria passiflorae</i>
	Seedling wilt	Fungus	<i>Phytophthora nicotianae</i>
	Blight of flowers	Fungus	<i>Aspergillus sp.</i>
	Fruit rot	Fungus	<i>Fusarium sp.</i>
	Root knot	Nematode	<i>Meloidogyne javanica</i>

Brown spot fungus *Alternaria passiflorae* causes the leaves to turn brown and to drop off. It gets worse where plants are planted close together. This disease can also get on the vines and can cause the end of the vine to die off. On the fruit sunken brown spots can occur when the disease gets on fruit. Pruning out some of the very thick vine growth helps control the disease. It could be sprayed with fungicide if this were appropriate.

Insect pests of passionfruit

<i>Helopeltis clavifer</i> (Walker)	Coreidae (HEM)	Cacao mirid
<i>Hemiberlesia lataniae</i> (Signoret)	Diaspididae (HEM)	
<i>Hemiberlesia palmarum</i> (Cockerell)	Diaspididae (HEM)	
<i>Idopsis grisea</i> Faust.	Curculionidae (COL)	
<i>Leptoglossus australis</i> (Fab.)	Coreidae (HEM)	Black leaf-footed bug
<i>Oribius cinereus</i> Mshl.	Curculionidae (COL)	Shot hole weevils
<i>Planococcus citri</i> (Risso)	Pseudococcidae (HEM)	Citrus mealy bug
<i>Pseudaulacaspis pentagona</i> (Targioni)	Diaspididae (HEM)	White scale
<i>Planococcus pacificus</i> Cox	Pseudococcidae (HEM)	
<i>Tiracola plagiata</i> Walk	Noctuidae (LEP)	Cacao armyworm

Food value 100 g edible portion

Common name	Moisture %	Energy KJ	Protein %	ProVit A µg	Provit C mg	Iron mg	Zinc mg	Edible part
Purple passionfruit	73.3	280	2.8	10	20	1.3	0.1	Fruit
Passionflower	64.2	421	4.9		5	8.4	1.1	Fruit
Passionflower	86.0	176	6.9		220			Leaves
Yellow granadilla								Fruit
Sweet granadilla	78.5	393	2.8	20	20	0.9		Fruit
Granadilla	78.4	339	1.9		15	2.9		Seed & aril
Granadilla	94.4	170	0.7		15	0.8		Flesh only
Banana passionfruit								Fruit

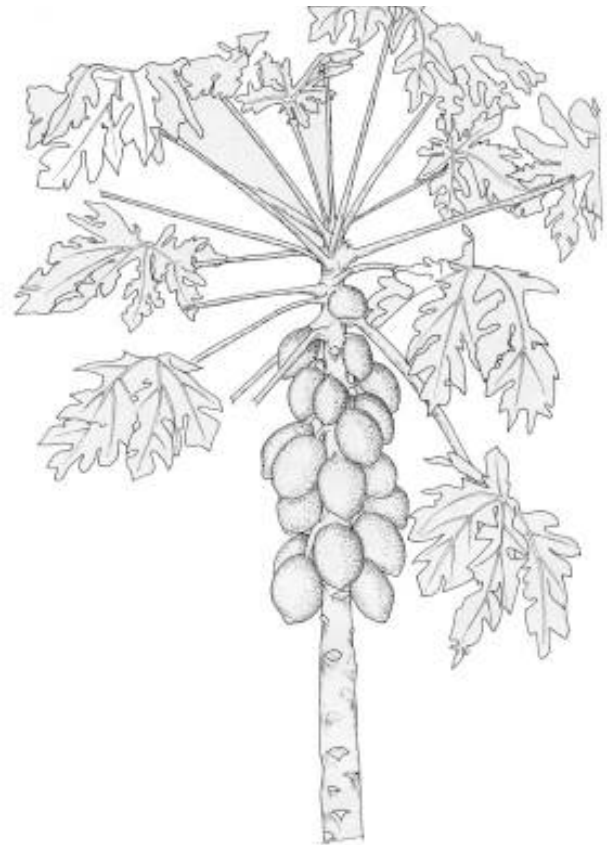
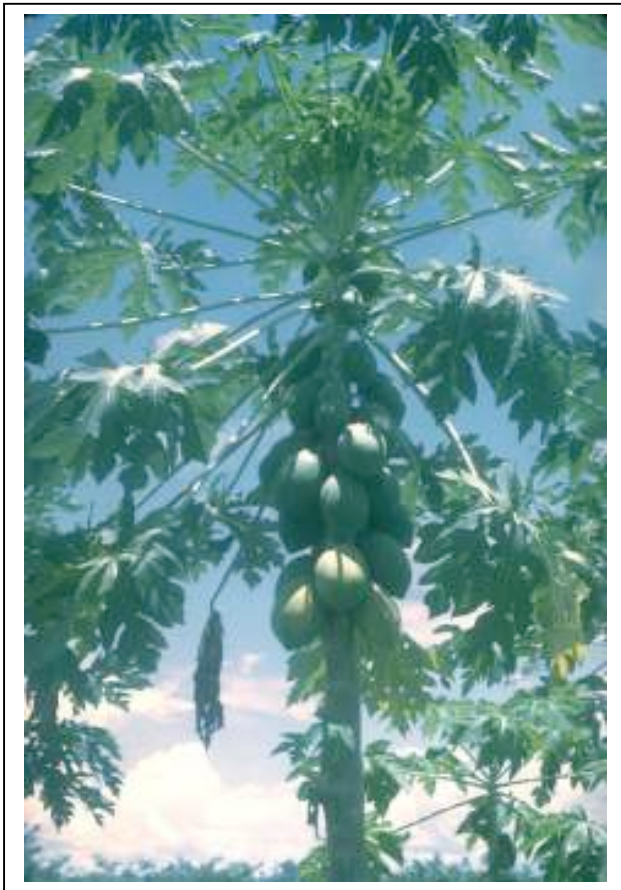
Pawpaw

Scientific name: *Carica papaya*

The Plant

Pawpaw is one of the very well known fruits of Papua New Guinea. The straight-stemmed plant grows up to 3-5 metres tall and only occasionally has branches. The stem is softly woody and has scars from fallen leaves along it. At the top of the plant there are a clump of leaves. The leaves are large (50 cm wide) deeply lobed and on long leaf stalks.

Several kinds of fruit occur. They are normally oblong or round, and yellow. The breeding behaviour of fruit will be explained in a few moments. The fruit mostly have many seeds inside. (There can be 300-700 seeds). Most of the fruit in Papua New Guinea has yellow flesh but red-fleshed kinds can occur. Yellow flesh colour will replace red flesh colour where both occur in the same group of interbreeding plants. So plants will soon produce yellow fruit.



Fruit shape

Trees of pawpaws can be of two separate sexes or they can have both sexes on the one tree. Then for the ones with both sexes on the one tree there are several different fruit shapes.

Male trees have flowers on long stalks and mostly don't produce any fruit although they sometimes fruit if the top is chopped off the plant.



male flower and no fruit

Female trees only have female flower parts and when these are pollinated from a male tree will produce round fruit. But seeds saved from these fruit will come up half male trees and half female trees.



female flower and round fruit

Other trees with both male and female flower parts produce long fruit. Whether the fruit is smooth around the fruit or has ridges or is twisted and what sort of plants grow when the seed is planted, depends on where the pollen comes from.



bisexual flower and long fruit

If people just want fruit to eat in their gardens or in the villages and they are not very fussy about the shape of the fruit, then the simplest rule is to just chop down all male trees and gradually develop all long fruited types. As these trees have both male and female parts they can fruit without male trees. And without male trees present, the seed that is saved and planted will all produce trees that have fruit.



fruit shapes long –twisted, ridged, smooth



Red fruited selection

This chart shows how the breeding behaviour occurs.

Parents

Offspring

	Female	Male	Bisexual
Female x male	1	1	0
Female x long bisexual	1	0	1
Long bisexual x male	1	1	0
Long bisexual self fertilised	1	0	2

To avoid male plants that don't bear fruit, pollen must come from bisexual fruit. Some of these types can also be influenced by the environment at the time the flower buds form.

Mountain pawpaw.

In the highlands of Papua New Guinea another pawpaw plant has been introduced. It grows from 1650 m altitude up to about 2200 m. It can stand a light frost. The fruit are small. The scientific name of the plant is *Carica candamarcensis*.

Growing pawpaws

In the lowland rainforest pawpaws just come up naturally when the forest is cleared. The sunlight allows the seeds that have been scattered by birds and flying foxes to start growing. So in the lowland forest areas people rarely plant pawpaws. As they are clearing the forest they look after female or bisexual trees and chop down male trees. Sometimes people just casually plant trees by scattering pawpaw seeds from the fruit they are eating. Pawpaw seeds grow easily and plants grow quickly. Fresh seeds can be used or if dry seeds are used they should be soaked before planting. To produce well they need a reasonably fertile soil.

Pawpaws will grow from sea level up to about 1700 m altitude. In the highlands they have to be planted. Seeds can be sown directly or the seeds can be put in a nursery and the seedlings transplanted. Seeds in a nursery should be about 1-2 cm deep. Seedlings can be transplanted when they are about 20 cm high. Plants should be about 3 m apart. On the coast pawpaws start producing fruit after about 4 or 5 months but in the highlands this may not start for 12-18 months. With good growth 100 fruit can be produced from one plant in a year.

Using pawpaws

Mostly in Papua New Guinea fruit are just eaten ripe as a snack. They can be eaten green by being cooked like a vegetable by boiling.

Food value in 100 g edible portion:

Moisture %	Energy KJ	Protein %	ProVit A µg	Provit C mg	Iron mg	Zinc mg	Edible portion
88.0	163	0.5	290	54	0.4	0.18	Fruit
75.4	378	8.0		140	0.77		Leaves

Pest and disease

Diseases of pawpaw

Disease	Cause	Scientific name
Butt rot	Fungus	<i>Athelia rolfsii</i>
Leaf spot	Fungus	<i>Cercospora papayae</i>
Shot hole leaf spot	Fungus	<i>Corynespora cassiicola</i>
Leaf spot (Anthracnose)	Fungus	<i>Glomerella cingulata</i>
Powdery mildew	Fungus	<i>Oidium caricae</i>
Leaf spot	Fungus	<i>Phyllosticta sp.</i>
Root rot	Fungus	<i>Phytophthora palmivora</i>
Leaf spot & fruit rot	Fungus	<i>Mycosphaerella caricae</i>
Fruit rot	Fungus	<i>Botrydiploia theobromae</i>
Fruit rot	Fungus	<i>Fusarium oxysporum</i>
Stem rot	Bacteria	<i>Pseudomonas cepacia</i>
Mosaic	Virus	
Root knot	Nematode	<i>Meloidogyne incognita</i>
	and	<i>Meloidogyne javanica</i>

Leaf spot & fruit rot pawpaw is caused by a fungus *Mycosphaerella caricae* of which the asexual form is *Phoma caricae-papayae*. This fungus produces a black spot on mature fruit and brown and white spots on leaves. Leaf stalks and stems can also be affected. The fruit rot gets worse in rainy seasons. Although rain is not essential for the disease to spread it gets worse with rain showers or in high humidity. The fungus blows in the wind. Leaf stalks may rot, young stems may rot at the end and plants can actually die back. Flowers may fall off and young fruits die. Fruit may continue to rot after harvest. To help control it, remove and burn infected plant material. Fungicide sprays can be used. Fruit after harvest can be put in hot water at 33°C - 33°C for 20 minutes to stop infected fruit rotting. The disease is described in CMI Descriptions of Pathogenic Fungi No 984

The fungus *Cercospora papayae* is also recorded from Papua New Guinea and probably does similar damage.

Mosaic of pawpaw is probably caused by a virus. Young leaves turn yellow and do not grow properly. Often there are yellow patches around the edge of the leaf. Trees are stunted. Often they grow several side branches. Affected trees are of little use. The disease is described in Vock, N.T., 1978, A Handbook of Plant Diseases in Colour. Vol 1 Queensland DPI

Powdery mildew of pawpaw is caused by a fungus *Oidium sp.* Light yellow patches develop on the young leaves. These become soft and water-soaked and have a white powdery growth over them. Round white patches can also develop on the fruit. Grey scarred areas are left after the white mould disappears. The disease spreads with the fungal spores blowing in the wind and rain. It is mainly a disease of seedlings that are planted too close together. Control is by using wider spacing in nurseries. Seedlings can be treated with a sulphur fungicide. (Sulphur dust can be used but can damage leaves when the temperature is above 24°C).

Root rot of pawpaw is caused by a fungus *Phytophthora palmivora*. Often *Pythium sp.* fungi are also involved. The older leaves turn yellow and collapse hanging limply around the trunk. The young leaves then die and the plant dies. Large roots show a soft wet decay and small roots are missing. Fruit can also be affected by this fungus. It occurs in warm areas with a high rainfall. Spores of the fungus can spread by wind and rain. They can be in the soil. Plants especially in wet areas die. A large number of plants can be damaged by this fungus eg pawpaw, coconut (bud rot), tomato, oil palm, rubber, cacao (black pod) etc. For control, avoid wet areas and do not replant pawpaws into soil where the disease is known to occur. Plant only disease free trees from a nursery that has clean soil. Avoiding damage to pawpaw trunks reduces trunk rot. The disease is described in the CMI Descriptions of Pathogenic Fungi No 831 and in Holliday, 1980, Fungus Diseases of Tropical Crops CUP.

Shothole of pawpaw is also called Brown spot and is caused by a fungus *Corynespora cassiicola*. Light-brown, round spots about 1 cm across develop on pawpaw leaves. The centre can sometimes fall out of the spots. Spots can also appear on petioles and fruit. The disease gets worse with temperatures between 20°C and 27°C. It can be carried on seed or can live on old diseased plant parts for up to 2 years. The spores can blow in the wind. On pawpaw, the disease is not serious. The same fungus also gets on tomatoes, eggplant, watermelon, melon, banana, daka, castor oil plant, soya bean, cowpea and some flowering plants. It has been recorded causing a leaf spot on sweet potato. Control is not normally required for pawpaw. The disease is described in the CMI Descriptions of Pathogenic Fungi No 303 and in Holliday, P., 1980, Fungal Diseases of Tropical Crops. Cambridge p 114.

Other leaf spots due to a *Phyllosticta sp.* fungus probably also cause similar spots with a hole in the centre.

Pawpaw insect pests

Boring stems

Cane weevil borer	<i>Rhabdoscelus obscurus</i> Boisduval	Curculionidae (COL)
Weevil reported damaging pawpaw	<i>Rhinoscapha maclayi</i> MacLeay	
	<i>Araecerus</i> sp. (See <i>Oxyderes</i>)	Anthribidae (COL)
Reported rotting fruit and dying petiole scars	<i>Oxyderes cyrtus</i> Jordan	Anthribidae (COL)

Damaging fruit

Reported adults feeding on ripe pawpaw fruit	<i>Ischiopsopha bifasciata</i> Quoy & Gaim var. <i>hyla</i> Heller	Cetoniinae (COL)
--	--	------------------

Eating leaves

Cacao armyworm	<i>Tiracola plagiata</i> Walk	Noctuidae (LEP)
Leaf roller	<i>Adoxophyes melichron</i>	Tortricidae (LEP)

Sucking sap

Amblypelta bugs	<i>Amblypelta</i> spp.	Coreidae (HEM)
------------------------	------------------------	----------------

Scales

Coconut scale	<i>Aspidiotus destructor</i> Sign.	Diaspididae (HEM)
White scale	<i>Pseudaulacaspis pentagona</i> (Targ.)	Diaspididae (HEM)
	<i>Drepanococcus chiton</i> (Green)	Coccidae (HEM)
Armoured scale	<i>Aonidiella orientalis</i> (Newstead)	
Armoured scale	<i>Aspidiotus excisus</i> Green	
Armoured scale	<i>Chrysomphalus dictyospermi</i> (Morgan)	
Armoured scale	<i>Howardia biclavis</i> (Comstock)	
Armoured scale	<i>Morganella longispina</i> (Morgan)	
Soft scale	<i>Pseudaulacaspis cockerelli</i> (Cooley)	
White scale	<i>Pseudaulacaspis pentagona</i> (Targioni)	
	<i>Icerya seychellarum</i> (Westwood)	
	<i>Steatococcus samaraius</i> Morrison	
Soft brown scale	<i>Coccus hesperidum</i> Linnaeus	
Soft scale	<i>Coccus longulus</i> (Douglas)	
Coffee scale	<i>Saissetia coffeae</i> (Walker)	

Mealy bugs

	<i>Dysmicoccus nesophilus</i> Williams	
	<i>Ferrisia virgata</i> (Cockerell)	

Aphids

Potato aphid	<i>Macrosiphum euphorbiae</i> (Thomas)	Aphididae (HEM)
---------------------	--	-----------------

Fruit fly

Banana fruit fly	<i>Bactrocera musae</i> (Try.) & <i>Bactrocera bryoniae</i> (Try.)	Tephritidae(DIPT)
Fruit fly	<i>Bactrocera neohumeralis</i> Hardy	Tephritidae (DIPT)



Leaf spot



Virus

Pineapple

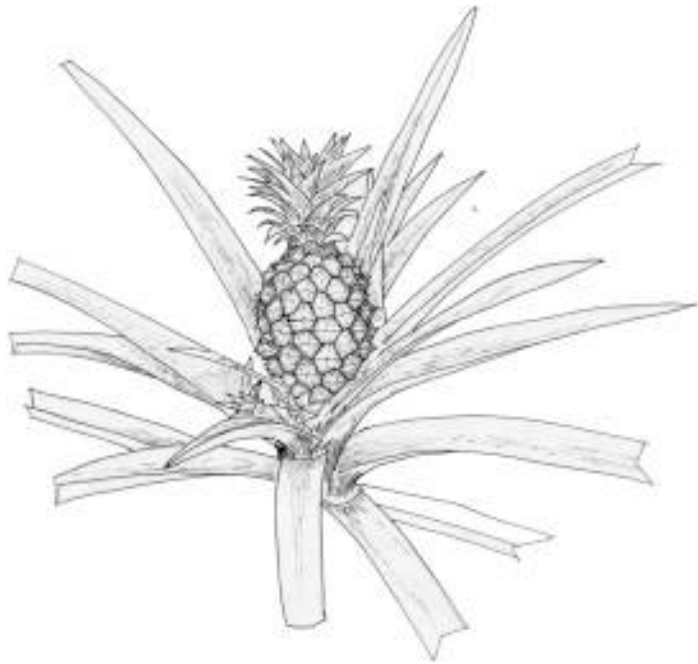
Scientific name: *Ananas comosus*

The pineapple plant

Pineapples are small cactus like plants up to 1 metre high and with thick fleshy leaves. The leaves are arranged in spirals. Some kinds have thorns along the edges of the leaves. The plant produces suckers both near the base of the stem and also higher up the stem near the fruit. These are called slips and they with the suckers are broken off and used for planting. The main plant dies after producing a fruit but the suckers keep growing.

The pineapple fruit grows at the top of the plant or the top of the branches.

The two main kinds of pineapples are the rough leafed variety that has spines on the leaves and produces a smaller but sweeter fruit. The other kind is the smooth leaf kind with spineless leaves and larger fruit.



Growing pineapples

The suckers and slips can be used for planting as well as the top of the fruit. The time to maturity is the fastest for the suckers near the bottom of the plant and slowest when the top of the fruit is planted.

Pineapples need well-drained and fertile soil. They suit an acid soil and can develop rots in soils where lime has been added. The soil acidity can be between pH 3.3 and 6.0. The best range is pH 4.5 to 5.5. They can grow in partial shade and in this situation the plants are normally more

green. The red colouring of pineapple leaves is due to a deficiency of the nutrient nitrogen. This shows up more quickly in plants in full sunlight.

Pineapples can be planted with 35,000 to 43,000 plants per hectare or 3 or 4 plants per square metre. If plants are spaced more widely they produce more suckers. Fruits become more acid where plants are closely spaced. If too many suckers are left growing from the main plant then smaller fruit will be produced.

The growth rate for pineapples gets slower as the temperature gets less. So plants grown in the highlands take longer to get ready for harvest. It takes 60 days from when the flower starts to form until it appears. Then there are 5 months until the fruit is ready for harvest. The time from planting to harvesting ranges from 11 months up to 32 months depending on temperature. The fruit are smaller, poorer shape and more acid where the temperatures are lower or there is less sunlight.

When the plant is sufficiently large it responds to changes such as less nutrients available or less water available and starts to produce a flower then a fruit. The number of hours of sunlight as well as reducing temperature and reduced sunlight also help the flowers start to form. The result of this is that flowering and fruiting is often seasonal. This can easily be changed by using a fruiting hormone that allows fruit to be produced at times to suit the grower.

Where are pineapples grown

Pineapples need an annual average temperature between 17.2°C and 26.9°C. In Papua New Guinea this is mostly between sea level and 1800 metres altitude.

Pineapples can grow in semi arid conditions and this is because the leaves can store some water. They also tend to lose only small amounts of water evaporating through their leaves. But with plenty of water they can grow well.

The roots are very sensitive to waterlogging. Therefore the soil must be well drained. Pineapples do not cover the soil well so it is good to use a mulch of plant material to help weed control, provide some nutrients and to stop soil erosion.



Red colour due to nitrogen deficiency

Using pineapple fruiting hormone

Because pineapples fruit at a couple of main seasons, especially in the lowlands this means that at some times there are lots of pineapples and at other times they are unavailable. There is a chemical available that can be poured onto the plant and this will help fruit to form at any time of the year. The chemical is called pineapple fruiting hormone or phymone. When the plant is sufficiently well grown a solution is made up and applied to the plant. Fifty drops of hormone in half a bucket of water (4.5 litres) for 75 plants or four drops in a fish tin of water for 7 plants, is mixed up. Then a little of this is poured into the top heart of the plant. A flower and fruit will then start forming. This needs to be done to different plants each few weeks if a regular supply of pineapples is required. After the hormone is applied it takes about 20 to 24 weeks for fruit for rough leaf pineapples and 26-30 weeks for smooth leaf pineapples.

Pests and diseases

Diseases

Water blister	Fungus	<i>Cerotocystis paradoxa</i>
Leaf blotch	Fungi	<i>Cochliobolus lunatus</i>
	and	<i>Stachylidium bicolor</i>
	and	<i>Trichobotrys pannosa</i>
Leaf spot	Fungus	<i>Asterina sp.</i>
	and	<i>Nigrospora sp.</i>
Wilt outside leaves	Fungus	<i>Pythium vexans</i>

Water blister of pineapple is also called Base rot of pineapple is due to a fungus called *Ceratocystis paradoxa*. Yellowish white leaf spots develop on the leaves. Suckers can develop a base rot. Fruit can rot. The diseased parts are soft and watery and have a smell. The disease gets worst at temperatures of 15°-21°C. It also gets worse with moisture and shade. It normally gets started where the plant is damaged. The fungus is very common in soil. It gets into plants through wounds. Spores can be spread by wind and rain. Fruit rot. Plants can die. Sugarcane, coconut, bananas, betel nut, coffee, cacao, and maize can also be attacked by this fungus. For control use dry healthy suckers and cure slips before planting. Don't plant pineapples and sugarcane together, get rid of diseased plant parts, don't damage plants, leave a stalk on fruit that is cut, plant during dry sunny weather, dry off tops and butts before planting and plant pineapples on mounds or well drained soil.

Pineapple insect pests

<i>Coccus viridis</i> (Green)	Coccidae (HEM)	Soft scale
<i>Dysmicoccus brevipes</i> (Cockerell)	Pseudococcidae (HEM)	Pineapple mealy bug
<i>Kilifia acuminata</i> (Signoret)	Coccidae (HEM)	Soft scale
<i>Leptococcus metroxyli</i> Reyne	Pseudococcidae (HEM)	Mealy bug
<i>Locusta migratoria</i> (Linnaeus)	Acrididae (ORTH)	Migratory locust
<i>Maconellicoccus hirsutus</i> (Green)	Pseudococcidae (HEM)	Hibiscus mealy bug
<i>Planococcus pacificus</i> Cox	Pseudococcidae (HEM)	Mealy bug
<i>Pseudococcus longispinus</i> (Targioni)	Pseudococcidae (HEM)	Mealy bug
<i>Pulvinaria ubicola</i> (Cockerell)	Coccidae (HEM)	Soft scale
<i>Scapanes australis grossepunctatus</i> Sternb	Dynastidae (COL)	N G Rhinoceros beetle
<i>Scapanes australis australis</i> (Boisd.)	Dynastidae (COL)	New Guinea Rhinoceros beetle

The mealy bugs can be controlled to some extent by dipping the planting material in a chemical called malathion. All chemicals have to be treated very carefully and stored very safely but malathion is one of the safer ones to use.

Sugarcane

Scientific name: *Saccharum officinarum*

Sugarcane

Most scientists consider that Papua New Guinea is the original home of sugarcane. It is one of the major centres in the world for sugarcane varieties. Several hundred varieties have been collected and used as the basis for the sugarcane crops in most countries of the world.

Sugarcane in subsistence is one of the commonest and most widely used of the food plants of Papua New Guinea.

The preferred varieties for chewing are normally very tall growing (up to 5 m) and thick (5-6 cm across). These large canes are also important in ceremonial exchanges.



Drawing by Celia Bridle

The plant

This coarse erect grass is a rapidly growing clump forming grass. The leaves clasp the stem then bend out with leaf blades up to 1.3 m long and 10 cm wide. At the top in many varieties a large open flower is produced.

A very large number of varieties occur. These not only vary in their height and thickness, but also in colour, length of internodes, toughness of the stem and in many other ways. Many of the stripes and colour patterns on the stems are just surface changes and sometimes not really good guides to how different the canes really are.

There are also important variations between varieties in how effectively they convert sunlight to sugar, some varieties are better suited to different temperatures and others can produce in poorer soils. Some can tolerate drought and withstand salty soils. This means particular varieties are selected for different regions of the country. Some varieties occur in most areas around the country while other kinds are just localised in certain villages.

There are also important differences in disease and pest resistance between varieties.

The large number of varieties has been able to develop because in the tropics sugarcane can both flower and produce seed that will grow.

Sugarcane as an industry

By far the biggest sugarcane industry in Papua New Guinea is the sugarcane people grow and eat in villages. This is a very important industry and we should never be fooled into thinking that sugarcane only becomes important in Papua New Guinea when people grow and process and sell it commercially from plantations. From subsistence sugarcane at least 300,000 tons a year of sugarcane are produced. For this, many varieties are maintained. Papua New Guinea is the home of sugarcane and hundreds of varieties have been collected and used in breeding for most of the sugarcane in the world. But even now in a village, one farmer may keep up to 20 or more varieties of sugarcane. Some are early maturing and others later, some are soft and some hard. Some grow very tall and some are shorter with many suckers. Each of these kinds is kept for reasons that are important to the farmer concerned. They need soft kinds for old people with bad teeth, long kinds for ceremonies and gift exchanges, and so on. With subsistence sugar, people want small amounts produced daily, rather than large amounts produced in one season. They need different kinds to suit different seasons. Most of this sugar grown and eaten in villages, is grown by intercropping with other crops in food gardens. The methods and the pest and disease problems all work on the same principles as commercial sugarcane but the way these things are organised is different.

Growing sugarcane

Within subsistence agriculture, by far the most common method of planting sugarcane is to use the top of the cane. As buds quickly develop and grow from the nodes of the cane, sections of the cane could be used, but in gardens the canes are normally used for chewing and the tops planted.

Plants can be ready in 9-10 months but often are left to grow for 2 years or longer.

Although in good soils plants can be cut back and allowed to regrow many times, this is not normally used in Papua New Guinea.

Tall canes have supporting poles to which they are tied to prevent them falling over and breaking.

Sugarcane can make very efficient use of sunlight and the wide spacing used with intercropping in subsistence gardens probably helps its growth.

Where is sugarcane grown?

Sugarcane grows in most areas of Papua New Guinea. Sugarcane grown in the highlands grows more slowly but is sweeter. Therefore sugarcane is a more important part of gardening and of the diet at altitudes over 1000 m. In many highland gardens sweet potato and sugarcane are the two main crops grown.

For most rapid growth sugarcane needs a temperature between 32°-38°C. These conditions occur on the coast. The average temperature for sugarcane needs to be about 21°C.

For sugarcane to become sweet and store lots of sugarcane it needs to have a check to its growth. This can be provided by cool temperatures or by drought. That is why commercial sugarcane is being established in the Markhum Valley where there is a seasonal dry period.

Varieties differ in how they respond to drought. Some can reduce water loss while others let leaves dry off and die then re-establish new leaves quickly when it rains again.



Pests and disease

Many different diseases, insects and other pests like rats have been recorded damaging sugarcane in Papua New Guinea. Often the same diseases and insects also damage other grasses similar to sugarcane and damage coastal pitpit.

Sugarcane insect pests

Bugs sucking sap

<i>Aleurodes comata</i>	Aleurodidae (HEM)	
<i>Amblypelta cocophaga</i> China	Coreidae (HEM)	Green coconut bug
<i>Amblypelta costalis szentivanyi</i> Brown	Coreidae (HEM)	
<i>Amblypelta gallegonis</i> Lever	Coreidae (HEM)	
<i>Amblypelta lutescens papuensis</i> Br.	Coreidae (HEM)	Papuan tip wilt bug
<i>Amblypelta theobromae</i> Brown	Coreidae (HEM)	Tip wilt bug
<i>Cicadella</i> sp.	Cicadellidae (HEM)	Severe brown spotting of leaves
<i>Leptocoris acuta</i> (Thunberg)	Alydidae (HEM)	Paddy bugs
<i>Leptocoris oratorius</i> (Fab.)	Alydidae (HEM)	Paddy bugs
<i>Leptocoris solomonensis</i> Ahmad	Alydidae (HEM)	Paddy bugs
<i>Lophops saccharicida</i> Kirk.	Lophopidae (HEM)	
<i>Machaerota humboldti</i>	Machaerotidae (HEM)	
<i>Neomaskellia bergii</i> (Signoret)	Aleyrodidae (HEM)	Sugarcane white fly
<i>Perkinsiella bicaloris</i>	Delphacidae (HEM)	Sugarcane leafhoppers
<i>Perkinsiella lalokensis</i>	Delphacidae (HEM)	Sugarcane leafhoppers
<i>Perkinsiella papuensis</i>	Delphacidae (HEM)	Sugarcane leafhoppers
<i>Perkinsiella rattlei</i>	Delphacidae (HEM)	Sugarcane leafhoppers
<i>Perkinsiella vastatrix</i> (Breddin)	Delphacidae (HEM)	Sugarcane leafhoppers
<i>Phaenacantha</i> spp.	Colobathristidae (HEM)	Sugarcane bug
<i>Plautia brunneipennis</i>	Pentatomidae (HEM)	Stink bugs

Aphids

<i>Aphis gossypii</i> Glover	Aphididae (HEM)	Melon aphid
<i>Aphis sacchari</i> Zehntner	Aphididae (HEM)	Sugarcane aphid
<i>Ceratosiphum lanigera</i> Zehntner	Aphididae (HEM)	Sugarcane woolly aphid
<i>Myzus persicae</i> Sulzer	Aphididae (HEM)	Green peach aphid
<i>Rhopalosiphum maidis</i> (Fitch.)	Aphididae (HEM)	Corn leaf aphid

Scales and mealy bugs

<i>Aspidiotus destructor</i> Sign.	Diaspididae (HEM)	Coconut scale
<i>Diaspis rutherfordi</i>	Diaspididae (HEM)	
<i>Dysmicoccus brevipes</i> (Cockerell)	Pseudococcidae (HEM)	Pineapple mealy bug
<i>Saccharicoccus sacchari</i> (Cockerell)	Pseudococcidae (HEM)	Sugarcane mealybug

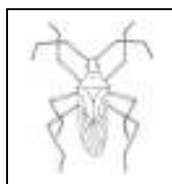
Borers

<i>Chilo terrenellus</i> Pag.	Pyralidae (LEP)	Sugarcane borer
<i>Lepidiotia reuleauxi</i> Brenske (Arrow)	Scarabaeidae (COL)	Ramu canegrub
<i>Maliarpha separatella</i> Rag.	Pyralidae (LEP)	White stem borer
<i>Mulciber linnaei</i> Thoms	Cerambycidae (COL)	
<i>Papuana</i> spp.	Scarabaeidae (COL)	Taro beetles
<i>Rhabdoscelis obscurus</i> (Boisduval)	Curculionidae (COL)	New Guinea sugarcane weevil
<i>Scoliopteryx</i> sp.	Chloropidae (DIPT)	Larvae boring into stems
<i>Sesamia grisescens</i> Walker	Noctuidae (LEP)	Stem borer
<i>Sesamia inferens</i> (Walker)	Noctuidae (LEP)	Violet rice stem borer
<i>Silba</i> sp.	Lonchaeidae (DIPT)	Larvae boring into stems
<i>Trochorhopalus strangulatus</i> Gyllenhal	Curculionidae (COL)	Adults bore into stems near ground
<i>Xyleborus perforans</i> (Wollaston)	Scolytidae (COL)	Larvae and adults bored into sugarcane stems at ground level

Eating leaves

<i>Anomala anoguttata</i> Burm.	Rutelidae (COL)	
<i>Araecerus</i> sp. (See <i>Oxyderes</i>)	Anthribidae (COL)	
<i>Araecorynus</i> sp.	Anthribidae (COL)	
<i>Arrhenes dschilus</i> Plotz.	Hesperiidae (LEP)	Moderate damage
<i>Atractomorpha crenaticeps</i> Blanch	Acrididae (ORTH)	Slight damage
<i>Austracris guttulosa</i> Walk	Acrididae (ORTH)	Spur throated locust
<i>Brontispa lateralis</i>	Chrysomelidae (COL)	

<i>Cirphus unipuncta</i> Haw	Agrotidae (LEP)	Cutworm
<i>Dasychira horsfieldi</i> Saunders	Lymantriidae (LEP)	
<i>Elassogaster sepsoides</i> Walk.	Platystomidae (DIPT)	
<i>Enoplopteron ?hieroglyphicum</i> de Mij	Tephritidae (DIPT)	On sugarcane
<i>Gesonula mundata sanguinolenta</i> Kraus	Acridiidae (ORTH)	
<i>Gryllotalpa africana</i> Pal.	Gryllotalpidae (ORTH)	African mole cricket
<i>Heteropternis obscurella</i> (Blanch)	Acrididae (ORTH)	Damage slight
<i>Hypolixus ritsemae</i> Pasc.	Curculionidae (COL)	Long narrow areas had been chewed in leaves but damage was slight
<i>Locusta migratoria</i> (Linnaeus)	Acrididae (ORTH)	Migratory locust
<i>Melanitis constantia</i> Cramer	Satyridae/Nymphalidae (LEP)	Larvae feeding on leaves
<i>Mythimna loreyi</i> (Dup.)	Noctuidae (LEP)	Rice armyworms
<i>Mythimna separata</i> (Walk.)	Noctuidae (LEP)	Rice armyworms
<i>Opogona saccharella</i>	Hieroxestidae (LEP)	
<i>Orinaeme sp.</i>	Cerambycidae (COL)	
<i>Oryctes rhinoceros</i> (L.)	Scarabaeidae (COL)	Asiatic rhinoceros beetle
<i>Oxya vittigera</i> (Blanch)	Acrididae (ORTH)	
<i>Pachybrachius nervosus</i> Horv.	Lygaeidae (HEM)	
<i>Patanga sp.</i>	Acrididae (ORTH)	Bands of grasshoppers
<i>Phaciocephalus sp.</i>	Derbidae (HEM)	Adults fed on leaf sheaths
<i>Phragmatiphila truncata</i>	Agrotidae (LEP)	
<i>Protaetia fusca</i> Herbst.	Scarabaeidae (COL)	Mango flower beetle
<i>Rhyparida coriacea</i> Jac.	Chrysomelidae (COL)	
<i>Rhyparida morosa</i> Jac.	Chrysomelidae (COL)	
<i>Spodoptera exempta</i> (Walker)	Noctuidae (LEP)	African armyworm
<i>Spodoptera mauritia</i> (Boisduval)	Noctuidae (LEP)	Paddy armyworm
<i>Stenocatantops augustifrons</i> (Walker)	Acrididae (ORTH)	Slight damage to sugarcane foliage
<i>Tauchiridea adusta</i> Bolivar	Acrididae (ORTH)	
<i>Tettigella pasiphae</i> Kirk	Cicadellidae (HEM)	
<i>Valanga irregularis</i> (Walker)	Acrididae (ORTH)	Giant grasshopper



Amblypelta bug



Leptocoris bug



Lophops



Perkinsiella leafhopper



Phaeacantha



Plautia



Sugarcane aphid



Peach aphid



Corn leaf aphid



Sugarcane borer



Ramu canegrub



White stem borer



NG Sugarcane weevil



Sesamia stem borer



Violet stem borer



Atractomorpha



Austracris



African mole cricket



Migratory locust

Sugarcane diseases

Red rot leaf sheath	Fungus	<i>Athelia rolfsii</i>
Eye spot	Fungus	<i>Bipolaris sacchari</i>
Pineapple disease	Fungus	<i>Ceratocystis paradoxa</i>
Veneer blotch	Fungus	<i>Deightonella papuana</i>
Brown stripe	Fungus	<i>Dreschlera stenospila</i>
Pokkah boeng	Fungus	<i>Gibberella fujikuroi</i>
Red rot	Fungus	<i>Glomerella tucumanensis</i>
Ring spot	Fungus	<i>Leptosphaeria sacchari</i>
Yellow spot	Fungus	<i>Mycovellosiella koepkei</i>
Downy mildew	Fungus	<i>Peronosclerospora sacchari</i>
Rind disease	Fungus	<i>Phaeocystotroma sacchari</i>
Tar spot	Fungus	<i>Phyllachora sacchari</i>
Rust, orange	Fungus	<i>Puccinia kuehnii</i>
Red leaf streak	Fungus	<i>Ramulispora sacchari</i>
Leaf scorch	Fungus	<i>Stagnospora sacchari</i>
Ramu stunt		
Red stripe	Bacteria	<i>Pseudomonas rubrilineans</i>
Fiji disease	Virus	Sugarcane Fiji disease virus
Mosaic	Virus	

Brown spot of sugarcane is caused by a fungus *Cercospora longipes* Butler. Brown spots form on the older leaves. They are long and oval in shape 13 mm by 1 mm. The spots are paler on the lower surface. There may be a pale yellow ring around the spots. They are similar to those of yellow spot. (*Mycovellosiella koepkei*). Presumably the disease spreads by wind blown spores. It can cause moderate damage to leaves causing them to die off. Some kinds of sugarcane get less damage. To help with control gardeners should avoid taking plants that have the disease on the leaves to their new gardens. The disease is described in the CMI Descriptions of Pathogenic Fungi No 418

Brown stripe sugarcane is caused by the fungus *Bipolaris stenospila* (Drechsler) Shoem. The disease spots are long and thin. (25 mm or more long). This makes them form streaks but they do not have a shape like eye spot. (*Bipolaris sacchari*). When spots join large dead areas may form. The fungus that causes the disease grows best at 28° to 32°C. The disease gets more severe in dry weather, and when sugarcane is not growing well. It is presumed that the spores of the fungus blow in the wind. Damage can be serious with some varieties but many sugarcane varieties have resistance. So it is important to use varieties that get less disease. The disease is described in the CMI Descriptions of Plant Pathogenic Fungi No.306 and map 483. Also by Krishnamurthi,M., & Koike,H.,1982, Sugarcane collecting expedition: Papua New Guinea,1977. Hawaiian Planters' Record 59(13) 273-313.

Downy mildew of sugarcane also affects Coastal pitpit and is caused by the fungus *Peronosclerospora sacchari* (Miy.) Shirai & Hara. Long light green stripes occur on the leaf. These may have white spots and leaves may strip into shreds. Older stripes may turn yellow. Fine white soft down can sometimes be seen. Young leaves get attacked first. The disease spreads when the temperature is about 25°C and there is a high relative humidity. It can spread in infected planting material. The disease mostly attacks the plant through the young buds on the stem. The spores (conidia) spread mostly in the middle of the night. They can blow 400 m in the wind. Growth of the sugarcane is restricted. Plants infected early can die. A number of grass plants can be attacked - sugarcane, sorghum, pitpit, *Setaria* and maize/corn. Some varieties of sugarcane get less disease. Healthy planting material should be used. Crops in grassland may be more attacked. It is important to get rid of diseased plants including nearby crops. Sugarcane sets can be treated with hot water (52°C for 1 hour) or chemicals. The disease is described in the CMI Descriptions of Pathogenic Fungi No. 453. Also by Leu, L.S. & Egan, B.T., in Ricaud, C et al, 1989, Diseases of Sugarcane. Elsevier p 107-117.

Eyespot of sugarcane is caused by the fungus *Bipolaris sacchari* (Butler) Shoem. Several small red-eyed spots develop on young leaves of sugarcane. These start about 1 mm x 1 mm across and grow to 3-6 mm x 5-12 mm across. They have a narrow yellow area around them. Large areas of leaf can die. Sugarcane must have moisture on the leaves for the disease to get started. Dew is more important than heavy rain. It is commonest in cooler months. Plants get worse damage when they are growing very quickly. Temperatures need to be less than 25°C. The fungus spreads by wind, and rain. It can be spread on machinery. Badly infected sugarcane can produce a lot less food. Elephant grass and lemon grass can also get the disease. Some varieties of sugarcane are more resistant so get the disease less. Too much nitrogen fertiliser should not be used. The disease is described in CMI Descriptions of Pathogenic Fungi No 305 & Map 349. Also by Comstock, J.C., & Steiner, G.W. in Ricaud, C. et al, 1989, Diseases of Sugarcane. Elsevier. p 123-129. Frohlich, G. *et al* , 1970, Pests and Diseases of Tropical Crops. Pergamon. p 235 Plate 35. and Holliday,P.,1980, Fungal Diseases of Tropical Crops. Cambridge. p 144.

Fiji disease of sugarcane is caused by Fiji Disease Virus (FDV). The sugarcane leaves become distorted and lumps and galls develop on the undersurface of the leaves. When leaves are growing quickly new leaves can be shorter and

stiffer and look like a fan. The plant can be stunted. The disease occurs from the coast to the highlands. The disease is spread by a small sap sucking sugarcane leafhopper insects *Perkinsiella spp.*. The disease can also be spread if planting material is taken from a plant which already has the disease. It cannot be spread on tools like bush-knives. The adult leafhoppers move in large numbers on nights with no wind. They sometimes move towards lights. The number of insects varies depending on highly favoured varieties of sugarcane being available. Plants can die. The disease can be serious if varieties of cane that favour the leafhopper and the disease are present. Coastal or long pitpit can also get the disease. To control the disease healthy planting material should be used as well as resistant varieties. Infected plants should be harvested early then the remainder of the plant destroyed. The disease is described in CMI Distribution Map 17 and by Egan, B.T., et al in Ricaud, C., et al, 1989, Diseases of Sugarcane. Elsevier. p 265-280 and Kula, G.R., Plant Pathology Note No 10 or Harvest 7(2) p 89

Leaf scorch of sugarcane is caused by the fungus *Stagonospora sacchari* Lo & Ling. Very small red spots develop on the leaves. They gradually become long and develop a yellow ring around the edge. Finally spots can be 20 cm x 1 cm in size. The disease spreads most rapidly when temperatures are between 20°-25°C. Wind blown rain and dew are essential for the fungus to spread. Infected canes store less sugar. Some wild grasses in the sugarcane family can get the disease. Some varieties get less disease and should be used. The disease is described in CMI Descriptions of Pathogenic Fungi No. 418 and by Lo, T.T. & Leu, L.S., in Ricaud, C., et al, 1989, Diseases of Sugarcane. Elsevier. p 135-140.

Leaf spot or ring spot of sugarcane is caused by the fungus *Leptosphaeria sacchari* v. Breda de Haan. Dark green spots with narrow yellow edges develop on leaves. These can become oval and irregular in shape and form dark reddish patches. The spots are more common on older leaves. The disease is probably caused by a fungus but this fungus may start to grow after other fungi have damaged the leaf. The spores of the fungus blow in the wind and are washed by rain. They can live for an extended time on old dead leaves. The disease is not normally serious but it may reduce seedling growth in some varieties. Control is not normally required. The disease is described in Abbott, E.V., in Hughes, C.G. et al (ed.), 1964, Sugarcane diseases of the world. Vol 1 p 53-58 and CMI Description of Pathogenic Fungi No 145 and Distribution Map No 330

Orange rust of sugarcane also affects Coastal pitpit and is caused by the fungus *Puccinia kuehnii* (Krug.) Butler. Small long yellow rust spots develop on both sides of leaves. These spots get longer and turn brown. Then an orange-brown rust pustule breaks out. The lumps occur in groups on the lower half of the leaf. (Another rust called common rust (*Puccinia melanocephala*) is spreading to most countries of the world, probably in the wind. It suits the highlands. 18° C.) The disease probably gets worse when temperatures are between 20°-25°C and up to 30°C and humidity of 70-90%. Cloudiness and wind help spread the disease. It is spread by wind and rain. The disease is not normally serious but leaves may die early. Sugarcane, coastal pitpit and wild *Saccharum* pitpit grasses also get the disease. For control, use varieties with high levels of resistance. Other control is not normally required. The disease is described in CMI Descriptions of Pathogenic Fungi No 10 and by Ryan, C.C. & Egan, B.T. in Ricaud, C. et al, 1989, Diseases of Sugarcane. Elsevier. p 189-202.

Pineapple disease of sugarcane is caused by the fungus *Ceratocystis paradoxa* (Dade) Moreau. With this disease, sugarcane setts turn red then rot. They have a smell like pineapples. The disease is caused by a fungus. The fungus normally occurs in the asexual or imperfect form. Small long spores and larger curved spores are produced in chains. It likes warm conditions between 25°-32°C such as on the coast in Papua New Guinea. When soils are cold and wet the sugarcane cuttings start to grow more slowly which gives the disease more time to attack the plants. The fungus gets spread from the soil by rain and wind. It gets into damaged and cut stalks more easily. Wind blown spores can get into canes through rat damage etc. The fungus can last in the soil for quite a long time. Sugarcane setts can rot completely and not grow. The fungus also damages pineapples, coconuts, oil palm and bananas. Sometimes it damages betel nut palm and other palms, soursops, sweet potato, corn and other plants. Control is by using healthy planting material and providing good growing conditions such as a warm, well-drained, moist soil. Diseased setts should be removed. Cuttings can be soaked in benomyl solution (1 part in 1600 parts of water). The disease is described in CMI Descriptions of Pathogenic Fungi No 143 & Map 142 and by Wismer, C.A. & Bailey, R.A. in Ricaud, C., et al, 1989, Diseases of Sugarcane Elsevier. p 145-151.

Pokkah Boeng of sugarcane also affects Coastal pitpit and is caused by the fungus *Gibberella fujikuroi* (Sawada) Ito apud Ito & Kimura. Young sugarcane leaves go yellow near the base, and leaves are wrinkled and red areas can occur. Stems can also be distorted. The disease gets worse in very wet weather especially when this follows a dry period. Cane between 3 to 7 months old and growing rapidly gets most disease. The disease can spread from the soil or through cut stalks or in the air. It is a fairly common but not very serious disease. Sets may not grow. When the disease gets bad, plants can die. It occurs on many grass plants including maize, rice, sugarcane and pitpit. It causes pink ear rot of corn and foot rot of rice. Some varieties have resistance. Sugarcane sets can be dipped in benomyl fungicide. Excessive amounts of nitrogen fertiliser should be avoided. The disease is described in CMI Descriptions of Pathogenic Fungi No 22 and by Martin, J.P., et al in Ricaud et al, 1989, Diseases of Sugarcane. Elsevier p 157-165.

Ramu scorch of sugarcane has an unknown cause. Large straw-coloured spots with red-brown edges occur on leaves. The spots have a yellow ring around them. In some varieties the spots joined to kill the leaves. Damage can be severe

in susceptible varieties. So for control use varieties that get less damaged by disease. The disease is described in Egan, B.T., New diseases appear in Papua New Guinea. BSES Bulletin (1986) No 16, 8-10.

Ramu stunt of sugarcane is probably caused by a virus or mycoplasma. White to pale yellow-green stripes occur on leaves. The growth rate is reduced and roots develop poorly. It spreads very rapidly. It causes serious loss in yield. The disease is described in Egan, B.T. New Diseases appear in Papua New Guinea. BSES Bulletin (1986) No 16, 8-10 and by Waller, J.M., Egan, B.T. & Eastwood, D., 1987, Ramu stunt, an important new sugarcane disease in Papua New Guinea. Tropical Pest Management 33(4),347-349.

Red rot of sugarcane also affects Coastal pitpit and is caused by the fungus *Glomerella tucumanensis* (Speg.)Arx & Muller. Red areas with white flecks occur within the stems. Small red spots can occur on the leaf sheath especially near the midrib. The buds get damaged & a poor stand of cane is produced. Stalks need to be cut lengthwise to check red and white patches in the stalk. Damaged stems, including borer damage, allows the disease to get started. It gets worse in cooler areas. The fungus can spread from the soil or old crop remains. Spores can be blown by wind. It can be spread in planting material. The fungus can only live for 6 months in the soil. Plants grow less well and can die. Sugarcane is less sweet. The disease occurs on *Saccharum* and *Sorghum* grasses. For control don't plant diseased material and get rid of diseased plants. Different varieties have different amounts of resistance. The fungus in canes for planting can be killed with hot air treatment. It is important to rotate sugarcane crops. The disease is described in CMI Descriptions of Pathogenic Fungi No 133 & Map 186 and by Singh, K.& Singh, R.P., in Ricaud, C.et al, 1989, Diseases of Sugarcane. Elsevier. p 169-182

Red stripe of sugarcane is caused by bacteria *Pseudomonas rubrilineans* (Lee *et al*) Stapp. It can cause leaf stripe and top rot. The leaf stripe has long narrow, uniform, dark-red stripes. They may start as watery-green stripes but become red. The disease is more commonly on young leaves. It gets worse with high humidity. It is worse in cool places. It spreads with wind blown rain. The bacteria ooze onto the surface of leaf spots during moist warm weather. This can wash down plants or splash between plants. It is rarely transmitted by cane knives. It can lie in the soil for a month and on old dead plants for up to 7 months. It can cause the top of plants to rot. It can also occur on sorghum grasses and maize. For control, use resistant varieties. Changing the planting dates can reduce top rot of seedlings in some areas. The disease is described in CMI Descriptions of Pathogenic bacteria No 127 and Distribution Map 39. Also by Haywood, A.C. in Fahy, P.C. & Persley, G.J. (eds), 1983, Plant Bacterial Diseases. A Diagnostic Guide. Academic. p 124-127, And by Martin, J.P. & Wismer, C.A., in Ricaud, C et al, 1989, Diseases of Sugarcane. Elsevier. p 81-91.

Rind disease of sugarcane is caused by a fungus *Phaeocystroma sacchari* (Ell.& Ev.) B Sutton. Leaves may turn yellow early due to the fungus on the leaf sheaths. Black spots like pimples (pustules) on the stalks can give off black, coiled, hair like masses of spores under moist conditions. The disease gets worse where there is low temperatures, high salinity, poor drainage, and mechanical damage to cane for planting. The small fungal spores blow in the wind or rain. It gets on seed cuttings and reduces their germination. It can seriously affect over mature cane causing the stalks to rot. It occurs on plants in the sugarcane group. Some varieties of sugarcane get worse damage. Harvest the sugarcane when it is mature especially if it has suffered injury to the stalks. The disease is described in the CMI Description of Pathogenic Fungi No 87 and Distribution Map 255

Sugarcane mosaic is also called yellow stripe disease and is caused by the sugarcane mosaic virus. A pattern of light green and dark green areas, develop on the leaves. The pale areas can be most easily seen in young rapidly growing leaves. Sometimes these are just yellowish stripes but there can be large yellowish patches. The pale areas can also be on the leaf sheath and the cane stalk. The virus can be spread by aphids (eg corn leaf aphid *Rhopalosiphum maidis*) and sugarcane aphid (*Longiunguis sacchari*). It can also be spread mechanically with things like bush knives. It can spread from infected planting material. The damage can be serious with kinds of sugarcane that get the disease easily. Sometimes plants can recover from the disease. It also occurs in maize, sorghum and on many other grasses. Control is by using disease free planting material and kinds of sugarcane that get the disease less. The disease is described in the CMI Distribution Map 330 and by Koike, H.& Gillaspie, A.G., in Ricaud, C et al, 1989, Diseases of Sugarcane. Elsevier. p 301-314.

Tar spot of sugarcane also affects Coastal pitpit and is caused by the fungus *Phyllachora sacchari* P.Henn. Black tar like spots occur on the leaves. The disease probably spreads by wind and rain spreading spores from infected crop debris. Leaves can dry up in serious cases. It is not normally serious. Sugarcane, coastal pitpit, sorghum, and other *Sorghum* and *Saccharum* grasses also get the disease. No control is normally required. The disease is described in the CMI Descriptions of Pathogenic Fungi No 588 and by Holliday, P.,1980, Fungus Diseases of Tropical Crops. Cambridge. p 330.

Veneer blotch of sugarcane also affects Coastal pitpit and is caused by a fungus *Deightonella papuana* D.Shaw. The disease causes a distinct pattern on the upper surface of the leaves. It begins as a small oval leaf spot, light green with a red border. New long spots develop on either side of the original spot forming a long patterned leaf spot. Sugarcane, long pitpit and other sugarcane type grasses get the disease. The disease is described by Holliday,P., 1980, Fungus Diseases of Tropical Crops. Cambridge. p 1124 and Shaw, D.E.,1959, PNG Ag. J. 11(1956):77

Yellow spot of sugarcane also affects Coastal pitpit and is caused by a fungus called *Mycovellosiella koepkei* (Kruger)Deighton. Different races of the fungus occur which means vertical resistance introduced by plant breeders can break down. On the young leaves of sugarcane and coastal pitpit small yellow pinpoint spots appear. These spots

later join and become irregular in shape. The disease gets worse during wet, humid weather and high temperatures (28°C). Humidities over 80% are possibly necessary. The spores (conidia) are washed off leaves. Although it does not spread on sets where pieces of the stalk are used it probably can spread on tops as used in Papua New Guinea. The leaves of sugarcane and pitpit die early. Some varieties get less of the disease (Traditional varieties are less damaged than hybrids.) The disease is described in the CMI Descriptions of Pathogenic Fungi No 417 & Map 341 and by Holliday, P, 1980, Fungus Diseases of Tropical Crops. Cambridge. p 71; Martin, J.P. *et al*, 1961, Sugarcane Diseases of the World. Vol 1. Elsevier. p 357ff and by Ricaud, C. & Autrey, L.J.C. in Ricaud, C *et al*, 1989, Diseases of Sugarcane. Elsevier. p 231-241.



Sugarcane leaf spots



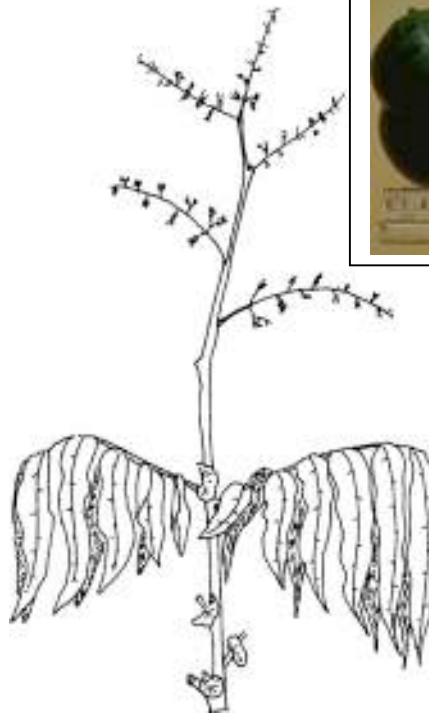
Nitrogen deficiency of sugarcane

TON

Scientific name: *Pometia pinnata*

Names

The tree that is called Ton (or Taun) in Tok Pisin was first described in 1776 by the botanists J.R. & G Forster. They gave it the scientific name *Pometia pinnata*. The name *Pometia* comes from a Latin word "pomum" which means fruit or apple. The other part of the name, *pinnata*, describes the way the leaflets grow opposite each other along a stalk. In many people's minds, these two things are typical of the tree - leaflets drooping from long stalks and a very enjoyable fruit.



Ton trees can vary a lot, and different forms or types of the tree have been described. Some types do not have edible fruit. Two main types are called:

Pometia pinnata JR & G Forster forma *pinnata*
and *Pometia pinnata* JR & G Forster forma *tomentosa*.

In some books these were described as two different species. They are in the plant family called Sapindaceae.



The tree

A ton tree can grow into quite a large tree up to 40 metres high. At the base of the tree there are often large buttresses and the bark is a bright orange brown colour and rough and scaly. The young leaves and twigs of the tree are bright red.

The lowest pair of leaflets are small and clasp the stem like stipules. There are often 5-11 pairs of leaflets along a stalk and the leaflets at the centre are often the largest.

The flowers are produced in clusters on stalks that are up to 50 cm long and grow near the ends of the branches. The flowers are small and yellowish green and do not have any scent.

Several varieties of ton occur, but the main part that varies is the colour of the fruit. Young fruit are green, but as they get ripe the colour can change to green, yellow, red or purple depending on the variety. They all taste much the same.

The fruit

In Papua New Guinea in coastal areas and on the islands this is one of the most popular fruits. The fruit is a bit like a rambutan, or a litchi, two fruits that are better known from Malaysia and China. The edible part is a white shiny layer around the seed. Scientists call this layer the aril. When a ton fruit is ripe, the skin peels off very easily, just like peeling a mandarin.

Where do the trees grow?

Ton trees only grow in SE Asia. The trees occur in Sri Lanka, Malaysia, Indonesia, Philippines, Papua New Guinea and some Pacific Islands.

The *tomentosa* type does not have fruit that can be eaten or if it is eaten it is much less attractive. It tends to grow on hill slopes and ridges between an altitude of 900 and 1200 metres. It is normally in well-drained positions. The type that has edible fruit is more commonly in the lowland rainforest, on riverbanks and in poorly drained places. It is this second type that is an important food plant.

Fruit production

Ton fruit are produced seasonally. The season is near Christmas, (December/January) and it tends to be short and a very distinct season with few trees bearing early or late. Sometimes there is a minor season in mid-year about June and July. These fruit are not as sweet. The season does not exactly coincide in different provinces of the country, and it can be a month or two later in New Ireland. As well, trees do not fruit equally well each year. On Manus Island, ton trees only produce a lot of fruit every few years. These good seasons then become times of great excitement and happiness. (Yen, in his study of this tree in the Solomon Islands said that flowers formed later in the year often did not set fruit. It appears that some fruit setting problem occurs, which needs study.)

Growing ton

Ton are planted from seed. Also self sown seedling are transplanted and some trees occur wild in the bush. The seeds are probably spread around by fruit eating bats. It probably takes about 5 years from planting until the trees bear fruit.

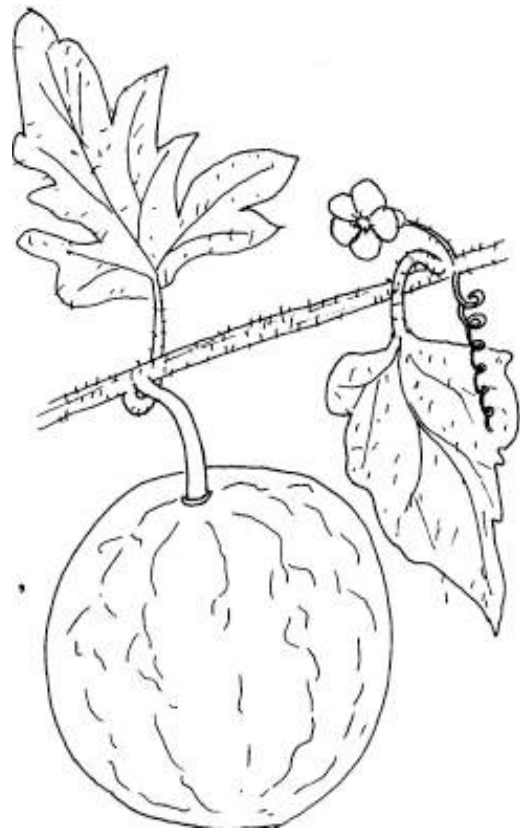
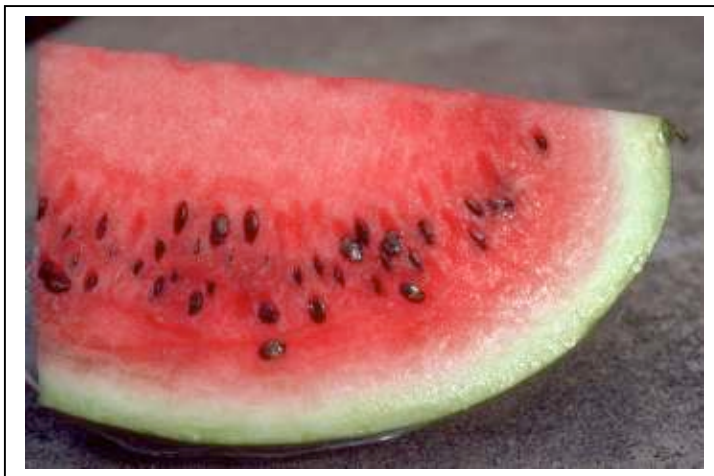
In the Solomon Islands, and in Malaysia, ton seeds are eaten after they are roasted. Also in the Solomons, ton leaves are chewed with lime. It is not known if either of these practices occurs in Papua New Guinea. The actual seeds have been reported as poisonous without treatment.

Watermelon

Scientific name: *Citrullus lanatus*

The plant

The watermelon plant is a climbing pumpkin family plant. The leaves and vines are hairy and it has tendrils enabling it to cling onto things. The leaves are up to 20 cm long and have 3 to seven lobes. The flowers are yellow and about 2 cm across. There are male and female flowers. The fruit vary in shape from round to oval and from green skinned to kinds streaked with various shades of green. The flesh is red or yellow. There are black flattened seeds in amongst the flesh. Because the plants cross-pollinate considerable variation exists between the plants.



Growing watermelons

It suits dry areas or can be grown in the dry season in other places. It is grown on the coast and up to about 1000 metres altitude. It suits sandy soils and is commonly seen and grows well on the sandy soils around Port Moresby. It must have a well-drained soil. It requires a high temperature for best production. The seeds germinate best where temperatures are between 24° and 30 °C. Fruit ready for harvest can be produced in 3 months from planting. Seed will keep for 2 years if carefully stored, dry.

Seed is sown 1 cm deep and with plants about 1 to 1.5 metres apart. Seed germinate within a week. If large fruit are desired they fruit should be thinned out to 2 or 3 per plant. It is not easy to tell when fruit are ripe but looking at the tendril near the fruit to see if it has wilted, watching a

slight colour change from white to yellow where the fruit rests on the ground and tapping the fruit for a dull sound all give some indication. The fruit can be stored for 2 or 3 weeks in a cool place.

The flesh of the fruit is sweet and watery and provides a refreshing substitute for a drink. The seeds are eaten raw or cooked. Small unripe watermelons can also be cooked as a vegetable.

Pests and disease

Watermelon diseases

Leaf spot	Fungus	<i>Cercospora citrullina</i>
Leaf spot	Fungus	<i>Colletotrichum lagenarium</i>
	and	<i>Leptosphaerulina trifolii</i>
Black rot	Fungus	<i>Mycosphaerella melonis</i>
Powdery mildew	Fungus	<i>Oidium sp.</i>
Damping off	Fungus	<i>Pythium irregulare</i>
Mosaic	Probably virus	
Root knot	Nematode	<i>Meloidogyne incognita</i>

Watermelon insect pests

<i>Tiracola plagiata</i> Walk	Noctuidae (LEP)	Cacao armyworm
<i>Dacus cucurbitae</i> Coq	Tephritidae (DIPT)	Melon fruit fly
<i>Planococcus pacificus</i> Cox	Pseudococcidae (HEM)	

Wrapping the fruit with paper while growing can help reduce fruit fly damage.



Nuts

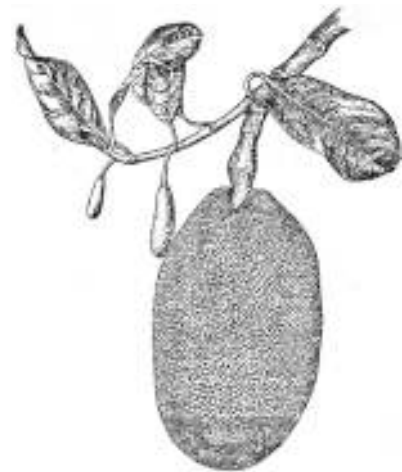
Aila		302
Breadfruit family	Breadfruit	305
	Jackfruit	310
	Parartocarpus	312
Candlenut		314
Castanopsis chestnuts		316
Coconut		318
Galip nuts		324
Finschia nuts		328
Karuka family	Karuka	331
	Wild karuka	338
	<i>Pandanus antaresensis</i>	341
Terminalia	Okari	343
	Talis	347
	Java almond	348
Pao nuts		350



Aila



Breadfruit



Jackfruit



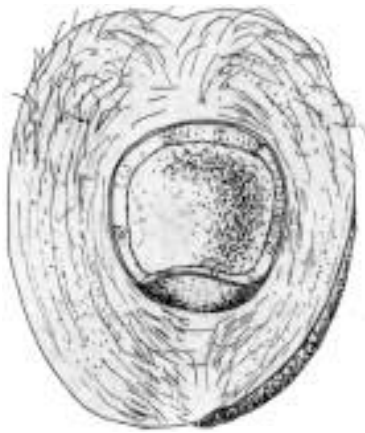
Parartocarpus



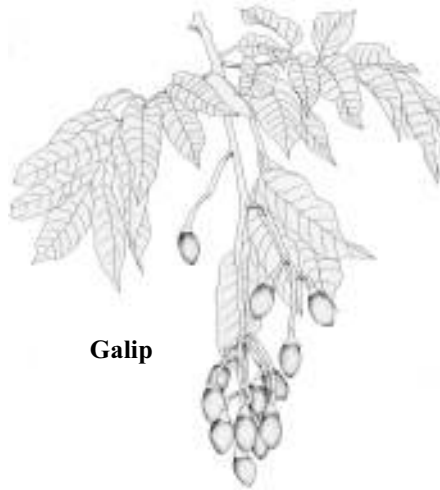
Candle nut



Castanopsis nuts



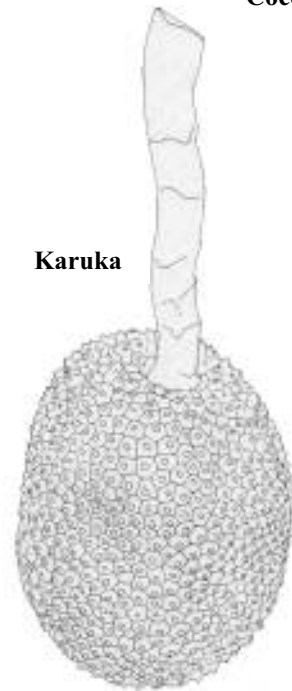
Coconut



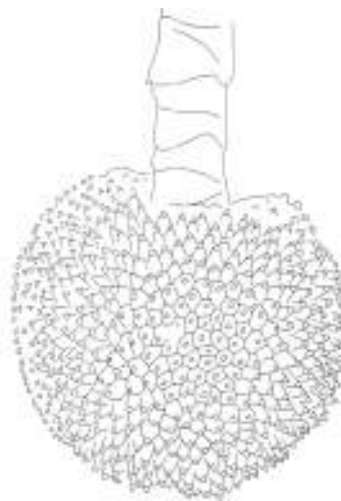
Galip



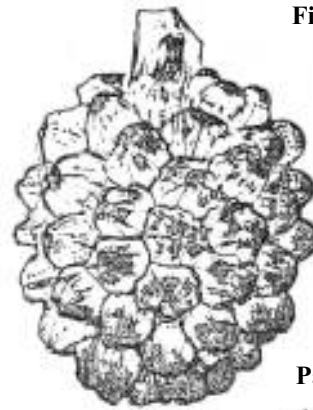
Finschia



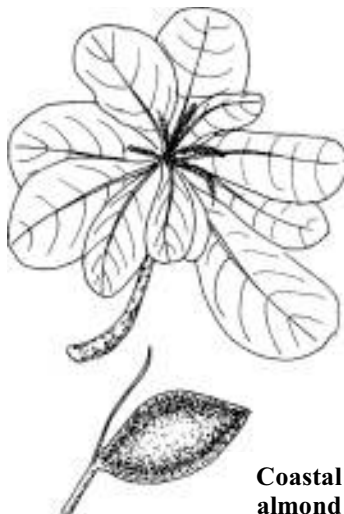
Karuka



Wild karuka



Pandanus



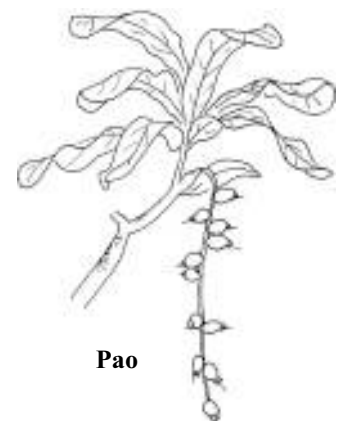
Coastal almond



Talis



Okari



Pao

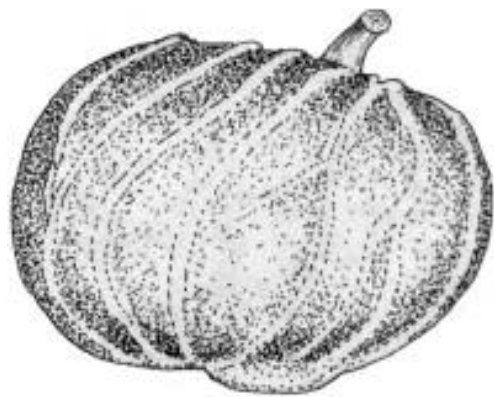
Aila

Scientific name: *Inocarpus fagifer*

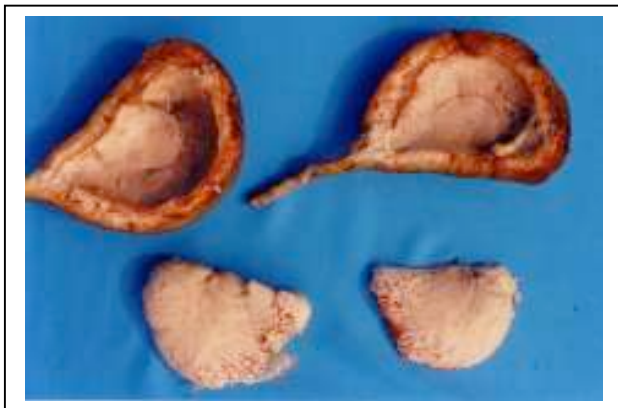
What is an aila tree like?

An aila or Tahitian chestnut is a large tree 20 metres or more tall and with buttresses at the base of the trunk. The bark is dark grey and gives a red sap when cut. The branches droop downwards.

The leaves are long (20 cm), leathery, shiny and feather veined. The leaves have short stalks and are one after the other (alternate) along the branch. Young leaves are pink.



The flowers of aila are not obvious. They are pale yellow and hang loosely on the twigs from the angles where leaves join. They have 5 narrow petals joined in a tube. The flowers smell sweetly.



The fruit is irregular or kidney shaped and has one seed inside. The outside of the pod is thick and leathery with a lumpy surface. It can be 8-10 cm across and 3 cm thick. The ripe fruit is yellow.

The fleshy layer around the seed is eaten.

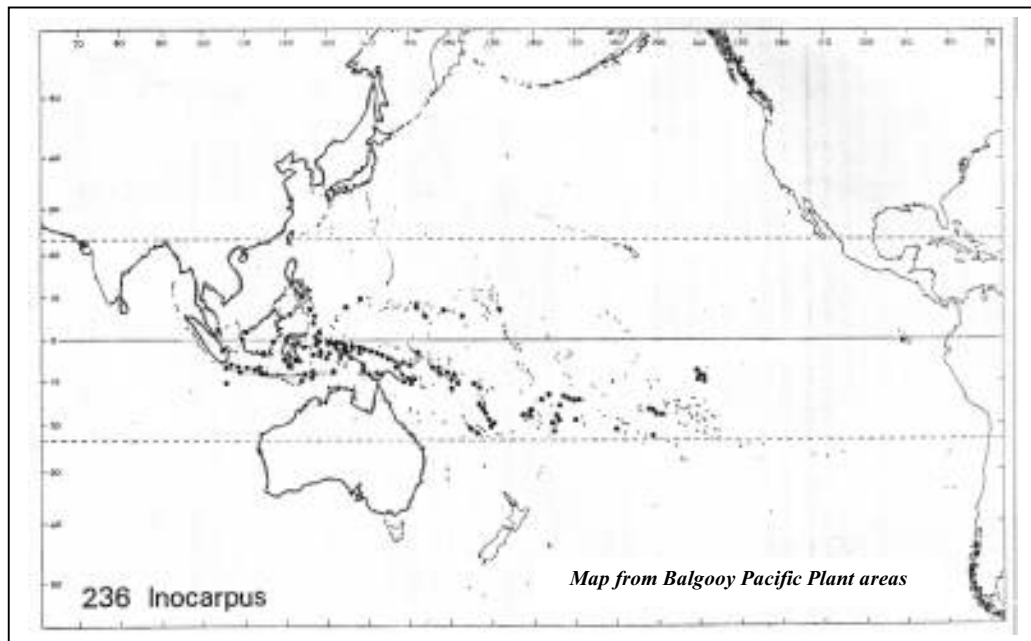
Where do aila nut trees grow?

Aila nut trees grow near sea level. Often they are very close to the waterfront. They are common on some of the off shore islands.

They can grow in swampy ground and are common in some river estuaries.

Trees can probably grow from sea level up to about 300 m altitude. They do better where there is no distinct dry season.

Aila nut trees do not only occur in Papua New Guinea but occur in some other South East Asian and Pacific countries as well. The map shows places where the trees occur naturally or commonly.



The countries include Malaysia, Indonesia and Pacific islands such as Fiji, Tahiti and Samoa as well as Papua New Guinea.

Growing Aila nuts

Aila nut trees often grow self-sown. The fruits are distributed by bats and other animals, although the seeds float easily as well.

Trees can be grown from seed. Trees can commence producing fruit about 8 years after planting. It is also possible to grow trees from cuttings.

Aila nuts are produced seasonally. The season is about the beginning of the year probably from January to May.

Insect pests of Tahitian chestnut

Scales and mealy bugs

<i>Ischnaspis longirostris</i> (Signoret)	Diaspididae (HEM)	Black thread scale
<i>Lepidosaphes rubrovittata</i> Cockerell	Diaspididae (HEM)	
<i>Parlatoria crotonis</i> Douglas	Diaspididae (HEM)	
<i>Pinnaspis aspidistrae</i> (Signoret)	Diaspididae (HEM)	
<i>Pinnaspis buxi</i> (Bouche)	Diaspididae (HEM)	
<i>Pinnaspis strachani</i> (Cooley)	Diaspididae (HEM)	
<i>Icerya seychellarum</i> (Westwood)	Margarodidae (HEM)	
<i>Ceroplastes rubens</i> Maskell	Coccidae (HEM)	Pink wax scale
<i>Coccus longulus</i> (Douglas)	Coccidae (HEM)	
<i>Coccus viridus</i> (Green)	Coccidae (HEM)	Green scale
<i>Neoplatyolecanium</i> sp.	Coccidae (HEM)	
<i>Dysmicoccus brevipes</i> (Cockerell)	Pseudococcidae (HEM)	Pineapple mealybug
<i>Maculicoccus malaitensis</i> (Cockerell)	Pseudococcidae (HEM)	
<i>Planococcus pacificus</i> Cox	Pseudococcidae (HEM)	

Aila nuts as food

The nuts are usually roasted although they can be boiled.

Soaked nuts can be grated, mixed with coconut milk and roasted in banana leaves.

Seeds can be stored by partly fermenting them in pits in the ground.

Nuts can be stored for a considerable time but once shelled or cooked will only keep a short time.

The wood of the tree is good for firewood.

Food value per 100 g edible portion:

Edible portion	Moisture %	Energy KJ	Protein %	ProVit A µg	Provit C mg	Iron mg	Zinc mg
Nut	43.0	1008	4.5	0	2		

The breadfruit family



Breadfruit
Artocarpus altilis

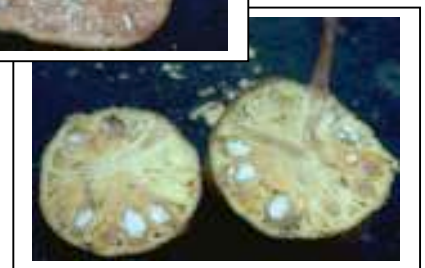
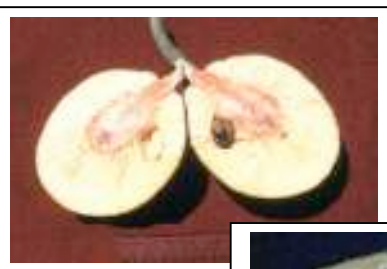


Jackfruit
Artocarpus heterophyllus



Pakal
Parartocarpus venenosa

Also *Artocarpus vrieseanus*



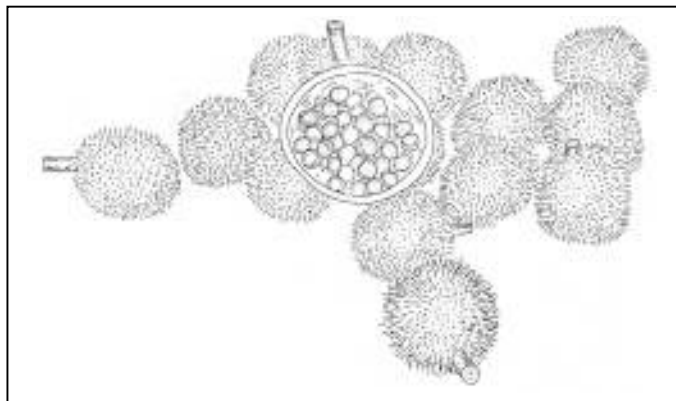
Breadfruit

Tok Pisin: Kapiak

Scientific name: *Artocarpus altilis*

The breadfruit tree

The breadfruit tree is a large tree often up to 15 or 20 metres tall. It has large, rough leaves that vary in how much they are divided around the edge. It produces male and female flowers separately but near each other on the same tree. It has a white sticky sap that leaks out from damaged parts of the bark.



Where is breadfruit grown?

The breadfruit tree is grown not only in Papua New Guinea but also in a number of other Pacific Island countries. It has also been taken to a number of other countries such as the West Indies. There is a famous story about one of the early explorers who tried to take a shipload of breadfruit trees to the West Indies. All the men on the boat refused to sail the ship any further so the crew were put off the boat on a small Pacific Island called Pitcairn.

But the breadfruit that is most common in the Western regions of Papua New Guinea is fairly different from the breadfruit that is grown on the coast and islands and in other Pacific countries. This is because the people in these places have picked out breadfruit that are full of seeds. It is these seeds that are eaten.

A breadfruit in the Western areas of Papua New Guinea looks fairly different from the breadfruit that coastal people know. This breadfruit has a lot of soft pointed spines all over the fruit. The breadfruits on the New Guinea islands have fruit with small rounded lumps all over them.



Breadfruit can be seen growing up to about 1200 metres altitude above sea level. It is not common at 1200 metres but becomes fairly common at places lower down.

Breadfruit seeds

A breadfruit seed weighs about 5 grams and is about 3 or 4 centimetres across.

A seed looks like this drawing



Growing breadfruit

Most of the seeded breadfruit is grown from seed. The seeds are often self-sown by birds and bats. These trees just come up naturally. Trees are also planted by people and some trees are transplanted from where the seeds grew naturally. Normally seeds should be planted fresh before they have dried out.

People have several different named varieties of their seeded breadfruit. These seem to continue to produce a similar variety of tree even when grown from seed.

Breadfruit can be grown from root cuttings and this method could be used if it were important to maintain a good kind of tree. This is the method used for the seedless types.



**A shoot growing
from a root of a
seedless breadfruit**

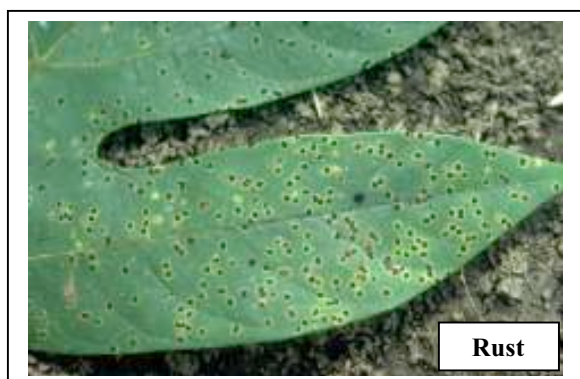
Pest and diseases

Breadfruit insect pests

<i>Abgrallaspis cyanophylli</i> (Signoret)	Diaspididae (HEM)	
<i>Aonidiella aurantii</i> (Maskell)	Diaspididae (HEM)	Yellow scale
<i>Aspidiotus destructor</i> Sign.	Diaspididae (HEM)	Coconut scale
<i>Ceroplastes rubens</i> Maskell	Coccidae (HEM)	Pink wax scale
<i>Chrysomphalus aonidum</i> (Linnaeus)	Diaspididae (HEM)	Florida red scale
<i>Coccus hesperidum</i> Linnaeus	Coccidae (HEM)	Soft brown scale
<i>Coccus longulus</i> (Douglas)	Coccidae (HEM)	
<i>Bactrocera umbrosus</i> (F.)	Tephritidae (DIPT)	Fruit fly
<i>Dysmicoccus brevipes</i> (Cockerell)	Pseudococcidae (HEM)	Pineapple mealybug
<i>Dysmicoccus nesophilus</i> Williams	Pseudococcidae (HEM)	
<i>Ferrisia virgata</i> (Cockerell)	Pseudococcidae (HEM)	
<i>Hemiberlesia palmarum</i> (Cockerell)	Diaspididae (HEM)	
<i>Icerya seychellarum</i> (Westwood)	Margarodidae (HEM)	
<i>Kilifia acuminata</i> (Signoret)	Coccidae (HEM)	
<i>Maconellicoccus hirsutus</i> (Green)	Pseudococcidae (HEM)	Hibiscus mealy bug
<i>Milviscutulus mangiferae</i> (Green)	Coccidae (HEM)	
<i>Mutabilicoccus vanheurni</i> (Reyne)	Pseudococcidae (HEM)	
<i>Parasaissetia nigra</i> (Nietner)	Coccidae (HEM)	Nigra scale
<i>Pinnaspis strachani</i> (Cooley)	Diaspididae (HEM)	
<i>Planococcus pacificus</i> Cox	Pseudococcidae (HEM)	
<i>Pseudococcus longispinus</i> Targioni	Pseudococcidae (HEM)	Longtailed mealybug
<i>Pseudaulacaspis pentagona</i> (Targ.)	Diaspididae (HEM)	White scale
<i>Saissetia coffeae</i> (Walker)	Coccidae (HEM)	Coffee scale
<i>Telostylinus</i> sp	Neriidae (DIPT)	
<i>Xyleborus</i> spp.	Scolytidae (COL.)	Island pinhole borer

Breadfruit diseases

Leaf spot	Fungus	<i>Pseudocercospora artocarp</i>
Rust	Fungus	<i>Uredo artocarp</i>



Leaf shapes vary considerably



Male flowers have a sweet smell and are burnt to keep mosquitoes away



Breadfruit as food

The young leaves and the male flowers can be eaten after cooking.

The seeds are cooked by roasting or boiling then eaten.

Seedless fruit are cooked and eaten.

Food value of 100 g edible portion:

Edible portion	Moisture %	Energy KJ	Protein %	ProVit A µg	Provit C mg	Iron mg	Zinc mg
Fruit	74.4	506	1.5	4	25	0.4	0.2
Leaves							
Flowers							
Seed	56.5	799	7.4	26	6.6	3.7	0.9

Jackfruit

Scientific name: *Artocarpus heterophyllus*

What is a jackfruit like?

The jackfruit tree is a large evergreen tree in the breadfruit family. Trees can be up to 20 m high.

The leaves are entire and leathery.

Flowers occur on spikes on stalks from the trunk or main branches. Some stalks only have male flowers, others only have female flowers while some have both male and female spikes.

The fruit are very large and hang from the trunk and the main branches. Fruit can be 60 cm long and weigh up to 30 kg in weight. They have spikes or prickles all over the surface of the fruit. Fruit are long and green. The flesh inside is yellow. The seeds are large and oblong with a slimy membrane over it and a brown skin.

The trees have a thick milky sap. Leaves can be 22 cm long.



Names

The scientific name is *Artocarpus heterophyllus*. Two other scientific names have also been used. These are *Artocarpus integrifolia* and *Artocarpus integra*. These names are no longer correct.

Where do jackfruit grow?

Jackfruit are less tropical than breadfruit and can be grown in cooler places. They will probably grow up to 2000 metres or more altitude. A warm wet climate is best. The soil needs to be well drained but otherwise a variety of soils will produce good jackfruit.

How do you grow jackfruit?

Often jackfruit are grown from seeds. Seeds need to be fresh or they won't grow. Seeds grow more quickly if they are soaked in water for 24 hours. Seeds germinate in about 3 weeks and need to be sown where the tree is to be grown as seedlings do not transplant easily. This is because the seedlings have a long delicate taproot.

Trees need to be spaced 12 to 14 metres apart.

Jackfruit trees grow quickly. A tree starts producing fruit about 4 to 6 years after planting. Fruit take about 100 to 120 days from when the flower is pollinated until a fully mature fruit is developed but can take another 4 months to ripen. Fruit are available most of the year round although the main season is October to May. Often trees have larger crops every second year.

Jackfruit as food

The flesh between the seeds of the fruit is edible. The seeds can also be eaten after they are cooked. The young flower clusters can be eaten and the young fruit can be used in soup. The fruit has a strong smell when ripe.

Food value in 100 g edible portion:

Edible portion	Moisture %	Energy KJ	Protein %	ProVit A µg	Provit C mg	Iron mg	Zinc mg
Fruit raw	74.5	395	1.5	30	6.7	0.6	0.4
Seed boiled	57.6	600	5.6	60	10	0.8	
Fruit + seed	85.8		1.6		13	0.1	
Leaves	75.5	300	5	170			
Flowers							

Pests and diseases

Jackfruit diseases

Pink Disease	Fungus	<i>Phanerochaete salmonicolor</i>
Leaf spot	Fungus	<i>Colletotrichum sp.</i>

Insect pests

<i>Parastasia guttulata</i> Fairmaire	Scarabaeidae (COL)	Adult reported boring tunnels into fruit
<i>Chrysomphalus dictyospermi</i> (Morgan)	Diaspididae (HEM)	
<i>Hemiberlesia lataniae</i> (Signoret)	Diaspididae (HEM)	
<i>Hemiberlesia palmae</i> (Cockerell)	Diaspididae (HEM)	
<i>Pinnaspis buxi</i> (Bouche)	Diaspididae (HEM)	
<i>Unaspis citri</i> (Comstock)	Diaspididae (HEM)	White louse scale
<i>Icerya seychellarum</i> (Westwood)	Margarodidae (HEM)	
<i>Anthococcus kerevatae</i> Williams	Coccidae (HEM)	
<i>Ceroplastes rubens</i> Maskell	Coccidae (HEM)	Pink wax scale
<i>Coccus longulus</i> (Douglas)	Coccidae (HEM)	
<i>Milviscutulus mangiferae</i> (Green)	Coccidae (HEM)	
<i>Parasaissetia nigra</i> (Nietner)	Coccidae (HEM)	Nigra scale
<i>Planococcus pacificus</i> Cox	Pseudococcidae (HEM)	

Pakal

Scientific name: *Parartocarpus venenosus*

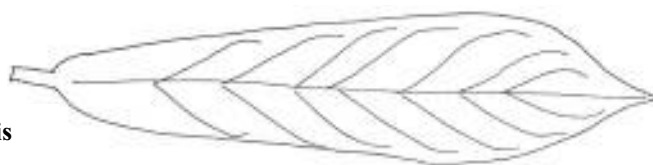
What is the plant like?

This is quite a large tree up to 25 metres or more tall. It has milky sap inside. It is in the breadfruit family.

The leaves of the tree are entire on outline and they are arranged on a spiral around the stem.



The leaves are shiny on both surfaces. The veins are raised under the leaf and sunken on top. The leaf is lighter green underneath.



The leaf looks like this

The fruit is large and can be 14 cm to 24 cm across. It has an irregular shape. The fruit is brown and slightly rough on the outside and with yellow flesh inside. There are quite a few large seeds inside. The seeds are something like breadfruit. The seeds have a yellow layer over them and are white inside.



The fruit hangs from the branches similarly to breadfruit. As the fruit get ripe they give off as strong sweet smell. This helps people find the fruit in the bush.

How are pakal trees grown?

Often pakal trees just grow wild in the bush. Flying foxes eat the fruit and they spread the seeds around. Small trees are sometimes transplanted nearer to houses.

Where do pakal trees grow?

Pakal trees can grow from sea level up to about 1000 metres above sea level. Mostly they are near the sea and are more common on islands.

In Papua New Guinea they mostly occur along the North Coast and on islands off the coast.

Where did the name come from?

Pakal is a Tok Ples name from one of the languages of Manus. It also has other Tok Ples names in other areas of PNG, but doesn't have a common Tok Pisin name.

The scientific name is *Parartocarpus venenosus*. The word parartocarpus means near or related to the breadfruit group of plants. Pakal or parartocarpus is a fruit tree like breadfruit or Kapiak.

Tok ples names	
Wogeo Is	Salang
Madang	Yang
Manus	Pakal
New Ireland, Kalau	Situ
New Ireland, Lamakot	Livu
Rabaul	Lapua

How are pakal used?

The yellow flesh inside the pakal fruit is eaten cooked. The flesh of the fruit is very dry and therefore it is necessary to have a drink of water afterwards.

The seeds are poisonous at least when they are unripe. In some places the seeds are cooked and eaten, but only after they have been soaked in seawater for a few days.

Candlenut

Scientific name: *Aleurites moluccana*

The candlenut tree

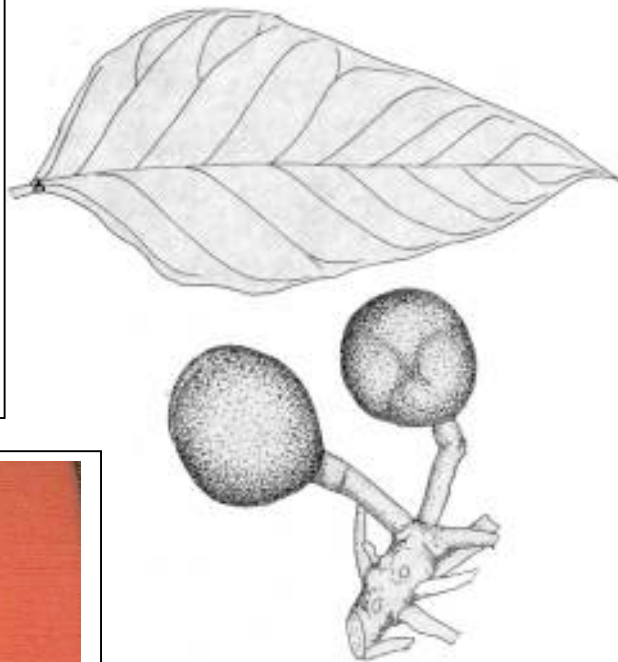
The tree is a large evergreen tree that can grow up to 40 metres tall and have a trunk which is one metre through at the base. The bark is rough. The trees can be identified at a distance by the pale green colour of the leaves.

The leaves, leaf stalks and flowers are all covered with short soft hairs. The leaves are large and can be round, triangular or have several lobes. Leaves of young trees are often a different shape from mature leaves on older trees. Two distinct brown glands occur where the leaf blade joins the stalk. The leaf stalk is long.

The flowers are small and white and in large groups on the ends of branches. Male and female flowers are separate but on the same tree. The female flowers are on the end surrounded by small male flowers.

The fruit are 4 to 5 cm across and green with one or two seeds inside. They do not open naturally to release the seeds.

The seeds or nuts are in a very hard shell. As well, the kernels do not easily come free from the shell and often they must be dug out. The outside of the shell is rough.



How do you grow candlenuts?

Candlenut seeds have a very hard shell. If the seeds are just planted it may take many months for this hard shell to break down and the seed to start growing. So a special way of preparing the seeds is required. A single layer of seeds is put on the ground. Then some dry kunai grass is spread over the top. The kunai grass is burnt and then while the seeds are still hot they are dropped into cold water. This cracks the shells so that when the seeds are planted they will grow more quickly.

Often candlenut trees are just self-sown, growing in the bush where the seeds fell. These small trees can be transplanted to a more suitable place if needed.

Where do candlenuts grow?

Candlenuts grow better in a drier climate. In Papua New Guinea they are quite common in areas like the Eastern Highlands, Bulolo and in the Western Province. They are most commonly on well-drained sandy soils.

The trees can be grown from sea level up to about 2000 metres altitude, but are more common in the lowlands.

Candlenut trees are common in Pacific Islands Countries, Papua New Guinea, Indonesia and Malaysia and as far as India. They have also been taken to other countries.

Candlenuts as food

The raw kernels of candlenut are poisonous. They are a strong purgative. Before eating they must be well cooked.

Mostly the nuts are roasted in the fire until the shell is blackened and half burnt, then the kernels are taken out by cracking the shells.

The nuts should probably only be eaten in moderate amounts. Because the kernels are high in oil, they can be burnt as candles. Also the black soot from the burnt seeds is used as a black paint for faces.

Food value:

When the seeds are dry they are high in both energy and protein. A 100 g sample contains:

Edible portion	Moisture %	Energy KJ	Protein %	ProVit A μ g	Provit C mg	Iron mg	Zinc mg
Kernel	24.4	2426	7.8			2.7	2.7
Kernel treated	12.8	1400	0.5				
Kernel cooked	1.4	2836	20.6			22.6	3.2

Pests and disease

A leaf spot probably due to a fungus can be seen on candlenut tree leaves.

Insect pests

<i>Chrysomphalus aonidum</i> (Linnaeus)	Diaspididae (HEM)	Florida red scale
<i>Hemiberlesia lataniae</i> (Signoret)	Diaspididae (HEM)	
<i>Hemiberlesia palmarum</i> (Cockerell)	Diaspididae (HEM)	
<i>Pinnaspis strachani</i> (Cooley)	Diaspididae (HEM)	
<i>Coccus longulus</i> (Douglas)	Coccidae (HEM)	
<i>Eucalymnatus tessellatus</i> (Signoret)	Coccidae (HEM)	
<i>Dysmicoccus nesophilus</i> Williams	Coccidae (HEM)	
<i>Planococcus pacificus</i> Cox	Coccidae (HEM)	

Castanopsis chestnuts

Tok Pisin: no name

Scientific name: *Castanopsis acuminatissima*

Tok Ples names:

Huli	Pai	Mendi	Pe	Foi	Bai
Wiru	Ka wongo	Pole	Pai		

The *Castanopsis* chestnut tree

This tree grows up to 40 metres tall and it can have a trunk 1 metre through at the base. Most trees have several suckers growing from their base and the roots of the tree are close to the surface.

The male and female flowers occur separately but they both occur on the one tree.

The tree has flushes of growth with new leaves having a slightly reddish colour.



The nut has a spiky type of covering around it and as it ripens this peels back and the nut falls. The nut is pointed, brown and slightly hairy. It is about 1.5 cm long and has two large "seeds" inside.



Where do these chestnut trees grow?

They grow throughout Papua New Guinea. The most common place is between 1100 and 2300 metres above sea level but they can occur down to 500 metres in many places and are at the sea level in the South Coast of New Britain. Some people have suggested that they grow down as far as the afternoon clouds commonly come down.

Often these chestnut trees are more common on the boundary between the grassland and the forest. They form a thick covering of leaves that stops many smaller plants from growing underneath. As well they commonly grow in groups or clumps made up only of chestnut trees. From aeroplanes, these *Castanopsis* forests can be picked out because they have a distinctive yellowish brown colour. Under the trees there is usually a thick layer of fallen leaves.

Growing *Castanopsis* chestnuts

The seeds grow easily. Self-sown plants can often be found under large trees. These can be transplanted to where you want to grow a tree. Or you can set up your own nursery by planting some seeds and then transplanting them when they are big enough.

Although suckers are common near the base of trees they do not grow easily.

The chestnuts

A nut is quite small. One nut weighs about 1 gm and the edible seed inside weighs about 0.5 g.



Small numbers of the nuts are eaten raw by children.

Mostly the nuts are cooked and eaten. If small amounts are available they are boiled in a container. If large quantities are available they are mumued. Cooked they taste like rice.

Cases have been reported of mouth ulcers and anaemia after people have eaten a lot of raw nuts. It is therefore safest to cook them.

Pigs like the nuts very much and in some areas such as Pangia people take their pigs out and tie them up under the trees in the bush during the nut season.



The tree as timber

Foresters call the tree Papua New Guinea oak because it is in the oak family and the timber looks like oak. It is a very valuable timber. The timber is hard and posts last a long time. People like it for house posts. The bark is used for walls, for insulation.

Coconut

The coconut palm

The coconut palm is one of the most familiar plants in the coastal regions of Papua New Guinea and the tropics. A common saying is that coconuts will not grow if they are out of sight of the sea, but they will grow reasonably well up to about 300 metres altitude.

The palm grows up to 30 metres tall and is normally unbranched. The trunk often curves towards the sunlight. They do not do well in shady and overcast areas. Coconuts in Southern Bougainville yield only very poorly because it is wet and cloudy. But coconuts also do not do well in areas with a long dry season unless they have underground water.



Coconuts need a moist atmosphere and a moderate temperature between 27°C and 32°C and a loose well-drained soil. These conditions are normally met near the coast. Coconuts do not require a salty soil but can tolerate some salt.

The flower stalk grows from the axil of the leaves and has both male and female flowers separately on the stalk. There are 20 to 40 female flowers near the base of each branch and 200 to 300 male flowers on the upper parts of each branch. Because the male flowers shed their pollen before the female flowers are open, plants are normally cross-pollinated. Wind and insects spread the pollen between palms. About 6 nuts mature on each flower stalk so that a palm produces 60 to 70 fruit each year. The green skin becomes yellow as the fruit ripen.

When the coconut is mature it is about 30 cm across and weighs about 2 kg. The nut inside is about 10-15 cm across and weighs 1.5 kg. The centre of the nut contains about 0.5 litres of sap called the coconut water. This is sweet and slightly aerated and makes a very refreshing drink. The

white layer around the seed inside the nut grows and hardens and as a nut germinates an "apple" forms inside. These can both be eaten. The dried white layer is copra that is removed, dried and sold.



Planting coconuts

It takes about 4 months for the shoot to appear. Young coconut seedlings go on feeding from the nut for a few months during their early growth. The trees need to be planted in a sunny place. They can be put in a nursery and transplanted after 6 to 12 months. Early sprouting nuts normally make the best plants.



Palms start producing nuts after about 6 to 7 years although the dwarf kinds produce earlier as do some of the newer varieties.

Pest and disease

Coconut diseases

Sooty mould	Fungi	<i>Capnodium sp</i>
		<i>Chaetothyrium sp</i>
		<i>Meliola sp</i>
Stem bleeding	Fungus	<i>Ceratocystis paradoxa</i>
Black leaf mould	Fungi	<i>Clasterosporium cocoicola</i>
	and	<i>Sporidesmium macrurum</i>
White thread blight	Fungus	<i>Corticium penicillatum</i>
Leaf spots	Fungi	<i>Bipolaris incurvata</i>
	and	<i>Pestalotiopsis palmarum</i>
		<i>Pseudoepicoccum cocos</i>
Root rot	Fungus	<i>Ganoderma lucidum</i>
	and	<i>Rigidoporus microporus</i>
Brown root rot	Fungus	<i>Phellinus noxius</i>
Bud rot	Fungus	<i>Phytophthora palmivora</i>

Basal stem rot coconut (Also called Butt rot and Ganoderma wilt)

It is due to a fungus *Ganoderma lucidum*. When coconuts get this disease the new fronds fail to open and the palm looks wilted and paler green. The older fronds then wilt and die from the tips. At the base of the palm dead spots occur with dead roots. Near the dead spot there is a bright yellow zone. The white fungal threads are visible. Bracket fungal bodies develop. The top of these has zones and a shiny appearance. Underneath is soft. The disease gets worse in dry weather because this allows the wilting to get worse. Poor drainage, heavy weed growth and poor soil fertility possibly help a little in the disease attack. The fungus is common on rotting trees. It can attack old coconut stumps. When new palms are planted near these the fungus spreads via the roots. Often the new palm does not show damage for 10-15 years. This type of fungus is common in forests on old rotting trees. Affected palms can die in 6 -12 months. It can also affect oil palm and other rotting tree stumps.

Control is by getting rid of all likely infected stumps before re-planting old plantations.

Brown root rot of coconut. This is due to the fungus *Phellinus noxius*. When coconuts get this disease, dead spots develop on the trunk. The trunk collapses. Sometimes before this occurs the leaves may turn yellow, wilt and hang down. The spots on the trunk are dark brown with dark brown zones. It mostly attacks palms over 10 years old. Palms in poor soil conditions especially low potassium get the disease more. The disease spreads by the fungal spores blowing in the wind. The disease takes 1 to 3 years before the palm is killed. It also attacks oil palm. It can attack avocado, cacao, coffee, rubber, kapok, mandarin, mangosteen, rambutan and other trees.

Control is by cutting out spots that need to be found early and then cut out. The area needs to then be treated with coal tar. Dead palms should be removed.

Bud rot coconut is due to the fungus *Phytophthora palmivora* (Butler) Butler

With this disease spots develop especially on young nuts and at the stalk end. It occurs in warm areas with a high rainfall. The fungus often occurs around the roots of coconuts and may spread from here. The disease mostly starts following damage to the young nuts. Nuts fall off early. The fungus also attacks cacao (Black pod), rubber (black stripe), pawpaw (fruit rot) and over 135 other plants.

Drechslera leaf spot of coconut is due to the fungus *Bipolaris incurvata* of which the asexual form is *Drechslera incurvata*. With this disease small spots develop on young coconuts. The spots are oval and brown but get larger and turn pale in the centre. The edges of the leaves can become dead. It gets worse when young coconuts are overcrowded or in heavy shade or have poor soil fertility. Heavy nitrogen fertiliser increases the amount of disease. It gets worse when there is dew on the leaves. The spores of the fungus blow in the wind.

Control is by increasing the spacing of plants, improving the soil fertility, making the nursery less shaded, fertilising young plants with potassium and phosphorus fertilisers and using shade cloth to reduce dew.

Grey leaf spot coconut. This disease is due to the fungus *Pestalotiopsis palmarum*. It causes small yellow brown spots to develop on the leaves. These become white to grey and have a brown edge. The spots are oval and about 1 cm long. It gets worse under poor growing conditions. This includes wet conditions, planting close together and where there is heavy shade. It often follows attack by insects. It gets worse with poor soil fertility. The fungus spores blow in the wind then grow and penetrate the upper surface of the leaf. It is mostly a problem of seedling coconuts. It also gets on Betel nut and Oil palm.

Control is not normally necessary. The disease is reduced by spacing seedlings more widely, using sprays of chemical fungicides eg Bordeaux or Zineb, using potassium fertiliser, and adding of sea water (200-1000 ml) and seaweed salt (20-100 g) to bagged seedlings to reduce the disease.

Stem bleeding of coconut can be due to a fungus *Ceratocystis paradoxa* of which the asexual stage is *Thielaviopsis paradoxa*. But stem bleeding can have other causes. With this disease a rusty brown discolouration of the bark occurs.

The disease produces a characteristic smell. The fungus has a resting stage in its cycle that allows it to survive longer when conditions are not suitable. The fungus grows well between temperatures of 25°-32°C. The fungus occurs very widely. It is spread through soil and plant remains. It causes pineapple disease of sugarcane. The fungus can attack pineapples, bananas, betel nut palms, oil palm, sweet potato, sorghum, cacao and corn. Control is by avoiding damaging the trunks of coconuts.

Coconut insect pests

Sap sucking bugs

Green coconut bug *Amblypelta cocophaga* and **Papuan tip wilt bug** *Amblypelta lutescens papuensis*. The adults are greenish brown with smoky wings and 20 mm long. They suck sap and secrete a toxic layer that causes plants to wilt and fruit to drop. The damage is probably worse when coconuts are in the bush as these insects live on other bush plants.



Coconut spathe bug *Axiagastus cambelli*. These insects are dark brown with yellow marks and 13 mm long by 7 mm wide. They give off a bad smell when disturbed. They feed on the male flowers of coconuts causing them to turn brown but nuts do not normally fall. It is mostly on the islands. It is controlled by other insects.



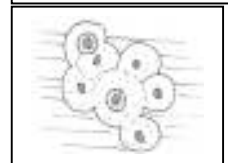
Coconut white fly *Aleurodicus destructor*. This insect produces long coiled wax threads that form a woolly covering on the underside of infected leaves. The damage is probably slight but nuts can fall early.

Coconut leafhopper *Zophiuma lobulata*. This lophopid treehopper or bug injects a toxin and can cause serious nut fall of coconuts in the Finschhafen and Popondetta areas. It has egg parasites that help control the pest. Adults and nymphs are present on palms.



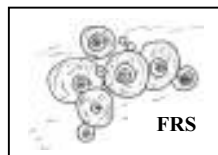
Scales and mealy bugs

Coconut scale *Aspidiotus destructor*. This yellow insect has a clear round scale over its body which makes it look like bumps on the leaves. They tend to be along the veins on the undersurface of the leaves and they suck sap. The leaves turn yellow. Damage can be bad until suitable predators are introduced into an area.



Soft brown scale *Coccus hesperidum*. These flat brown scale insects are about 3-4 mm across and occur on a number of trees. These insects tend to cause sooty moulds to grow on the secretions from the insect.

Florida red scale *Chrysomphalus aonidum*.
Pineapple mealy bug *Dysmicoccus brevipes*.
Pink wax scale *Ceroplastes rubens*.



Moths and butterflies

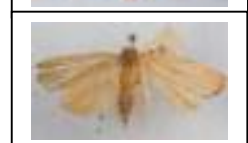
Banana skipper *Erionota thrax*. The larvae of this case building caterpillar chew the edges of leaves then use them to build its case. Drought probably helps outbreaks of this pest and damage can occur in the Markham Valley. It also attacks bananas.



Coconut cup moth *Thosea sinensis*. The larvae of this moth cause extensive damage to young coconuts in the Central Province. The larvae are green or grey with a stripe along the back and coloured spots on the side.



Coconut spathe moth *Tirathaba rufivena* & *Tirathaba ignivena*. These small light brown coloured moths have larvae that feed on newly opened coconut buds. They cause nuts to fall. The larvae bore into male flowers causing them to become webbed together. Some parasites and predators help control. Populations of crazy ants can make the nut fall more serious.



Lesser Coconut spike moth *Batrachedra arenosella*. The larvae chew male and female flowers and can cause slight damage.



Coconut skipper *Cephrenes mosleyi*.



Beetles and weevils

Asiatic rhinoceros beetle *Oryctes rhinoceros* is about 35 to 50 mm long and the adult male has a horn that curves backwards. They mostly fly at night to the crowns of palms. The creamy white curl grub is 60 mm long and the whole life cycle for the insect takes 5 to 9 months. These beetles also attack pandanus, sago nipa and oil palms as well as bananas. They can kill young palms by boring into the crown of the palm. But they also allow the palm weevil to get access to the palm through the hole they make. The insect only occurs on the islands, but is bad in the Gazelle peninsula. The main control is by getting rid of breeding places. The beetles can be collected and killed. A virus disease has been introduced to help control this pest.



Cane weevil borer *Rhabdoscelus obscurus* is mainly a pest of sugarcane but can bore into coconut palms.



Coconut bole weevil *Sparganobasis subcruciatus* attacks the lower parts of coconut palms and palms eventually fall over. They lay their eggs in the trunk of the palm about 25 cm from the ground.



Coconut hispids *Brontispa longissima*; *Brontispa palmivora* and *Brontispa simmondsi*, are small orange and black beetles 10 mm long and 4 mm wide. They lay their eggs between tightly folded young leaves and the larvae feed inside these leaves. They can severely damage young coconut palms. The adult chews narrow stripes in the leaf. The main problem is in nurseries.



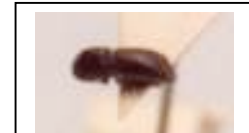
Coconut leaf miner *Promecotheca papuana* is a golden brown colour with a blue tip. It is about 8 mm long and the insect passes its life cycle in the crown of coconuts. It is normally only a problem on Manus and New Britain where the adults chew the leaves of mature palms. It can take a palm up to 2 years to begin producing nuts again. Some other insects including kurukum ants help control.



Elephant beetle *Dynastes gideon*. This insect is distinctive because of the long horn on the male. They live on the underneath surface of the coconut frond and damage young leaves.



Island pinhole borer *Xyleborus exiguus*; *Xyleborus perforans*, coconut shot-hole borer. These bark beetles damage the trunk and allow other diseases and insects to get into the trunks. The adult beetles are small about 2 mm long and reddish.



Lesser coconut borer *Diocalandra taitense*. The larvae of this weevil can cause some damage to coconuts but mostly only where other insect damage has already occurred. [Possibly also *Diocalandra frumenti* (F.)]



New Guinea Rhinoceros beetle *Scapanes australis grossepunctatus* and *Scapanes australis australis*. These are large beetles with a horn of their heads. Males have two horns on the thorax. These beetles occur on the coast and up to about 900 metres altitude. The adults attack young coconut palms and they can kill the palms. They are controlled by removing the adults by hand removing decaying logs that are the breeding sites and by growing cover crops through the plantation.



Palm weevils *Rhynchophorus bilineatus* - black palm weevil & *Rhynchophorus ferrugineus* - red palm weevil. The adult weevils are about 40 mm long with a long snout. They fly in the morning and evening making a buzzing sound. They are probably the most damaging pests of young coconuts. They gain entry into the palm through cuts or damage by other insects. They can also attack young leaves causing them to drop off. To control



them it is important to avoid damaging coconut palms and to seal off damage holes. Fronds should be cut off, not pulled off.

Taro beetles *Papuana spp.* These beetles are common in taro gardens. They are about 15 to 25 mm long and the white curl grubs feed on plant roots. These beetles can dig well and damage the roots of young palms. They are hard to control.



Other beetles and weevils

Ischiosophia ignatipennis Boisd.

Cetoniidae (COL)

Lophotectes penicilliger (Heller)

Curculionidae (COL)

Meredolus cocotis Marshall

Curculionidae (COL)

Oryctes centaurus Sternb

Scarabaeidae (COL)

Reported damaging coconuts.

Pseudoligota sp

Staphylinidae (COL)

On male flower of betel nut palm. On male flower coconut.

Trichogomphus excavatus Mohinke

Scarabaeidae (COL)

Moderate damage to coconut fronds.

Trichogomphus semmelinki Rits

Scarabaeidae (COL)

Rhinoceros beetle

Reported damaging coconuts.



Grasshoppers

Coconut tree-hoppers *Eumossula gracilis* and *Segestidea spp.* These longhorn grasshoppers damage the leaves and crowns of coconuts especially where there is no long dry season. The green tree ant is a deterrent, and some other insects also attack these pests.

Oxya japonica (Thnb.)

Acrididae (ORTH)

Also occur on rice, maize, coconuts, cacao, coffee and cotton.

Psammoecus sp.

Silvanidae (COL)

In old coconut leaf mine.



Termites

Microtermes biroi Desneaux

Rhinotermitidae (ISOP)

Building runways on trunk coconuts. See DAL Entomology Bulletin No 47

Galip nuts

Scientific name: *Canarium indicum*

Names

In Tok Pisin the word "galip" can be used in several different ways. It has both a general and then also a specific meaning. It can be used very widely to include many nuts such as peanuts, pao nuts, and several other nuts from trees. As the word "galip" was originally a Tolai word from the Kuanua language this is the way it is being used in this article. Tolais used "galip" for the nuts of a particular tree that is also called the Canarium almond in English.



Scientists give every plant a scientific name in the Latin language, then it is the same for all scientists of the world, no matter what language they speak. The name scientists have given to this plant is *Canarium indicum*. It was given this name by a man called Linnaeus as long ago as 1759. Unfortunately early scientists mixed up two similar nut trees and so the scientific names have also got mixed up and are often used incorrectly. The correct name for the common galip in Papua New Guinea is *Canarium indicum* L. A similar, but different, nut tree grown in Malaysia and in Pacific Island countries such as Fiji, is called *Canarium vulgare* Leenhauts. A name that has been used incorrectly for both these plants is *Canarium commune* L and this name should no longer be used.

The way to tell the difference between these 2 plants is by looking at a leafy type of growth (called a stipule) that occurs near where the leaf stalk joins the branch. In the PNG galip (*Canarium indicum*) this leafy part stays on the stalk and around the edge of it, there are teeth like a saw. In the Pacific tree (*Canarium vulgare*) this leafy stipule has a smooth edge and also tends to drop off the tree quickly.



Within the *Canarium* genus or group, there are several different plant species that produce edible nuts. The ones that occur in Papua New Guinea and have nuts that are eaten are listed below.

Canarium indicum L - Common galip or galip tru

Canarium solomonense Burt

Canarium kaniense Laut

Canarium schlechteri Laut.

There is also probably a species in the Western Province of which the flesh is eaten, after cooking, like the Chinese olives (*Canarium album*).

It is interesting that such a large and important group of food plants has not been studied and improved by agriculturalists.

This group of plants called *Canarium* were given this part of their name after a Malayan word "kanari" which was used for these plants. There are about 100 different species of plants belonging to this group called *Canarium*. All of these plants originally occurred only in a few countries of the world, mostly in the Asia and Pacific area.

The area is shown on this map drawn by a botanist called Leenhauts who has made a special study of these plants. A few of these plants also occur in Africa.

Map showing where *Canarium* nuts occur

The next table is of the different scientific names of the edible *Canarium* plants known from other countries.

<i>Canarium album</i> Raeusch	<i>Canarium amboinensis</i> Hochr.
<i>Canarium australasicum</i>	<i>Canarium bengalense</i> Roxb.
<i>Canarium decumanum</i> Gaertn.	<i>Canarium denticulatum</i> Blume
<i>Canarium grandiflorum</i> Benn	<i>Canarium littorale</i> Blume
<i>Canarium luzonicum</i> A Gray	<i>Canarium megalanthum</i> Merr.
<i>Canarium muelleri</i>	<i>Canarium nigrum</i> Engl.
<i>Canarium nitidum</i> Benn	<i>Canarium odontophyllum</i> Miqu.
<i>Canarium oleosum</i> (Lamk.) Engl.	<i>Canarium ovatum</i> Engl.
<i>Canarium patentinervium</i> Miqu.	<i>Canarium polyphyllum</i> K.Schum.
<i>Canarium pseudo-decumanum</i> Hochr.	<i>Canarium purpurascens</i> Benn.
<i>Canarium rufum</i> Benn.	<i>Canarium samoense</i> Engl.
<i>Canarium schweinfurthii</i> Engl.	<i>Canarium secundum</i> Benn
<i>Canarium strictum</i> Roxb.	<i>Canarium sylvestris</i> Gaertn.
<i>Canarium vulgare</i> Leenh.	<i>Canarium williamsii</i> C.B.Rob.
<i>Canarium zeylanicum</i> Blume	<i>Canarium harveyi</i>

What is a galip nut tree like?

It is a large tree often up to 40 m high. The stems are often twisted or rough and there are usually buttresses at the base of the tree.

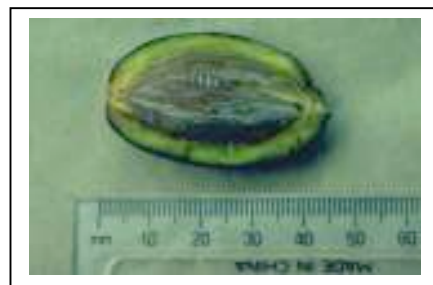
The small branches are more or less powdery. If a small branch is cut crossways and looked at very carefully, small round vascular strands can be seen in the pith or centre mass of cells. (This is different to most woody trees where these are in a more or less continuous circle around the edge of the branch).

The leaf of a galip tree is made up of 3 to 7 pairs of leaflets. The leaves do not have hairs on them. The leaflets are oblong and can be 7 to 28 cm long and 3 to 11 cm wide.



At the base of a leaf where the stalk joins the branch there is a special leaf like structure that is important for helping to identify the PNG galip tree. This leafy structure is called a stipule and it is large and has saw like teeth around the edge. (Another PNG *Canarium* nut (*Canarium kaniense*) also has a similar large stipule.)

The flowers are mostly produced at the end of the branches. A group of flowers are produced on the one stalk. The flowers are separately male and female. The male flowers have 6 anthers or pollen containers in a ring. In the female flower these 6 stamens are improperly developed (staminodes) around a 3-celled ovary.



The galip fruit has 3 cells (sometimes 4) but mostly only one cell is fertile so that 2 of the cells are empty, and one has a kernel.

Where do galip nuts grow?

The galip (*Canarium indicum*) grows in coastal areas, and is most common in the islands such as North Solomons Province, New Britain and New Ireland. It also occurs naturally in the Solomon Islands, Vanuatu and Guam. It occurs on the New Guinea mainland and Irian Jaya as well as in Maluku in Indonesia. It has been taken to some other countries to grow.

Galip nuts are common in the lowland rainforest.
They mostly grow from sea level up to about 300 m altitude.

How do you grow galip nut trees?

Many of the galip nuts take several months for the seeds to start to grow. As well, the seeds normally should not be buried under the ground, but should be just near the surface of the ground. Care is needed to see that the seeds and seedlings do not dry out.

As the seed grows or germinates, a well-defined cap is split off the nut.

Trees grow fairly quickly.



Varieties of galip nuts?

Not all galip nuts are the same. People on the St Matthias group of islands off New Ireland recognise 7 different kinds. These include the most common pale coloured galip but also one with a reddish black seed, one with a larger kernel, one with a small kernel, one with a round fruit and one with a thin walled nut. This sort of variation is important for plant breeders who want to improve the kinds that are grown.

Pest and disease

Disease

Heart rot	Fungus	<i>Phellinus noxius</i>
-----------	--------	-------------------------

Insect pests of Galip

<i>Ectatorhinus magicus</i> Gerstaecker	Curculionidae (COL)	Weevil boring into trunk of galip
<i>Pinnaspis buxi</i> (Bouche)	Diaspididae (HEM)	
<i>Coccus hesperidum</i> Linnaeus	Coccidae (HEM)	
<i>Planococcus pacificus</i> Cox	Pseudococcidae (HEM)	Mealy bug
<i>Pseudococcus solomonensis</i> Williams	Pseudococcidae (HEM)	Mealy bug

Finschia nuts

Scientific names: *Finschia chloroxantha*
Finschia ferruginiflora
Finschia rufa

The tree and nuts

These three different nut trees occur in the several areas of Papua New Guinea with especially *Finschia ferruginiflora* near Kainantu but the others are important in several areas. They are related to the more famous macadamia nuts that have been introduced and are now being grown in some areas of Papua New Guinea.

The trees can be up to 24 metres tall and often they have buttresses near the base and they can have stilt roots. In many areas the trees grow naturally in the forest, but in some areas the trees are planted and the nuts regarded more importantly.

The leaves are often clustered near the ends of branches so that the tree does not have a dense covering of leaves. The leaves can be 25 cm by 10 cm in size and have a vein around the edge joining the other leaf veins. The flowers occur in a long cluster up to 30 cm long and are bright orange in colour. They hang below the leaves and on the older wood. The flowers have both male and female parts in the same flower. The fruit are round and 2.5 cm by 3 cm across and brown. They have a sharp point on one side. The outside of the fruit is soft but there is a hard shell inside with one large edible seed.



The trees occur from the lowlands up to about 1800 metres altitude and can occur in swamp forest but not where the soil is covered with water. Because this tree is regarded as a valuable nut the tree is rarely cut down but the timber is a good hard and attractive timber.

The nuts have a very hard shell but this is removed by cooking. The kernel of the nut is then removed and eaten. This nut is used in Vanuatu, Solomon Islands and Papua New Guinea as well as in Micronesia. Trees flower from December to March and nuts are available from March to August.

	Tree	Leaves	Flowers	Fruit
<i>Finschia ferruginiflora</i>	30 m	18 x 5 cm smooth	Brown Very hairy	5 cm round
<i>Finschia chloroxantha</i>	5-25 m tall	40 x 12 cm smooth	Orange-yellow Almost smooth	4 cm flat on one side
<i>Finschia rufa</i>	15-18 m tall	30 x 12 cm	Yellow-brown Reddish & hairy 40 cm long	

Names.

These trees have been given several different scientific names during the time scientists were getting to know them and work out how they are related to other trees. These names include:

For *Finschia chloroxantha*

Helicia micronesica Kanehira
Finschia micronesica (Kanehira) Kanehira
Grevillea densiflora C T White
Finschia densiflora White
Finschia elaeocarpifolia Gillaum
Grevillea micronesica Sleum
and others

The confusion over names comes from the fact that these trees have flowers like *Grevillea* trees and fruit like *Helicia* trees.

These trees are in the plant family Proteaceae and most of the trees in this family occur in Australia and South Africa. Very commonly the trees will grow well in hot dry climates.

Pest and disease

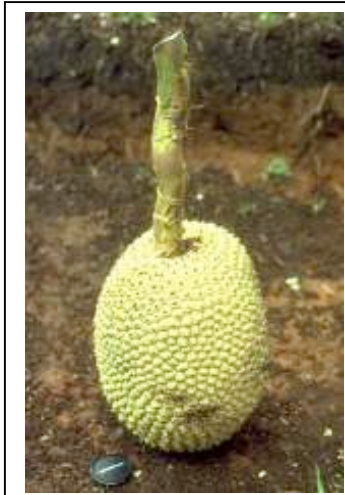
These have not really been studied for these nuts. It is not known if the pest and diseases that damage macadamia nuts also damage these trees.

Diseases

Black mould	Fungus	<i>Chaetothyrium fusisporium</i>
Rust	Fungus	<i>Puccinia finschiae</i>
Black leaf mould	Fungus	<i>Stenella sp.</i>



Karuka or pandanus family



Karuka
Pandanus julianettii



Wild karuka
Pandanus brosimos



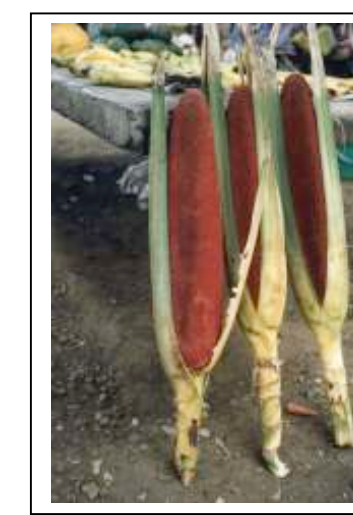
Pandanus antaresensis



Pandanus conicus



Coastal pandanus
Pandanus tectorius



Marita
Pandanus conoideus

Karuka

Tok Pisin: Karuka

Scientific name: *Pandanus jiulianettii*

Two species of pandanus are commonly used for the nuts that are eaten. They are karuka (*Pandanus jiulianettii* Martelli) and wild karuka (*Pandanus brosimos* Merr & Perry). At least 3 other species of pandanus are used occasionally in Papua New Guinea for edible nuts and marita pandanus is used for the long red fruits. The leaves of many other pandanus species are used for rain capes, sleeping mats, canoe sails etc.

This article is about cultivated karuka.

The karuka plant

The karuka tree is a tall palm like tree with a straight trunk and aerial prop roots at the base. Sometimes it branches near the top to produce 3 or 4 crowns of leaves.

The leaves grow in pairs opposite each other and they are twisted to look like a spiral going up the trunk. The leaves are long (3 m), narrow, have spikes along the edges and are often bent at the tips.

The fruit is a round composite fruit 15 to 30 cm across which is made up of about 1,000 individual keys which contain the nut which is eaten.

Karuka trees have male and female flowers separately on separate trees. Male trees produce a white flower but no fruit. They are not very common.



Where does karuka grow?

Karuka grows in several highland provinces of Papua New Guinea. It mainly grows at altitudes between 1800 metres and 2500 metres above sea level. Outside this range it often does not grow well.

Karuka is only grown in Papua New Guinea.

Within these areas, karuka has a special place where it grows best. Karuka needs fairly good soil fertility so it does best along the banks of small creeks, in the natural hollows that occur around the edges of hills, and around the edges of small clearings in the bush. Lots of karuka are seen out on knobs in the grassland but often these only bear small nuts.

Some areas produce good karukas, while karuka grows poorly in other places. In some places karukas are grown in lines as boundary markers between garden plots.

The karuka fruit and nut

One crown of leaves on the one branch of a karuka tree normally only produces one cluster of nuts (called a syncarp) during the one season. In fact, that particular branch normally only produces one bunch every second year.

On a branch that is about to bear fruit, the leaves are upright and clumped slightly together. The fruit bunch emerges from the centre of these leaves. It hangs close to the trunk amongst the dead hanging leaves. Large leaves (bracts) almost cover the fruit bunch while it hangs there.

A fruit bunch hanging down from between the leaves and covered by dry brown leaves.



While the fruit is being produced, the tree stops producing new leaves. A new sprout of leaves eventually shoots up in the centre of the clump and this is normally taken as a sign that the nuts are ready to harvest. The whole bunch is normally cut down with a bush knife. Often the tree has to be climbed to do this.



The outside layer of the fruit is burnt off, in a fire. This allows the bristly ends of the individual keys to be seen.



**A portion of the surface
after the skin has been
burnt off**

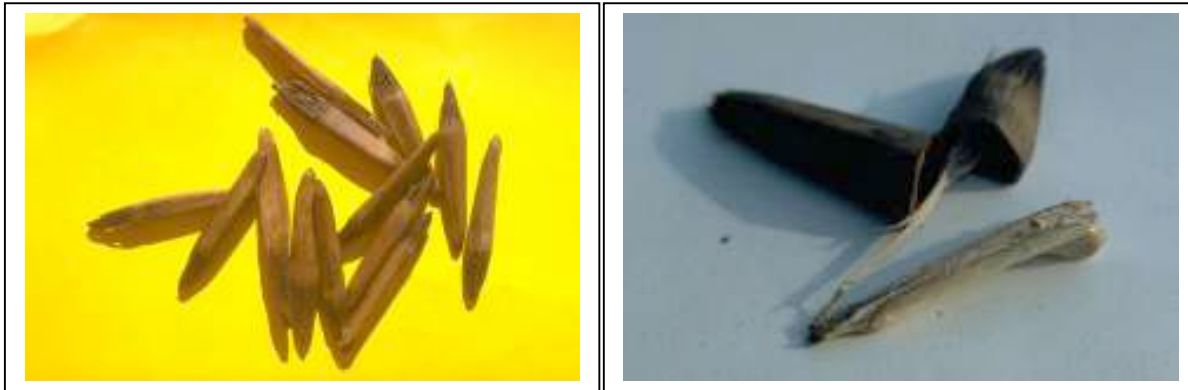


**The honeycomb
looking spongy
central portion
that can be eaten.**

In the centre of the bunch is the stalk. This is surrounded by a spongy type material into which the ends of the individual nuts are inserted. This spongy layer (the mesocarp) has an appearance like honeycomb, when it is separated from the nuts. It can be cooked and eaten.

The individual keys or nuts can then be separated and broken open to get out the kernel that is eaten.

A single shell and kernel looks like this:



How do you plant karuka?

There are some different ways of planting karuka.

One of the common ways is to cut the top section off one branch of a mature tree that has several branches. When planted in moist fertile soil it quickly develops roots and becomes established. This method has two advantages. You can be sure that the new tree will be exactly the same as the old one because it is vegetative propagation. Also old trees with a number of branches tend to have smaller clusters of fruit because the fruit are competing on the same plant for their requirements.

Sometimes karukas develop young suckers or shoots near the ground. When these are seen, they are broken off and replanted.

Karuka can be grown from seeds. It is best to wait till the nuts are fully ripe and start falling naturally from the tree. These nuts are taken and planted while fresh. They are planted in the shell with the bristles uppermost.

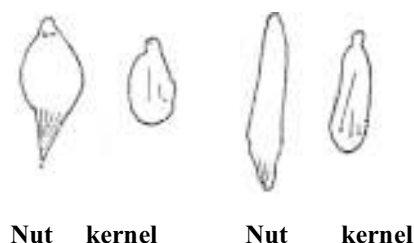
Normally the seeds are established in a nursery and then transplanted to their permanent sites a few months later. Karukas can start to produce nuts 5 or 6 years after planting. They can keep producing for probably 50 years.

To produce good-sized nuts the karuka plantation needs to be kept free of weeds.

Varieties

There are many varieties of karuka. Up to 20 varieties are maintained by some growers. One farmer near Paip in the Mendi Valley knew 35 varieties.

One of the most noticeable things that varies is the shape of the nut and kernel. Two kinds are drawn below.



Most varieties are roasted before eating but one or two varieties are eaten uncooked. All varieties can be mumued. All varieties can be smoked and stored.

All varieties tend to fruit at the same time but some kinds get ready to harvest more quickly than others.

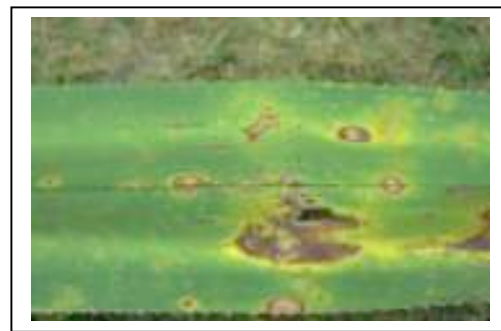
Varieties differ in their height, number of branches, thickness of the shell of the nut, and a little bit in their general appearance and colour of leaves and bark.

Pests and Diseases

Karuka have some pest and disease problems.

At least 4 different kinds of fungal diseases can be seen damaging the leaves. There is a sooty mould that makes irregular black patches over the surface of the leaf. It is really only growing on the rubbish left on the leaf surface by small insects. Another black leaf mould grows in thin straight streaks along the middle of the leaves. It only seems to grow on some varieties and village people seem to use it as one indicator to help them recognise the different varieties. These two diseases probably do not cause too much trouble.

There are also two yellowish leaf spots, one clear and sharp and the other faint and irregular that can commonly be seen on the leaves. They seem to vary both with variety and time of the year.



One of the serious insect pests of karuka are longhorn grasshoppers.



A longhorn grasshopper

These grasshoppers climb the trees and chew the leaves. Damage can be severe and by eating out the growing point of the tree they can actually kill the tree. Similar longhorn grasshoppers damage coconuts on the coast.

Village people try to reduce the damage by pushing grass and leaves in between the leaves near the crown to stop the insects getting in.

The grasshoppers lay eggs in the grass and rubbish near the base of the tree. In coconut plantations clearing around the bottom of the tree then spraying, is used. Control of these insects in karuka has not been studied.

A large black grub also damages karuka by burrowing into the bunch of fruit and causing it to fall before the bunch is ripe. It eats the spongy layer and the fruit goes black outside.

Occasionally wood boring grubs burrow into the aerial prop roots of karuka.

A fungal disease has also been recorded growing on karuka nuts.

Diseases

Black leaf mould	Fungus	<i>Lembosia pandani</i> (Rostr.) Thiess
Sooty mould	Fungus	<i>Meliola juttingii</i> Hansf.
Leaf spot		
Diffuse leaf spot		
Fungus on seeds		<i>Macrophoma pandani</i> Berk & Vogl

Insects

Longhorn grasshoppers		<i>Segetes gracilis</i>
		<i>Segistidea montana</i>
Cockroaches		<i>Periplanata americana</i> (L.)
Caterpillar		
Wood borer		

Possums are another problem with karuka. People build platforms up the trunk of the tree to stop possums climbing up.



A framework to stop possums

For karuka nuts stored in houses, rats and cockroaches are the two main problems. These can be controlled by hanging the nuts in the smoky areas above the fire. But if nuts are left too long in this position they start to develop a smoky taste that is not liked.

Storing and using karuka.

Karuka nuts can be harvested before they are fully ripe by climbing the tree and cutting the whole bunch. When this is done, the fruit bunch is cut in half the central pink portion cooked and eaten and the two halves with the outside skin burnt off can be stored in a platform above the fire. These halves can be mumued with hot stones and the nuts eaten.

Two varieties at least can be eaten fresh without cooking.

The whole fruit bunch can, if desired be stored in damp waterlogged ground for a few months if there are too many fruit to use at the one time. These fruit are collected again and cooked and used as if they had just been harvested.

Particularly for nuts harvested ripe there are two ways to use them. They can be eaten fresh after cooking. Or they can be dried and stored and eaten later without cooking. When the nuts are harvested ripe the individual nuts are pulled out from the central honeycomb looking spongy material. This central piece can be boiled if only a few are available, or mumued if a lot are available. It is then eaten. The individual nuts can be roasted by tying them along a stick and holding them over a fire. If they are to be stored they are sun dried. To dry the nuts they are put out daily in the sun and taken into the house at night. After they are dry they can either be stored in the shell for about 6 months or if it is wanted to store them for 1 or 2 years, they are normally shelled and only the kernels stored. These can be stored by filling up a bamboo, or by making a container of leaves.



Sometimes karuka nuts that have been harvested ripe are stored for up to 6 months by putting the individual nuts in the ground, separated and surrounded by soil. When they are taken out they taste like fresh nuts.

Karuka as food

In 100 g of the part eaten there are the following amounts of different nutrients.

	Moisture %	Energy cals	Protein g	Calcium mg	Iron mg	proVitA µg	provitC mg
Kernels	9	540-700	11.9-14.1	419			
Centre		8.5 dry wt					

This means karuka are good quality food.

Amount of food produced

An average karuka fruit can be about 6 kg weight. It is about 25 cm high and 20 cm across. It contains about 1000 separate nuts. After burning off the outside and removing the stalk, the weight is about 5 kg. A single kernel weighs about 0.5 g. The weight of edible kernels in a fruit is about 8% of the total fresh weight or about 0.5 kg.

Season

Karuka is seasonal. The season is often about February but it may vary from December to May. Sometimes there is a second small season about July. Often trees only bear a good crop every second year. Normally any individual branch of a tree only has a bunch of fruit every second year. If it does have two bunches two years in a row, the bunches are usually small.

Wild karuka

Tok Pisin: Karuka

Scientific name: *Pandanus brosimos*

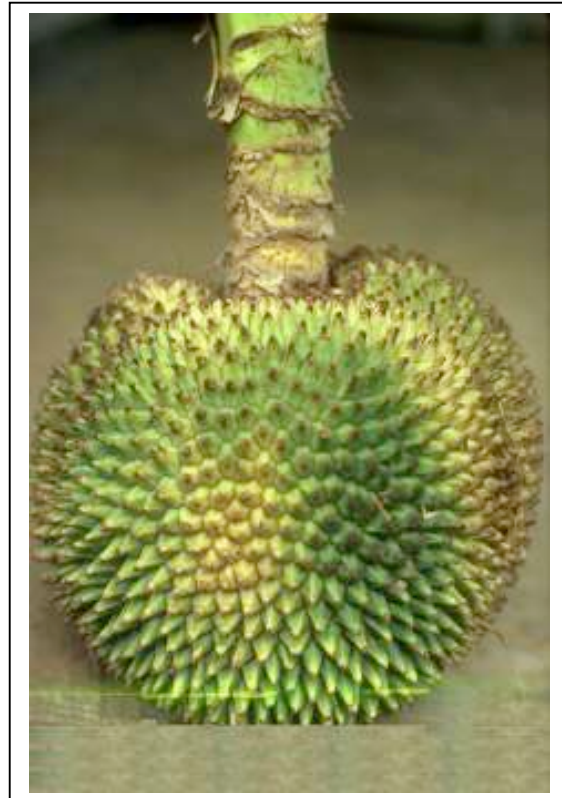
The wild Karuka plant

The wild karuka plant looks a lot like the cultivated karuka. The leaves are bigger and normally they point straight up instead of bending over at the top.

The trunk of the tree is straight like a palm but it can have some branches near the top. The leaves are long and have thorns along the edge. Dead leaves normally hang down around the top of the tree.

The fruit is a round cluster of nuts. The ends of the individual nuts come to a sharper point than in cultivated karuka. The shell of the nuts is very hard.

Different varieties of wild karuka are recognised. These have different shaped nuts. Other small differences are also noticed by village growers.



Sometimes another pandanus that grows in grasslands and bush in the highlands is also called wild karuka. This pandanus has much larger individual nuts. It has the scientific name *Pandanus antaresensis* and is described in a separate article.

Where does wild karuka grow?

Wild karuka (and cultivated karuka) only grows in Papua New Guinea. Wild karuka only grows in the high mountain areas although sometimes people transplant an occasional tree down to lower places where they have their gardens.

It grows between 2500 and 3100 metres altitude above sea level.

In the Southern Highland Province wild karuka can be seen growing beside the roads that go to Tambul, Kandep and through the Tari gap. It is also in the bush in other high mountain bush places but you have to walk in to see it.

Often plants are just scattered singly through the bush.

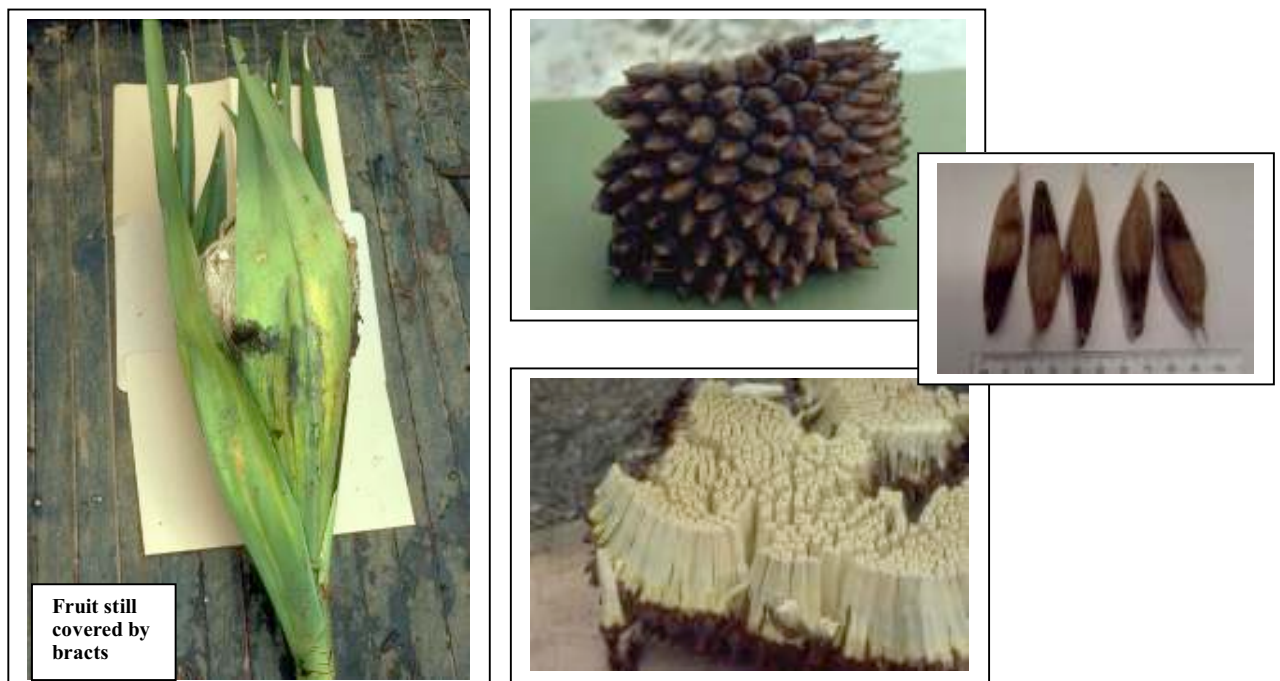
Who owns the wild karuka?

Normally the wild karuka belongs to the clan on whose land it is growing. Different clans have different areas of wild karuka. The pattern may vary in different places but the commonest method of looking after wild karuka in the SHP is: The clan own the karuka. Individual people within the clan are given permission to look after different sections or trees. These people clear the bush near the base of the tree and build traps to stop tree kangaroos. When the tree bears fruit, the person who has been looking after that tree is allowed to share out that fruit with the other people in his clan. At karuka nut time often lots of friends come from other places to eat karuka.

What does the fruit look like?

As a wild karuka plant is getting ready to produce a bunch of nuts the leaves at the top of the tree go tightly together and stick straight up. Then the top of the leaves become a red colour (With cultivated karuka the top of the leaves change to a white colour.)

The round clump of nuts grows out of the top of the tree amongst the leaves then falls over to hang near the trunk amongst the dead leaves. The fruit has green leaf like bracts over it. If these green bracts are taken off, the clump of nuts that make up the fruit look like this next picture.



Harvesting karuka

Sometimes the wild karuka fruit is not harvested by climbing but the nuts are allowed to fall. At least when the first few nuts start to fall people know the karuka is ready for harvesting. The shells of wild karuka nuts are very hard. They are broken with a stone or axe. Sometimes the nuts are buried in the ground to let the shells soften before breaking them open to eat the kernel.

During the wild karuka season families often go to the bush and take their pigs. They build temporary houses from the leaves of karuka and stay in the bush living off karuka nuts and wild animals.

The inside of a wild karuka is very similar to a cultivated karuka. The soft spongy layer around the nuts between the stalk and the nuts can also be eaten. The wild karuka nut looks much like a cultivated karuka nut except that the outside is a little bit rougher with fibres and the end with the fibrous hairs is longer and has a sharper point.



Surface of fruit



nut

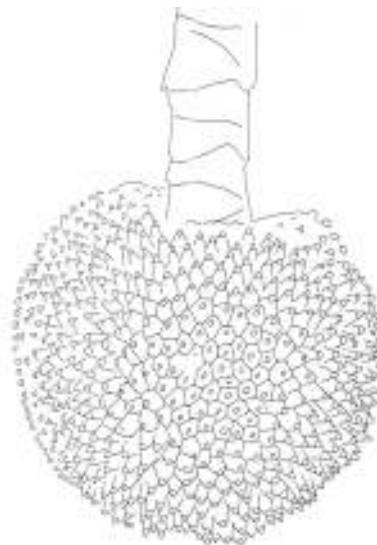
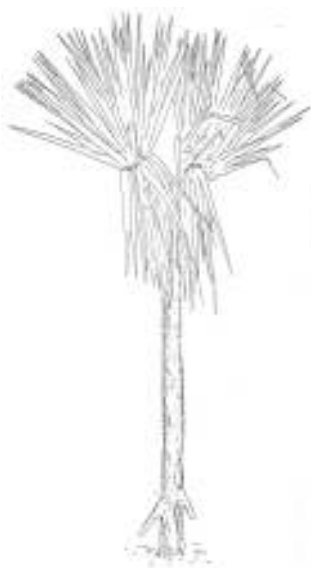
The wild karuka season

It is not easy to say when the wild karuka season occurs. It is possible to have a good season for cultivated karuka and yet in the same area to have a poor season for wild karuka. All places do not have a good wild karuka season in the same year. But the probable pattern is that the season is either at Christmas or mid year or it can occur at both times. Also trees probably only have a clump of fruit every two years.

Pests and diseases

Wild karuka does not seem to get many leaf spots even when it is planted next to a cultivated karuka which has many disease leaf spots. Other diseases of wild karuka seem very rare but because the plants are scattered and spread around in the bush, it may be that trees simply avoid the diseases.

Tree kangaroos are a problem with wild karuka the same as they are with cultivated karuka. People build similar traps to stop them climbing the trees.



Pandanus antaresensis

(Scientific name)

No common Tok Pisin or English name.

Tok ples names:

Mendi: - pem, pembras

Imbongu: - kupili

The plant

This pandanus grows naturally between about 1600 and 2500 metres altitude in the highlands.

It often grows in swampy places.

Most trees have a number of widely spaced branches. At the top of these there is normally a shoot of leaves making a point which points upwards.

The leaves are often a light green. They have thorns along the edge, although the thorns are normally less about the middle of the leaf.

The cluster of nuts hangs down below the leaves on a long stalk.

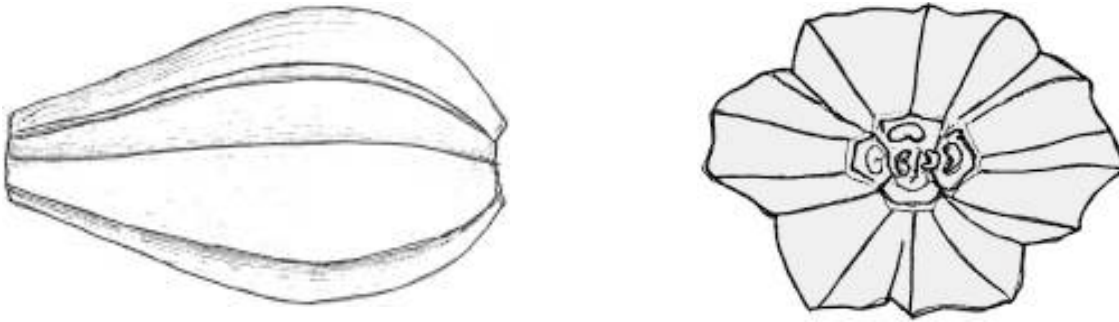


The pandanus fruit

The fruit of this tree is made up of clusters of nuts grouped together in groups of 4 or 5 nuts. Together they make up a round knobbed cluster about 30 cm across.

As the fruit matures the cluster turns an orange colour and the small groups of nuts fall, one by one.

An individual group of nuts that fall down look like this.



As the nuts dry out, lots of hairy looking fibres can be seen. The shell is hard and must be broken with an axe or a stone. The nut inside is small.

Because the shell is hard and the nut small some people don't eat these nuts at all. Other people only eat them sometimes. But some people plant these pandanus near their gardens and like the nuts.

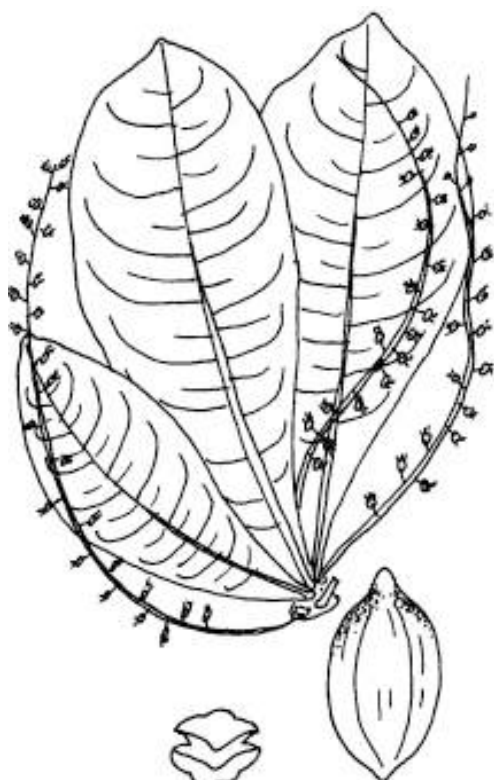
The Okari nut family



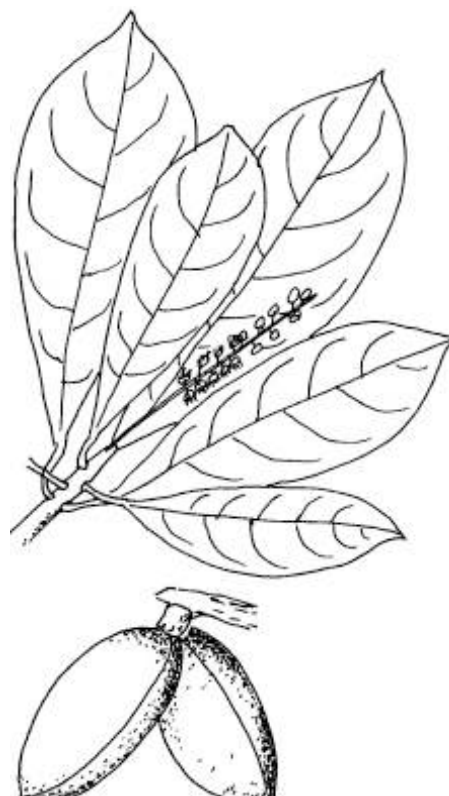
Terminalia catappa



Terminalia impediens



Terminalia copelandii



Terminalia kaernbachii

Okari

Tok Pisin: Okari

Scientific name: *Terminalia kaernbachii*

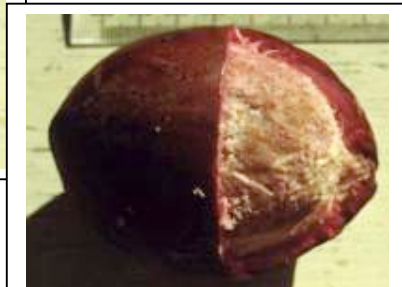
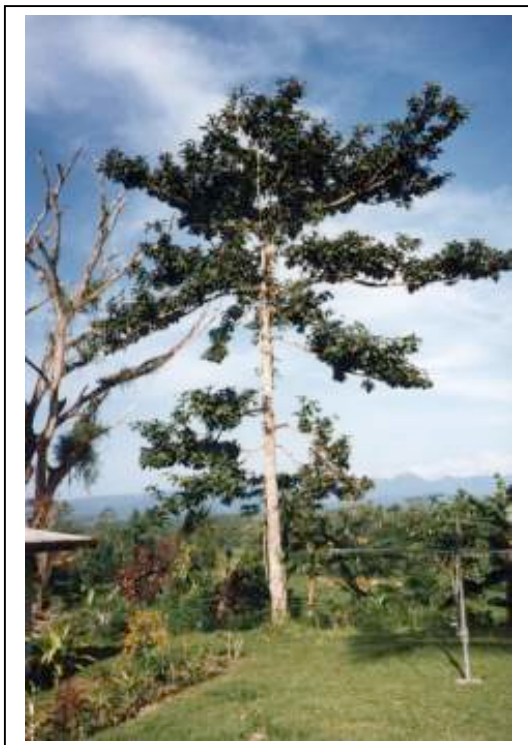
The okari nut tree

This tree grows up to 40 m tall. The tree has distinctive type of branching where branches come out in several "layers" along the trunk. The branches also have short thick twigs along them and the leaves tend to be in clusters near the ends of branches. The leaves are large (25 cm x 15 cm) and have reddish brown hairs underneath.

At the ends of the branches the tree produces a long flower shoot and the fruits develop on it. A number of fruits can grow on the end of the one twig.

The fruits are flattened and green when young. As they ripen they change to a red colour.

Inside the fruit is a hard shell and the kernel is inside this shell. It is this kernel or nut that is eaten.



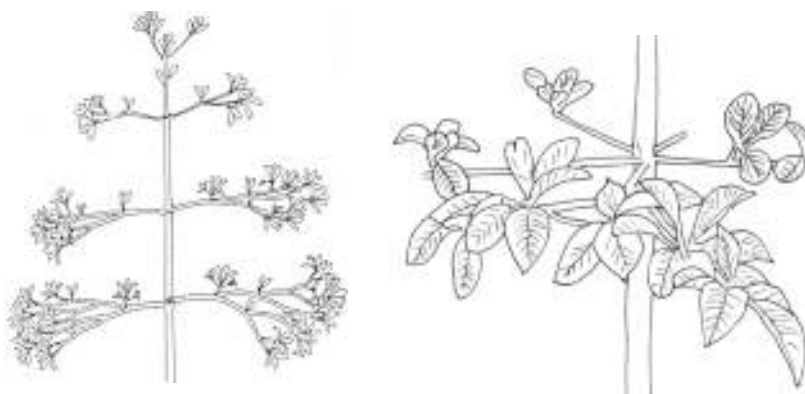
Where do okari nuts grow?

The okari nut tree grows in the lower areas below about 800 metres altitude. Some trees growing near Erave (1100 m) only have a few fruit on them although the trees grow well. The best yield of nuts comes from the lower areas.

Other trees like Okari

Several trees with the name Terminalia are used in Papua New Guinea for edible nuts. These include the Java almond and Talis. All these trees have the same distinctive type of branching. The branches come out in layers and they have thick twigs that come out at right angles.

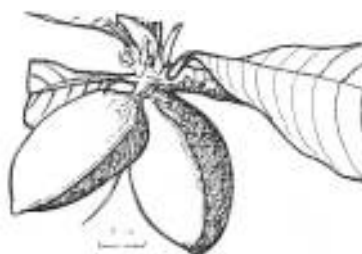
A diagram of the type of branching of trees called Terminalia. Okari and some other nut trees like it have this type of branching.



What is an Okari fruit and nut like?

The okari fruit is a green, slightly flattened fruit that becomes dark red when ripe. The outside layer is soft and fleshy.

Two young green fruits on a twig.



A mature fruit can be up to 20 cm long and 10 cm wide. It is oval in shape and slightly flattened.

A ripe red okari nut fruit.



This fruit is split open with an axe to reveal the kernel that is inside the hard shell. The shell has ridges and holes in it.

A fruit, shell and kernel



It is the kernel inside the shell that is eaten. The kernel can be 7-8 cm long and 3-4 cm wide.

The kernel is made up of coiled leaves that make up the seed. A kernel can weigh up to 10 grams in weight. These are eaten either raw or after a slight roasting.

Growing trees and producing nuts

Okari nut trees are normally grown from seeds. The trees grow very fast and they can increase in height by up to 2 metres in one year. But trees need to be fairly old before they produce many nuts. Twenty year old trees often only produce a few nuts.

Pest problems

Not a lot of insect or disease problems have been recorded on okari nut trees, but these may not have been well looked at.

Trees can get a leaf spot due to a fungus.

They can also get sooty mould fungus growing over the surface of the leaves. This is a black sooty like covering over the leaves. This fungus is really only growing on the rubbish left behind by small insects and can be rubbed off the leaf. But it can block out the sunlight.

Some larvae of moths belonging to the armyworm family have been recorded eating leaves of Okari nut trees.

Diseases

Leaf spot	<i>Cercospora sp.</i>
Sooty mould	<i>Lembosia terminaliae</i> Hansf.

Insect pests

Larvae on leaves	<i>Aiteta iridias</i> Meyr.
Insect for mould	<i>Perissopneumon</i> mealybug
Borer termite	<i>Neotermes sp.</i>

Talis

Name: Talis

Scientific name: *Terminalia impediens*

(Other *Terminalia* are also called Talis)

The plant

A tree that grows up to 42 m tall. Often the tree has buttresses. The twigs are usually fairly large. The young parts of the tree are sometimes hairy. The young leaves are purple underneath. It has leaves that are clustered at the ends of thick twigs. Leaves can be 25 cm x 12 cm or larger and they taper towards the stalk. The leaves are often blunt at the tip. The leaves often have a purplish colour underneath. The flowers occur on spikes 10-30 cm long. The flowers are small. The flower spikes are longer than okari nut (*Terminalia kaernbachii*) and less hairy looking. The fruit are 7-9 cm long by 3.5-6 cm wide. They are red and have fibrous flesh. They usually do not have a wings or flanges. Inside there is a large woody stone. The stone inside the fruit splits into 2 unequal parts. The 2 kernels inside are edible.



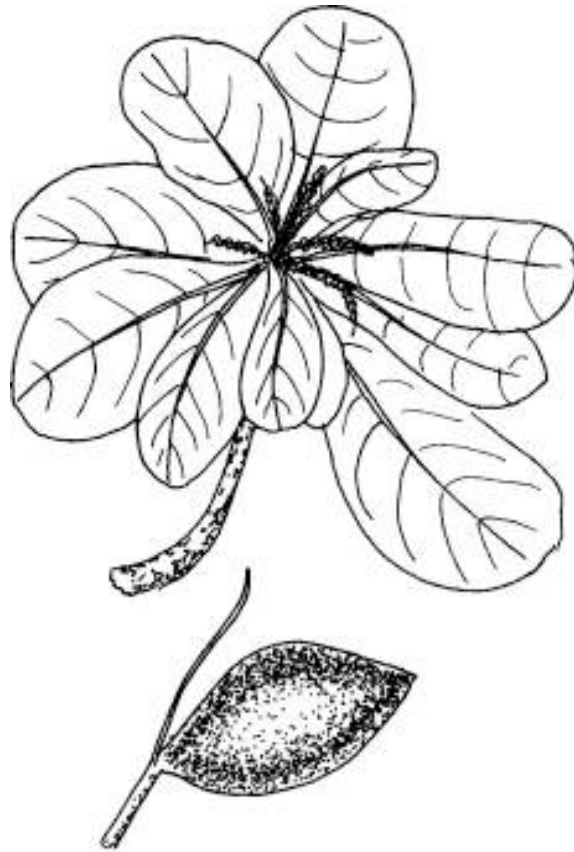
It occurs in the lowland forest in Papua New Guinea. Trees grow wild and are preserved in gardens. They grow from seed. The kernel inside the hard shell of the fruit is edible.

Coastal almond

Names: Indian almond, Coastal almond **Scientific name:** *Terminalia catappa*

The plant

A large tree that grows up to 25-40 m tall. It loses its leaves during the year. The trunk can be straight or twisted. There can be buttresses up to 3 m tall. The branches lie horizontally and come out in layers. The leaves are long, smooth and shiny with an abrupt point at the tip and a rounded base. Leaves tend to be near the ends of branches. Leaves can be 17-29 cm long and 10-15 cm wide. Young leaves have soft hairs. The leaves turn red and fall off twice a year. Flowers are greenish white and in a spike at the end of the branches. The lower flowers on a spike are female, then the others are male. The fruit is about 6 cm long by 3-4 cm wide, thick and flattened with a flange around the edge. The fruit are green and turn red when ripe. The pulp is edible.



Where does it grow?

It is a tropical plant. This tree occurs on the beachfront in most tropical countries in the world. They occur near the seashore from northern Luzon to southern Mindanao in the Philippines. They are sometimes cultivated as a shade tree. The tree is common in lowland areas particularly on sandy or rocky beaches. Seeds are spread by both bats and seawater as well as being planted by people. Trees are common along streets in coastal towns. They will grow from sea level up to about 800 m altitude. Plants are frost tender. They can tolerate drought. It suits hardiness zones 11-12.

How do you grow Coastal almond?

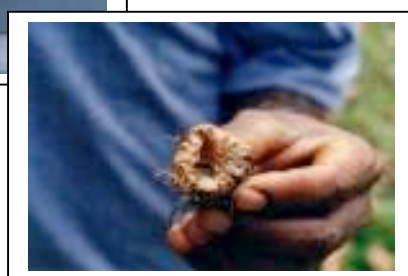
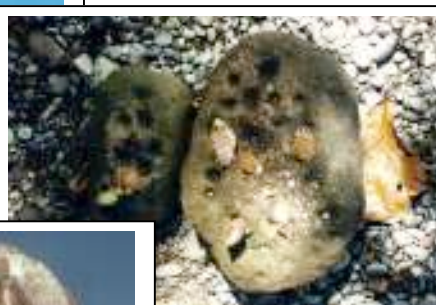
Plants can be grown from seed. Seeds can be stored dry for a year or more. Seeds germinate freely and most seeds grow. Insects can badly damage the leaves of young seedlings. It is fast growing. Nut production is seasonal.

Coastal almond as food

The kernels of the fruit are eaten raw.
An edible oil can also be extracted.

Moisture %	Energy KJ	Protein %	ProVit A μ g	Provit C mg	Iron mg	Zinc mg
4.2	2987	20.0	0	2	6.3	41.0

This means the nuts are good for energy and protein and are especially high in zinc that is needed by all growing children.



Pao or Barringtonia nuts



Barringtonia edulis



Barringtonia novae-hibernae



Barringtonia procera



Barringtonia niendzuema



Barringtonia racemosa

Pao nuts

Scientific name: *Barringtonia* spp.

What is the plant like?

A pao nut tree is a small tree in the coastal areas of Papua New Guinea. The tree grows up to 6 or 8 metres tall. The trunk is often only 10-15 cm across and near the top the tree has a few short thick branches.

The leaves are large and shiny. The leaves are crowded towards the end of branches. A leaf can be 50 or 60 cm long and 20-24 cm across. Near the tip of the leaf the edge is wavy and often slightly toothed, with the tip bent backwards. The veins of the leaf show up clearly on both sides of the leaf. The leaf stalk is only short about 1 cm long.

A long hanging yellow flower is produced from the branches. It can be 80 cm long and is densely covered with flowers. There can be up to 120 flowers along a stalk. The flowers do not have a scent. Along this stalk the fruits form, giving a long hanging stalk of quite large nuts.

The fruit is oval shaped and about 6-8 cm long by 3-4 cm across. The seed or nut inside the fruit has lines running along its surface. This edible part is about 3 cm long by 1-2 cm across and white coloured. The seed is flattened particularly on one side.



Pao nuts

Pao nut trees tend to flower and produce nuts throughout the year.

There are some different kinds. The size and shape of the nuts can vary slightly. Also some are white inside and some are red. The most obvious difference is the colour of the outside of the fruit. Some kinds are green or slightly blue whereas other kinds are a dark reddish black.

The nuts have a fairly hard shell and are split open with a knife. The white part in the centre is eaten raw. It also has a fairly hard texture.

Naming of Pao nut trees

Pao nut is one of the more common Tok Ples names for these nuts and is often used for them in Tok Pisin. They also have different Tok Ples names and they have been given scientific names by scientists.

Two species are grown and used as food in Papua New Guinea. The scientific names of the two plants are:

Barringtonia procera
and *Barringtonia novae-hibernae*.

In 1875, the first plant was named *Butonica procera* by a botanist named Miers. As more was learned about the plant it was renamed *Barringtonia procera* in 1939 by another scientist named Knuth. Sometimes other names like *Barringtonia magnifica* have been used for this plant. They have now been replaced. The other species was first named by a botanists called Lauterbach in 1911. The name *Barringtonia* was given after and English naturalist Daniel Barrington who was born in the year 1800.

Barringtonia procera is a less branched tree and tends to grow nearer the coast. The leaves are larger.

Barringtonia novae-hibernae has a more branched trunk and a smaller leaf. It grows more inland and has a sweeter nut.

In Fiji, a very similar, but different species is used for its edible nut. The scientific name of this species is *Barringtonia edulis*. It does not occur in Papua New Guinea but sometimes this name has been used incorrectly for the Papua New Guinea plant.



TOK PLES NAMES

Papua New Guinea

Province	Language	<i>B. procera</i>	<i>B. novae-hibernae</i>
Madang			Tegeli
Morobe	Laluan		Pao
Manus			Pulei/purei
New Ireland	Pala	Paua-hutun	Pao
New Britain	Kuanua	Pao-vutug	Pao
North Solomons	Siwai	Hari	

Solomon Islands

Province	Language	<i>B. procera</i>	<i>B. novae-hibernae</i>
Shortland Is		Borolong	Sioko
New Georgia		Tinga	Hala/fala/kenu
San Cristobal		Hara	Hara
Santa Cruz		Nua	Nuado

Vanuatu

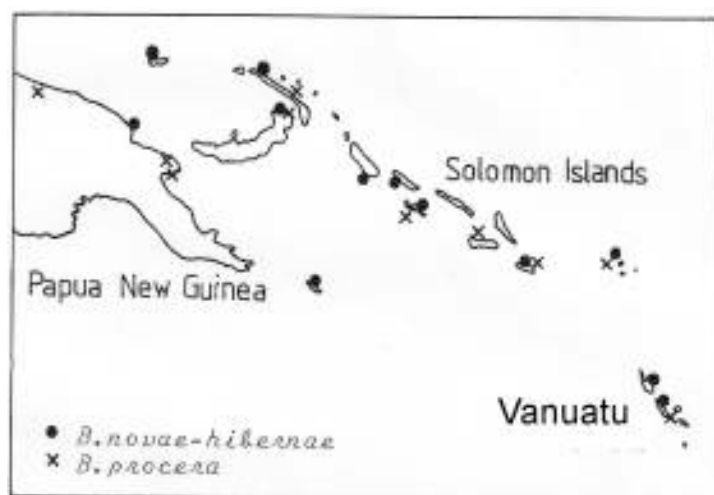
Province	Language	<i>B. procera</i>	<i>B. novae-hibernae</i>
		Va rodh	Vevingen

Because there are some very poisonous *Barringtonia* trees it is important to check with local people both the names and which ones are used as food. One tree is commonly used as a fish poison to stun fish.

Where do Pao nut trees grow?

Pao nuts mostly grow in tropical lowland coastal areas. In Papua New Guinea they are common along the North coast at places such as Madang and nearby islands, then they are very common in New Ireland and occur on New Britain near Rabaul. They also grow in the Solomon Islands and in Vanuatu. A similar, but different tree grows in Fiji.

The map below will show you some of the places where pao nuts are known to occur.



How do you grow pao nut trees?

Pao nut trees are mostly grown from seed. Several different races or types of pao nut have been selected by villagers and these trees seem to produce fruit that is similar to the seed that was planted.

Trees can be grown from stem cuttings. Trees grown from cuttings have shorter trunks and branch closer to the ground.

If trees are planted in suitable sites and well looked after they can produce fruit in a year or two.

As pao nuts often do well and are most common on low off shore islands and coral waterfront villages, it may be particularly suited to coral and alkaline soils. This needs to be further studied.



The major food plants of Papua New Guinea

<i>Aleurites moluccana</i> (L) Willdenow	Candle nut	314
<i>Allium cepa</i> var <i>aggregatum</i> G.Don	Spring onion	219
<i>Allium porrum</i> L	Leek	218
<i>Alocasia macrorrhiza</i> (L) Schott	Giant taro	61
<i>Amaranthus</i> spp.	Amaranth	110
<i>Amorphophallus paenifolius</i> (Roxb) Bl	Elephant foot yam	59
<i>Ananas comosus</i> (L) Mead	Pineapple	284
<i>Annona muricata</i> L.	Soursop	238
<i>Annona squamosa</i> L.	Sweetsop	240
<i>Arachis hypogea</i> L.	Peanuts	187
<i>Areca cathecu</i> L.	Betel nut	
<i>Artocarpus altilis</i> (Parkinson) Fosberg	Breadfruit	306
<i>Artocarpus heterophyllus</i> Lam.	Jackfruit	310
<i>Averrhoa carambola</i> L.	Five corner	242
<i>Baccaurea papuana</i> F.M.Bail.		
<i>Barringtonia novae-hibernae</i> Laut	Pao nuts	350
<i>Barringtonia procera</i> (Miers) Knuth	Pao nuts	350
<i>Basella alba</i> L.	Indian spinach	
<i>Brassica oleracea</i> var <i>capitata</i> L.	Cabbage	167
<i>Brassica sinensis</i>	Chinese cabbage	168
<i>Burckella obovata</i> (Forst.) Pierre	Bukubuk	224
<i>Cajanus cajan</i> (L) Millsp.	Pigeon pea	
<i>Canarium indicum</i> L.	Galip nuts	324
<i>Canavalia ensiformis</i> D.C.	Sword bean	151
<i>Canna edulis</i> Ker	Queensland arrowroot	98
<i>Capsicum annuum</i> L.	Capsicum	172
<i>Capsicum frutescens</i> L.	Chilli	174
<i>Carica papaya</i> L.	Pawpaw	279
<i>Castanopsis acuminatissima</i> (Bl.) A.DC.	Castanopsis chestnuts	316
<i>Citrullus lanatus</i> (Thunb.) Mansf.	Watermelon	298
<i>Citrus</i> spp	Oranges, lemons, limes	226
<i>Clymenia polyandra</i> (Tanaka) Swingle	Clymenia	226
<i>Cocos nucifera</i> L.	Coconut	318
<i>Colocasia esculenta</i> Schott	Taro	65
<i>Corynocarpus cribbianus</i> (FM Bail) L.S.Sm	Mundroi	269
<i>Cucumis sativus</i> L.	Cucumber	209
<i>Cucurbita</i> spp.	Pumpkins	210
<i>Cyathea contaminans</i> (Wall ex Hook) Copel	Tree ferns	122
<i>Cyphomandra betakea</i> (Cavanilles) Sendtner	Tree tomato	273
<i>Cyrtosperma merkusii</i> (Schott) Merrill	Swamp taro	63
<i>Dicliptera papuana</i> Warb	Dicliptera	134
<i>Dioscorea alata</i> L.	Greater yam	83
<i>Dioscorea bulbifera</i> L.	Potato yam	88
<i>Dioscorea esculenta</i> (Loureiro) Burkill	Lesser yam	84
<i>Dioscorea pentaphylla</i> L.	Five leaflet yam	89
<i>Diplazium esculentum</i> (Retz.) Sw.	Fern	123
<i>Dracontomelon dao</i> (Blanco) Merr. & Rolfe	Mon	265
<i>Durio zibethinus</i> Murray	Durian	
<i>Elaeocarpus</i> spp.	Elaeocarpus nuts	
<i>Ficus copiosa</i> Steud.	Kumu musong	128

<i>Ficus dammaropsis</i> Diels	Highlands "kapiak"	125
<i>Finschia chloroxantha</i> Diels	Finschia	328
<i>Flacourtia</i> spp.	Lovilovi	257
<i>Gnetum gnemon</i> L.	Tu lip	137
<i>Hibiscus manihot</i> L.	Aibika	104
<i>Inocarpus fagifer</i> (Parkinson) Fosberg	Aila	302
<i>Ipomoea aquatica</i> Forskal	Kangkong	128
<i>Ipomoea batatas</i> (Linnaeus) Lam.	Sweet potato	42
<i>Ipomoea macrantha</i>	Fongaar	99
<i>Lablab purpureus</i> (L.) Sweet	Lablab bean	156
<i>Lagenaria siceraria</i> (Molina) Standley	Bottle gourd	204
<i>Luffa acutangula</i> (L.) Roxburgh	Angled loofah	211
<i>Luffa cylindrica</i> (L.) M.Roemer	Smooth loofah	212
<i>Lycopersicon esculentum</i> Miller	Tomato	
<i>Maesa edulis</i> White		
<i>Mangifera indica</i> L.	Mango	257
<i>Manihot esculenta</i> Crantz	Cassava	20
<i>Metroxylon sagu</i> Rottb.	Sago	31
<i>Metroxylon solomonense</i> (Warburg) Becc.	Solomon's sago	40
<i>Momordica charantia</i> L.	Bitter cucumber	213
<i>Morinda citrifolia</i> L.	Indian mulberry	249
<i>Morus nigra</i> L.	Mulberry	265
<i>Musa</i> sp (<i>A</i> &/or <i>B</i> genome) cv.	Banana	7
<i>Myristica holrungii</i> Warb		
<i>Nasturtium officinale</i> R.Br.	Watercress	142
<i>Nasturtium schlechteri</i> O.E. Schultz		143
<i>Nastus elatus</i> Holttum	Highlands bamboo	150
<i>Nypa fruticans</i> Wurmb	Nipa palm	
<i>Oenanthe javanica</i> D.C.	Waterdropwort	147
<i>Omphalea gageana</i> Pax. & Hoffm.		
<i>Ormocarpum orientale</i> (Spreng) Merr	Kalava	131
<i>Oryza sativa</i> L.	Rice	
<i>Pandanus antaresensis</i> St John		341
<i>Pandanus brosimos</i> Merrill & Perry	Wild karuka	338
<i>Pandanus conoideus</i> Lamarck	Marita	258
<i>Pandanus jiulianettii</i> Martelli	Karuka	331
<i>Pandanus tectorius</i> (Solander) Parkinson	Coastal pandanus	
<i>Pangium edule</i> Reinw	Sis	
<i>Parartocarpus venenosa</i> (Z & M) Becc	Pakal	312
<i>Passiflora quadrangularis</i> L.	Granadilla	276
<i>Passiflora</i> spp.	Passionfruits	276
<i>Persea americana</i> Mill.	Avocado	221
<i>Phaseolus lunatus</i> L.	Lima bean	155
<i>Phaseolus vulgaris</i> L.	Common bean	153
<i>Piper betle</i> L.	Daka	
<i>Polyscias</i> spp.	Valanguar	135
<i>Pometia pinnata</i> J.R.& G Forster	Ton	296
<i>Psidium guava</i> L.	Guava	246
<i>Psidium littorale</i> Raddi	Cherry guava	246
<i>Psophocarpus tetragonolobus</i> (L.) D.C.	Winged bean	74
<i>Pueraria lobata</i> (Willd.) Ohwi	Kudzu	
<i>Rubus</i> spp.	Raspberries	

<i>Rungia klossii</i> S.Moore	Rungia	132
<i>Saccharum edule</i> Hasskarl	Long pitpit	187
<i>Saccharum officinarum</i> L.	Sugarcane	287
<i>Sechium edule</i> (Jacquin) Swartz	Choko	206
<i>Setaria palmifolia</i> (Koenig) Stapf	Highland pitpit	193
<i>Solanum nigrum</i> L.	Blackberried nightshade	118
<i>Solanum quitoense</i> Lam.	Naranjilla	271
<i>Solanum tuberosum</i> L.	Potato	26
<i>Spondias cytherea</i> Sonnerat	Golden apple	244
<i>Stenochlaena palustris</i> (Burm.f) Bedd	Climbing swamp fern	121
<i>Syzygium aquea</i> Burm.f.	Watery rose apple	254
<i>Syzygium malaccensis</i> L.	Malay apple	253
<i>Eugenia uniflora</i> L.	Surinam cherry	255
<i>Tacca leontopetaloides</i> (L.) O.Kuntze	Polynesian arrowroot	96
<i>Talinum triangulare</i> (Jacq.) Willd.	Waterleaf	147
<i>Terminalia catappa</i> L.	Java almond	348
<i>Terminalia</i> spp.	Okari, talis	343
<i>Trichosanthes cucumerina</i> L.	Snake gourd	
<i>Trichosanthes pulleana</i> Cogn ex Harms		
<i>Triphasia trifolia</i> (Burm.f.) P.Wils	Limeberry	226
<i>Vigna unguiculata</i> subsp <i>unguiculata</i>	Cowpea	154
<i>Vigna unguiculata</i> subsp <i>sesquipedali</i> (L. Verdc.)	Snake bean	153
<i>Xanthosoma sagittifolium</i> (L.) Schott	Chinese taro	54
<i>Zea mays</i> L.	Corn	174
<i>Zingiber officinale</i> Rosc.	Ginger	176

Alphabetical index of common name

	<i>Baccaurea papuana</i> F.M.Bail.	
	<i>Maesa edulis</i> White	
	<i>Myristica holrungii</i> Warb	
	<i>Nasturtium schlechteri</i> O.E. Schultz	143
	<i>Omphalea gageana</i> Pax. & Hoffm.	
	<i>Pandanus antaresensis</i> St John	341
	<i>Trichosanthes pulleana</i> Cogn ex Harms	
Aibika	<i>Hibiscus manihot</i> L.	104
Aila	<i>Inocarpus fagifer</i> (Parkinson) Fosberg	302
Amaranths	<i>Amaranthus</i> spp.	110
Angled loofah	<i>Luffa acutangula</i> (L.) Roxburgh	211
Avocado	<i>Persea americana</i> Mill.	221
Banana	<i>Musa</i> sp (A &/or B genome) cv.	7
Betel nut	<i>Areca cathecu</i> L.	
Bitter cucumber	<i>Momordica charantia</i> L.	213
Blackberried nightshade	<i>Solanum nigrum</i> L.	118
Bottle gourd	<i>Lagenaria siceraria</i> (Molina) Standley	204
Breadfruit	<i>Artocarpus altilis</i> (Parkinson) Fosberg	306
Bukubuk	<i>Burckella obovata</i> (Forst.) Pierre	224
Cabbage	<i>Brassica oleracea</i> var <i>capitata</i> L.	167
Candle nut	<i>Aleurites moluccana</i> (L) Willdenow	314
Capsicum	<i>Capsicum annuum</i> L.	172
Cassava	<i>Manihot esculenta</i> Crantz	20
Castanopsis chestnuts	<i>Castanopsis acuminatissima</i> (Bl.) A.DC.	316
Cherry guava	<i>Psidium littorale</i> Raddi	246
Chilli	<i>Capsicum frutescens</i> L.	174
Chinese cabbage	<i>Brassica sinensis</i>	168
Chinese taro	<i>Xanthosoma sagittifolium</i> (L.) Schott	54
Choko	<i>Sechium edule</i> (Jacquin) Swartz	206
Climbing swamp fern	<i>Stenochlaena palustris</i> (Burm.f) Bedd	121
Clymenia	<i>Clymenia polyandra</i> (Tanaka) Swingle	226
Coastal pandanus	<i>Pandanus tectorius</i> (Solander) Parkinson	
Coconut	<i>Cocos nucifera</i> L.	318
Common bean	<i>Phaseolus vulgaris</i> L.	153
Corn	<i>Zea mays</i> L.	174
Cowpea	<i>Vigna unguiculata</i> subsp <i>unguiculata</i>	154
Cucumber	<i>Cucumis sativus</i> L.	209
Daka	<i>Piper betle</i> L.	
Dicliptera	<i>Dicliptera papuana</i> Warb	134
Durian	<i>Durio zibethinus</i> Murray	
Elaeocarpus nuts	<i>Elaeocarpus</i> spp.	
Elephant foot yam	<i>Amorphophallus paenifolius</i> (Roxb) Bl	59
Fern	<i>Diplazium esculentum</i> (Retz.) Sw.	123
Finschia	<i>Finschia chloroxantha</i> Diels	328
Five corner	<i>Averrhoa carambola</i> L.	242
Five leaflet yam	<i>Dioscorea pentaphylla</i> L.	89
Fongaar	<i>Ipomoea macrantha</i>	99
Galip nuts	<i>Canarium indicum</i> L.	324
Giant taro	<i>Alocasia macrorrhiza</i> (L) Schott	61
Ginger	<i>Zingiber officinale</i> Rosc.	176
Golden apple	<i>Spondias cytherea</i> Sonnerat	244

Granadilla	<i>Passiflora quadrangularis</i> L.	276
Greater yam	<i>Dioscorea alata</i> L.	83
Guava	<i>Psidium guava</i> L.	246
Highland pitpit	<i>Setaria palmifolia</i> (Koenig) Stapf	193
Highlands "kapiak"	<i>Ficus dammaropsis</i> Diels	125
Highlands bamboo	<i>Nastus elatus</i> Holttum	150
Indian mulberry	<i>Morinda citrifolia</i> L.	249
Indian spinach	<i>Basella alba</i> L.	
Jackfruit	<i>Artocarpus heterophyllus</i> Lam.	310
Java almond	<i>Terminalia catappa</i> L.	348
Kalava	<i>Ormocarpum orientale</i> (Spreng) Merr	131
Kangkong	<i>Ipomoea aquatica</i> Forskal	128
Karuka	<i>Pandanus julianettii</i> Martelli	331
Kudzu	<i>Pueraria lobata</i> (Willd.) Ohwi	
Kumu musong	<i>Ficus copiosa</i> Steud.	128
Lablab bean	<i>Lablab purpureus</i> (L.) Sweet	156
Leek	<i>Allium porrum</i> L	218
Lesser yam	<i>Dioscorea esculenta</i> (Loureiro) Burkill	84
Lima bean	<i>Phaseolus lunatus</i> L.	155
Limeberry	<i>Triphasia trifolia</i> (Burm.f.) P.Wils	226
Long pitpit	<i>Saccharum edule</i> Hasskarl	187
Lovilovi	<i>Flacourtia</i> spp.	257
Malay apple	<i>Syzygium malaccensis</i> L.	253
Mango	<i>Mangifera indica</i> L.	257
Marita	<i>Pandanus conoideus</i> Lamarck	258
Mon	<i>Dracontomelon dao</i> (Blanco) Merr. & Rolfe	265
Mulberry	<i>Morus nigra</i> L.	265
Mundroi	<i>Corynocarpus cribbianus</i> (FM Bail) L.S.Sm	269
Naranjilla	<i>Solanum quitoense</i> Lam.	271
Nipa palm	<i>Nypa fruticans</i> Wurm	
Okari, talis	<i>Terminalia</i> spp.	343
Oranges, lemons, limes	<i>Citrus</i> spp	226
Pakal	<i>Parartocarpus venenosa</i> (Z & M) Becc	312
Pao nuts	<i>Barringtonia novae-hibernae</i> Laut	350
Pao nuts	<i>Barringtonia procera</i> (Miers) Knuth	350
Passionfruits	<i>Passiflora</i> spp.	276
Pawpaw	<i>Carica papaya</i> L.	279
Peanuts	<i>Arachis hypogea</i> L.	187
Pigeon pea	<i>Cajanus cajan</i> (L) Millsp.	
Pineapple	<i>Ananas comosus</i> (L) Mead	284
Polynesian arrowroot	<i>Tacca leontopetaloides</i> (L.) O.Kuntze	96
Potato	<i>Solanum tuberosum</i> L.	26
Potato yam	<i>Dioscorea bulbifera</i> L.	88
Pumpkins	<i>Cucurbita</i> spp.	210
Queensland arrowroot	<i>Canna edulis</i> Ker	98
Raspberries	<i>Rubus</i> spp.	
Rice	<i>Oryza sativa</i> L.	
Rungia	<i>Rungia klossii</i> S.Moore	132
Sago	<i>Metroxylon sagu</i> Rottb.	31
Sis	<i>Pangium edule</i> Reinw	
Smooth loofah	<i>Luffa cylindrica</i> (L.) M.Roemer	212
Snake bean	<i>Vigna unguiculata</i> subspesquipedali (L. Verdc.)	153

Snake gourd	<i>Trichosanthes cucumerina</i> L.	
Solomon's sago	<i>Metroxylon solomonense</i> (Warburg) Becc.	40
Soursop	<i>Annona muricata</i> L.	238
Spring onion	<i>Allium cepa</i> var <i>aggregatum</i> G.Don	219
Sugarcane	<i>Saccharum officinarum</i> L.	287
Surinam cherry	<i>Eugenia uniflora</i> L.	255
Swamp taro	<i>Cyrtosperma merkusii</i> (Schott) Merrill	63
Sweet potato	<i>Ipomoea batatas</i> (Linnaeus) Lam.	42
Sweetsop	<i>Annona squamosa</i> L.	240
Sword bean	<i>Canavalia ensiformis</i> D.C.	151
Taro	<i>Colocasia esculenta</i> Schott	65
Tomato	<i>Lycopersicon esculentum</i> Miller	
Ton	<i>Pometia pinnata</i> J.R.& G Forster	296
Tree ferns	<i>Cyathea contaminans</i> (Wall ex Hook) Copel	122
Tree tomato	<i>Cyphomandra betakea</i> (Cavanilles) Sendtner	273
Tu lip	<i>Gnetum gnemon</i> L.	137
Valangur	<i>Polyscias</i> spp.	135
Watercress	<i>Nasturtium officinale</i> R.Br.	142
Waterdropwort	<i>Oenanthe javanica</i> D.C.	147
Waterleaf	<i>Talinum triangulare</i> (Jacq.) Willd.	147
Watermelon	<i>Citrullus lanatus</i> (Thunb.) Mansf.	298
Watery rose apple	<i>Syzygium aquea</i> Burm.f.	254
Wild karuka	<i>Pandanus brosimos</i> Merrill & Perry	338
Winged bean	<i>Psophocarpus tetragonolobus</i> (L.) D.C.	74