

# Conserving Traditional Varieties of Economic Plants: Breadfruit as a Case Study

Trees for Improving Sustainability, Resource Conservation, and Profitability on Farms and Ranches

Kona, Hawai‘i May 16-19, 2006  
Koror, Palau June 26-27, 2006  
Agana, Guam June 29-30, 2006

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**Loss of Crop Diversity**

- 50,000 crop varieties estimated to have disappeared.
- 75 percent of crop genetic diversity may already be lost.



Since 1900, about 75 per cent of the world's crop varieties have become extinct, and around 50,000 disappear each year according to the Food and Agriculture Organization (FAO). At present, the world's population gets 90 per cent of its calories from 20 crop species; four of these account for 50 per cent of total calories (rice, maize, wheat and potatoes).

<http://www.un.org/ecosocdev/geninfo/sustdev/es&5biod.htm>

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**Why conserve traditional economic plants?**



- Cultural significance
- Functionality
- Nutritional value
- Ecological value
- Economic value
- Aesthetics

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**How to conserve traditional economic plants**



***In situ* conservation**

- Cultivation and management of crop populations by farmers in the agro-ecosystems where the crop evolved.

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Coconut varieties can no longer be brought into the Hawaiian Islands because of restrictions on palm importation due to lethal yellows disease that has devastated coconut plantings throughout the tropics.

Leslie Wishard established a world-class coconut collection in the mid-1900s on his property on the Big Island. A fire in the late 1970s destroyed many trees and the property has been subdivided, but a few of Mr. Wishard's original plantings remain. A part of the collection was shared with Kahanu Garden but numerous trees have been killed by a *Phytophthora* bud rot.

The International Coconut Genetic Resources Network (COGENT) is a network of coconut-producing countries which is supported by the International Plant Genetic Resources Institute (IPGRI) in its capacity as the organizer and executing agency, and by other partner institutions and donors. COGENT supports and coordinates research of national, regional and global significance to promote sustainable collecting, exchange, conservation, enhancement, evaluation and utilization of coconut genetic resources for the socioeconomic and environmental benefits of coconut farmers and the coconut industry.

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TaroGen: taro genetic resources:conservation and utilisation (<http://www.spc.int/tarogen/>)

Regional Germplasm Centre (RGC) Fiji: ([http://www.spc.int/lrd/genetic\\_resource\\_team.htm](http://www.spc.int/lrd/genetic_resource_team.htm))

The RGC assists Pacific Island countries in conserving the region's genetic resources, and providing access to those genetic resources. The RGC has a unique collection of taro from the Pacific and also has some cultivars from Southeast Asia – the collection numbers 675 accessions in all.

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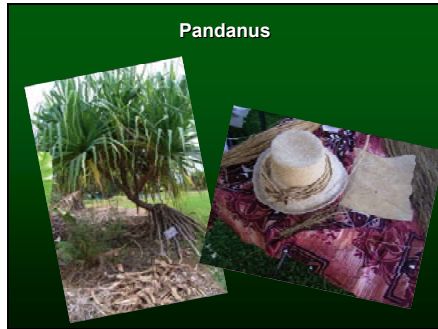
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Minimally processed products such as:

- Honey
- Herbal medicines
- Herbal drinks, teas
- Oils
- Dyes
- Seeds, propagated material
- Nursery products

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*Piper methysticum* is an extremely important cultural plant in Pohnpei, Samoa, and elsewhere in the Pacific. It is an significant cash crop in Pohnpei. In an integrated approach to watershed conservation, farmers in Pohnpei are encouraged to grow sakau in lowland areas and not to clear native forest to cultivate this plant,

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Breadfruit-based agroforestry systems are complex, species-rich production systems. Raynor and Fownes documented more than 100 species in 54 farms on Pohnpei. A few species were found in all sample areas, breadfruit, coconut, *Cananga odorata*, mango, bananas, *Hibiscus tiliaceus*, *Morinda citrifolia*, *Alocasia macrorrhiza*, *Dioscorea alata*, and *Piper methysticum*.

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Breadfruit Diversity	
Island(s)	Number of variety names
Chuuk	20-56
Fiji	13-55
Kosrae	13-21
Marquesas	25-34
Pohnpei	42-131
Puluwat	40
Samoa	20-45
Society Islands	24-56
Solomon Islands	20-147
Vanuatu	24-132

Amy B.H. Greenwell Ethnobotanical Garden - Captain Cook, Big Island  
([www.bishopmuseum.org/exhibits/greenwell/greenwell.html](http://www.bishopmuseum.org/exhibits/greenwell/greenwell.html))

Kahanu Garden - NTBG - Hana, Maui  
([www.ntbg.org](http://www.ntbg.org))

Harold L. Lyon Arboretum - Honolulu, Oahu

([wwwdev.hawaii.edu/lyonarboretum](http://wwwdev.hawaii.edu/lyonarboretum))

Maui Nui Botanical Gardens - Kahului, Maui  
([www.mnbg.org/](http://www.mnbg.org/))

Waimea Valley Audubon Center - Waimea, Oahu

([www.audubon.org/local/sanctuary/Brochures/Waimea.html](http://www.audubon.org/local/sanctuary/Brochures/Waimea.html))

All of the gardens work together and share cultivars with one another.

Taro at Lyon Arboretum are conserved *in vitro*, in their tissue culture facility.

Lyon is unable to grow Hawaiian bananas because of banana bunchy top disease.

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Field gene banks - Field gene banking is used for collections of plants with recalcitrant seeds and/or vegetatively propagated accessions. Most traditional economic crops must be conserved in field gene banks.

Seed banks - Seeds are stored under controlled conditions for short or long-term periods by drying (desiccation), chilling, or cryopreservation.

In vitro/tissue culture - Propagation of plants in a controlled, artificial environment, using plastic or glass culture vessels, aseptic techniques and growing medium.

Lyon Arboretum has a tissue culture conservation program for native Hawaiian plants, taro, and kava.

The Regional Germplasm Centre, Fiji, has an active, regional program to conserve traditional crop varieties in tissue culture: taro, yam, sweet potato and banana, as well as cassava, kava, breadfruit and traditional leafy vegetables.

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**The International Treaty on Plant Genetic Resources for Food and Agriculture**

**Food crops included in the multilateral system**

Breadfruit	Barley
Asparagus	Sweet Potato
Cat	Grain peas
Beet	Lentil
Brassica (includes oilseed and vegetable crops such as cabbage, rapeseed, mustard, chiro, rocket, radish, and turnip)	Apple
Pigeon pea	Cassava
Chickpea	Banana / Plantain
Citrus	Rice
Cottonseed	Pearl Millet
Major crops include taro, cocoyam, cassava and banana	Soybean
Carrot	Pea
Yam	Rye
Finger Millet	Potato
Strawberry	Eggplant
Sunflower	Sorghum
	Miscle
	Wheat
	Faba Bean / Vetch
	Cowpea
	Maize

The multilateral system also includes 29 legume, grain and other forage species.

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**Regional Conservation Strategy**

- November 2002 - Working with Secretariat of the Pacific Community (SPC) and PAPGREN developed a regional strategy for the conservation and use of breadfruit genetic resources in the Pacific.
- Participants from 14 Pacific nations.

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1. Distribute catalogue of NTBG collection especially information on the "core" collection.	NTBG
2. Develop a standardized methodology for field assessment of breadfruit diversity, provide training and implement national surveys.	NTBG, SPC, national programs
3. Intensify investigation of tissue culture as rapid propagation method.	NTBG, SPC
4. Distribute ex situ material from NTBG once safe, rapid propagation method is in place.	NTBG, national programs
a. Identify a sub-set of the collection of potential interest to atolls.	NTBG, SPC, national programs
b. Carry out pest risk assessment to facilitate safe movement of germplasm.	SPC

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Pacific Breadfruit Germplasm Collections		
Location	Accessions	Status
Hawaii - NTBG	200	Active
Hawaii - USDA	~40	Active
Fiji*	(70)	Never existed
Kosrae, FSM	~20	Abandoned
Pohnpei, FSM	~25	Abandoned
Samoa*	260	Abandoned
Solomon Islands	25	Abandoned (Active 1995)
Vanuatu**	65	Active

\* SPC collections established late 1950s-early 1960s.  
 \*\* Vanuatu collection established in 2005.

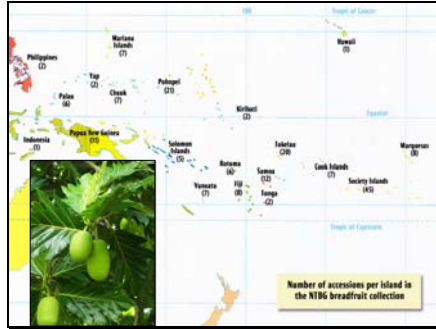
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NTBG Breadfruit Germplasm Collection	
<b>Polynesia</b> (Hawaii, Samoa, Cook Is.*, Marquesas, Society Is., Tokelau, Tonga)	<b>98</b>
<b>Micronesia</b> (Guam, Mariana Is., Palau, Yap, Pohnpei, Kiribati)	<b>46</b>
<b>Melanesia</b> (Papua New Guinea, Fiji*, Vanuatu*, Solomon Is.*, Rotuma*)	<b>41</b>
<b>Other</b> (Seychelles, Philippines, Indonesia, Unknown)	<b>15</b>
<b>Total</b>	<b>200</b>

\* Includes accessions from SPC collections.

SPC Collections: A regional breadfruit germplasm collection of more than 100 accessions was established in Samoa in the late 1950s and early 1960s. The collection was abandoned and fewer than 10 accessions remained in 2002.

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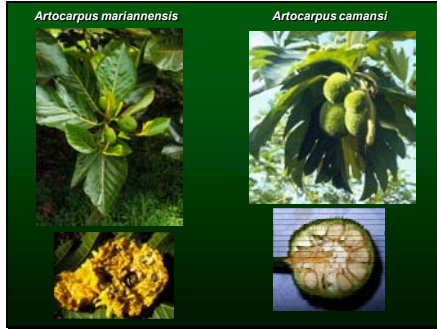


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Examples of breadfruit morphological diversity.

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*Artocarpus mariannensis*: This seeded species of breadfruit grows wild in Palau, Guam, and the Mariana Islands and is cultivated throughout Micronesia. The ripe yellow fruit is a nutritious source of provitamin-A carotenoids.

*Artocarpus camansi*: the seeded, ancestral form of breadfruit, known as breadnut, grows wild in New Guinea and has been introduced to other Pacific Islands in the past 50 years. It has been grown in the Caribbean, Africa, and other tropical areas for the past 200 years. The nutritious seed is high in protein, low in fat, and has the taste and texture of chestnuts.

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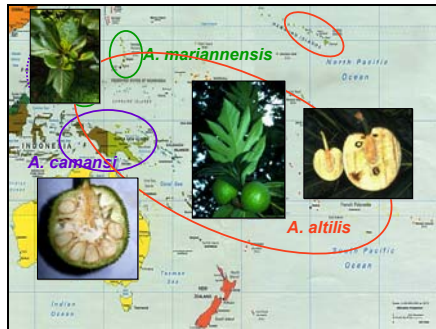
*Artocarpus altilis* is most widely distributed and cultivated species of breadfruit, with seeded as well as seedless forms. There are hundreds of varieties in the Pacific Islands and a few seedless varieties from Polynesia were introduced to the Caribbean 200 years ago. These subsequently spread to other tropical regions and breadfruit is now grown in close to 80 countries.

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Numerous natural hybrids between *Artocarpus altilis* and *A. mariannensis* are found in Micronesia. The fruit is typically seedless. Hybrid varieties are typically better adapted to saline soils of coral atolls than *A. altilis*.

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A core collection of 20 varieties that produce fruit year-round at Kahanu Garden in Hana, Maui, have been selected for intensive evaluation, including nutritional analysis and fruit quality.

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### Fruit Quality Evaluation



- Steamed fruit evaluated for 15 attributes (aroma, visual texture, flavor, sweetness, moistness, firmness, creaminess, color, etc.).
- Chips evaluated for nine sensory attributes (color, flavor, lightness, visual texture, aroma, tenderness/hardness, crispness).
- Six varieties recommended for additional evaluation and potential for commercialization.




A collaborative project between the Breadfruit Institute and the University of Hawaii Department of Tropical Plant and Soil Sciences evaluated fruit quality and nutritional composition of 20 breadfruit varieties. A trained taste panel evaluated and described fruit quality of fruit cooked by steaming and breadfruit chips. The commercial potential and availability of processed products made from breadfruit such as chips and other snack foods, flour, starch, baby food, as well as fresh and frozen fruit has yet to be determined.

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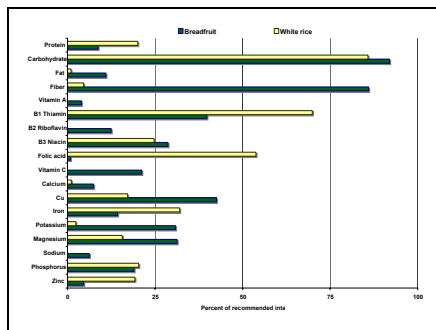
### Nutritional Composition

Nutritionally, breadfruit compares favorably to other staple starchy foods commonly eaten in the tropics (e.g., taro, plantains, cassava, sweet potato, and white rice). Breadfruit is an equivalent or better source of calcium, magnesium, potassium, and thiamin, and is a slightly better source of iron and niacin. Depending on the cultivar, breadfruit has two to three times the amount of fiber in plantains, cassava, or sweet potatoes, and more than 16 times the fiber content of white rice.

Nutritional analyses of 20 varieties of breadfruit showed significant differences for energy, carbohydrates, ash, crude protein, potassium, magnesium, sodium, iron, copper, and zinc.

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Provided by 500 calories (410 g 1 2/3 cups of breadfruit: 385 g 2 1/8 cups rice) 100g Rice=130 cal, breadfruit=average 121 cal; range =107-138.



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Breadfruit is a versatile food, and fruits can be used at all stage of development to prepare delicious and nutritious dishes.

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Breadfruit has long provided food security to Pacific island nations and has the potential to provide economic security as well.

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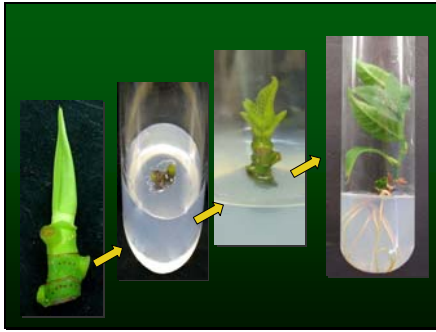


Breadfruit is well-suited to home gardens and mixed cropping systems. There are few commercial plantings of breadfruit in the Pacific or Caribbean, but there is a demand for fruit for local markets as well as export to New Zealand, the U.S. mainland, Canada, and the UK.

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Collaborative research projects are underway between the Breadfruit Institute and the Regional Germplasm Centre, the University of Guelph, and the University of British Columbia to develop protocols to propagate breadfruit to facilitate conservation and germplasm distribution.

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Breadfruit plants produced by vitro propagation being acclimatized to greenhouse conditions.

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Healthy, well-developed root system of breadfruit plant grown by in vitro propagation. Ready for planting in ground 3-6 months from tissue culture.

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3-year-old breadfruit tree

Breadfruit begins bearing in 3-5 years and is productive for many decades. Minimal care is required to grow and maintain healthy and productive trees.

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The Breadfruit Institute of the National Tropical Botanical Garden was established in 2002 to promote the conservation and use of breadfruit for food and reforestation.

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Detailed information about breadfruit uses, preparation, history, propagation and the breadfruit collection at Kahanu Garden is available at [www.breadfruit.org](http://www.breadfruit.org).

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The breadfruit collection at Kahanu Garden is being documented and described for a web-based collection catalog, including photographs of fruits, leaves, male flowers, and seeds.