

## Breadfruit

*Artocarpus altilis* (Parkinson) Fosberg

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## Introduction

The world is going through a lot of problems at present. Global warming is so concerning that recent studies predict that food production will need to grow by 69% by 2035 to feed the growing population. (Smedley, 2017). In a lot of countries in Africa, children are dying from hunger and in other countries like Venezuela food has become so expensive that people are fighting for it. In both of these regions, *Artocarpus altilis*, also known as Breadfruit has a great growth potential. Breadfruit is not only a fruit, it is a solution for the future. The purpose of this paper is to explain many aspects of this tropical fruit.

The Ecology chapter will go into depth on the origins of the fruit and its present distribution. It will also talk about the requirements of breadfruit from an environmental perspective, covering such topics as soil requirements, altitude and temperature regimes best suited to its growth. The third chapter will look into the fruit's biology explaining about its life cycle, phenology and sexuality. I will then explain its propagation and management in chapter four, looking specifically at the fruit's specific techniques like root cuttings and root shots and end with a summary of pest diseases and controls. Lastly, I will finish the monograph with Chapter five : the market and economy context. With all the nutritional value of the fruit and the energy that it can provide, this can be a really good meal for a lot of of the population that is beneath the poverty line. Breadfruit is also very easy to plant and keep because it does not need much care and with a single tree you can get up to 500 fruits during one season. (Ragone, 2011). It is also very easy to eat: it can be eaten raw or cooked for a brief period of time. Breadfruit for many is a very rare fruit and is known locally where it grows, but it has the potential to become a really staple for the world's population.

## Chapter 2: Ecology

### 2.1 Distributional Context

#### 2.1.1 Affinities

*Artocarpus altilis*, better known as Breadfruit, comes from the family *Moraceae* which consists of different species of trees and shrubs that are planted typically in tropical and warm regions. (Stevens, 2012). Breadfruit's genus *Artocarpus* comes from the greek words 'artos' (bread) and 'karpos' (fruit). This genus contains approximately 60 other Asian native species. Based on morphological data and DNA sequences of the Breadfruit family, the closest relatives of this fruit are *A. camansi* and *A. mariannensis*. (Zerega, 2003). One of the closest relatives from the *Artocarpus* family is the Jackfruit, *Artocarpus heterophyllus* which physically looks very similar to the Breadfruit but is a bit bigger in size.

The Taxonomic Tree of *Artocarpus altilis* (de Sousa et al., 2017):

- Domain: Eukaryota
- Kingdom: Plantae
- Phylum: Spermatophyta
- Subphylum: Angiospermae
- Class: Dicotyledonae
- Order: Urticales
- Family: Moraceae
- Genus: Artocarpus
- Species: Artocarpus altilis

#### 2.1.2 Origin

Breadfruit has always been a highly traditional fruit through the coasts of Oceania. (Powell, 1973; Leakey, 1977). Breadfruit comes from the genus *Artocarpus* (*Moraceae*). Implications for Human Migrations in Oceania'. (Zerega, Ragone, & Motley, 2004). Concerning the lack of recordings of the Breadfruit, this plant has several theories about his wild ancestors but the strongest hypothesis is that this fruit was derived by selection from some species like the *Camansi*. (Quisumbing, 1940). Another theory dictates that the wild breadfruit and the *A. Blancoi* hybridized in the Philippines to create the triploid seedless breadfruit common in Polynesia. (Fosberg, 1960). Over the years, *A. altilis* has spread to the

caribbean being used as a seed crop over the cost of South America too. (Zerega, Ragone, & Motley, 2004). This fruit originated in one of the following regions according to different authors: Polynesia (Purseglove, 1968), Pacific and Tropical Asia (Rajendran, 1992), the Malayan archipelago (Popenoe, 1920), or the region embracing New Guinea, the Philippines and the Moluccas (Smith et al., 1992).

### **2.1.3 Present distribution**

Due to the present importance that is surrounding Breadfruit because of the theory that it can cure world hunger, Breadfruit is being grown, produced and distributed all over the tropical regions where it is suitable to grow. Because of that, Breadfruit is now widely distributed throughout the humid tropics, including in Oceania, Asia, Africa, North, Central and South America and the West Indies. (Morton, 1987).

*Artocarpus altilis* is now present in almost 150 different countries including Mexico, Costa Rica, Maldives, and Colombia. Breadfruit was mainly spread by humans during the period of Spanish colonization when the Spanish brought seed of this fruit to the Mexican coasts. (Parrotta, 1994). After this, the British colonists planted Breadfruit trees in Jamaica with the goal to have a cheap source of food for their slaves. (Ragone, 2011). Over the years, Europeans kept on bringing different seeds to different places across their territory. The last place to propagate Breadfruit was the United States when the department of agriculture brought trees from Panama in 1906. (Morton, 1987).

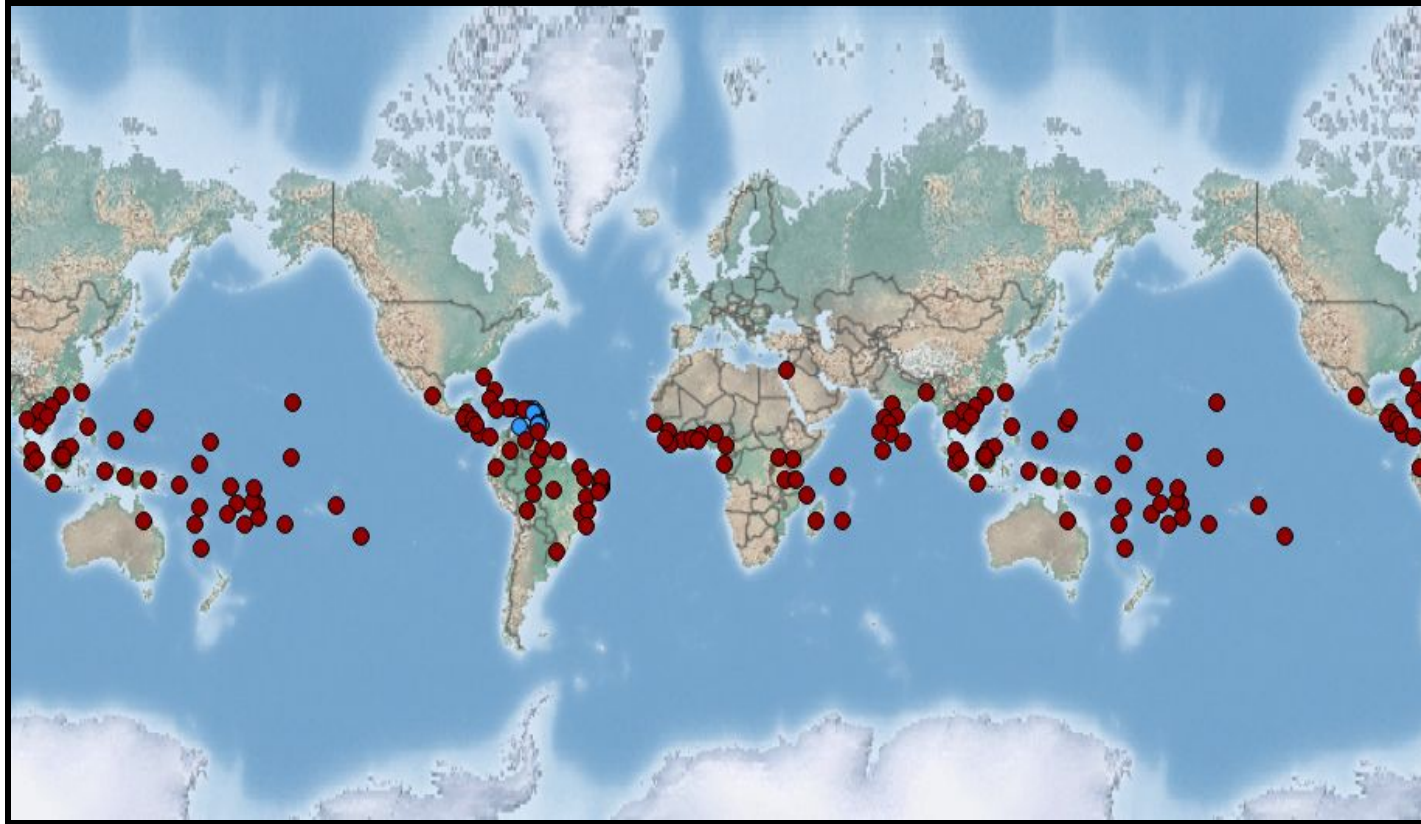


Figure 1. Distribution Map of Breadfruit  
(n.d.). Retrieved December 19, 2017, from <https://www.cabi.org/isc/datasheet/1822>

## 2.2 Environmental Factors in Distribution

### 2.2.1 Elevation and Climate

*Artocarpus altilis* is known for being a crop that is favorable for growth in warm, tropic lowlands. This species have the best productivity in elevations starting from sea level to 650 m, but it is sometimes found in highlands up to 1550 m (Orwa et al., 2009; Ragone, 2011). The preferred altitudes to grow this fruit are about 17-25 degrees north and south of the equator. (Ragone, 2006). The Breadfruit prefers humid areas with hot temperatures especially located in or close to the equator. They also need an annual between 1500 to 3000 mm. (Ragone, 2006).

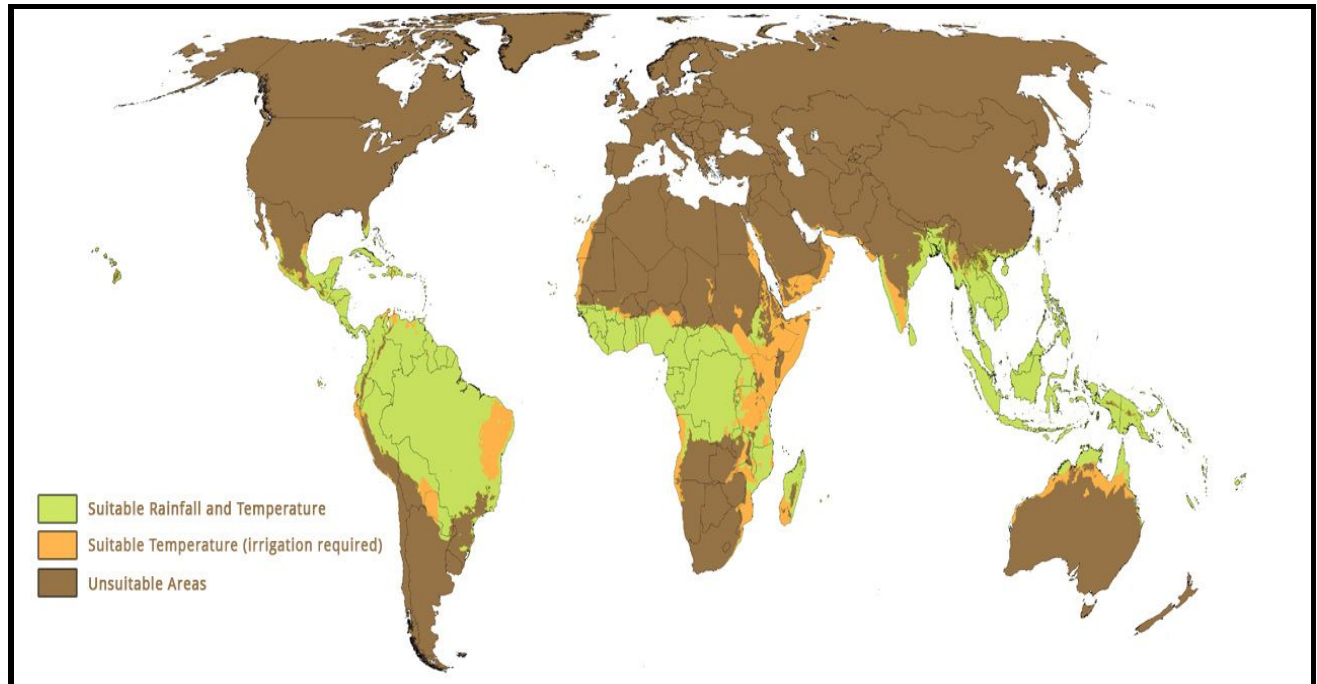


Figure 2: Suitable Climate for Breadfruit plants

Food security for a growing world. (n.d.). Retrieved December 19, 2017, from <http://globalbreadfruit.com/>

## 2.2 Geology & soils

Breadfruit's best soil to grow in, is a fertile (pH 6.1-7.4), it is also much better to have well drained soils to ensure the best response possible from this plant. *Artocarpus Altilis* tolerates saline soils and shaded conditions of 20-50% shade. This plants are able to grow in sandy surfaces. However they do not tolerate frost or waterlogged soils (Ragone, 2011). Even though the seed is cultivated at higher altitudes and cooler soils, the fruits quality is not the same because they prefer warmer land. The Breadfruit tree has a soil texture described as heavy, light and medium. The soil drainage is free and the soil reacts to acids, alkalines and neutral substances.



## 2.3 Interactions & Effects

The Breadfruit species are characterized for having long delicate roots and being highly perishable after harvest. Because of this, farmers need to be very careful when planting and processing this plant. (Oladunjoye et al., 2012). The vast majority of this plants contain milky latex and opposite leaves. (Wilmott-Dear and Brummitt, 2007) *Artocarpus Altilis* is used for many functions and purposes throughout the globe. In some places they use it as a food source since you can eat breadfruit in a variety of ways. The fruit may be cooked whole or put into thin slices and also fried. In other places it is seen more as a decorative tree. In places like Central America it is used to feed cattle. Lastly in the Eastern regions the tree is also used to create clothe and the wood is a great source to produce fire in the Pacific Islands. (Orwa et al., 2009). In every region of the planet this fruit has different names. The leaves, the latex and the inner banks of the fruit are used as medicine to cure headaches and stomachaches. (Ragone, 2011). In Brazil it has the name of fruta-pao. In the Asian regions like Thailand and Vietnam it has the the name of Saké and in Italy it is Albero de Pan.

## Chapter 3: Biology

### 3.1 Chromosome Complement

The studies made for Breadfruit's Chromosome complements are not common at all. However, in 2001 there was a study conducted by Dr. Diane Ragone in Indonesia, the Philippines, and 16 different Pacific Island groups. She studied the different chromosome numbers for three different species, (*Artocarpus altilis*, *A. mariannensis*, and *A. camansi* [Moraceae]).  $2n = 84$  (triploidy) were the numbers observed for *A. altilis*. Triploidy means they have three sets of chromosomes. Most diploid cultivars of *A. altilis* were seeded, but two cultivars with reduced seed number were observed. (Ragone, 2001).

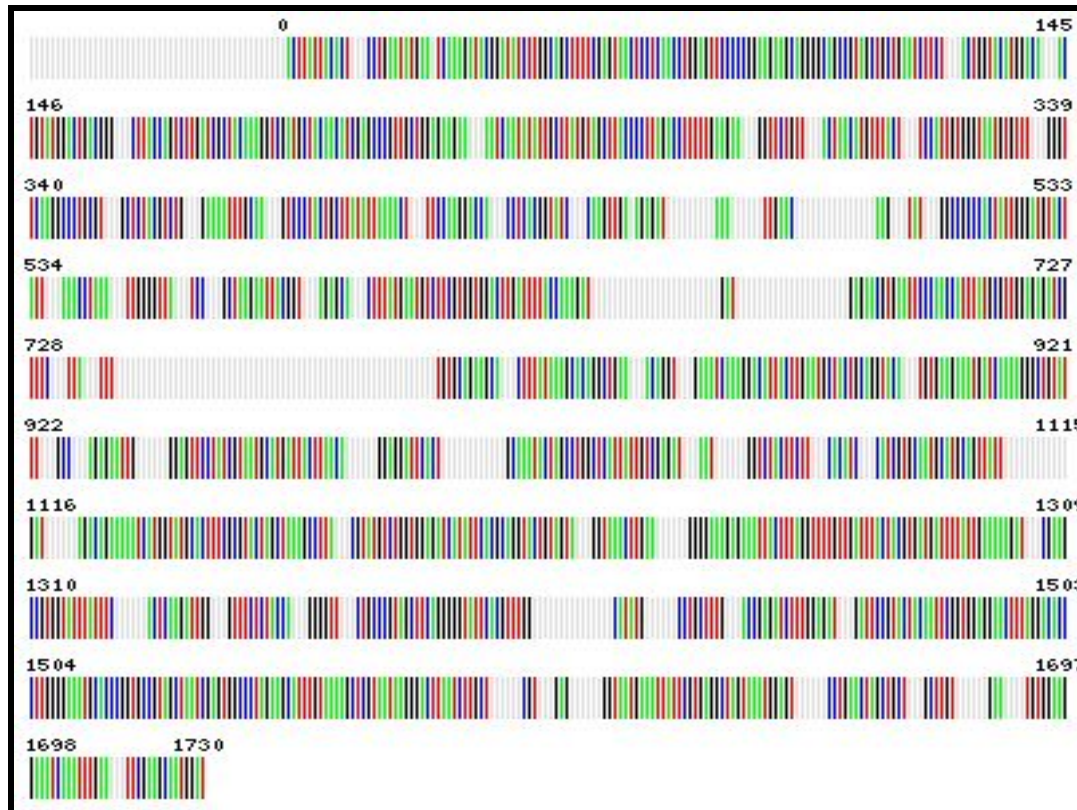


Figure 3: Barcode Sequence of the chromosomes of Breadfruit

<http://v2.boldsystems.org/connect/REST/getBarcodeRepForSpecies.php?taxid=210590&iwidth=400>

## 3.2 Life Cycle and Phenology

### 3.2.1 Life Cycle

Breadfruit is generally a fast growing plant when it grows in favorable conditions. It can generally grow about 0.5–1.5 m (1.7–4.8 ft) per year and to a diameter of close to 1 m (3.3 ft) in the first 10–12 years. (Ragone, 2001). If the tree is properly seeded it can reach heights of 25 meters (82 ft) and a single tree can produce up to 200 fruits per season and are able to produce it with very limited care. (Morton, 1987). Small branches often die back at the tip after fruiting, but new shoots and branches continue to develop throughout the life of the tree. (Ragone, 2011).



Figure 4: Breadfruit tree

<https://www.smallaxetreeservice.com/breadfruit-tree/>

### 3.2.2 Flowering and fruiting

*Artocarpus altilis* bears seasonally and most varieties produce one or two crops per year. The main and best crop typically occurs during the summer seasons of the respective country and it is followed by a smaller crop three or four months later. (Ragone, 2006). Seeded trees start producing fruit after 6-10 years while in vegetatively propagated trees we start seeing fruit in 3 to 6 years. (Ragone, 2006).

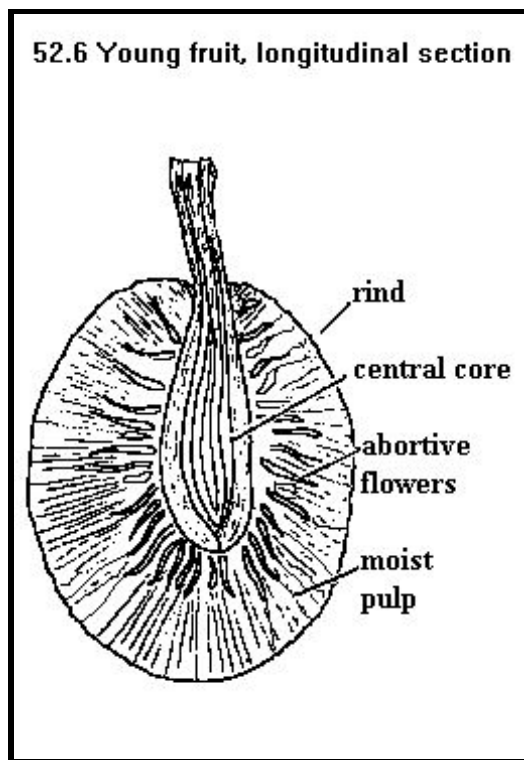


Figure 5: Inside the Breadfruit fruit

<http://www.amjbot.org/content/91/5/760.full>



Figure 6: Breadfruit plant

Retrieved from: <https://www.cabi.org/isc/datasheet/1822>

### 3.3: Reproductive Biology

#### 3.3.1 Pollen/Pollination

In the Breadfruit trees, pollination occurs mainly by fruit bats, but cultivated varieties produce fruit without the need of pollination. *A. altilis* is also one of the highest-yielding food plants, with a single tree producing up to 200 or more grapefruit-sized fruits per season, requiring limited pollination and care. (Richmond, 2017)

Table that show some varieties and their yielding :

Variety	Number of fruits	Average yield
'Mein iwe'	30-268	141
Mein Padahk	26-557	219
Mei uhwp	10-615	218

### 3.3.2 Sexuality

When we talk about the trees, Breadfruit is a monoecious species, with separate male and female flower clusters each consisting of thousands of tiny flowers. The male cluster is a cylindrical shaped soft catkin around 15 to 40 cm long and 2 to 3 cm in diameter, yellow at first then turning brown. The tiny flowers, each with a single stamen, are crowded on the outside. The female flowers clusters around 6 cm long and 4 cm in diameter; the flowers fuse together and develop into the edible, fleshy portion of the fruit. Breadfruit flowers are cross-pollinated, but pollination is not required for the fruit to pollinate. (Ragone, 2006)

Figure 7:

Two Bread Fruits: <https://www.alamy.com/stock-photo/breadfruits.html>





Figure 8 : Two pictures of different sizes of Breadfruit plants and their flowers

<http://cookislands.bishopmuseum.org/species.asp?id=5768>

### **3.4 Ecophysiology**

Concentrations of chlorophyll were lower in breadfruit in January than in August, which also means that the yields are greater at the start of the year and lower at mid year. It is also important to know that regarding soil, Breadfruit's best soil to grow in, is a fertile (pH 6.1-7.4), it is also much better to have well drained soils to ensure the best response possible from this plant. (Ragone 2011)



## Chapter 4: Propagation

### 4.1 Nursery Propagation

Young breadfruit plants grow best in partial shade, so full- sun hardening is often not necessary. However, if plants are to be planted in full sun, gradually move to full-sun conditions in the nursery to harden them to the site conditions, at about 2 months. Young plants should never be allowed to dry out or be exposed to strong wind. (Zerega, 2004)

Yo



Figure 9: Young Breadfruit plant

Retrieved From:

<http://3.bp.blogspot.com/-LCx9sChf7ks/TsQOru7wICI/AAAAAAAAAFYc/HXzOy3s3QWA/s1600/DSCF0225.JPG>

#### 4.1.2 Propagation from seed

When you are thinking of propagating breadfruit it is not recommended to use seeds. Breadfruit is easy to propagate from root shoots or root cuttings and by air-layering branches. Seeds are rarely grown because they do not develop true to type so it is not favorable for anyone who is trying to produce a certain type of that fruit. (Ragone, 2006).

#### 4.1.3 Vegetative Propagation

Vegetative propagation is a must for seedless varieties, and root shoots or root cuttings are the preferred methods for both seeded and seedless varieties.

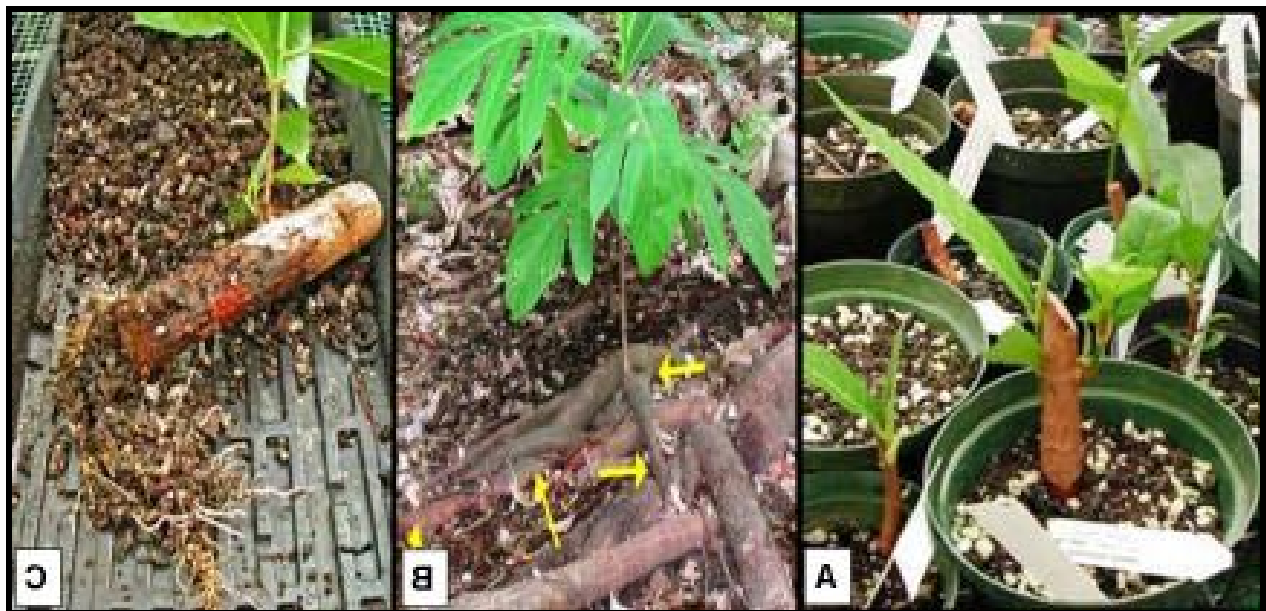


Figure 10

Vegetative propagation of breadfruit plant; (A) shoots produced by the root cuttings in potting media; (B) sucker produced by a root in natural habitat; (C) sucker produced from a horizontally placed root cutting in organic material; photograph adapted from D. Ragone (2006)

#### **4.1.4 Storage**

The storage of *A. altilis* depends on the use you have planned for the plant. If you are using its interior gel and its crust you can store it for several months in the refrigerator. If you want to consume it, it is recommended to eat it before 5 days of the cutting of the fruit from the tree.

#### **4.2 Propagation by root cuttings and root shoots**

It is best to collect root shoots and root cuttings after the fruiting season is over and when the tree is in an active vegetative stage, producing new leaves. This generally coincides with the end of the dry season, and root shoots/cuttings should be collected as the rainy season commences. This is the period when carbohydrate stores in the roots are at their highest levels. (Ragone, 2006)

#### **4.3 Root Cuttings**

Root shoots are not always available from a desired variety, and root cuttings can be used to mass-propagate breadfruit. Collect roots from healthy, vigorous trees. Carefully excavate roots that are growing just beneath the surface of the soil. Do not use surface roots because these tend to dry out and have a lower success rate. Look for roots with small rounded bumps on the surface; these adventitious buds will develop into new shoots. (Ragone, 2006)

##### **4.3.2 Root shoots**

The use of root shoots to propagate breadfruit is the traditional method in the Pacific region. To propagate you need to collect healthy shoots when they are at least 20–25 cm (8–10 in) tall and the stem has become woody and is producing lobed leaves. Shoots up to 1 m (3.3 ft) tall can be used. Remove by cutting the attached root 10–15 cm (4–6 in) on either side of the shoot and carefully lifting out the shoot and any attached root system. (Ragone, 2006)

#### 4.4 Pest and disease control

Diseases and pests are not really a problem but in every different region there is a certain factor. *Phellinus noxius*, a root rot, and fruit rots caused by *Phytophthora*, *Colletotrichum* (anthracnose), and *Rhizopus* can be a problem. Fruit flies infest ripe fruits on the tree and ground. (Ragone, 2011) Tree decline and dieback have been a problem throughout the Pacific and Caribbean islands, especially on atolls. A good solution for this problems is to apply proper husbandry practices, such as removing dead and dying branches and mulching, are essential to maintaining the health and vigor of the trees.



Figure 11: Healthy *A. altilis* fruit

<http://www.loverofcreatingflavours.co.uk/2014/02/breadfruit-pie/>



## **Chapter 5: Marketing and economy**

### **5.2 Major Distributors**

*Artocarpus Altilis* is not a common fruit to export or distribute but with all the changes coming up in the world and in our society, it has the potential to become a great solution for both hunger in warm countries and an exclusive gluten-free meal for the fitness market (Ragone, 2006). In places like Jamaica and the Philippines an initiative to commercialize Breadfruit has caught the attention of many investors and the main goal of this Breadfruit production, is to enter into the United States gluten free market. The Business Center of the University of Hawaii came up with some quantitative predictions about the U.S market demand. (Campbelh, 2013)

### **5.3 Products**

The *Artocarpus* species has a lot of different functions for humans. Some serve as a staple starch crop while other people cook it as a fruit. (Orwa et al., 2009; Ragone, 2011). Breadfruit is getting the attention of a lot of marketing executives since it is a great potential for value added products. Value added products are foods or objects that can be used as several things, transforming one product into many. Breadfruit can be transformed into products such as pies, pudding, punch, chips, fritters, and the male inflorescence can be made into a confectionery. The leaves of the tree are sometimes boiled to make a drink which is known for relieving symptoms of heart diseases and high blood pressure. Breadfruit is also used as animal feed especially during droughts. (Ragone, 2006).





Figure 12: Breadfruit different products: Top row from left to right: muffins, pasta, marmalade and humus. Bottom row from left to right: Fries, roasted breadfruit, flour and juice. <https://www.facebook.com/media/set/?set=a.10151051756138123.436064.110309848122&type=3>



Figure 13: Breadfruit Chips: <http://www.oahufresh.com/recipe/breadfruit-chips>

## 5.4 Nutritional Value

*Artocarpus altilis* is a nutritious, low-glycemic and gluten-free source of food it also can be modified to serve as medicine and renewable materials. Recently, this tree has also proven a viable means to fight diabetes and reduce hunger around the world. Incredibly, breadfruit thrives in regions most affected by food insecurity. A single tree can produce between 400–700lbs of fruit continuously throughout the year. Breadfruit is an excellent dietary staple and compares favorably with other starchy staple crops commonly eaten in the tropics, such as taro, plantain, cassava, sweet potato and white rice. Complex carbohydrates are the main source of energy with low levels of protein and fat and a moderate glycemic index. 100 g of fresh fruit provides 102 calories. Breadfruit is a good source of dietary fiber, iron, potassium, calcium, phosphorus, and magnesium with small amounts of thiamin, riboflavin, and niacin. Some varieties contain small amounts of folic acid. Many varieties can be a good source of provitamin A carotenoids and flavonoids. While breadfruit tends to contain low levels of protein, it is a complete protein, providing all of the essential amino acids, so necessary to human health. (Ragone 2011)

Nutritional value per 100g of raw breadfruit & yam		
	Breadfruit	Yam
Carbohydrates	27.12g	27.9g
Protein	1.07g	1.5g
Vitamin C	29mg (35%)	17.1mg (21%)
Fat	0.23g	0.17
Iron	0.54g	0.54g
data: USDA		

Figure 14: The nutritional value of raw breadfruit

(<https://folakemiodoaje.com/2014/08/02/breadfruits-too-posh-to-see-the-nutritional-benefits-male-flowers-repel-mosquitoes/>)



## **5.5 Other uses**

To expand the idea of food security to reduce global hunger, the truth is that Breadfruit grows the best in regions that are affected by this severe problem. Many countries in Africa and in the Caribbean can really benefit from this tree. The only thing they need is organization and seeds. If the affected people are able to plant the tree and make a proper preparation, this fruit could really be a great solution. The people are not only going to have something to eat, they are going to have something nutritious that gives them energy at the same time.

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